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Extended Gate

Barriers and opportunities for intermodal improvements, a case study of Port of Gothenburg

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Abstract

Extended gate is an intermodal concept aiming to achieve improved transport efficiency in the hinterland through a more integrated model, compared to concepts that are currently in use, such as dry ports. Functionally it is an extension of the gated area of a port terminal into the hinterland in order to achieve operational efficiency for the supply chain actors and improve customer experience for cargo owners. The concept has been developed for several years and, with increasing digitalization, the implementation chould be nearing. The challenge is to define and implement an extended gate. The extended gate is aiming to increase transport efficiency and to mitigate negative environmental effects in the hinterland transport network such as congestion, noise and air emissions while also strategically directing trade corridors in ports' competition for hinterland.

The study is made in cooperation with the port authority of Gothenburg and aims to investigate innovative hinterland transport solutions and this will consequently be achieved by answering the three research questions raised regarding the extended gate concept.

- *What could an extended gate mean for terminals and port, in terms of transport efficiency?*
- *What could an extended gate be, in terms of level of integration?*
- *How could an extended gate potentially be implemented in the case of Port of Gothenburg?*

In order to achieve this, the authors investigated the relevant frameworks through a literature study. During the study, stakeholders were asked questions relevant to the effects of, and implementation of, an extended gate. Both in general, and in Port of Gothenburg (PoG) specifically. Barriers and opportunities were identified by the interviewees and is presented in the results. These results were applied to the extended gate concept and conclusions drawn with regards to the development and implementation of an extended gate from the PoG.

An extended gate can be achieved either by vertical integration or through more close cooperation. Acquisitions remove conflicts of interests, whilst collaborations can create shared incentives among the stakeholders. A collaborative extended gate network can through co-ownership with multiple stakeholders be kept local. As the extended gate network adds

value to the PoG, the added value can be assigned a price in a lease. Offering access to digital infrastructure can be as important as access to physical infrastructure. Transportation to and from the extended gates can be offered as a concession.

As average container vessel size continues to increase, more and more containers are shifted at a port call. By establishing a sustainable, high-capacity, transport corridor, economies of scale can be achieved in the port hinterland. The extended gate is adding value by reducing the complexity of intermodal transport, lowering working capital needs for importers, reducing the carbon footprint, reducing the overall lead times, and increasing transport efficiency.

An extended gate does not have to be completely what the literature describes it to be, it can be designed for any mode of transport and be located at any distance from the port. Neither does the extended gate have to be exclusively intermodal, nor necessarily orchestrated by the port terminal. Therefore, the authors suggest a distinction between a city-centred extended gate, located adjacent to the port city, and a hinterland extended gate. The authors find that the hinterland extended gate is a more integrated version of an intermodal terminal and can be made useful in achieving other strategic goals than the city-centred extended gate.

Key words: Extended Gate, inland terminal, port supply chain integration

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David Hällgren

Gothenburg May 2020

Erik Bengtsson

Gothenburg May 2020

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Abbreviations

- **3PL** - Third party logistics, company that provide freight forwarding services
- **APMT** - AP Møller Terminals, Danish terminal operator owned by Maersk shipping line operating the container terminal in the PoG.
- **GGG** - Green Gothenburg Gateway, APMT's hinterland network concept
- **GHAB** - Göteborg Hamn Aktiebolag - The port authority company of PoG
- **PoG** - The Port of Gothenburg - Sweden's largest transport hub
- **TEU** - Twenty-foot equivalent unit - measurement for container

Definitions

- **Connectivity**: The level of connection and thus usefulness in a network.
- **Concession**: A special right to property or land, usually for a fee.
- **Consignee**: Receiver of a consignment, not necessarily the cargo owner.
- **Direct port call**: A port call along a main shipping route without need for transhipment through feeder traffic.
- **Feeder (Vessel)**: Smaller ship, serving smaller routes out of hub ports
- **Hub-and-spoke**: Transport system where cargo is consolidated distributed through a hub for high capacity longer transport between hubs.
- **Intermodal**: Transportation through more than one form of carrier during a journey
- **Modal shift**: Replacing one means of transport for another.
- **Port Authority**: Official organisation controlling and managing activities in a port
- **Port supply chain**: Supply chain for distributing and collecting containers in the associated hinterland of a specific port.
- **Port terminal**: Intermodal terminal with access to sea transport
- **Railport**: Concept based on the dry port concept, produced by GHAB.
- **Shipper**: Person/company who sends cargo by any form of conveyance
- **Supply Chain**: A sequence of value adding functions to produce a product or service for an end consumer.

1. Background

Initially, an introduction to containerized trade and recent developments in hinterland logistics will familiarize the reader the subject at large. Thereafter, the port supply chain for the case will be introduced followed by a description of the problems relevant to the study field and finally the research questions and delimitations will be presented.

1.1 Introduction

Globalization and increased economic prosperity have increased world trade, and thereby, maritime trade. Since the advent of the container, the benefits of reduced port turnaround time, reduced handling costs and economies of scale has pushed container shipping costs down. The reduction in cost has meant that more commodities have become containerized, adding further to the growth in container trade. Containers are transported globally, in large shipping lanes, forming consolidated supply chains.

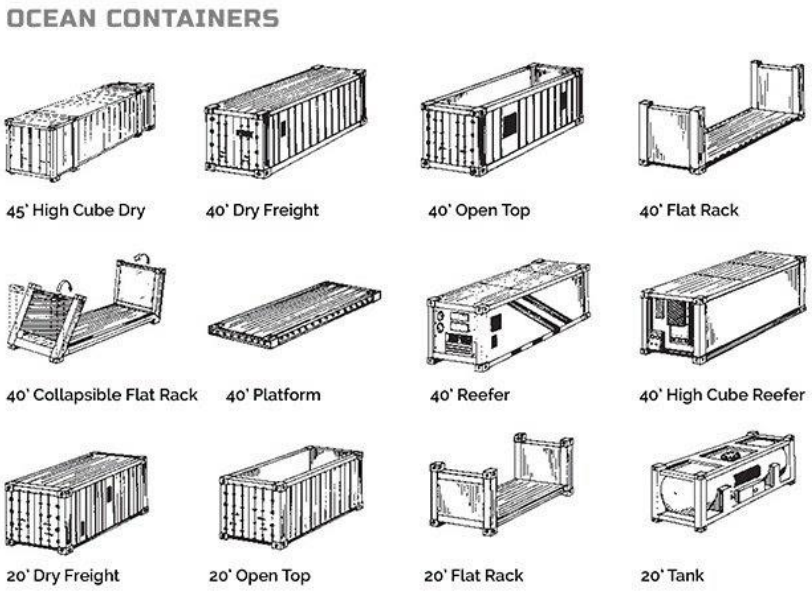

Figure 1: Illustration of different ISO container types (Croome, 2017)

However, recent developments have highlighted supply chain risks, be it trade wars, real wars, environmental disasters, or pandemics. The outlook for continued growth of containerized trade is thus less predictable. Trade is becoming more and more complex, with increasing interconnectivity and customer demands on reliability and speed in the supply chain.

Policymakers and shippers have an increasing interest for environmentally friendly transport and shippers therefore request multimodal transport, which is perceived as less environmentally damaging (Veenstra et al. 2012).

Millions of containers all over the world are currently in motion and extensive networks are built and constantly developed to make the container's journey more effecient. To describe the local port supply chain for containers, the container arrives to the port and enter a port terminal from global shipping lines. Through the port terminal, the container is transported by either one or multiple transport modes inland, usually to a terminal from where the contents of the container is then distributed to the receiver's warehouse. When emptied the container is sent to a depot at a terminal where it is washed and repaired in wait of an exporter in need of a container. When stuffed the container make the way back through the hinterland to the port and is loaded on a ship for international transport. This description of the physical flow of containers explain the import flow. For export containers the flow is simply reversed. More companies are engaged in these hinterland supply chains for containers than just the ones involved in the physical lifting and transportation. Freight forwarders, information service providers, infrastructure managers, customs and more are also necessary to make the supply chain work properly.

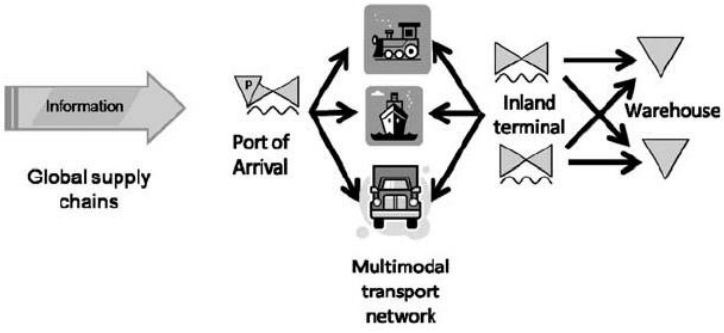

Figure 2: Multimodal hinterland network (Veenstra et al. 2012)

Multimodal hinterland networks consist of several forms of companies linked together to offer a supply chain for goods to be transported which has been described above. However, in the supply chain they constitute, there are several challenges. These challenges are amongst others, congestion, pollution, delays due to weak administration, unstable hinterland connections, fierce competition in low margin industry between logistic service providers and a constant search for how to find value adding services that are connected to the cargo handling process.

These problems are inherently difficult to solve cooperatively but the involved actors all wish to achieve a higher performance in the supply chain, while making a profit. (Veenstra et al. 2012)

Given the challenges that container supply chains are facing, several different methods of mitigation can be applied. The siloed structure of the supply chain is however a hinder to addressing some problems. Therefore, different concepts have been developed for port supply chain improvement, and the extended gate concept is one such concept. This thesis attempts to build understanding for the extended gate concept and how it potentially can handle challenges in the hinterland transport network. The authors of this thesis have been invited by the Port of Gothenburg to investigate how the concept works and how it can be expected to deliver in a local setting.

1.1.1 What is the Extended Gate?

As it was introduced by Veenstra et al (2012), the extended gate is a more integrated model of an inland intermodal terminal. The extended gate term comes from the concept being an extension of the fenced area of one terminal, specifically a port terminal. The fenced area of a terminal functions as the edges to its activities, both operationally and judicially. Extended gate aims to increase the efficiency in the inland terminal through connecting the terminal to seaports by vertical integration strategies where several functions of the supply chain are carried out by, or orchestrated by, the same actor. The intermodal setup currently in use are built on independent actors focusing on one specific function of the supply chain in which they have their core competences. The extended gate incorporates an inland terminal located non-directly adjacent to the main terminal and the integrated terminal is supposed to be operated as if the two terminals were the same.

The extended gate concept can be envisioned in different forms. The authors perceive the concept in two distinctive parts. Either the city-centred extended gate, or the hinterland extended gate. The city-centred extended gate is a terminal adjacent to the city of the associated port and is a place where all container transfers are made, except the ones over quay. As such, the port terminal receives containers from international container trade and shuttles all of them, unsorted, to the extended gate a few kilometres inland, utilizing a push strategy. The city-centred extended gate is performing the interactions previously made by the port terminal, such

as receiving and releasing containers. This city-centred extended gate attempts to reduce congestion in the port terminal and to reduce negative externalities associated with heavy truck traffic through the port city. However, the city-centred extended gate is adding additional container lifts when loading and unloading onto the rail shuttle, while not transporting the containers very far. These extra lifts add costs that are not proportional to the distance in many cases. A city-centred extended gate in Gothenburg was examined by Bäckström and Waidringer (2015) located at a distance of 20-30 km, and this case will be further discussed in the literature study.

The benefits from the push strategy with unsorted containers requires an exclusive extended gate, i.e. closing the gate at the port terminal, and performing all interactions in the extended gate. If cargo owners would have the choice to pick up or drop off in the extended gate as well as the port terminal gate, the terminal operator would have to sort the containers in the port terminal which would require more information and administration.

In the case of Port of Gothenburg neither the port terminal nor the city is experiencing heavy congestion. The port terminal is dimensioned for higher capacity, thus the main motive in form of increasing operational efficiencies in the port terminal are not a priority. Due to the lack of congestion, the remaining incentive is focusing on reducing truck traffic through the city. As the port terminal is operated by a private actor under a concession lease, the incentive for implementing a city centred extended gate to address the negative environmental externalities associated with traffic through the city is limited compared to if the municipality owned actor GHAB would operate the terminal. As such the authors see limited viability for a city centred extended gate in Gothenburg and will therefore in this thesis focus on a hinterland extended gate.

The hinterland extended gate is perceived as not being adjacent to the port city but located further into the hinterland. In comparison to the city centred extended gate, the hinterland extended gate takes a more business-oriented, strategic approach, trying to compete for new customers to the associated port. The hinterland extended gate is an evolution of the existing dry port network, centred on increased integration of intermodal terminals with the port terminal. To a customer there should be no difference whether her container is dropped off in the port terminal or in the hinterland extended gate. When using the hinterland extended gate,

the responsibility for the container and thus the associated risk is taken over by the company running the hinterland extended gate terminal. The benefits for shippers are that they only have one point-of-contact and do not have to worry about difficulties associated with booking rail transport and risks of delays and disruptions of their shipments. Benefits are not exclusive to cargo owners, from a societal perspective an increased modal shift from road to rail and thus a reduction of negative externalities such as pollution from road traffic are beneficial. Hereafter, a hinterland extended gate will only be referred to as an extended gate.

1.2 Problem discussion

In this chapter, challenges that are associated with intermodal inland transport, that theoretically can be mitigated by the extended gate concept will be discussed. Thereby, the authors are investigating how the extended gate concept fits in the setting of Port of Gothenburg's hinterland supply chain.

1.2.1 Transport trends

Technological development impacts society and changes, fundamentally, the basis for rational decisions. The introduction of the container increased the efficiency by which a vessel could be loaded and unloaded during a port call. Thus, vessels needed less time alongside berths, which in turn freed-up space that had previously been claimed by port operations. The economies of scale-advantages to shipping will continue to concentrate goods in a few hubs. Average vessel size is predicted to keep increasing (Baker, 2019), thus creating high peaks in terminal handling and challenging the capacity as deep-sea vessels will discharge more containers at each port call. As bottlenecks shift due to technological or organizational improvements, rational decision makers change their priorities accordingly. As vessel sizes continue to increase the bottleneck will shift to the hinterland leg and thus the efficient operation of a container port will have to involve high capacity for container distribution also in the hinterland, which will be crucial for the overall efficiency of the entire supply chain (Cullinane & Khanna, 2000).

In the last 20 years, the largest container vessel sizes have tripled in capacity, from about 8000 TEU to 24000 TEU. Although it would be desirable, there has not been a corresponding development in hinterland transport efficiency, as the inland actors are not as financially strong as the shipping lines and are somewhat disregarded in global supply chain. Container terminals in ports worldwide are faced with these challenges coming with growth in numbers of

containers traded and the challenges includes capacity expansion, environmental impacts and community restrictions (Bergqvist et al. 2013).

Another trend is that customers are demanding more sustainability with regards to supply chains and transport. The ambition to decouple greenhouse gas emissions growth from GDP growth is a threat to the outsourced production model and potentially has the ability to decrease intercontinental trade flows. At the same time, this ambition presents an opportunity for intermodal transport.

Although container volumes increase globally, trends of miniaturization, nearshoring, backshoring and an increased value of the products that are being produced as well as increased competition from other ports, suggests that demand for container transport could decrease locally. In order to mitigate effects of a potential local stagnation in container volume and increased competition, container ports might also need to consolidate. Consolidation can be achieved by increasing the catchment area of the hinterland, e.g. by implementing corridors for goods transportation, using economies of scale to their advantage. In a Swedish perspective, there are several indications for increased competition such as the completion of the fixed connection over Fehrman belt, which will increase the competition from German ports in southern Sweden. Looking ahead, continued growth of the PoG, seems to be depending on successfully competing for the Swedish import and export cargo with both German ports as well as the alternative ports in Sweden such as Helsingborg, Gävle and Norrköping.

The rail services to and from PoG served both the purpose of increasing the hinterland and reducing CO2 emissions, and the railway continues to enjoy a large share of container transport to PoG. However, the rail infrastructure currently connecting the Port of Gothenburg with the inland distribution of containers is not used in a sufficiently effective way, according to GHAB. Therefore, it is of interest to investigate how the hinterland intermodal network could be further developed to benefit the PoG logistics hub and how it could be structured and improved to attract more container volumes to the Port of Gothenburg.

1.2.2 Supply chain development issues

Local supply chains must increasingly adapt to larger regional and interregional supply chains to fit in a more globalised world. The local port supply chain in Gothenburg have to adapt to fit with large shipping lines' scheduling to remain relevant and to attract direct calls (Bergqvist et al. 2013). This adaptation applies to investments in increased capacity as well.

Continuous improvement is desirable in all business ventures, and port terminal operators are constantly attempting to increase the terminal efficiency. Technological improvements are done through updating the machinery and equipment in the terminals to handle more containers per hour and infrastructure is developed to increase capacity and improve operations. Aside from operational technological improvements, tactical and strategic organizational improvements can also be implemented, such as utilizing resources differently or cooperating more closely to create more value. However, organizational improvements are hard to achieve in complex supply chains as actors may have different incentives and are facing difficulties to affect issues outside their own functions, thus restricting increased overall supply chain performance.

Another problem with supply chain development initiatives is to share benefits and costs between involved actors failry. Benefits of integration and faster moving goods are not likely to be distributed according to the costs. Cargo owners, on one hand, will benefit from faster and safer supply chains but will make little own investments, whereas terminal operators can impact the supply chain performance significantly by investing heavily into updated machinery but benefit relatively little from this. Silo organized functions of the supply chain prevents integration through collaboration as actors only focus on their own KPIs and not overall supply chain performance. In other words, actors have different incentives and risk profiles and thus goals and missions can be difficult to align with the rest of the supply chain. For example, an intermodal terminal operator does not necessarily have a similar inclination or ability to invest in CAPEX as a large multinational corporation and as such there exist a problem with lack of mandate in the supply chain.

In the PoG the port authority does not operate the port terminal. Their mission is to focus on strategic supply chain improvements, but they lack the mandate to directly affect the operational business in the port. This is due to GHAB solely being directly linked to one actor in the supply chain, through a concession lease. As such GHAB cannot directly improve the terminal

efficiency to attract more volumes which is their primary way of growth. The concession holder APMT are (as all supply chain actors) interested in supply chain improvements but are focusing on the operational work of running the terminal and are hence restricted in their strategic horizon of the concession length of 25 years. Additionally, large investments to lower terminal handling costs are difficult to be absorbed by terminal operators due to low margins. Limitations in mandate from the port authority and the operational focus of APMT impact the supply chain by creating a situation where large, collective, and strategic developments are challenging.

1.2.3 Land development problems

Historically the PoG has grown geographically in relation to the growth of the traded volumes and during the last 400 years as the city has grown, the port activities of Gothenburg has repeatedly relocated outward from the city centre about once every 100 years. This continuous relocating and geographical wide spreading are according to the Port Authority no longer a viable option as there is no more space to relocate to and substantial investments has been made in the port area which are not to be abandoned. (GHAB, 2020b) With the restrictions of the current setting and the increasing vessel sizes, the bottleneck of peak container handling capacity constitutes a challenge for ports, which could create congestion and hence inefficiencies. Thus, the port has to become more effective by the current geographical restrictions to be able to handle long term growth of volumes and not through expanding that historically has been used as a solution for increased terminal efficiency.

In many ports in the world congestion and lack of space are critical problems, but the PoG is spared from the worst forms of this issue. However, less congestion eases terminal handling and reduces negative environmental externalities so there always exists an inclination for countering congestion in ports. Decreasing the impacts from negative externalities associated with port activities is always important. Both to the operators but also to other stakeholders such as the associated city or public bodies. Congestion, transport emissions and noise affect public health and opinion as well as the efficiency of the associated hinterland transport leg. Another goal of the Port authority is to strategically secure volumes through Port of Gothenburg in the future. As there exist a trend of increased competition that will only further increase in the future, the port authority is continuously examining ways to improve and develop the port and the associated hinterland network. It is very much desirable to keep the special position the PoG currently holds in the Swedish transport business.

1.3 Purpose of study

The purpose of the study is to examine the extended gate concept and the possibilities for an extended gate integration with inland terminals for the PoG. This will be done through collecting and analysing insights from identified stakeholders in the current and potentially expanded hinterland of the PoG. By investigating incentives for stakeholders, a greater understanding for the industry structure can be achieved and thus opportunities for the extended gate concept could be found that does not seem possible through a study solely based on reviewing academic literature on the topic.

The study is suggested by the port authority of the PoG to examine what the extended gate concept can offer in regard to optimizing opportunities in the transport network and developments in form of transport economy and positive environmental effects. Through the method chosen, the study will hopefully prove successful to be able to aid GHAB in their mission to strategically develop the port supply chain to remain an important actor in the container trade.

Furthermore, by taking a collective view based on interviewees and literatures different perceptions of the concept, a suggestion of what an extended gate can be will be made. The suggestion will be based on two origins: the requests by stakeholders and the extended gate concept. By applying the extended gate concept in conjunction with what is desired by stakeholders, a way forward can be formulated, and recommendations can be suggested.

To achieve the study's purpose, the authors has raised three research questions. The first and second questions are aiming to provide a more general understanding of the extended gate concept and what it will imply for a supply chain. The third question is focusing on whether the concept would be theoretically possible to implement in the context of the PoG.

1.3.1 Research questions

- *What could an extended gate mean for terminals and port, in terms of transport efficiency?*
- *What could an extended gate be, in terms of level of integration?*
- *How could an extended gate potentially be implemented in the case of Port of Gothenburg?*

1.3.2 Delimitations of study

Limitations has been made for the study to remain comprehensible for the authors, primarily the extended gate concept has been reviewed in regard solely to container traffic. The PoG attracts large volumes of non-containerized goods as well from the hinterland that potentially also could benefit from integrated inland terminals, but due to accessibility to suitable literature and statistics the container segment has been chosen. Containerized goods are also drastically more efficient to handle compared to other forms of cargo through inland terminals based on the multimodality of the container. Thus, the relevance for other forms of transport solutions is limited in the context. When trailers or other modes of transports are mentioned, this is to give the reader insights into the competitive environment of intermodal transport.

2. Methodology

2.1 Research design

In order to achieve the purpose of the study, a clear and suitable method must be built and consequently followed and described. This will be done in this chapter and this is important to maintain a scientific approach to the studied field and for being transparent with one's research. In addition, the following chapter will describe some theoretical concepts on methodology to provide understanding for how the study has been performed.

In theory, research is conducted along an axis between two paradigms: positivism and interpretivism (Saunders et al, 2012). Positivism makes use of quantitative methods and seeks to describe objective facts independent from connections of the researcher. Interpretivism is common in the social sciences and uses qualitative methods, not intended to describe facts but rather to provide context, describe perceptions and explore a concept further. Thus, there are differences in the usage and approach of these ends of the spectra and ways in between can be used with elements of both quantitative and qualitative methods in performing one's research. When selecting an appropriate methodology, consideration must be taken to the nature of data available and the purpose of the study (Saunders et al, 2012).

2.2 Data collection

Both primary and secondary data has been used in the study. Primary data has been collected during interviews of stakeholders and secondary data has been collected by means of a literature study. Snowball technique, which is when the researcher allows one identified suitable source recommend the next, was used to identify suitable researchers and stakeholders for interviews. The initial interview was held with the port authority of Gothenburg which suggested a research on the extended gate concept. Subsequently, the research questions were raised in discussion with the supervisor.

2.2.1 Literature collection

In research, it is important to build one's study on the already existing knowledge and thus create context for the research problem (Collis & Hussey, 2014). A well written literature review identifies gaps in research that allows the researcher to define what the study aims to achieve, and the literature review also provides a foundation to base the analysis of the collected results upon. The literature study identifies theoretical frameworks and provides the paper with relevant contextualization.

In this study several forms of secondary data have been collected for the literature review. Books, academic articles, documents from governing bodies, newsletters, previous studies, company websites and other internet sources has been used to acquire sufficient information for the study.

When browsing for relevant articles, the databases of the university of Gothenburg's library has primarily been used and the authors has exclusively chosen peer reviewed articles to ensure quality in the chosen sources. A systematic search for literature using keywords was conducted to identify suitable studies for review. The search words have been identified through recommendations of professors at the university and throughout the literature study new words has been found to continue the research with.
Search words that has been used are:

- Extended gate, Dry port, Inland terminal, Port of Gothenburg, Port supply chain, Supply chain integration, Vertical integration, Intermodal transport, Hinterland network

2.2.2 Interview process

For the study seven interviews were held. The interviews were semi-structured where inland intermodal logistics were discussed in general and the dry port setup and potential for extended gate were discussed in particular. The length of the interviews ranged between one to one and a half hour. Audio recordings was taken from the interviews to be used as backup to the notes taken and no full transcriptions were considered necessary.

The interviewees were selected from recommendations from GHAB, recommendations from the authors' supervisor which has extensive connections in the research field and the interviewees were asked if they considered other actors to be of interest for the study. They

were selected based on their role for the dry port supply chain to enable the authors to get a holistic view on the context, to later on be able to make legitimate conclusions. Although there are several competing actors for several of the functions, the authors consider one of each category to be sufficient to answer the research questions but did not limit the interviewees of each category to strictly one.

All of the interviews except one were held over online services due to the Coronavirus raging at the time. Due to the virus most of the companies restricted unnecessary physical encounters for their employees. Not all interviews would have been held in person anyhow, as some of the interviewees were not stationed in Gothenburg.

Interviewee	**Role in Supply Chain**	**Position**	**Company**	**Date**
Jonas Börjesson	Rail shuttle operator	Strategic Account Manager	Green Cargo	18-3-2020
David Pan	Forwarding agent	Business Coordinator	Berling	19-3-2020
Markus Ekwall	Rail shuttle operator and inland terminal operator	Head of department rail & sea container	GDL	25-3-2020
Joakim Eriksson	Freight Forwarder	Key account manager	DB Schenker	31-3-2020
Magnus Lundberg	Port terminal operator	Head of commercial Nordic	APM-Terminals	31-3-2020
Nicklas Fredriksson	Shipping Company	Logistics Manager	MSC	1-4-2020
Pär Svensson	Inland Terminal operator	Logistics Developer	Eskilstuna Logistik och Etablering	14-4-2020

Table 1: Presentation of interviewees and their supply chain role.

2.3 Method of analysis

2.3.1 Stakeholder analysis

The stakeholder analysis is a method for examining and analysing engagements from stakeholder connected to a specific issue. Stakeholder analysis is a valuable qualitative tool for improvement in the decision-making process and also in project implementations (Collis & Hussey, 2014). The successful interaction with stakeholders is also ensuring legitimacy for the task as this enables involved parties to become closer in regard to goals, challenges, and expectations. As different stakeholders have different positions and therefore different influences, the stakeholder analysis aids the project to examine and map these influences to know what and who is necessary for success (Collis & Hussey, 2014). Between different types of stakeholders there also exist differences such as, between public and private stakeholders, and between organisations and society.

As business case studies falls in the qualitative sector of research, the stakeholder analysis is used to identify the incentives and barriers for the different involved actors constituting the port supply chain studied. The unit of analysis in this thesis is the relationship between the identified stakeholders in the case study. Additionally, events relevant to the aforementioned relationships has been studied to further grasp the context of the study field.

2.3.2 General analytical procedure

As the collected data is qualitative the selected methodology for analysis has to be appropriate for use on qualitative data. The issue of analysing qualitative data, as described by Morse (1994), is that there is a lack of description on how to go about performing the actual analysis. This want of description of the analysis leaves room for arbitrary conclusions. I.e. the same data collected would not necessarily result in the same conclusions if the analysis is repeated by other researchers. The general analytical procedure is the common way to describe this methodology where the researcher follows a structured method to reduce as much of the arbitration as possible through the four steps of collection, reducing, displaying, and analysing. As previously mentioned, low reliability is an issue with qualitative data, and this lack of rigid methodology again highlights this issue.

For the purpose of this study, the general analytical procedure was chosen as the methodology of analysis. This method is suitable as it supports multiple data collection methods and is commonly used, accepted and hence, legitimate. The data collected will be reduced, displayed, and analysed to maintain reliability in the study.

2.4 Source critique

The field of intermodal inland logistics, which is the topic of this thesis, has been of great interest in the academic field in the Gothenburg region during the last two decades. Several of the top scholars researching the concept of inland terminals and it is several forms are stationed at the universities in Gothenburg and this has been a great opportunity and aid of the authors of this thesis. Access to these top researchers allowed the authors to discuss the topic to gain insights and understanding how to approach it and where to start to seek for sources and interviewees for the study. As most stakeholders have commercial interests, their views on the subject can be influenced by these considerations.

Infrastructure and logistics attract interest from governmental bodies. In the collected material for this study, several sources are Swedish governmental organizations. Government agencies are at risk of being sensitive to political considerations and this can influence their recommendations.

2.4.1 Reliability and validity

The nature of the research question posed in this paper is qualitative and the population of interest is limited in numbers. For this reason, a qualitative methodology is suitable. A quantitative approach would rely on a limited population to extract data from; therefore, results would be statistically weak. The theoretical impact of a qualitative approach is high validity but low reliability of results. Low reliability is a challenge for the qualitative methods and for this paper. Furthermore, this paper aims to explore relationships between stakeholders, for this reason an exploratory approach has been selected. This choice is primarily due to the purpose being to develop concepts, rather than testing a hypothesis.

Keeping the issue of low reliability in mind, the choice and structured application of the chosen methodology is crucial. Morse (1994) suggests that any method of analysis of qualitative data

encompasses four steps: comprehending, synthesizing, theorizing and recontextualizing. These steps are intuitive to understand. Comprehension of the subject and the theoretical framework, synthesizing the learnings and observations from the research, theorizing to develop structure and links to other concepts and finally, recontextualizing and moving from the applied and specific to the general once again.

In this study the empirical data is collected through interviews, which always affects the results through biases and views of the interviewees regarding the described phenomenon. All interviewees have a natural bias for the businesses they represent. Additionally, the snowballing technique for finding the next interviewees might lead to one actor's bias resulting in additional biased actors being interviewed. In the interview situation, the researchers can influence the subject. This risk is increased in an unstructured interview. The interviewees' legitimacy is however ensured through their senior positions in their respective companies and the companies are legitimate due to their impact in the local port supply chain.

2.4.2 Problems related to the research

As this thesis was written during the spring semester of 2020 the Coronavirus led to some issues. Primarily, the restriction of physical meetings with the interviewees and supervisor. This meant that meetings were held online which could possibly be affecting the empirical results compared with if the interviews were held in person and thus possibly being a more open discussion. Furthermore, with the pandemic influencing every aspect of business, it is possible that supply chain risks and risk mitigation have been overstated by the interviewees. In a normal business environment, the stakeholder could be more open to taking on business risk. Another problem has been conceptual confusion around the extended gate concept. Due to the lack of a common understanding for the specific concept, the interviews tended to discuss general logistics, instead of the specifics of the concept.

3. Literature study

In this literature study chapter, the Port of Gothenburg is initially presented and how the container industry is structured follows. Thereafter, different forms of inland terminals are discussed leading up to extended gate concept, which will be further examined, and a pre-study of extended gate made in Gothenburg will be presented. Subsequently, strategies for integration, implementation and establishments of inland terminals are discussed, and later on, decision making for transport regarding factors such as costs and market structures are covered. Finally, the chapter ends with a short summary of the extended gate concept to remind the reader of the key aspects of this thesis before moving on into the discussion chapter.

3.1 Container shipping and Port of Gothenburg

3.1.1 Consolidation of container shipping

In the years from the 1980's until the late 1990's container shipping saw significant growth, especially in the Asia-Europe and Asia-North America trade lanes. The growth attracted new competitors and saw margins decline, prompting carriers to either withdraw or act to improve their profits. As a response, carriers formed alliances. The formation of alliances and the sharing of capacity was an attempt to address the problems of imbalance between supply and demand and to reduce costs (Talley, 2009). When the formation of alliances alone was not enough to improve profitability, mergers and acquisitions increased (Talley, 2009). In 1997 P&O merged with Nedlloyd forming what was then the world largest container shipping line. In response, Maersk merged with Sealand in 1999, claiming the title of world's largest container shipping line (Talley, 2009).

Mergers have continued and today, the market is dominated by three alliances: 2M, OCEAN and THE alliance. Maersk and MSC form the "2M alliance". "OCEAN" consists of COSCO Group, CMA-CGM and Evergreen. "THE alliance" members are Hapag-Lloyd, ONE, Yang Ming and Hyundai Merchant Marine (Orelli, 2020). The consolidation has resulted in the 10 largest container shipping lines in 2020 representing more than 80 % of global TEU capacity (Alphaliner, 2020). Through larger shipping lines which are extremely dependent on scale economies, there has been a growth in vessel sizes that reduce the number of ports able to facilitate them. Furthermore, the consolidation of shipping lines reduces the number of hubs

and increases container volumes in the selected ports, thus increasing the average number of containers handled during port calls which in turn requires higher terminal capacity. The increased volumes in hub ports enhances opportunities for intermodal traffic.

3.1.2 Development of container volumes in the Port of Gothenburg

Since the privatization of the port in 2010 the terminals have been separated and operated under concession leases with different actors, with APMT operating the container terminal. The most recent annual report gives an account of the development of TEU volumes from 2014 until 2019. A reduction from 837 000 TEUs in 2014 to 772 000 TEUs in 2019 (GHAB, 2020b). The labour conflict between unionized dockworkers and APMT during 2017 helps to explain the downturn in volumes for that year. GHAB reported a market share of container handling in Sweden of 47 % in 2019, down from 57 % in 2014 (GHAB, 2020b).

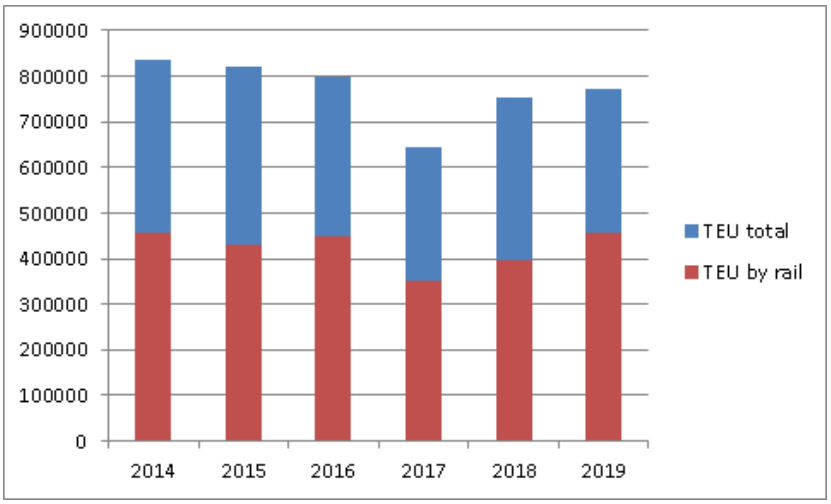

Figure 3: Proportion of container throughput in the PoG handled by rail (GHAB, 2020b, edited by authors)

3.1.3 The Port of Gothenburg and GHAB

The Port of Gothenburg is located on the northern shores of the Göta Älv inlet in Västra Götaland Region on the west coast of Sweden. The port area is outspread on a large area situated west of the city of Gothenburg. The Port is the largest port in the Nordic countries and is an important part of the transport network as a major hub for transhipment of goods to a large part of the surrounding areas. It is the largest port both in terms of weight and value and the port has the highest throughput of cars, energy products and containers of any port in Sweden (GHAB, 2020c). The Gothenburg Port Authority (in Swedish: Göteborgs Hamn AktieBolag) (GHAB) estimates around 30% of all Swedish international trade passes through the port which shows the significance of the transport hub. GHAB is a city owned company that is responsible for

maintaining, developing, and marketing the transport chain in the port. It maintains the land areas, quays and other infrastructure connected to the port and is developing land and facilities to keep pace with development. In addition, one mission of GHAB is to be communicating opportunities to attract import and export cargo shipped through the PoG. The business concept is to create conditions for maintaining a strong, efficient, and sustainable Scandinavian freight hub. The Port Authority is self-financed, and its revenues is generated through concession charges, port charges, freight charges and through leases of property. Revenues are reinvested in the port or contributed to the owner in case of excess capital (GHAB, 2020c). Through increased volumes handled at the port, GHAB gain revenue from growing freight charges, and thus it is in their best interest to increase the container throughput. Therefore, GHAB aims to develop quality infrastructure for the export industry and society to facilitate exports and imports (GHAB, 2020a). The port authority launched the "Port of Gothenburg logistics park" project in 2015, seemingly adopting a port-centric strategy. Focusing on developing land adjacent to the port area and bringing in commercial real estate developers in multiple rounds of development (Heitz et al. 2018). The logistics park project is planned to be ongoing until 2025.

3.2 Hinterland logistics

3.2.1 Importance of hinterland logistics

The size of the hinterland of a port is affected by how effectively it can be managed through modes of transport and efficiency in terminals and routes. Cullinane & Wilmsmeier (2011) tells that the overall hinterland of ports globally has grown through the containerization of goods and more effective operations and as such the growth of port's hinterland makes the hinterland overlap each other which creates situations for competition between ports attraction area. Supply chain improvements from one port lead to its hinterland expanding onto a larger geographical area and ports with weaker supply chains that traditionally has attracted cargo volumes in these new areas might lose business to the new competitor. As such, the hinterland connectivity to the associated port is a substantial part of that port's value proposition towards its customers (Cullinane & Wilmsmeier, 2011). Thus, the port must ensure quality in strategic transhipment nodes and affected infrastructure to be able to offer the best value for the customers, who faces options through overlapping effective hinterland of ports (Bergqvist et al. 2013). Hinterland management is therefore an important part for ports to engage themselves in and this leads the discussion into concepts for hinterland logistics.

3.2.2 Establishing inland intermodal terminals

For inland terminal establishments to be rational and well assessed, some components need to be examined in order to see if the inland terminal is to be economically feasible in a certain region. The inland terminal will according to Vandervoort and Morgan (1999) have to align with a complex transport network where the supporting infrastructure in form of railway and roads is in place, the maintenance for these is assured and where legislative regulatory and institutional systems are set up in accordance to optimally involve both public and private sector. Bergqvist et al. (2013) lifts three major categories that are important for the inland terminal to be implemented efficiently and these are flow of goods, infrastructure, and stakeholders. Physical flow of goods is a driving force of transport, infrastructure must be in place and of quality for the transports to be possible and effective and stakeholders must be consulted to understand coordination, freight volumes, and bundling of goods in the context. In extension to this, regulatory and operational frameworks, for stakeholders and behaviours and perceptions for the stakeholders are important to take into consideration when attempting to understand inland terminal development and usage. Historically, infrastructure projects for rail, road or ports were often developed in isolation in contrast as to being developed in integration with a designed transport network.

3.3 Inland terminal concepts

There are several similar concepts of inland terminals, where the extended gate is one of them. An inland terminal is in its simplest form a location situated inland where operational container transhipment is performed as part of a hub and spoke network (Notteboom et al. 2020). Containers arrived with one transport mode and is lifted of and loaded onto the next transport mode with varying timeframe in between discharge and loading. As more value adding services are added to the fundamental concept, the inland terminal evolves and expands its strategic offering to become something more than just an inland terminal. Inland terminals should be located in rural settings where the cost for land is low, regulation for land use are less restrictive, close to main transport links such as railways or highways, and close to importers and exporters (Toh et al. 2008).

3.3.1 The dry port

A dry port (or inland port) is an inland intermodal terminal which has a direct connection to a seaport, via a high capacity transport mode such as rail or barge (Roso, 2009). The dry port is an established concept, used in many parts of the world, to offer the comparable connectivity to international container trade for inland locations as to locations situated close to the seaport. The dry port as an effective high capacity solution where shuttles frequently perform a simple transport mission between two points, namely the dry port and the seaport. The term dry port was defined by the UN in 1982, as an inland terminal to where from and to shipping lines could issue bills of lading (UNCTAD, 1982). The definition of dry ports has since grown to include more than just containers and also includes all activities that would usually be performed at a seaport, now performed at an inland terminal. There exists many versions of definitions for dry ports but there exists a conformity that the hinterland logistics should be improved in cost efficiency, logistical quality through less queues and waiting times at port terminal gates and environmental performance such as less congestion, less CO_2 pollution, less noise, better safety and better health (Bergqvist et al, 2013; Roso, 2009). Moreover, the dry port implementation should allow the possibility for seaport terminals to increase their throughput unconnected to physical expansion at the location. Services offered in larger dry ports, beyond the transhipment that non dry port inland intermodal terminals provide, usually consist of storage, consolidation, empty container depot, forwarding, container maintenance, customs clearance, etc (Roso, 2009).

3.3.2 Dry ports in Sweden

The structure of the inland intermodal setup today could be considered as dry ports. There are several rail shuttles running daily to inland intermodal terminals scattered around Sweden and the railroad has a significant share of container transport to and from PoG. Around 70 freight trains are every day operated to and from the port and of these, 25 are container shuttles. This network of rail shuttles connects to around 20 inland terminal locations around Sweden and parts of Norway to the PoG (GHAB, 2020a).

The Swedish dry ports differ in size of terminal area, TEUs handled/year and in services offered. Smaller terminals handle around 2000 TEUs/year and larger ones 70 000 TEUs/year which shows big difference in the scale of the inland terminals (Bergqvist, 2013). Furthermore, the dry ports also differ in organizational structure as the dry ports are generally operated

independently and this is especially true for the larger ones, while the smaller terminals are more often operated by local logistic service providers whose main focus are on other services (Bergqvist, 2013). The ownership of the terminals is mostly either in its entirety owned by municipalities and is in some cases jointly owned between municipalities and the private logistic service providers who operate them. However, issues arise as several neighbouring municipalities want to establish terminals in a region where the flow of goods is only large and consistent enough for one terminal to be economically viable. Problems like these calls for authority and strong actors that can take the responsibility to make sure the efficiency in the transport network is sufficient and developed (Bergqvist, 2013). For such an actor to take the responsibility, incentives to do so are needed, or the lack of commitment will lead to low efficiency. It is not rational for all types of actors to establish a terminal but, hard to find incentives for one strong actor to take control in the matter.

3.3.3 Port of Gothenburg Railport concept

In the years leading up to the privatization the port authority developed a rail network concept based on the current dry port setup. The concept called the Port of Gothenburg Railport was developed to capture more goods and, as Sweden has a geography with long distances, rail is a viable option. The aim was to further connect and strategically structure the hinterland rail transports to make transport to the PoG cheaper and more effective to be able to secure hinterland and compete for volumes in more areas in Sweden, while improving customer experience (GHABc, 2020). However, since the port terminals were privatized and leased, the Railport concept has not delivered the growth in terms of TEUs of former years (Monios et al, 2018). The rail connection and the large share of container transport by rail has been prominent in public relations and sustainability efforts.

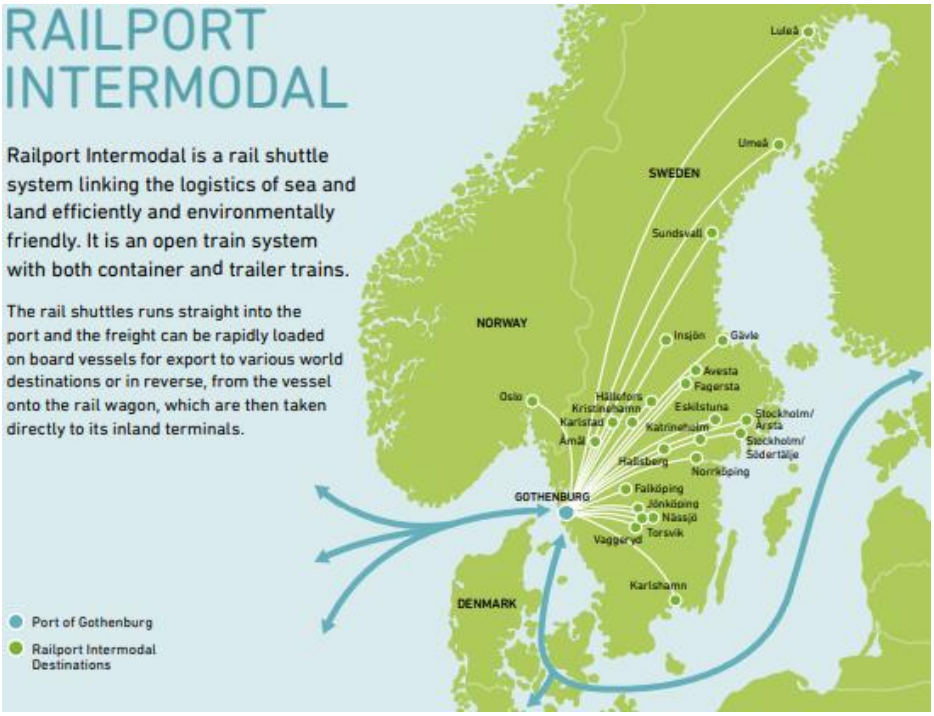

Figure 4: PoG Railport (GHAB, 2019)

3.3.4 Extended Gate Concept

The extended gate concept is a network solution provided by the seaport terminal. A key feature is that delivery and pickup point for containers can be moved to an inland intermodal terminal (Veenstra et al. 2012). The extended gate should, like a dry port, be directly connected to the seaport terminal with high capacity transport means, but according to the extended gate concept the port terminal operator should control the flow of containers to and from the extended gate. The origins of the concept are from 2004/2005 where the competing ports of north-western Europe in the LeHavre Hamburg range were highly congested with containers due to unexpectedly fast trade growth from China. The port terminal operator ECT, located in the port of Rotterdam, decided to start pushing containers to inland locations instead of waiting for them to be collected by cargo owners. By "extending" their gate to inland terminals, ECT could send containers to the inland location without first consulting the shipping company, the shipper/receiver, or the customs (Veenstra et al. 2012). In order to do this ECT had to arrange and pay for shuttling the containers a few kilometres inland, a service usually not performed by a port terminal. Taking on extra cost for shuttling containers was at this point rational for a port terminal operator, in means of relieving heavy congestion which drastically affected terminal operations.

Through this concept an inland intermodal terminal would figure as the same entity as the port terminal but at an inland location. The extended gate figures as a more integrated concept then a dry port, in terms of integration between the intermodal terminal and the port terminal (Veenstra et al. 2012).

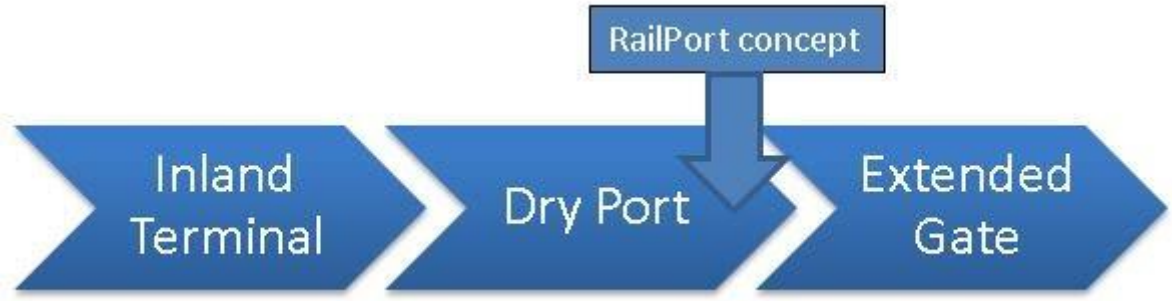

Figure 5: Illustration of the levels of integrated inland terminals (authors elaboration)

Van der Berg (2015), describes that the extended gate is characterised by more frequent and more reliable connections between the terminals compared to other forms of inland intermodal terminals. To achieve the frequency, the terminal requires high volumes shipped between the port terminal and the extended gate. For the reliability to be achieved, control over the transport services is needed, such as loading and unloading of rail shuttles. There is usually also a larger number of services offered compared to other forms of inland terminals, as the extended gate should according to van der Berg (2015), offer the same range of services as the port terminal in order to be effective. One key feature of extended gate concept is to change the fundamental logistical system from a pull system, where the receiver of the container decides when to pick up his container in the terminal, to a push system, where the terminal can send the container inland. By doing this, the operations in the port terminal can become more effective as less stacking of containers results in less complexity (Rodrigue & Notteboom, 2009). With fewer levels of stack height, the average number of lifts in the terminal decreases due to less repositioning, and in the extreme case with only one layer, all containers are accessible directly.

The port terminal will be simultaneously improved with hinterland transport and inland terminal optimising. This optimising will also be allowing more effective repositioning of empty containers as these could be stored inland to a larger extent instead of being sent back to the port terminal (van der Berg, 2015). The extended gate's function as inland storage area is very relevant for shippers as a form of distribution centre. The inland storage is not exclusive to the

extended gate but can potentially be improved through the more integrated characteristics. With these satellite terminals located in proximity to shippers, orders to receive or deliver containers can be met with short timespans, in a matter of hours. As such, warehousing operators are utilizing inland terminals for stock that are not needed at the moment which creates close operational relationships between shippers and inland terminals (Rodrigue & Notteboom, 2009). Hence, the inland terminal has a more valuable function than just as a transhipment point as in the case of pulling containers and performing transport on the last mile from the inland terminal to the destination.

The potential to handle large volumes of containers and the multimodal offer is key factors in selecting which inland intermodal terminals that are suitable to be extended gates (van der Berg, 2015). In addition, the ability to attract volumes is a paramount success factor and thus the strategic positioning of the terminals along important trade corridors is of uttermost importance, in order for them to function as effective hubs. An operational difference in the case van der Berg (2015) studied was fixed service windows for the integrated terminals at the port terminal, but not for the smaller inland terminals. Thus, the smaller terminals were induced to connect to the extended gate hubs instead of connecting to the port terminal directly. By doing this, the hinterland transport network can be more effectively managed and controlled by the port terminal.

Inland terminals like dry ports or in this case extended gates, allows the port not only the possibility to manage and control the flow of goods into the port but also to improve access for its customers and establish a physical and mental presence in the hinterland (Bergqvist & Woxenius, 2011). Key goals of the extended gate concept strategy are operational improvement and competitive environment management within and outside of the port area. Through a correctly implemented extended gate concept, several benefits will be experienced such as modal shift, better logistics performance and development in inland regions associated with the extended gate. The concept builds on the dry port idea of Veenstra et al. (2012), that all economic activities does not have to be located nearby seaports, but instead that developed infrastructure through efficient inland nodes can facilitate and generate trade growth, as well as generate direct development for the associated inland region.

Veenstra et al's (2012) study case was made of the port terminal operator ECT in the Port of Rotterdam which has a network of six extended gate terminals connected to it, located in Netherlands, Belgium, and Germany. In their study, the findings were that the service was reliable, fast (though trucking was marginally faster, it suffered more from disruptions due to motorway congestion) and cheap. A key success factor for the extended gate concept is to achieve high frequency of shuttles between the port terminal and the extended gate. In the case in Rotterdam the shuttles needed three to four daily departures. To achieve this in regions with comparatively lower volumes there was a joint subsidiary (Brabant Intermodal) by four independent terminals in the Dutch Brabant region to coordinate the shipments to and from the port terminal to the hinterland and thus achieving sufficient volumes.

The development of the concept of extension of port terminal gates in the article from Veenstra et al. (2012) is built of a framework of business network innovation which takes a form of vertical integration. In order to further broaden the service offering, the extended gate can also function as a hub in a greater transport network by multimodal transhipment to more remote locations.

One major issue with the extended gate concept is the legal responsibility for the transport leg between the port terminal and the extended gate. To achieve the desired efficiency benefits in the port terminal, the port terminal operator will have to take control the container flows between the terminals (Veenstra et al, 2012). Compared to the common dry port setup where several actors are involved in inter-terminal transport (but not including the port terminal), this is a major difference between the extended gate and the dry port concept. Usually, third party logistic firms take the responsibility for inland transport and delivery.

3.3.5 Pre study of extended gate in Gothenburg

In 2015 a pre-study was conducted by Bäckström and Waidringer (2015) on whether an extended gate based on high capacity truck shuttles could be a suitable solution to challenges connected to the heavy cargo traffic to and from PoG through the city of Gothenburg. The intended extended gate was to be located in the northern parts of Gothenburg around 20 km from the PoG. The pre study was made collectively by representatives from the Swedish environmental institute and Logistics Landscapers. Based on the calculations made, the project owner, Vinnova (which is the Swedish government body for innovation in technology,

transport, communication and job market) did not find reasons to reject the proposal with extended gates (Bäckström & Waidringer, 2015). In other words, the study found that the concept of extended gate in Gothenburg would be feasible based on the cost analysis. However, in the most cost-effective version of the proposed extended gate system, Bäckström and Waidringer calculated with extra heavy trucks that would have higher capacity than trucks allowed on Swedish roads at the time. These high capacity trucks would, if permitted, generate the best performance of the concept in terms of economy and environmental aspects. A prerequisite for the study was that no new technology or system development was necessary. Necessary assumptions for success of the extended gate project was that there would be no problems with queues at the extended gate and that the actual volumes were sufficient enough to allow filled shuttles in both directions.

Bäckström and Waidringer (2015) investigated if an extended gate could deliver benefits on several parameters. Firstly, if a lower level of traffic and less driven kilometres on the traffic routes of the city of Gothenburg could be achieved. Secondly, if the extended gate concept would lower emissions of CO2 and NOx associated with the road transports to and from the PoG. Thirdly, if the concept would generate lower costs and shorter "turnaround" times for trucks that are picking up and dropping of containers in the port. Fourthly, if the PoG's capacity for receiving and releasing containers would be improved and if the queues for trucks in the port gate would be relieved. Lastly, Bäckström and Waidringer (2015) also investigated whether there existed an opportunity to establish a permanent shuttle flow that would be possible to use as a "Living Lab" for transport and infrastructure development.

Bäckström and Waidringer (2015) found that the extended gate would likely lower the number of trips of heavy traffic through the city with 50-75% and the number of driven kilometres with 30-50%. The extended gate solution would be cost neutral with a volume of 90 000 TEUs per year and with a volume of 200 000 TEUs the cost per TEU would be 50 SEK lower than in the contemporary case with direct trips to the port. The CO2 emissions would decrease with 20-30%, the NOx emissions would decrease with 80% and the energy consumption in the system would not increase. Thus, the extended gate was to benefit the environmental goals and increase connectivity in the city of Gothenburg. The numbers shown above were calculated on a situation where the extended gate was to be located 20 km from the PoG, and Bäckström and Waidringer (2015) argues that if the extended gate were to be located an additional 10 km

further away the environmental benefits of the concept would increase significantly. In addition, the pre study concluded that through consolidation of cargo volumes and modal shift, the capacity in existing transport structures would increase and render lower transport times due to less disruptions and increased productivity.

3.4 Business strategy

In this section, business strategies that are the basis of the extended gate concept will be discussed. The extended gate concept is fundamentally built on the supply chain working closer together, and this closeness can be achieved in different ways. Firstly, integration will be discussed as a way for businesses to control more of the supply chain through expansionist mergers or acquisitions and thereafter strategic partnerships through horizontal collaboration will be discussed as a contrary form of supply chain consolidation.

3.4.1 Horizontal and vertical integration of terminals

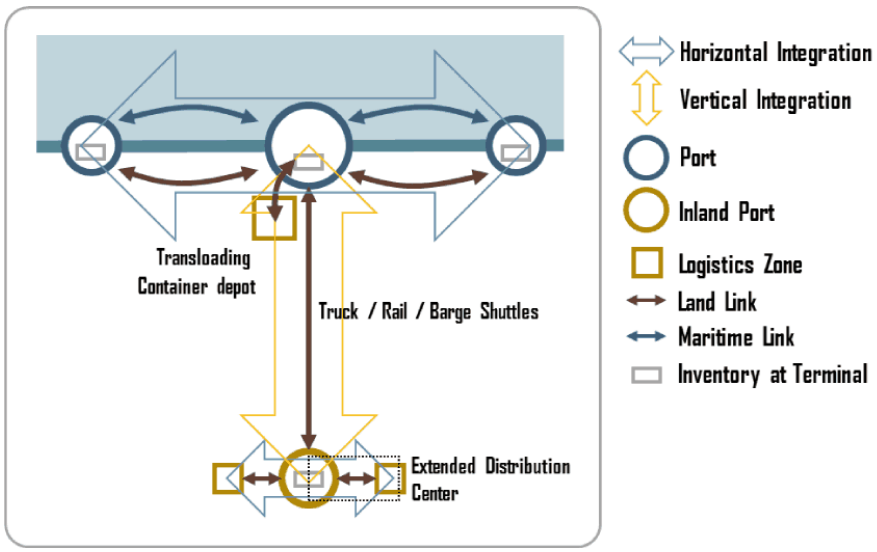

Figure 6: Illustration of integration of hinterland terminals (Rodrigue, 2020a)

Ports around the world are constantly trying to improve their hinterland accessibility to improve their value offer for customers and thus attract more volumes of containers (Rodrigue, 2020a). This process is called port regionalisation and the extended gate concept is one such strategy for improving the hinterland services and for the port to becoming more regionally important. The extended gate is structured with the services offered by a port terminal operator, extended to inland locations. This means that terminal operators are vertically and horizontally integrating their business and expanding their service offering.

By horizontally expanding business, the terminal operator expands by performing the same activities as before but at more locations (Rodrigue, 2020a). This could for instance be at another port which would allow the terminal operator to through maritime feeders, rail shuttles or barge connections transport its customers' containers between ports to access a larger transport network. This would be viewed as a service for the customer as it reduces complexity and allows the customer to drop of the container in a less well-connected port but that are more convenient for the customer. This setup can hence be used by the terminal operator to improve utilization of assets if the operator has assets in the two ports. The inland terminal also enables better inventory efficiency as containers can be stored at the terminal, allowing the cargo owner to pick up or deliver their container whenever it is suitable for his supply chain. Improved inventory could also be experienced for customers through extended distribution centres, which is another level of the horizontal integration. These are using the inland terminal as a warehouse through leaving the container there and considering the container to be part of the warehouse inventory. This saves space at the customers' location with the container close by and safe in the hands of the terminal operator (Rodrigue, 2020a).

The port terminal operator could integrate its terminal vertically by either operating an or connecting to an inland terminal that perform logistical services outside the gates of the terminal. Rodrigue (2020a) argues that the usage of inland dry ports is the highest level of vertical integration for the extended gate concept. The usage of the inland port allows the terminal operator to set up transport services to deliver and pick up containers at a location that is closer to the customers that are exporting or importing. The vertical and horizontal integration of terminals are not exclusive and both methods could be used by the terminal operator. In summary, horizontal integration is to perform the same activities in more locations where vertical integration is for the same actor to perform more steps in the supply chain (Rodrigue, 2020a). Both of these strategies have its strategical benefits and associated risks.

3.4.2 Horizontal collaboration

Cools et al. (2009) developed a framework for logistics service providers attempting to establish horizontal collaborations. Four steps are included: strategic positioning, design, implementation, and moderation. Strategic positioning encompasses the formulation of what to expect from the cooperation, what the objectives and benefits are, as well as the limitations and the level of collaboration. One limitation may be to exclude certain competitors and the collaboration can take place on a strategic level, tactical or an operational level. The design phase includes identifying a partner, negotiating the conditions, defining the strategy and vision and choose the shape of cooperation.

Cools et al. (2009) suggests that partners can be selected on the basis of complementary strengths, i.e. my strength is your weakness, or supplementary strengths, e.g. a higher capacity when combined. Strategic fit as well as cultural fit should be assessed. Furthermore, the optimal partnership should be between partners of somewhat equal footing. This in order to minimize risk of an unequal sharing of risk and reward (Cools et al., 2009). In the negotiation phase, the risk and reward sharing will be the most essential talking point. Costs, benefits, and activities need to be shared according to a win-win situation. Cools et al. (2009) proposes that the formulation of the partnerships strategy and vision should include: the time span of the cooperation, the objectives that are to be achieved and the reach of the partnership.

After these steps have been concluded, the partners need to implement the agreement, sign the contract, and adjust processes accordingly. Without a formalized contract, the partnership risks ending at the first point of disagreement. Once the collaboration is implemented in practice, the agreement needs to be moderated and managed. Circumstances may change and the collaboration should therefore have a process for alterations. KPIs should have been agreed upon. Selected KPIs will help decision makers determine whether the partnership is moving in the right direction or not (Cools et al., 2009). Contracting is important to the success of a horizontal collaboration. Petersen & Østergaard (2017) suggests a strategic approach to contracting. Strategic contracting recognizes the need for strategic fit between the two parties. Risk and reward sharing can be asymmetrical, based on the risk aversion of the involved parties. A less risk averse partner can guarantee a protection from financial losses of a partner in exchange for all profits above a certain threshold.

Best practices to minimize conflicts in horizontal collaborations according to Cools et al. (2009) are: regular face-to-face meetings, distributed minutes of all meetings and agreements to involved parties, distinguish between hard conflicts (financial, technical or operational aspects) and soft conflicts (intrapersonal or cultural), clear guidelines for financial control and accounting, intellectual property rules are established, share all relevant information on the evolution and performance of the partnership.

3.4.3 Horizontal collaboration in a Swedish context

A recent study on horizontal collaboration within logistics in Sweden included SSAB and ICA (Arvidsson, 2018). The purpose of the study was to identify best practices in overcoming barriers to horizontal collaboration. Arvidsson (2018) concludes that a neutral trustee is not necessary in order to develop and maintain a horizontal collaboration. However, trust between the parties have to exist. Furthermore, a leader has to exist in the partnership. Someone who takes responsibility and develops the collaboration. A second study on horizontal collaborations in a Swedish context, which was conducted by Holmberg et al. (2014), concluded that actors can reduce costs. Holmberg et al. (2014) concludes that cost reductions of 1-10 % are possible if one large actor cooperates with smaller actors, and up to 20% or more if smaller actors cooperate.

3.4.4 Cooperation between public and private parties

Public stakeholders and decision-makers view inland terminals as a facilitator to competitiveness of the businesses in the direct and regional area (Bergqvist, 2008). As such, it also improves attractiveness of the region for logistic businesses. Public stakeholders also have a greater interest in sustainable logistics, which is one distinguished dry port concept feature. Therefore, the establishment and development of inland terminals are usually carried out in cooperation between private and public stakeholders (Bergqvist, 2008). These partnerships lead to certain challenges in form of the characteristics in the two types of actors. Bergqvist (2013) mentions tendering, concession agreements, terminal operations independence, transparency, ownership, and responsibilities to be issues that will be faced in all inland terminal establishments. Another issue is to cooperate with without common goals and with different time horizons. Although there exist challenges with public-private partnerships, they also generate opportunities. The partnerships aim to utilise the benefits from characteristics from both of the types of actors in form of the private actors' closer relationship with the market and

public actors' long-term strategic perspectives and access to investments funds for infrastructure. To address these challenges in cooperation between private and public parties, Bergqvist et al (2013) has identified a key set of factors. These include local enthusiasm, formal agreements, operational frameworks, information exchange, port connectivity, aligning stakeholder objectives with funding sources and planning schedules.

3.4.5 Inland terminal centred strategy

Berg and Langen (2015) proposed the introduction of a third value proposition, in addition to door-to-door and port-to-port services, namely a service to and from inland terminals. Researchers have argued that dry port operations increase the performance of the connected seaport. Thus, a dry port can be implemented not exclusively as a remedy to congestion but as an increase of the service offering (Jeevan et al. 2018). However, Haezendonck and Langenus (2018) investigated Antwerp in a case study and could not find that the integration efforts of the port had resulted in increased competitiveness for the port. Thus, integration does not necessarily pay-off, at least in the short term. Roso (2009) also notes that the dry port establishment is not in itself a certain solution to the congestion issues of seaports or better inland accessibility but can be a part of such a solution.

3.4.6 Transport decision making

The aim of transport for supply chains is to bridge gap between manufacturing and the markets (Veenstra et al, 2012). To perform this task the transport decision maker will have to consider several aspects such as inventory strategy, warehouse locations, consignment size and frequency of the transports, transport mode and port choice. These transport decisions are according to Veenstra et al. (2012) based on a three-level hierarchy where transport is the lowest tier, and these decisions being derived from overhead global supply chains and from firms' logistics management, which are the two upper tiers. Therefore, transport decisions are not always optimized locally as they are being derived from higher hierarchy decisions. The lower tiers of the hierarchy can however influence the decisions made at higher levels such as more effective transport through intermodality can lead to alternative manufacturing supply chain design.

Modal choices are also a function of logistics considerations. Ben-Akiva et al. (2012) exemplifies some of these considerations in their paper on modelling of transport flows: locations of distribution centres, frequency of shipments, loading unit of choice and decisions by the forwarder or carrier. A large shipment of high density, heavy cargo travels differently from a small shipment of low density, light weight cargo. Within maritime shipping the parcel size distribution influences the vessel sizes as carriers aim to accommodate the preferences of the shippers. Within logistics parcel sizes are commonly categorized in full truckload (FTL), less than truckload (LTL), less than container load (LCL), full container load (FCL), wagon load or system trains. Each category captures segments of the market that are most suitable to the transport service they offer. The great contribution of containerization was to increased scale and thereby move from handling a separate item to handling a container. This is the principle of economies of scale in logistics.

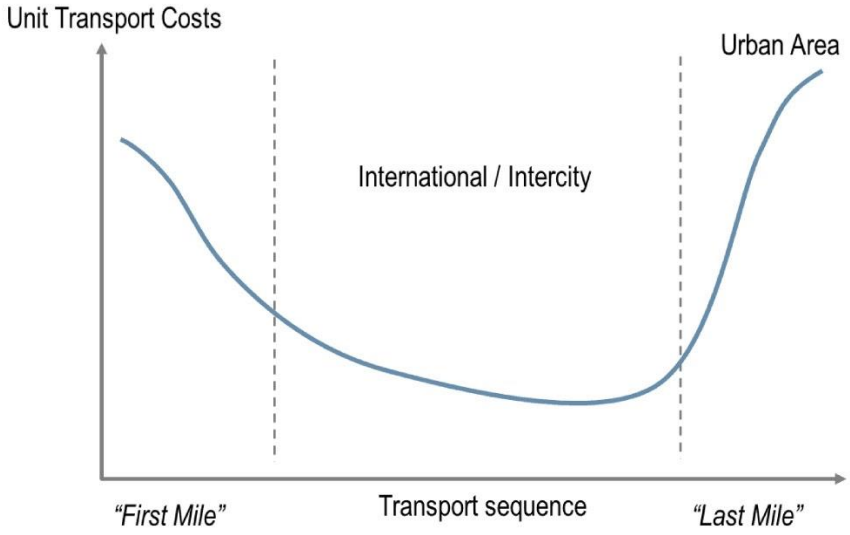

Figure 7: Transport unit cost illustration (Rodrigue, 2020b)

Ben-Akiva et al. (2012) reasons that as cargo is moved from the smaller local carrier to the larger high capacity carrier, the cost of transport per unit transported falls. This reduction in price can be achieved if cargo can be concentrated in a transport corridor, bundled together. As the cargo approaches its destination, the opportunities for bundling with other cargo owners diminishes and the carriers become smaller and local again, with prices increasing as a result. According to Ben-Akiva et al. (2012), on the spectrum of service, air freight is considered fast and reliable whereas rail and sea is considered slow and unreliable. This results in time sensitive, high value goods traveling by air parcels and less time sensitive, low value goods traveling by rail and sea.

Ben-Akiva & de Jong (2007) found in a study based on almost 750 000 outbound Swedish shipments that several factors influence the modal choice: access to industrial rail tracks, access to port facilities, large senders are more likely to use rail, high value products are more likely to be shipped in smaller quantities, large shipments of petroleum, metal and chemicals are more likely by rail, sea transport is more likely for large shipments of ore, metal waste, chemicals and petroleum. These findings are well supported by theory and illustrate the multitude of considerations shippers underpin their modal choices upon.

Lundberg (2006) published a paper on Swedish transport buyers and their choices. She found that transport buyers are willing to change supplier for a cost saving of 2-5 % (average 3,8 %) (2006). Indicating how cost sensitive transport buyers are in Sweden. Another result from Lundberg (2006) is a correlation between the value of the cargo and the valuation of delays. A company that produces high value goods values a reduction of delays more than a company that produces low value goods. The valuation of a reduction in delays is twice as high for the high valued goods producing company. This result is likely due to high value companies position further downstream where delivery windows and demands from the market are tougher. It may also be due to a higher focus on keeping less inventory, short lead times and reducing value tied up in production, a LEAN orientation of the business.

In the study Lundberg (2006) conducted, the readiness to change is quantified. Lundberg observes that companies do not value increased frequency or faster deliveries. Arguably, this is due to the setup that is already in place today, where frequency and delivery times are adapted to internal processes. Stumm & Himelbaur (2018) argue that frequency is essential for intermodal services. Regular and daily departures are necessary in order to compete with road transport.

Nelldal, Troche & Wajsman (2009) clarify that choice is confined by three factors: Restrictions, Inertia and Selection. Restrictions such as time, physical limitations or consignment size can exclude certain modes. Inertia is the use of a suboptimal mode due to lack of information, habit, contractual obligations, or personal opinion. Finally, Selection is when the transport buyer has actual options to choose from. This classification illustrates that transport buyers' choices are not free from preconditions. In conclusion, to compete with existing transport setups, price has to be lower, or, in targeting high valued goods, a significant reduction in delays must be offered.

3.5 Transport in the Hinterland

In the main passages of the hinterland transport network, volumes are high, and efficiency achieved, usually through transport modes such as trains or barges. These transport modes have high capacity economies of scale, low environmental impact, quick transit times in terminals and less delay from road congestion. The costs and lead times created in the hinterland supply chain is usually created in the smaller routes in the network where volumes are low and unpredictable (Bergqvist & Woxenius, 2011). The smaller routes that are linking cargo origins and destinations to terminals are transported almost always by trucks and managed by third party logistic firms, who have multiple smaller transport errands to organize. The leg from the dry port terminal to the port are commonly operated by a company with all their transport missions on the route in question.

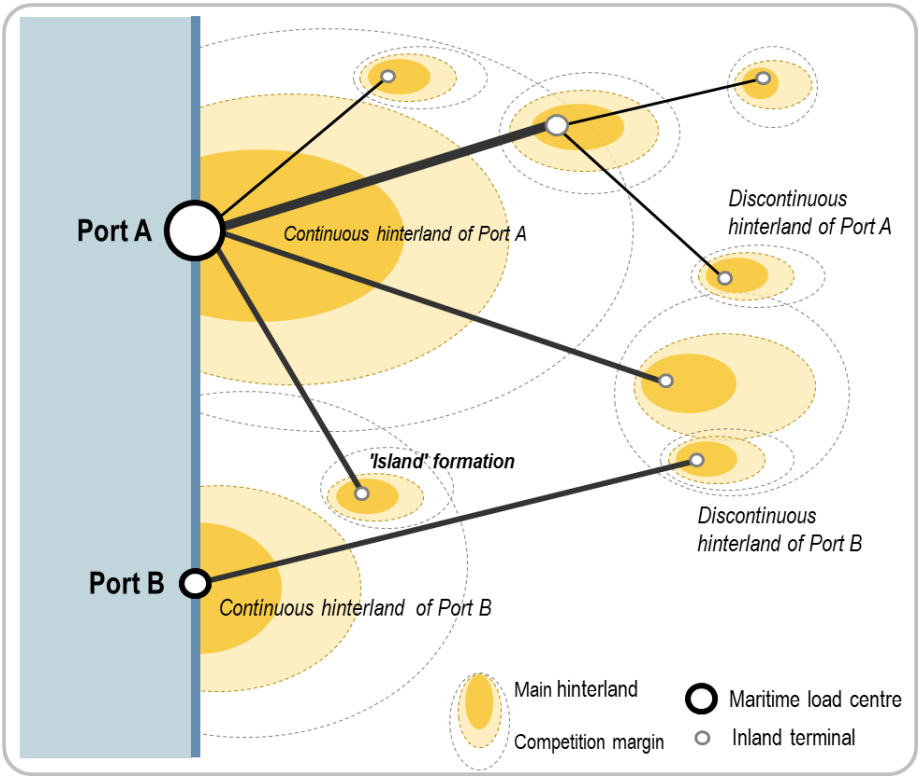

Figure 8: Illustration of hinterland expansion generated by satellite terminals (Rodrigue, 2020a)

3.5.1 Increased competition for Swedish hinterland

Over the last few years, indications of increased competition of the regional hinterland for PoG has risen. Large infrastructure projects such as Stockholm Norvik Port and Fehmarn Belt bridge has potential to break current competition situations and challenge the current actors for market shares. The Fehmarn belt bridge is a planned Danish-German connection to finish constructed in 2028 and will provide a faster road and rail connection from Scandinavia to the continent and its large ports, primarily Hamburg (Fehmarn, 2020). Adding to this, train lengths are planned to be expanded up to 1000 meters from Maaschen outside Hamburg and into Denmark (Fröidh, 2013). This will most likely increase competition for cargo volumes in southern Sweden. Stockholm Norvik port is a port under construction, located 50 Km south of Stockholm and that is scheduled to be open for business in 2020. With a planned capacity of 500 000 TEU, railway connection, terminal services and in proximity to a region in which 50 % of Sweden's consumption and BNP is generated, increased competition seems very likely (Hutchinson Ports, 2020).

3.6 Role of information in the supply chain

Hinterland connectivity for a seaport is not only a challenge in physical operational transportation, but also in virtual connection with the catchment area. The need for effective communication and information exchange is an essential factor for managing the supply chain overall but in the hinterland especially. In contrast to the port area, actors in the hinterland supply chain is not at arm's length and are more often forgotten. According to Furió (2013), the information and communication management of the hinterland leg of the port’s supply chain is usually ineffective and an area for improvement potential. Furió (2013) experienced through a pilot project in Spain with Madrid dry port and the port of Valencia that benefits from integration of information through common standards for information exchange generates benefits for the supply chain in form of service quality improvements and cost reductions, in form of both operational and administrative costs. Noteworthy, is that these benefits were experienced in both the seaport and the dry port. Thus, focus must not only be targeted towards the physical flow of the supply chain (Furió 2013). In order to reach customers increasingly elevated expectations on modern supply chains the information management in the supply chain is critical. To achieve expected customer-oriented adaptability in business processes the supply chain will have to cooperatively work for online planning, virtual communication and demand oriented processes (Veenstra et al. 2012).

In a Swedish context, Dahlén et al. (2018), researched on information sharing within steel industry logistics. They conclude that access to high quality and timely data can increase the efficiency in the supply chain. Actors can become more proactive and plan capacity according to accurate demand information. Issues involve the many manual processes and transparency of the organisations involved. Furthermore, they suggest that ports could own digital infrastructure just as they own physical infrastructure.

3.7 Transportation cost theory

Cost of transport is among the most important factors behind trade. Rodrigue (2020b) writes that empirical evidence suggests a 10 % increase in transport costs would reduce volume of trade by more than 20 %. Transport costs are however not the same as the rates charged towards the shippers. In a competitive market, rates can be low, subsidies could be added to the rates or the pricing model used by the carrier could use incremental steps, in any of these circumstances, the rate could well be below or very close to the actual cost of transport.

The cost of transport is influenced by distance, time, product type, economies of scale, energy costs, availability of backhauls, infrastructure, mode of transport, competition, regulations, subsidies, surcharges, taxes, and tolls (Rodrigue, 2020b). The variations in cost between different modes due to distance is due to the difference in fixed and variable costs between road, rail, and sea. Because of higher fixed costs and higher terminal handling costs, rail and sea have a disadvantage over road for shorter distances. However, as distance increases the cost of road transport becomes higher than for sea and rail. This is indicated by the steeper slope of the curve as illustrated below. As terminal handling costs makes up a considerable part of total shipping costs. Intermodal solutions suffer from the added terminal handling costs when load units need to be transferred from one mode to another.

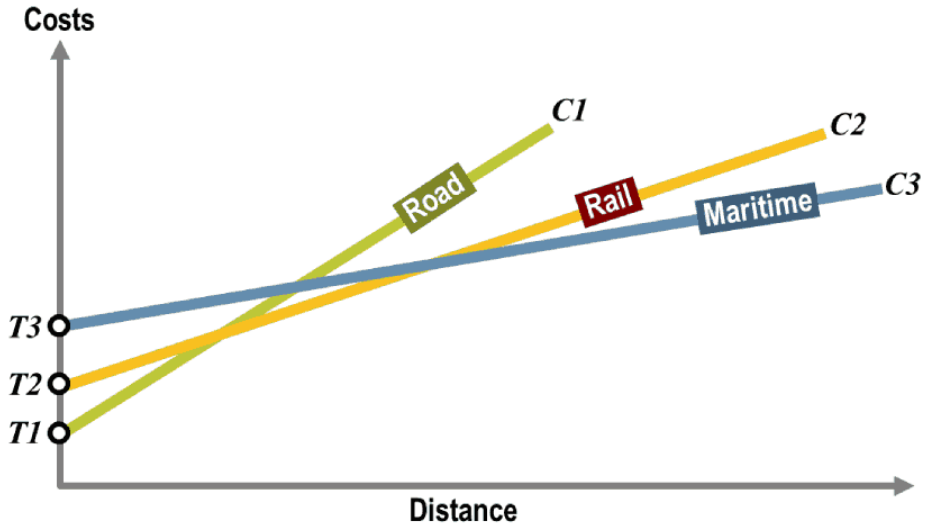

Figure 9: Illustration of transportation cost as a function of distance for various transport modes. (Rodrigue, 2020c)

Road transport is not only the primary competitor but also a necessary complement to intermodal solutions for first and last mile delivery. This further increases the barrier for shippers to look for alternatives to road transport as they are dependent on the commercial and technical requirements of accommodating road transport even if the load unit is later shifted to an intermodal train (Hersle & Moback, 2019).

Another difference between the trailer and container is the value of the load unit itself. A trailer is about 3-4 times as expensive compared to the equivalent container volume (Trafikanalys, 2019). This price premium affects the way trailers are used. Speed is more important, and the lead times involved in trailer transport are generally shorter. The higher price also makes it more rational to send empty trailers further from the point of unloading in order to find a cargo for the return leg. Trafikanalys (2019) estimates 100-150 km which is considerably longer compared to container hauls. Furthermore, about 5-10 % of trailers on the road in Europe are possible to lift. This limits the possibilities for shippers who uses trailers to employ intermodal solutions (Himmelbaur & Stumm, 2018).

3.7.1 Environmental aspects on transport costs

Regulators, both Swedish and EU, are potentially a challenge to expansions and investments unless those investment blueprints can show very little or no increase of CO2 emissions. The risk of regulation can be an incentive for the market actors to act in order to avoid legislation (Bergqvist & Woxenius, 2011). Additionally, the EU emissions trading scheme (EU ETS) of CO2 emissions is projected to increase prices on carbon emissions in the future. The EU have acted against oversupply of carbon allowances and prices per ton of CO2 emissions increased from 5.8 Euro in 2017 to 15.5 Euro in 2018, an increase of 169.2% (Healy et al. 2019). The EU ETS spot price in March of 2020 is around 20 Euros per ton (Quandl, 2020). This cost is a further incentive for actors to reduce emissions.

3.8 Swedish transport market

3.8.1 Barriers to intermodal transport

Trafikverket is the government agency in Sweden responsible for the long-term planning, construction and maintenance of Sweden's state-owned road and rail infrastructure. In 2018 Trafikverket investigated barriers to increased use of rail and intermodal setups for goods transport. The report on barriers was published in December 2019. Identified barriers include lack of punctuality, lack of reliability, lack of flexibility and high costs (Knutsson & Åkerfeldt, 2019). Knutsson and Åkerfeldt (2019) proposes more time slots and capacity allocation for goods on rail, longer trains, government guarantees to assume risk when initiating an intermodal setup, prioritized corridors for intermodal trains, discounts on rail fee and increased subsidies. In the report they also highlight that low profitability within the rail sector prevents investments and adoption of new technology. Therefore, a final conclusion from Knutsson and Åkerfeldt (2019) is to suggest that Trafikverket performs a public procurement for innovation within intermodal railway transport.

In the interviews by Knutsson and Åkerfeldt (2019), the shared impression by stakeholders is that the trains carrying goods are not prioritized on the rail network, the rail network capacity is restricted and that costs are too high. Capacity allocation on the railroad poses challenges in creating and managing time schedules for personnel and adjoining transport legs, and, keeping equipment utilization high. Capacity on the railroad has to be applied for in April and is allocated one year at a time. Since 1990 the number of passenger train kilometres, a measure on the density of departures, have doubled (Knutsson & Åkerfeldt, 2019). Cargo trains are

stopped and forced to wait in order for passenger trains and railroad maintenance to be carried out. These stoppages together with the variability of time slot allocation makes the logistics planning difficult. The nature of an intermodal setup is such that it depends on arriving and linking to another carrier. Terminals and ports need to plan work hours and capacity, ships and other carriers need to receive cargo without delay and depart for the next transport leg, inventory is stuck in transit and the variability in lead time results in higher inventory costs. Knutsson and Åkerfeldt (2019) conclude that the image of low reliability and punctuality is a barrier to shippers. Furthermore, the capacity allocation planning process is harder for cargo planners as cargo needs short term solutions in response to sudden peaks, seasonality, market development etc. This yearly plan and application process are in stark contrast with transport buyers experience when interacting with road hauliers and adds further to railroads image issues according to the stakeholders (Knutsson & Åkerfeldt, 2019).

Train operators confirm in the same report by Knutsson & Åkerfeldt (2019) that the problem of reliability and punctuality makes shipper hesitant to try rail. Given the low profitability in the rail sector, the operators are not prepared to assume that risk on their own and thus intermodal and rail setups struggle. Road transport is cheaper and more flexible. Cabotage rules makes road even more competitive on price.

3.8.2 Intermodal costs in Sweden

Based on Swedish conditions for employment and wages, the breakeven point between road and rail is approximated at 400 km. Trafikanalys (2019) estimates it at 350 km, but they assume 100 % fill rate of the train. However, when employing cabotage drivers the breakeven point is around 600 km (Knutsson & Åkerfeldt, 2019). Bengtsson et al. (2019) found that the share of foreign drivers has increased from 30 % in 2012, to 41 % in 2019.

Behrends and Flodén (2012) identified three critical success factors for intermodal trains: terminal handling costs, the filling rate, and the number of load units. Based on cost calculations by Berglund et al (2015), intermodal terminal costs are estimated at 250 SEK per container and 300 SEK per trailer. This cost is shared 50/50 between the intermodal terminal and the road transport leg (Berglund et al. 2015). Trafikanalys (2019) estimates 200-250 SEK per lift, however, they refer to stakeholders quoting 300 SEK per lift. The actual cost is thus uncertain but indicates a range of 200-300 SEK.

The high costs necessitate filling rates between 70-90% of trains. This represents a significant increase in amount of cargo, from a truck with trailer to a full train, and means that shippers must have large goods flows before a train would be economically viable (Hersle & Moback, 2019).

Since 2010 competition in Sweden from EU road hauliers have increased (Knutsson & Åkerfeldt, 2019). Transportstyrelsen published a survey among drivers indicating a wage difference of approximately 30-45 % between non-Nordic and Nordic drivers (Bengtsson et al. 2019). The effect of this wage difference has been modelled by Trafikverket, using KTHs models of transport costs. The results indicate a 19 % lower cost compared to Swedish road hauliers. This causes a downward pressure on transport prices for the entire Swedish transport market, including rail and sea, and transfers cargo from sea and rail to road. As the downward price pressure lowers profitability, investment activity is low (Knutsson & Åkerfeldt, 2019).

The breakeven point between intermodal and road is assuming that regulations on work and rest hours are being complied with. In the interviews held by Trafikverket, the actors are concerned that this is not the case. Enforcement of legislation and control of trucks is perceived as minimal (Knutsson & Åkerfeldt, 2019). Although, Transportstyrelsen reports an overall positive trend of compliance in their latest survey (Bengtsson et al. 2019). Illegal cabotage road transport pushes the breakeven point further and reduces the amount of goods that are available for intermodal transports on economically competitive terms. Adding to this situation are legislative plans for longer and heavier road units, platooning technology, and autonomous driving. These developments will further increase the competitiveness of road vs rail.

3.8.3 Intermodal transport work in Sweden

Trafikverkets (2019) statistics on share of transport work shows that the development has been steady. This is supported by the findings of the transport purchasers survey by Chalmers, Göteborgs Universitet & IVL. Road transport dominates the freight market (Styhre, 2018). The intermodal freight market is separated into containers or swap bodies and semi-trailers or other road units. As can be seen in the table below, trailers have a higher utilization compared to containers and swap bodies. As mentioned, trailers are more expensive compared to containers, and road transport is more flexible. Therefore, the transport performance of trailers is almost on-par with containers.

2018	*Intermodal transport*
	Tonnes carried (in thousands)
6 229	- of which with containers and swap bodies
4 343	- of which with semi-trailers and other road vehicles
10 572	**Total**
8 159	- excluding tare weight of transport units
	Transport performance (million ton-km)
2 921	- of which with containers and swap bodies
2 858	- of which with semi-trailers and other road vehicles
5 779	**Total**
4 496	- excluding tare weight of transport units
	Units carried (in thousands)
996	Containers and swap bodies, TEU
60	- of which loaded (percent)
210	Semi-trailers and other road vehicles
87	- of which loaded (percent)

Table 2: Intermodal freight transport by rail, by type of transport unit (Trafikverket, 2019)

3.8.4 Policy decision impacts on transport costs

Regulatory changes between 1990 to 1993 reduced road transport costs by approximately 20 %. Increased maximum payload on road from 51 to 60 tons per truck, as well as an increase in maximum road unit length from 24 to 25,25 meters was implemented (Knutsson & Åkerfeldt, 2019). The goal for Trafikverket is to expand allowance of 74-ton trucks across the entire state-owned road network (Trafikverket, 2020). Furthermore, a proposal yet to be decided on by the Swedish government, is to increase maximum road unit length from 25,25 to 34,5 meters. The

impact on cost of transport has been estimated by Trafikverket. An increase from 60 to 74 metric tonnes will decrease transport cost by 17 % for a road haulier with Swedish drivers (Knutsson & Åkerfeldt, 2019).

To promote competitiveness of rail and intermodal transport, a project to initiate market-based planning of capacity is scheduled to be introduced in 2022. Trafikverket is expecting this initiative to free up capacity and reduce waiting time for cargo. Additionally, Trafikverket is evaluating a dedicated cargo corridor, similar to the Scandinavian-Mediterranean goods corridor. According to Knutsson and Åkerfeldt (2019) the challenge to intermodal transport is not primarily the type of goods or the load unit, as most cargo transported on road can be transferred to rail. The barriers for that transfer to take place is a workable timetable, with reasonable transit time, reliability, and cost.

The length of an intermodal train is important for the overall cost. As road transport has become longer and heavier, decreasing the cost per unit carried, so could rail transport. Fröidh (2013) calculates that rail cost would decrease by 55 % if train length could be increased from 630 meters to 1000 meters. Trafikanalys, together with KTH, have illustrated the impact of longer trains in the graph below. An intermodal train, traveling over 600 km with a fill rate of 80 %. In the comparison between an intermodal train and a European road haulier, the European road haulier is using an 18-meter truck i.e. not the maximum allowed 25,25 meters. In this comparison, the intermodal train has to be in excess of 1000 meters to be cost competitive. At the time of this report, a maximum of 630 meters due to the limited length of side-track available for overtaking and passing trains. The ambition of the EU is to increase the length to 750 meters across the union. Planned length is 1000 meters in Denmark and Germany, until Maschen switchyard outside Hamburg (Fröidh, 2013).

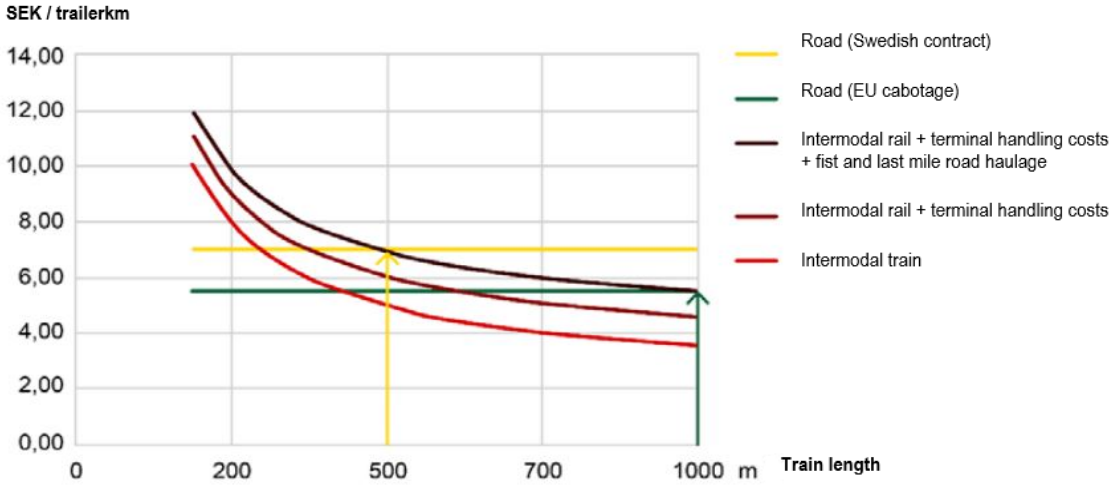

Figure 10: Break-even comparison, intermodal rail between Malmö - Stockholm with 80 % fill rate. Road prices verified by haulier in Malmö 2019-11-08 (Knutsson & Åkerfeldt, 2019).

When considering the costs for intermodal services from PoG, it should be clarified that the port terminal performs a direct transfer to train, i.e. with no added costs for road transport except in one end. Additionally, the trains departing PoG are not rearranged in the switchyard (Nelldal, Troche & Wajsman, 2009).

Another measure to improve the efficiency of rail and intermodal transport is to allow axle loads and train weight to increase. In North America (axle load 32-36 metric tonnes) and in Australia (40-42 metric tonnes) heavier loads are allowed compared to Europe (22.5 metric tonnes). Certain designated tracks allow 25 or 30 metric tonnes in Sweden. Fröidh (2013) illustrates by example the impact of allowing higher axle loads; 32.5 metric tonnes, as in North America, would decrease the cost per ton km by 30 % and increase capacity per train by 56 %.

Measures that increase the efficiency of freight trains also decreases the number of departures necessary to perform the transport work. This alleviates congestion and helps to further enhance efficiency. Allowing trains to travel faster is another measure to reduce the number of departures needed to perform the same amount of transport work. According to Fröidh (2013), apart from investments in infrastructure needed to support longer, heavier, and faster trains, the electricity supply also has to be increased. In the northern part of Sweden, where most power production is located, trains weight from 3200 tonnes up to 8500 tonnes, whereas in southern Sweden, trains are restricted to 1600 tonnes.

3.9 Short summary of extended gate concept

An extended gate can be understood as a regular terminal gate, further from the terminal, with the service level and the customer experience being the same. Veenstra et al. (2012) who coined the term, describes the intermodal terminal of the extended gate as the same entity as the port terminal. Without the integration of the extended gate, and its' associated depot, with the port terminal, the extended gate is an intermodal terminal, in form of a dry port.

According to van der Berg (2015) the main purpose of an extended gate is to increase port terminal efficiency. This is achieved by reducing congestion and dwell time in the port terminal by pushing containers towards the customers. A shift from a pull to a push system. The port terminal is the entity which is being extended and the requirements of the port terminal is one of the motivational forces behind implementation of the extended gate. The main purpose is to provide the same experience to inland customers as to customers located adjacent to the seaport.

4. Interview Results

In the following chapter, the results from the interviews will be presented. Interviewees are referred to on a general level to solely describe the situation and context. It is important to note that the extended gate concept is not well established or precisely defined among the interviewees. A lack of definition somewhat hinders a discussion on the potential and implementation of an extended gate. Rather, discussions on general improvements to the current intermodal transport solutions was held angled towards more integrated models of the current dry port setup.

4.1 Intermodal hinterland Transport

As of today, a large share of transport, to and from PoG, is done by rail. The dry port intermodal setup currently in use is well established and the actors agree that the current rail solutions serves its purpose, but there is room for improvement. During the interviews it was also mentioned that the current setup is able to handle more volumes, both in terminals and during the transport legs. Rail as a mode of transport is not perceived as a negative by the interviewed stakeholders. Even if delays occur on the rail system, it is not perceived as a problem for the stakeholders involved. This is due to the considerable margins towards container closing times that are used and trains often are operating during off-hours while receivers are not discharging the cargo until the following day. Hence, trains can be delayed several hours without impacting the transport chain.

The process of booking and establishing rail transport is seen as an area of improvement. Additionally, the rail transport segment is also problematic in its inability to easily scale rail supply according to variation in volumes. The rail sector would according to interviewees likely be more attractive if it would be more flexible. A large part of this inflexibility is derived from long planning horizons when rail transport operators are booking slots on the railway through the governing body. The slot allocation process is non-digital and made on a yearly basis, which restricts the rail operators from adjusting their capacity easily. Efforts to increase the user friendliness of rail transport booking would likely improve the potential for an extended gate.

For the port terminal it is essential to be able to rely on the containers being available for loading of the vessels. Thus, the planning requirements of the port terminal has to be factored in for the priority and timing of container transport to and from the extended gate. As distance increases

between the terminal gate and the inland terminal, requirements on container closing times will inevitably change. Using overnight trains, these additional time requirements can be kept low.

Some of the interviewees expressed that exports are derived from imports, i.e. that empty containers located at an intermodal terminal connected to rail creates opportunities to offer competitive prices for export volumes loaded at the same terminal. Therefore, a suggested approach by one of the interviewees is to start by identifying significant importers and choose a location based on availability of unloaded import containers and then match the demand by attracting compatible export volumes. Interviewees mention that municipalities in general are positive towards the establishment of intermodal terminals as they offer increased logistics services to the region.

However, an issue is imbalances, both due to regions being either export oriented or import oriented as well as due to different container types, such as 40ft, 20ft, reefers or high cubes. In addition, shipping lines are the owners of containers and are very reluctant to share containers amongst each other. Thus, an imbalance is created not only from container type but also from ownership, resulting in empty containers being transported in both directions dependent on ability to find business for import or export. Hence, to reduce empty repositioning of containers from significant import regions, comparatively low margin goods that normally would not be transported by container can be attractive for export. This is however a fine balance, as shipping lines are very reluctant to allow storage of empty containers at inland locations. The reluctancy is due to the shipping lines' prioritization of customers and therefore the empty equipment needs to be accessible. Empty containers are thus to the largest extent kept at depots in ports where they can be distributed inland or overseas according to demand. Shipping lines' business are extremely hard to differentiate to capture more value, as their core service is to transport steel boxes loaded with goods, so the accessibility of empty equipment is a central competitive advantage compared to competitors. Therefore, shipping lines wants guarantees for a certain amount of export cargo over time, to be allowing significant storage of containers inland. Terminal operators address the importance of treating a container as part of a pool rather than as an individual unit, also in the hinterland.

Cost is the most important factor for transport buyers according to the interviewees. An intermodal transport solution needs a high filling rate in order to be profitable. Because an intermodal transport has high fixed costs and long planning times, the commercial risk is high. Transporters recognize the desirability of a guaranteed volume or other form of minimum guaranteed compensation when initializing an intermodal service. Cargo owners have different approaches to logistics, in some cases they will stipulate a certain preferred solution or leave the decisions to a 3PL provider. Thus, marketing an intermodal solution includes targeting both cargo owners and forwarders. However, the interviewees observation is that customers are increasingly interested in environmentally friendly logistics solutions.

Furthermore, the interviewees agrees that there are environmental benefits from intermodal transport solutions compared to road transport. Reduced greenhouse gas emissions are mentioned by the actors and seen as a positive selling point of intermodal transport. However, price is recognized as being the most important factor and the rail service is only used when being economically competitive, thus the environmental factors are being regarded primarily as efforts to establish a green profile of companies.

The third-party logistics companies, that holds contracts with cargo owners, are preferably using developed existing transport solutions, in contrast to creating new specialized ones for their clients. This is due to long lead times in developing new transport solutions and the ability to achieve high service level in the deliveries, by using established, efficient solutions. Once a shuttle service is trafficking a route, there are high barriers for other actors to compete on the same route, as container volumes are not sufficient. According to one of the shuttle operators, in order to make a profit, a shuttle service requires approximately 90% filling rate and for a rail route to be profitable the scale requires around 1000 railcar per year in both directions, where a railcar is equivalent of 2 TEUs.

4.2 Extended gate - benefits and barriers

The extended gate concepts have the ability to generate several benefits to the intermodal hinterland transport network according to the interviewees. That said, the respondents also highlight a number of obstacles that are associated with conceptual intermodal setups. Fundamentally, cargo should take the path of least resistance, in terms of cost. No transport solution can survive long term with inconveniences for importers and exporters with regard to booking transport, information etc.

As for potential benefits, the interviewees are positive for the opportunity to gate in export cargo at the inland terminal. This provides cargo owners with more security through a feeling of more local contact with the extended gate terminal compared to the port terminal hundreds of kilometres away. For the cargo owner the gated in container is close but administratively the container is in the seaport terminal. Cargo owners are according to interviewees eager to have a feeling of control and the ability to call the terminal and check up on their cargo.

Furthermore, the extended gate concept provides transport improvements through the ability to distribute the shuttled container volumes on several days. In contrast to today when the containers are booked on a train departure from the inland terminal not regarding the internal order for containers of actual departure from the port. If the export containers were gated in at the extended gate, the port terminal operator could distribute the containers arrivals in a way to avoid peaks and thus heightened congestion. Therefore, the rail shuttles would obtain higher efficiency and could potentially redistribute the numbers of empty container trips more effectively as well.

With inland terminal solutions containers can be stored further inland, where land is cheaper, and congestion is less problematic. On the same note, a further advantage for the extended gate is the possibility to move imported containers closer to the end-consumer, whilst still keeping imported goods non-declared from customs. Thereby importers are achieving shorter lead times from terminal to warehouse, less congestion at importers yards and a reduction in risk compared to having the container stored at the port terminal. A reduction in the number of days an importer has to up-front customs duties and value added taxes reduces the working capital requirements in their business. As regulations regarding customs warehousing can be perceived as complex, the ability to comprehend such questions are challenging for smaller importers.

Another benefit to the extended gate that is mentioned with regards to customs practices is the reduced risk of a container not being cleared for export. As of today, interviewees mention the risk that containers are accepted at the intermodal terminals but refused at the port terminal and returned to the intermodal terminal again. As the gate-in process is transferred to the extended gate, any container that is not cleared for export will be refused already in the hinterland.

Interviewees mention that it is positive to reduce container dwell time in the port terminal, as it offers savings on demurrage and detention charges for importers. However, the ability to keep stock waiting in containers is restricted by the containers' owners, the shipping lines. They require turnover on their equipment to make a profit and need the containers available for new missions according to their prioritisation of customers. Thus, the shipping lines are viewed as essential to involve in the extended gate concept formation as they decide where the containers are to be stored. Consequently, for a potential implementation of an extended gate concept it is necessary to show shipping lines that their business is aided through more volumes and reduced repositioning by inland empty container storage.

A trade-off is created for shipping lines and port terminals between more volumes and less empty repositioning, traded for less demurrage and detention revenue. One income generating aspect of business is traded for another one with benefits from extended gate, and thereby creating a puzzling balance for these actors when and when not to endorse the concept based on trade levels, congestion etc.

Some interviewees regard the extended gate concept as an opportunity to generate competitive advantages to intermodal transport, through the integrated model with closer collaborations. However, in order to achieve higher transport efficiency, autonomous operations of the rail shuttles by the port terminal are perceived to be essential.

Many of the interviewees were, despite the apparent concept confusion, positive to the extended gate concept but quickly mentioned the issues of taking risks connected to new concepts in such a low margin business. In order to implement the extended gate concept, some form of mitigation of these business risks were seen as necessary and several of the interviewees discussed contracts to guarantee volumes to the concept. Terminal and rail shuttle operators especially are reluctant to engage themselves in these projects due to low margins and high

operational risks. Short duration contracts and volatile markets are distinct impediments for collaborations that are necessary for the concept, regardless of the benefits closer dialogues and increased transparency can yield. It can however be hard to find cargo owners that are willing to guarantee volumes for such concepts and that are determined to remain loyal to intermodal rail solutions due to the lower cost for road transport.

Contrary arguments towards benefits of standardised intermodal concepts based on hubs are that through direct routes and specialised solutions 3PLs can provide its' customers with better transport performance. Through a direct transport model, unnecessary margins in time can be removed, but will likely generate more cost.

For an extended gate concept to work, the system integration is also viewed as a very desirable feature. The collective collaboration to achieve higher integration requires a common system for information sharing throughout the supply chain. Terminals are currently quite non-digital in their administration and lack system integration with other actors in the supply chain. However, the large shipping lines have their own systems and are thus reluctant to adapt to local supply chain setups. On the contrary note, for a system to be effective it needs to be specialised for the specific purpose, so just integrating smaller actors into a bigger one's system is not advisable either.

The empirical data from interviews suggests that freight forwarding companies as well as individual shipping companies are reluctant to make long term commitments to intermodal transport volumes as customers regularly renegotiate tenders and change forwarders and carriers. A forwarder or shipping company could find itself committed with long term capacity on intermodal transport but with no customers. The longer planning horizon and commitment over time, which is essential to large capacity transport systems, is in conflict with shippers purchasing transport as a service, ready to change supplier at short notice. This suggests that, even if, a collaborative format could be found where forwarders did not fear the loss of sensitive information, the fear of losing the underlying customer contract remains.

Benefits with an extended gate for importers and exporters includes becoming closer to the global container trade, that generates better convenience and a developed competitive alternative to the local port. The extended gate concept could function for a container in the

same way as a flight trip where every transhipment is on the same boarding card, printed at the airport of departure. In the journey of the container, the gate-in at the extended gate signifies the takeover of responsibility by the port terminal operator and then subsequent legs of the journey are handled by the same actor. As number of transhipments and actors involved decrease, the inherent risk for delays and loss of containers are also decreased. Additionally, this would reduce the number of steps in the information chain, potentially easing the physical flow of containers. The overall benefit generated for the supply chain will show in form of eased overall control that can create local logistical advantages, throughout functions. Through tighter collaboration and communication between functions, the flexibility of the supply chain can be improved, and scaling capacity can be achieved within a shorter time frame.

In the future, interviewees address that the viability for intermodal concepts like the extended gate might improve as it may not have to carry its' current costs to legitimise its' existence. For instance, through transport policies, empty haulage might be penalised to reduce "unnecessary" mileage and hence disrupt current transport structures, making way for new ones.

4.3 Potential for Extended gate from the Port of Gothenburg

An extended gate from PoG could possibly be established both on a short distance and long distance based on the respondents of the interviews. The dry port setup in Falköping is known to business insiders as "Julapendeln"; the Jula shuttle. It is a cooperatively operated dry port and shuttle between large retailer Jula and DB Schenker and are connected to the PoG Railport network. Jula have an established environmental transport policy, shown in a strategy focusing on intermodal transport and thus are guaranteeing container volume to the shuttle. The Jula rail shuttle is sustainable both financially and logistically on a distance of approximately 130 km and the successful implementation of the Jula shuttle train is mentioned as a positive example that organizational efforts overrule distance. An extended gate in Eskilstuna, approximately 400 km away, would compete with the East coast ports of Gävle, Norrköping and Norvik. The most attractive value proposition to East coast customers, according to one interviewee, is the shorter lead times to Asia that can be offered by removing transhipments, thus attracting lead time sensitive exporters.

Importers are recognized by the stakeholders as the most suitable focus group initially. One selling point is offering reduced costs of demurrage and detention in the PoG. Another value proposition is to offer customs warehousing closer to end consumers, reducing working capital requirements. An extended gate should attempt to offer a basic service, that can be added on to, as a basic service is easier to sell at an initial stage according to stakeholders. Furthermore, a basic product is easier to adapt to existing logistics systems. A pilot or an already established service is seen as positive factor that favour the sales process. However, it is not necessary to establish the service before attracting customers, especially if targeting larger customers with in-house logistics capabilities. Although customers could be attracted before the concept is launched live, the key partner have to be tuned in beforehand. Therefore, a pilot is recommended. The proposed extended gate concept should initially be kept rather basic, easily understood, and approachable in order to attract customers and then over time developed with more added features as it matures. Subsidized pricing can be used to attract users initially and increase the filling rate of the train shuttles over time as the concept proves itself on the market. The leadership of the pilot project are according to interviewees necessary to be in the hands of GHAB, APMT or collectively, but the shipping lines are important to involve as they determine whether a container are to be considered "in-gated" and cleared for export. Subsequently, one must look into who the other actors are and what incentives could be used to attract them towards an implementation of the extended gate concept.

In the port terminal, importers have three free days of storage after discharge, then the price is increased over the following days and after 9 days the price for port terminal storage is approximately 900 SEK/day. The cost of terminal storage at inland terminals is significantly lower, as one would expect, with approximately one tenth of the cost after 9 days compared to the port terminal.

4.4 Level of integration for Extended gate

Several stakeholders point at the importance of keeping information to a need-to-know basis. Either, due to commercial interests, or due to sensitive content, such as cargo of high retail value or dangerous nature. Therefore, one strength of the disintegrated set-up of a dry port is to limit risks of information leakage. When choosing a level of integration, the need for information exchange should be considered.

An extended gate can be established by mergers and acquisitions of intermodal terminals and transport providers. As actors have different incentives based on origins of their income, collaboration can despite conceptual agreements be difficult to achieve in practice. One actor's high priority customer might be in conflict with another ones. Doubts concerning prioritisation of cargo, hidden agendas and conflicts can be eliminated by an integrated approach where one actor controls the entire chain of operations.

The weakness of an extended gate established by mergers and acquisitions is the loss of sensitivity and customer relations. Partners in collaboration can maintain already established relations and remain customer centred that keep the ability to attract and serve smaller businesses as well. Smaller businesses generally offer better margins for the logistics service providers and thus an extended gate that alienates small businesses risks losing profitability. Whether or not an extended gate can be established by mergers and acquisitions, by the PoG or another local actor, is doubtful according to the interviewed subjects. A fully integrated extended gate concept would imply that one actor underwrite all the risk and will hence probably have to be implemented by a large global actor to be confident in the risk taking while having the financial strength to acquire parts of the supply chain inland. The large shipping lines are the natural actor for this, but the interviewees reckon that customers probably will be hesitant to endorse such a setup as it risks being too bureaucratic and inflexible.

Actors are restricted to participate in collaborations as business secrets cannot be shared in a highly competitive market, thus hindering transparency. This is especially true for the shipping lines and the large 3PLs. Furthermore, the shipping lines cannot cooperate with each other freely due to competitive law that restrict businesses from engaging themselves in anti-competitive endeavours. One interviewee addresses that even without a fully integrated extended gate setup, there probably still need to be a leader/owner for the supply chain. This creates an awkward situation where junior actors will have to share information in the concept to a senior partner that they are not willing to. Understandably, it is complicated with business integration as agreement on conceptual level is one thing and practical agreement is another.

The 3PLs functions as middlemen in the current dry port setup and provide transport solutions between the shipper and the shipping line. Their key ability in the network is to detect transport demand and matching export and import to reduce empty haulage to save cost. A large 3PL with multiple customer contracts is more likely to effectively match cargo in different directions through triangulation and can also arrange effective joint loading. As the 3PLs holds the contracts and contact with the shippers and consignees they are significant actors for the network. Some of these abilities can possibly through the extended gate concept be undertaken by port and inland terminal operators in order to broaden their value offering to customers of intermodal transport.

4.5 Supply chain disruptions during spring 2020

The interview with Eskilstuna intermodal terminal, which was held in the middle of April, revealed an interesting trend regarding some features of the extended gate concept. Due to the coronavirus outbreak, global supply chains were disrupted in several ways. In light of these disruptions, shippers approached ports and intermodal terminals to facilitate storage of undeclared import containers. As the response to the Corona virus crisis led to reduced consumer demand, this in turn increased demand for interim storage of imported containers.

The containers were shipped from China several weeks prior to the reduction in demand. Trade disruptions creates fluctuations with peaks and troughs that are challenging to tackle. Additionally, supply chain disruptions for containers are severely impacting JIT production. The excess imported goods not used in production or in retail due to the reduced demand, are preferably stored as close to the consignee as possible, because of the rapid changes associated with the virus pandemic.

China was the first country to be impacted by the virus, and the spread of the pandemic took several weeks which created a situation where consumption in the west still remained as before with Chinese production and transportation drastically reduced, a backlog for exports to catch up to was generated and containers were stuck in the Chinese hinterland. When the virus spread, the demand for imported goods fell elsewhere as China started to send the previously ordered goods. The disruptions have led to lack of containers, lack of vessel capacity, port congestions and imbalances.

In response to the development, the Gothenburg port authority together with a number of intermodal inland terminals connected to the PoG Railport concept are in mid-April acting and creating interim storage at locations situated throughout Sweden close to warehouse agglomerations. This development could be viewed as a step towards the extended gate concept as some features of the concept will be put to the test, such as container storage at the inland terminal for rapid delivery to warehouses. The result of these responses is at time of writing yet to be seen and whether the responses are sufficiently transport- or cost effective to remain after the extraordinary circumstances during the pandemic are also up for questioning.

4.6 Port of Gothenburg associated hinterland networks

The port terminal operator in the PoG, APM-T, is developing its own hinterland collaboration network, called the Green Gothenburg Gateway (GGG). The aim is to consolidate volumes in Gothenburg to increase the number of direct calls per week and this will be motivated through another goal set for the concept; that every Swedish export container, wherever originated, should access the global container market within 48 hours. The transport through the terminal is to be completely fossil free as of next year and through this the customers using the GGG will be able to achieve certificates to climate certify their transport chain. The GGG is not a competing concept with the GHABs Railport concept as the actors are not performing the same tasks in the supply chain and as both actors have the goal to attract more container volumes to Gothenburg.

5. Analysis

In the following chapter a discussion regarding the extended gate concept and its viability will be held. The findings from the literature study will be applied to the insights from the interviews. By this process the research questions will be analysed to be able to make legitimate conclusions that benefit the research field and the industry. The chapter will be structured by firstly identifying the main actors through the stakeholder analysis and thereby creating a hierarchy to be followed for the subsequent discussion. The analysis is structured based on interviewed actor and the stakeholder hierarchy defines the internal order of importance of the discussion.

5.1 Stakeholder analysis

The identified stakeholders can be divided based of level of interest and their level of influence over the issue, in this case the implementation of an extended gate. As found during the interviews, based on their different strategic horizons, operational mandate and local versus global scope there exist a difference between actors for their interest and influence for the potential implementation. Their overall supply chain power is varying significantly based on competition situations and financial strength. Some functions are only served by one actor while others have many different competing ones, while some are local smaller Swedish logistics providers and others are large multinational enterprises whose turnover are in tens of billions globally.

Even though the port authority clearly is a high interest actor, their influence is limited due to only being connected to other actors through the concession lease. A high influence actor are the shipping lines, that are required to give their approval to the usage of their containers. APMT are to be seen as a high influence, high interest actor. As the only port terminal, they are extremely influential, and through the Green Gothenburg Gateway initiative it shows that they have an interest in hinterland network development projects. The challenge being to bring together their initiatives with GHABs for their inland projects.

The inland terminal operators and the shuttle operators are quite exchangeable and relatively weak financially, thus limiting their influence. Additionally, their interest is also rather limited as they are very operational in their business approach compared to more strategic actors, and they would not have the power to spearhead any initiatives for an extended gate. The freight

forwarding companies, can be viewed as somewhere in between as they have strong financial influence but there exists a competitive scene where other strong actors can be used. Their interest towards an extended gate is to be viewed as low as the extended gate is somewhat intruding on their field of business. The 3PLs are making their money based on the difficulty of transport booking and the extended gate concept are amongst other things trying to facilitate this process. Although cargo owners were not interviewed, their incentives were collected through the forwarding agents that represent them. The cargo owners are to be viewed as key actors as they are necessary for making the extended gate profitable. They have both the influence on transport choice and the interest for economical and sustainable transport, resulting in an essential role for the concepts viability.

In order to achieve a successful extended gate implementation from the PoG, the port authority needs to get APMT and the shipping lines aboard on the concept for its operational viability and the cargo owners for the economic viability. The cargo owners are to be interested through the facilitated transport process and sustainable aspect from the extended gate and will have to guarantee volumes through the concept for any other actors to be willing to accept the business risk of operating the concept.

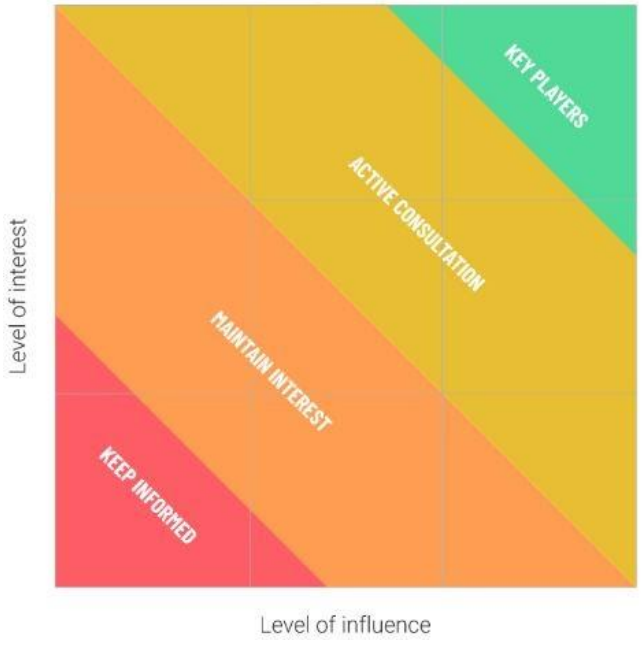

Figure 11: Stakeholder analysis grid and suggested associated attitudes (Grégoire, 2019)

The view of the integrated and collaborative cooperating supply chain is not necessarily the optimal solution nor the truth. Veenstra et al (2012) suggests that the various actors aim to improve the performance of the supply chain. However, as the actors are not necessarily using

the same metrics and can have conflicting interests, they are not always looking out for the best interests of the overall supply chain. Sub-optimization of the supply chain is a trade-off versus requirements on integration between the actors. Low level of integration makes the actors silos and thus able to carry on without adapting to one another. There are positive aspects of the siloed structure, organizations are better equipped to handle changing contracts over time and differing service levels for different accounts.

5.1.1 Port authority

An extended gate will compete primarily with road carriage, reduce congestion, and improve environmental metrics in the port city. By locating the extended gate close by the port terminal, the complexity of implementation and establishment of the extended gate can be reduced. A decision by the city or region to restrict trucks would force the usage of the extended gate. If the location is selected carefully, disruptions to existing logistics can be reduced.

Additionally, an extended gate further into the hinterland will not only improve the logistics performance of the already connected hinterland but expand the catchment area of the port. By further integrating the intermodal terminal with the port terminal, a higher barrier to other competitors in hinterland transport is raised. The extended gate terminal enjoys an improved competitive position versus other terminals since they are able to offer a higher service level towards the shippers. Being integrated with a large port has the potential to generate business for the extended gate terminal. As the shippers return empty containers in the hinterland, the extended gate terminal can potentially attract more export volumes. The availability of empty containers generates better prices for exporters and provides incentives for shipping lines to increase their sales efforts. Furthermore, the extended gate terminal can use the opportunity to secure contracts to load and unload containers on behalf of shippers, capturing an increased share of the value-added services.

However, attracting export volumes to the extended gate rather than the PoG is a trade-off to the port owners. Both in terms of local employment and real estate development, an extended gate in the hinterland would compete with services offered in Gothenburg. The PoG is serviced by daily trains and the intermodal traffic is competitive as of today. For the purpose of this study, the consideration is whether an extended gate will increase the attractiveness of the PoG by improving the hinterland connectivity. Network economies and shorter lead times to Asia

through direct calls are the most essential competitive advantages of PoG. Expanding the hinterland network will improve the network economy of PoG, the expansion will also enable the PoG to offer these reduced lead times to an increased number of shippers.

Dahlén et al. (2018) suggests that ports could own critical IT infrastructure just as they own port infrastructure. Digitalization makes IT systems part of the critical infrastructure necessary to service global shipping. The municipalities of affected regions can be involved as stakeholders in the extended gate infrastructure. A co-ownership approach provides incentives to continuous improvement of the network. Public ownership in both competing East coast ports and the extended gate network presents a conflict of interest. However, an extended gate network would improve the logistics service level of the hinterland and thus improve the local business environment through increased competition to the local port. Municipalities could serve the local interest by both developing the extended gate network and competing ports.

5.1.2 Port operator

For the port terminal, an extended gate would allow them to move from a pull to a push system. The port terminal operator can determine where to best locate containers until they are to be loaded on a vessel or picked up for import. This requires the port terminal operator to know where the customer would like the container to be stored for import. Also, it requires the port terminal operator to have a mandate by the shipping lines to move their equipment to and from the extended gate, that according to the interviewees can be hard to achieve. The challenges presented by these aspects can be reduced by limiting the distance from the port terminal to the extended gate. Additionally, the port terminal operator has to be able to price the hinterland transport leg at a competitive rate and has to have the commercial right to perform the transport and get paid for doing so.

The port terminal can reduce the overall stack height by pushing containers into the hinterland. This reduction of stack height will reduce the number of repositionings in the terminal and increase operational efficiency. A decrease in the number of repositionings also reduces overall risk of damage and loss to equipment or goods. A reduced stack height decreases the requirements on the equipment employed in the terminal and can have a positive effect on the capital tied up in equipment. By adding the hinterland transport to the port terminal service

offering, the port terminal can increase revenue and profitability. Furthermore, the port terminal increases barriers to competitors in the hinterland and increases the catchment area of the port.

Even if rail is used extensively today, it is recognized that the distance between the port terminal and the extended gate also adds risk. In an extended gate, this risk is transferred to the port terminal as they have taken custody of the container in the hinterland. As distance increases between the terminal gate and the extended gate, requirements on container closing times will inevitably change. As container closing times has to be adjusted for the time required for transport between the terminal and the extended gate. Using overnight trains, these additional time requirements can be kept low. The port terminal must be able to rely on the containers being available for loading of the vessels. Thus, the planning requirements of the port terminal has to be the underlying motivation for the priority and timing of container transport to and from the extended gate. If the port terminal increases its commitments in the hinterland, it is intuitive that the port terminal has to be devoted to the process of development and implementation of the extended gate. It is, after all, their gate that is being extended.

5.1.3 Shipping lines

Shipping lines invest in equipment and strive to maintain high utilization of their containers. Maintaining safety stock of containers in hinterland terminals adds costs and is not an incentive. However, increasing the utilization and reducing dwell time of equipment would be an incentive. If the extended gate can increase those metrics, then shipping lines could be inclined to accepting another inland depot. In the form of owners of the equipment and accompanied with the large size these global actors, the shipping lines has an immense bargaining power within the port supply chain.

5.1.4 Cargo owners

Cargo owners can make the decisions needed to secure long-term commitment to intermodal transport. By involving the cargo owners, and securing sufficient volumes of cargo, the commercial risk is reduced. In light of disruptions to global supply chains by the Coronavirus, the inertia of transport decision making has been reduced considerably. If intermodal actors are able to deliver viable and long-term transport solutions, the corona crisis offers opportunities for modal shift.

Shippers have an essential role to play in shifting to intermodal transport and to the implementation of extended gates. As the cargo owners own the cargo, they have the power to change the supply chain. Furthermore, they have incentives as collaborations between cargo owners have potential to save both costs and reduce emissions. Additionally, through using intermodal transport that are viewed as more sustainable, the cargo owners can benefit from favourable media and political attention, as long as costs can be kept at a competitive level. Findings both from literature and interviews suggests that cost is the most essential factor to determine modal choice. Therefore, cost has to be guaranteed at a competitive rate towards the actors. The PoG and other actors involved in the port supply chain, such as train and terminal operators, are responsible for the implementation of the extended gate. Cargo properties such as weight, volume, value etc. plays a part in determining the mode of transport. Therefore, the design and development of the extended gate need input from forwarders, shipping companies and cargo owners in order to be as inclusive as possible to various goods. However, the responsibility of development should be with the supply chain actors.

Another suggestion by Knutsson & Åkerfeldt (2019) is that intermodal solutions need to reduce complexity with regards to booking and set-up. This view of rail and intermodal transport as too complicated is consistent with results from the interviews. The potential promise of an extended gate system is to increase the customer service level by limiting the number of coordinations between supply chain actors necessary for the cargo owner. The service level of logistics solutions needs to be adapted to the individual customer's needs. Therefore, an extended gate has to be compatible with several levels of customer service requirements, depending on the end-user's preferences. Large customers may have extensive capabilities in-house and only require a minimum of service level, whereas smaller businesses may need to purchase a full range of export services. This speaks to the advantage of a less integrated set-up between the intermodal terminals and the individual cargo owners.

Rodrigue and Notteboom (2009) argue that close operational relationships between cargo owners and inland terminals are a result of cargo owners using the intermodal terminals as close proximity storage of containers. Imported stock which is not needed at the moment and containers booked for export are kept at the inland terminal, available at short notice at the cargo owner's facility. These close operational relationships can be leveraged by the cargo

owners in an extended gate implementation effort. If cargo owners lean on inland terminals to offer extended gate service level at their facility, it may persuade inland terminals to do so.

5.1.5 Transport operators

Commercial risk is elevated as intermodal transport has high fixed costs, high capacity, and a long planning process, as compared to road transport, which hence decreases the attractiveness of intermodal transport. The higher fixed costs of intermodal transport are supported by theory and well-illustrated by an increasing competitiveness over longer distances. In the interviews conducted during the research, commercial risk was mentioned by several actors as a problem associated with intermodal transport. The interviewees' reluctance for these concepts is very likely due to risks not being proportional to the low rewards in a low margin business. A guarantee of income or goods volume would reduce the commercial risk associated with an extended gate. A start-up bonus on intermodal services as suggested by Knutsson & Åkerfeldt (2019) serves the same purpose.

High capacity in transport networks is both a positive and a negative feature. In the interviews a filling rate of 90% in each direction has been indicated as sufficient to maintain a profitable service. The high capacity and long planning processes is a barrier to initialise an intermodal train service. Imbalances exists between regions, individual shippers and seasons and thus make it hard to keep a high utilisation in initial stages of the concept. In order to reduce the risk of running a low occupancy train, the shuttle operator in the extended gate concept need guarantees to handle the fixed costs.

To counter the issue of finding key cargo owners willing to guarantee volumes, Himmelbaur & Stumm (2018) suggests the formation of a neutral body to facilitate slot sharing on intermodal trains. A trustee that serves as an intermediary between shippers, forwarders, and train operators. Shippers could potentially reduce costs by collaborations as Holmberg et al. (2014) concludes. The slot sharing system, also suggested by Knutsson & Åkerfeldt (2019) is one way of collaborating and would reduce transport costs for shippers. Theoretically, in a pool of companies, the share of import vs export goods as well as seasonal trends evens out across the participants and thus, the problem with seasonality and unbalanced transport needs is reduced. However, interviewees suggest that sharing and coordination is far from practicable. One reason is the transport decision hierarchy by Veenstra et al (2012) where transport considerations can

be overruled by strategic decisions. What seem to be a rational transport decision in one case will be affected by the overhead logistics. Even though an importer and exporter may be located next to each other, it will still be hard to triangulate the container for the importer and exporter internally as they will need the same 3PL and shipping line container. Another reason is the cost of coordination that is incurred and needs to be shared among the participants. Reduced costs for shippers can be realized with increased collaboration and reduced empty repositioning. An extended gate concept that is designed to allow for reduced transport costs has potential to be successful.

5.1.6 Freight forwarders

Results from the interviews suggests slot sharing within supply chain is sensitive to 3PLs. Information asymmetry, customer details and needs, are the bread and butter of 3PL companies. Any collaborative attempt must protect the participants against sensitive information disclosures. This is supported by Arvidsson (2018) who finds that trust, but not necessarily a trustee, is important to horizontal collaborations. However, the horizontal collaborations studied by Arvidsson (2018) involved shippers who were not competitors. Considering this need for trust is essential for the implementation of the extended gate.

An extended gate should attempt to keep lead times short also from the extended gate terminal whilst maintaining good accessibility the shipping network. Through the extended gate, lead times will not only be retained, but can also be decreased through disintermediation of actors or tighter collaboration. The disintermediation will thus be beneficial for cargo owners but not all will abide. Through extended gate concept, key actors will through vertical integration start intrude onto other actors' commercial space, primarily the commercial space of 3PLs. Large 3PLs such as DB Schenker, DHL, Kuehne Nagel, etc, that are very strong actors, could resist the extended gate's effort to move closer to shippers and make shipping easier. Therefore, if 3PL's can be involved in the extended gate, by offering concessions or share intermodal capacity, this risk can be reduced.

Attempting to achieve a system of both need-to-know basis and transparency, one could potentially use blockchain technology. The established rail transport from PoG, potentially benefits from the low level of information sharing and limitations of the service. If competitors are not comfortable sharing a train service, a reduction of the information sharing could remove barriers to collaboration.

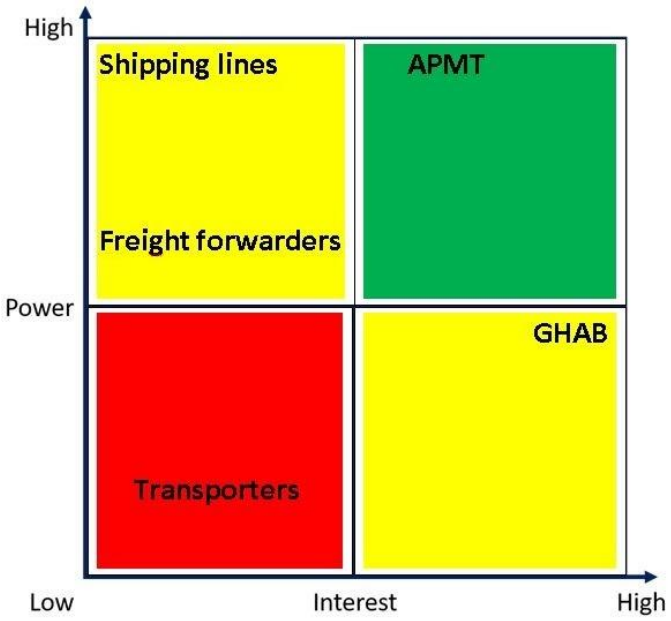

Figure 12: Stakeholder analysis matrix (authors elaboration)

5.2 How can it be implemented in the PoG?

In the case of PoG, an extended gate can be implemented either by means of vertical integration on behalf of one actor or as a complementary collaborative partnership. In a vertical integration approach the terminal operator or the port owner is the most likely to act. They have incentives to increase the catchment area of the port hinterland and to increase the volumes of containers handled in the port. However, the port terminal operator would be reluctant to make investments in hinterland transport as they are operating the port on a concession. If the lease is terminated the old terminal operator could be left in charge of a hinterland transport network servicing an uncooperative competitor operating the container terminal in PoG. On the contrary, by expanding into the hinterland and controlling an effective network, the port terminal operator could potentially strengthen its strategic position for renewing the concession.

Port owner already has significant investments in physical assets and can take a long-term approach to investments. Thus, the municipality of Gothenburg is a natural owner and

developer of an extended gate in the hinterland. The municipal ownership of the port does not exclude vertical integration of the hinterland. To the contrary, it provides a good foundation for partnerships with other municipalities and public owners. It is in the public interest to reduce congestion on roads and minimize investment in upgrades of road infrastructure to and from the PoG and its hinterland. By increasing transport efficiency, both of these objectives can be achieved. In a partnership between multiple municipalities, shared areas of concern such as: long term planning of infrastructure, environmental targets, and improved competitiveness of local industry, can be addressed collectively.

As many intermodal terminals have public ownership interests, the municipalities of the hinterland are well positioned to become part-owners in an extended gate network, with the municipality of Gothenburg as the cornerstone investor. The effort to establish an extended gate can also be done through a contractual, collaborative approach. In such a collaborative effort between selected partners, the objectives should be agreed upon between the parties so that whole-hearted support can be received in both ends of the transport corridor.

The intermodal terminals in the hinterland that become connected to the PoG via the extended gate infrastructure take a commercial risk by becoming associated with the PoG. Shippers can have an unfavourable view of the PoG and chose to use other terminals instead. It is important to decide if the establishment of an extended gate in an intermodal terminal makes the terminal exclusive to the PoG. If the intermodal terminal is allowed to service other ports, there is still a risk that shippers will fear being neglected in favour of PoG containers.

The intermodal terminals should be provided incentives to grow the network and improve the service level. By doing so, the extended gate can in itself act to integrate shippers and other terminals, in line with the transhipment. By providing the extended gate the tools and incentives to grow its' own network, the extended gates can organically expand the hinterland of the port terminal even further. As a conclusion, it is the authors' views that the intermodal terminals with extended gates should have part ownership and share both risk and reward with the PoG.

In the case of PoG, where a terminal operator is leasing the port terminal, an extended gate infrastructure will add value to the port terminal which is under the leasing contract. Therefore, it is only natural that the port owner, the municipality of Gothenburg, would charge a higher

rent for a terminal with such added values. The port owner remains as owner of the infrastructure, including infrastructure in the hinterland and digital infrastructure with regards to the extended gate. The benefits from the extended gate network to the port terminal operator is priced in by an increase in the cost to lease the terminal from the port owner.

An extended gate does not have to be a fixed concept completely in line with what Veenstra et al. (2012) presented and thus it is not exclusive to intermodal rail. A high-capacity road corridor could be established. Exemptions allowing longer and heavier trucks would increase the transport efficiency from the Port terminal to an extended gate. The extended gate could be positioned in a location that reduces congestion and other negative externalities inside the city, whilst maintaining good connectivity to main highways. Establishing an extended gate by road could be a strategy to reduce congestion due to peaks, whilst avoiding the complexity of intermodal transport and rail. In the future both automation and electromobility could fundamentally change the rationale of modal choice. Thus, achieving the high flexibility of road haulage combined with low emissions, and low cost of automated processes.

5.2.1 Suggestions for implementation

The concept of an extended gate needs to be defined and a structure should be agreed upon by the involved actors. This is the first challenge in establishing an extended gate, a common understanding of what it is and what features are to be included. The suggestion is to establish a working understanding of an extended gate, a gate where the customer experience is as if the customers was using the non-extended gate, i.e. the port terminal gate. Establishing common expectations is important for the actor’s ability to cooperate in a persevering partnership.

If the extended gate is defined as an inland terminal to which the port operator has full autonomy to move containers to and from, then it is unlikely that it can be implemented unless regulated. City or regional legislators could decree that the extended gate has to be established outside of the port city in order to minimize heavy traffic within the port city. An extended gate that is implemented by legislation should be established close to the existing terminal so as to minimize disruption to existing logistics networks, in a location with good connectivity and removed from the city area.

Furthermore, it is the authors' suggestion that those parties that stand to gain from the extended gate concept should carry the cost of development and implementation. If the extended gate is implemented through mergers and acquisitions, the cost falls on the acquiring actor. In a horizontal collaboration, the use of strategic contracting (Petersen & Østergaard, 2017) and the best practices suggested by Cools et al. (2009) can provide a foundation for cooperation and distribution of risks and rewards among the parties. The PoG, container terminal operator, train operator and hinterland intermodal terminal could share costs and revenue from the extended gate system according to investments and operating costs incurred.

In order to implement the concept, the authors further suggest that a phasing strategy should be used. For instance, the extended gate could expand the range of services offered over time as it develops. This could include services such as customs clearance, container storage, container cleaning and repair, loading/unloading, cross-docking and consolidation of less than container loads. Additionally, partners and functions should also be phased in. Trying to find one core actor to start integrating, to, over time, achieving an extended gate.

Integration by one strong actor may likely generate operational benefits for the supply chain through reduction of actor's margins (both in cost and time), but it may also decrease competition. Regardless if the vertical integration approach or collaborative contractual approach is chosen, it is the authors' suggestion that only one municipality is chosen for such a collaboration, until a working blueprint has been established. Once the concept has been proven, more terminals can be added to the network.

An extended gate towards the Stockholm region can attract more goods to PoG and increase competition against the East coast ports of Norrköping, Norvik and Gävle. Municipalities which are also port owners such as Gävle, Norrköping and Stockholm are likely to resist an extended gate from the PoG. However, hinterland municipalities that are a natural part of the PoG hinterland, are already, to a large extent, integrated with the PoG. In the already established hinterland, the extended gate can be implemented, improved, and showcased. In a second wave, establishing an extended gate in a location further east will bring more benefits but also be more challenging.

6. Conclusions

An overall finding in this study is that the extended gate can be motivated by different strategic goals. In a port terminal centred perspective, the reduction of heavy congestion can be achieved through an extended gate in short distance from the port, based on a push strategy from the port terminal. This type of extended gate is the primary view of the literature. The aim is to increase terminal efficiency by reducing dwell times and stack heights inside the terminal, as well as relieve the city of transport associated negative externalities. However, as the PoG does not face the heavy congestion the concept is built around, there are very limited incentives for the port terminal to carry costs for shuttling containers, and thus, the environmental benefits will not be achieved either.

This study does however open up the concept for a broader interpretation compared to the view of the existing literature. The authors do not find the extended gate to be restricted to only a short distance, city centred, concept, rather it can also be a more integrated version of a dry port. Through this approach, the extended gate will be more strategically aimed at hinterland management and customer experience and thus attracting more volumes to the port.

Additionally, as stated, the concept can be more than one thing, but the authors' perception of the concept is that the paramount feature for being an extended gate is the more integrated approach compared to a dry port. In the authors views, the extended gate can in terms of this essential integration be achieved in two ways. Either, through the supply chain functions being integrated vertically, or through closer cooperation. Through integration, friction of space and time between the actors is reduced and customers benefit from shorter lead times to international markets. The two different ways to achieve higher integration of the supply chain, has their respective strengths and weaknesses. Vertical integration through acquisition removes conflicts of interests and time margins between supply chain actors, while being finance heavy and potentially negatively affecting competition. A collaborative approach between actors to implement an extended gate is a softer version, with less benefits but fewer impediments. By developing the extended gate in a collaborative effort, incentives can be shared among the stakeholders. The extended gate network can, through co-ownership with selected intermodal terminals, be kept local and sensitive to market demands.

Furthermore, the expanded extended gate concept does not have to be exclusively intermodal, nor necessarily orchestrated by the port terminal. Rather, the authors find that desirable features of the concept could be developed to fit in a Gothenburg context and phased in over time, in contrast to developing a full-size concept and trying to fit it into the current setup. The suggestion is to continue developing the GHAB Railport concept and evaluate how different features of a collaborative extended gate concept could be applied, for instance the customs warehousing practices implemented in response to corona pandemic disruptions.

Owning and developing infrastructure is core business to GHAB. The hinterland infrastructure as well as digital infrastructure should be considered part of the port. If vessel sizes continue to increase, a hinterland bottleneck should be pre-empted. By exploiting the economies of scale available in the PoG, a sustainable, high-capacity, transport corridor can be established. The corridor can be designed for any mode of transport and distance.

If an extended gate implementation is successful in terms of increased customer experience and transport efficiency, one could expect increased container volumes which the port as well as the port terminal operator will benefit from. Furthermore, by delivering more containers straight into the hinterland, operational efficiencies can be achieved by reducing the stack height inside of the port terminal. As a consequence, the terminal and port will lose revenue from demurrage and detention charges, but potentially increase the efficiency of operations and number of containers handled. As the extended gate network will add value to the PoG, this added value should be reflected in the pricing of the concession. The port terminal operator will have to allow extended gates access to their digital infrastructure. Offering access to digital infrastructure, as well as other investments into the development and implementation of the extended gate network, is a valuable contribution and should be recognized.

Incentives are provided for cargo owners by keeping costs competitive, and at the same time, reducing complexity of intermodal transport and lowering working capital needs for importers. The reduced carbon footprint is an added benefit that acts as an insurance against future policy decisions by governments targeting carbon emissions. The potential for an extended gate increases if transport buyers become progressively more concerned with environmental performance and thus, more devoted to intermodal services. The supply chain can benefit from

an extended gate in a reduction of overall lead times through a decrease of time margins between actors.

Incentives for shipping lines can be provided by increasing the utilization rate, and reducing the dwell time, of containers. One way the extended gate can achieve this is by attracting non-containerized cargo to the extended gate terminal. By establishing the extended gate in a location with significant import volumes, and thus access to empty containers, the extended gate can efficiently compete to attract non-containerized export goods for loading. This would require the import containers to be of a type that is acceptable to exporters and the extended gate terminal to have the ability and capacity to serve multiple and diverse customers. However, this could redirect cargo that is currently being loaded in the PoG or in terminals nearby. The PoG thus risks losing the extra revenue from cargo handling and developing cargo handling facilities. Additionally, even if a container is loaded in the extended gate terminal there is no guarantee that the container will be shipped via PoG.

In summary, the literatures' view of the extended gate based on the push strategy is not applicable in the PoG case, but the integrated approach of the concept can still be very relevant for developing hinterland terminals and thus reaping associated benefits. The way to achieving the integrated intermodal terminal is not however fixed but can according to the authors either be through vertical integration by acquisitions or through increased supply chain collaboration. The recommendation for the PoG is to look to the interesting features of the concept and phase them in instead of focusing on the concept as an entity as several extended gate features are not suitable in the Swedish hinterland context which is significantly larger and more sparsley populated than the areas where the concept were conceived.

6.1 Further research

A suggestion is to conduct research into the different approaches towards implementation of the extended gate. For example, a more thorough comparison of collaborative integration versus vertical integration by mergers and acquisitions. By researching different approaches to integration, best practices with regards to extended gate implementation could be explored. Furthermore, research into if one model of integration has a higher success rate or is more suitable to a certain organization would be valuable.

Another interesting approach for future research is to review how the features that are slowly implemented in response to the 2020 coronavirus pandemic contributed to transport economy and efficiency. Extraordinary situations like a pandemic can convince stakeholders to take decisions and risks that they would not in a normal situation. Thus, it is of interest for the intermodal hinterland research field to assess how these responsive actions played out, to further understand how the extended gate concept can best be implemented and utilized.

Through closer cooperation/integration, one would generate a reduction in time margins, which in turn would lead to shorter overall lead times for the supply chain. It would be interesting for the industry to further investigate how much of an economic saving this lead time reduction would amount to and how much of these time margins that are possible to remove.

The chances of achieving growth are greater if an extended gate can accommodate different cargo interests. Trucks and trailers represent a significant share of the transport market, an extended gate that also compliments the trailer market therefore offers increased opportunity. This should be considered during the development of the extended gate so that it does not exclude the trailer segment. Further research into the specific requirements of a complimentary intermodal shuttle service would be valuable.

Lastly, research that aims to define a new concept, exclusively encompassing the hinterland extended gate, could provide a clearer demarcation between a short distance, city centred, extended gate and a hinterland extended gate.

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