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Title:

The Influence of the Port of Gothenburg towards Inland Mode Choice Decision-Making

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ABSTRACT

The transportation sector is an essential component for a country's economy and its population well-being; however, this sector is a major contributor to the current environmental issues that society is facing and directly connected with the quality of life e.g. emissions, accidents, health impacts, etc. Furthermore, the Port's role has changed as they are key drivers of development not only on the seaside but also in the inland side regarding environmental externalities mitigations. In the case of the Port of Gothenburg there is currently a lack of initiatives/incentives that may promote a more sustainable transportation sector. Therefore, the researchers investigated and identified Green Port Initiatives/Incentives from several ports around the world that may be adopted by Port of Gothenburg. For this purpose, a literature review regarding the transportation sector and its activities related to the ports was gathered. In addition, interviews were conducted to actors with expertise within the field e.g. Government Institutions, Port and Regional Authorities; surveys were developed and sent to Swedish Shippers to obtain information from their perspective regarding the transportation sector. The results of this master's thesis showed that there are several port initiatives/incentives e.g. Information Systems Platforms, Monetary Discounts and Regulations that may be considered and address the environmental sustainability problems in the transport sector at the Port of Gothenburg; thus, benefit the City of Gothenburg and Sweden. However, many challenges impede the promoting of the initiatives/incentives e.g. collaboration among actors, leadership, infrastructure, etc.

Keywords: Inland Terminal, environmental incentives, sustainable transport, intermodal transport, ports, mode choice, modal shift, etc.

Note: When discussing the following terms within this research thesis *"Initiatives"* refers to any technological developments, regulations and collaboration between stakeholders for improvements and *"Incentives"* refers to any monetary funding.

ABBREVIATIONS

AGVs	Automated Guided Vehicles
CEDR	Conference of European Directors of Road Report
CO2	Carbon Emissions
ERTMS	European Rail Traffic Management System
ETS	Emissions Trading System
EU	European Union
GHGs	Greenhouse Gas Emissions
HIT	Hinterland Intermodal Transportation
ICT	Inland Container Terminal
ILT	Institute of Logistics and Transport
ISO	International Organization for Standardization
ITU	Intermodal Transport Unit
IWW	Inland Waterways
JIT	Just-in-Time
LC	Logistics Centers
LNG	Liquefied Natural Gas
LSPs	Logistic Service Providers
NGOs	Non-Governmental Organization
OCR	Optical Character Recognition
OECD	Organization for Economic Co-operation and Development
PPH	Pre-Post Haulage
RQ	Research Questions
SEK	Swedish Krona - Currency of Sweden
TEU	Twenty-foot Equivalent Unit
TG	Target Groups
UN	United Nations
WCED	World Commission on Environment and Development
WPCI	World Port Climate Initiative

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CHAPTER 1

This chapter describes the overall existing problems at Ports regarding development strategies and the environmental impacts in the transportation sector; furthermore, the aim of this master's thesis is to determine if the Port of Gothenburg is capable of influencing Swedish Shippers Mode Decision-Making. Therefore, the problem, purpose and delimitations are explained.

1 INTRODUCTION

"Freight Transportation Revolution" with the creation and introduction of the container into the transportation sector more than 50 years ago allowed for rapid connectivity and standardization in intermodal transportation. In 1969, the container was introduced as a standardized unit measure for the transportation of goods, giving birth to the present term of Twenty-foot Equivalent Unit (TEU). This standardization permitted a more efficient and effective container handling (transhipment), decrease in lead-time, increase in safety as well as an increase in traffic volumes granting economies of scale. (Rodrigue, 2020). Furthermore, transportation and information system integration enhanced the transport speed, time and reduced costs. (Haralambides, 2017)

In 1987, the sustainable development concept was introduced in the *"Brundtland Report"* with the purpose of promoting environmental awareness due to the negative impact of a rapid global economic growth. Over time many forms of the concept of *"Sustainability"* have been presented. (Brundtland, 1987). According to the "World Commission on Environment and Development" (WCED), sustainable development is *"the development that meets the need of the present without compromising the ability of future generations to meet their own needs".* Further, the WCED stated that the politicians, planners and practitioners should integrate the concept as an essential part of their work practices. Additionally, the "Organization for Economic Co-operation and Development" (OECD) defines sustainable transportation as *"transportation that does not endanger public health or ecosystems and that meets needs for access consistent with (a) use of renewable resources that are below their rates of regeneration, and (b) use of non-renewable resources below the rates of development of renewable substitutes".* (Wiederkehr, Gilbert, Crist & Caïd, 2004)

It is important to mention that the majority of stakeholders involved in the transportation sector are economically benefiting from the implementation of new innovative technologies; however, many are still not addressing the environmental challenges that may arise when integrating new changes. (Haralambides, 2017)

According to Wilmsmeier, Monios & Lambert (2011) there are two types of approaches when considering inland development which are driven from and are related to the direction from which development takes place from (1) Government

(Municipalities) or Private Sector (Railway-Barge operator) *towards* the inland terminals; (2) Port Authorities or Seaport Terminal Operators *towards* the inland terminals this in order to capture and increase inland transportation market share; however, normally Port Authorities assist the Terminal Operators in these types of endeavor as entities involved may benefit e.g. increase clientele, competitive advantages, social benefits level (e.g. job opportunities), and environmental benefits in the entire country (e.g. cleaner air, less congestion, decrease noise pollution).

Sweden belongs to the first type mentioned above as their municipalities are driving development for their inland sector, they assist terminal operators to mitigate environmental impacts through modal shift and developing the region. Sweden's directional development approach has increased inland development speed leading to competition between municipalities and sometimes resulting to unequal competition as their goals are not aligned. (Wilmsmeier et al., 2011)

The port's role today has evolved due to the impact they have on both the inland and sea legs as they are able to drive and shape the entire transportation sector. Furthermore, due to increasing risks of sea shipping companies to bypass ports regarding value adding services and neglecting them, ports are required to consider strategies that will allow them to be in a more dominant position; and therefore invest in inland development from both an economical and environmental perspective. (Wilmsmeier et al., 2011)

Finally, some strategies being utilized are initiative/incentives projects which tend to derive from a micro-level in the majority of cases from private entities in a form of business competition i.e. Terminal Operator, Port Authorities; however, it can also be implemented from a macro-level in a form of regulations and policies (Government, European Union - EU, etc.). (Aregall & Bergqvist, 2017)

1.1 Background

1.1.1 Sweden - Actors and Transportation Goals

In Sweden regulations and policies for the freight transportation sector are established by the government, parliament and state authorities, they also provide the infrastructure required; further, any negotiations with the European Union (EU) and the United Nations (UN) are dealt by the Swedish government. (Regeringen, 2018). The agreements between both entities are regarding topics i.e. the direction of global transport in order to promote growth, addressing environmental issues that may arise from regulations and policies being implemented and funded e.g. climate change, rights, fuel decisions to mention a few (EUR-Lex, 2020).

It is important that any freight transportation development projects should consider the needs of the entire transportation system. The municipalities in Sweden are in-charge of matters concerning planning overviews, traffic planning and regulations, business development, building permits and infrastructure development regarding their own region (Regeringen, 2018).

In 2019, the Swedish government established goals that are intended to be completed by 2024. These are some of the established goals: to promote modal shift from road to rail or inland waterways (IWW), road upgrade to carry heavier vehicles i.e. load-bearing class 4 (BK4) which are utilizing 12% of the country's road network since 2018 and consist of 74-ton trucks; rail connectivity and infrastructure improvement as well as future development involving e.g. Malmö-Göteborg-Stockholm which are main network corridors, Göteborg-Borås link, etc. These initiatives aim to promote cycling and the use of public transport through urban planning and sustainable agreements through the collaboration of the different actors e.g. shippers and government. Lastly, it intends to address the society challenges within the National Swedish Transport sector e.g. to become a fossil-free country. However, these projects come with challenges as they will increase traffic within this network Malmö-Göteborg-Stockholm triangle therefore, changes are needed e.g. in Mälarbanan/Malmö and Lund to a 4-track railway expansion, Gothenburg West Link construction. The Swedish government will invest in the transportation projects an approximate total of SEK 622.5 billion (SEK 333.5 billion for development; SEK 289 billion for maintenance however, SEK 90 billion are from taxes, rail and infrastructure fees, loans and financing). (Trafikverket, 2019)

The main objective of the City of Gothenburg within the goods transportation sector is to promote the city as a leading logistics hub in Scandinavia through industrial development; support the Port of Gothenburg to maintain its leading position; consequently, reducing unemployment without compromising its citizens quality of life, goods transportation volumes via roads should remain at the same levels of 2010 and transit times in road/rail should remain at 2014 levels. In addition, the collaboration between the different stakeholders is necessary i.e. regional cooperation and academic institutions e.g. urban planning and innovations. Further, it intends to achieve these goals through facilitation of the goods transport accessibility; increase Rail/IWW efficiency i.e. increase capacity utilization and prioritize over passenger traffic in some routes. Finally, the City of Gothenburg will enhance efficiency by incorporating new technological innovations e.g. road charging systems, handling equipment suitable for a sustainable modal shift to the different terminals. (Gothenburg, 2014)

1.2 Problem/Situation Description

In 2019, the Swedish Climate Policy Council stated that 90% of the road transportation emissions constitutes ⅓ of total Greenhouse Gas Emissions (GHGs) e.g. land, air and sea and 19% of that total was due to heavy vehicles. The high-level emissions in road transport are because of the use of fossil fuels (diesel and petrol). Sweden's railway transportation sector was operated via more than 90% (electricity) and remaining utilizing diesel (Railway-Technology, 2008). Furthermore, these levels of emissions are influenced by traffic volumes, efficiency of transport network and emission intensity (generated per km GHGs and affected by vehicle weight, speed, engine efficiency, etc.). A research conducted in 2010 demonstrated that the efficiency

of the transportation network for freight had declined. In order for Sweden to reduce by at least 70% GHGs by 2030 (base level 2010) all stakeholders involved in the transportation sector i.e. Municipalities, Government, Operators and Private entities should collaborate. Moreover, for any goal to be achieved the Government is considered the key actor to carry out the appropriate coordination for the initiatives/incentives development. The established goals will be achieved through the increase of transportation efficiency, modal shift and utilization of alternative fuels. (Klimatpolitiskaradet, 2019). However, there is an existing lack of leadership clarity and responsibility roles of the actors (state, municipality and region); consequently, this misalignment has led to problems and conflict of interests e.g. while Municipalities are trying to reduce traffic and promote sustainable transport, the Swedish State requires municipalities to accommodate the increasing volumes by the development of infrastructure. Also mentioned is that infrastructure development should be driven by policies goals and not only based on population growth economic development forecast link. (Klimatpolitiskaradet, 2019)

Further explained by Wilmsmeier et al. (2011) is that Ports have re-evaluated their strategies in order to compete and consequently promote environmental sustainability aspects because of the changing norms in conducting transportation. Also mentioned was that the number of studies surrounding coordination strategies within the supply chain has increased; consequently, focusing on how to attract high volumes of container traffic. The four coordination strategies are vertical integration, partnerships, collaboration and contracts providing incentives. The incorporation of these strategies within the shipping line industry have led to port selection increasingly being influenced by landslide factors i.e. intermodal infrastructure; with possible revenue increases. Due to benefits that derive from the increase of container volumes, traffic, and value-added services the inland operations have gained high importance; therefore, ports have lost hierarchy position regarding development and changes taking place both seaside and landside. It is for this reason that ports are now required to be more involved in the activities pertaining to the hinterland sector. (Wilmsmeier et al., 2011)

Aregall & Bergqvist (2017) state that ports need to redirect their attention towards the inland leg to gain a more competitive position as well as increase in volumes finding that an alternate solution is via implementing intermodal transportation. Further, port initiative/incentives (monetary funding as well as technological innovations) should be implemented to provide motivation to the Swedish Shippers (manufacturer, producers or service providers) to transport their goods via rail or IWW. Further an increase in modal shift will also address the environmental aspects of a sustainable transportation method.

1.3 Purpose of Study

The aim of this Master's Thesis is to provide a greater understanding from an Academic view and Environmental Perspective regarding Port initiatives/incentives development from the Port of Gothenburg towards the inland leg. The research will

allow a deeper comprehension of the relationship, behaviour and involvement of the transportation stakeholders in influencing the Swedish Shippers mode decision-making from a sustainable environmental aspect (green perspective). Furthermore, in order to evaluate the existing scenario of current initiatives/incentives or if there is a lack of them, the researcher will gather information of previous studies conducted in this area to identify *"if"* the Port and Government Authorities currently offer initiatives/incentives; and if not, *"how"* they can motivate Swedish Shippers mode decision-making.

1.4 Research Problem Questions and Objectives

In this section the research questions will be further developed; included are the research problem and sub-problem questions surrounding the transportation to and from the Port.

Main Research Question

- ***Main Research Question:*** *Is the Port of Gothenburg able to influence Swedish Shippers mode decision-making in order to promote environmentally sustainable transportation?*

The question above is the main objective of this master's thesis research. The question will address the overall perspective of the problem surrounding our area of study. In order to answer the question, research will be conducted concerning the current practices in Global Ports, Port of Gothenburg and what criteria are of importance to Swedish Shippers when selecting a mode of transportation on the inland leg. Further, the researchers will include what are the responsibilities and roles of each of the actors to carry out these initiatives/incentives (power level both regulation/implementation).

Sub-Research Questions

- ***Sub-Research Question 1:*** *Does the Port of Gothenburg have initiatives/incentives that can promote a more environmentally sustainable inland transport?*

The first sub-research question is regarding green port initiatives/incentives; to identify any existing ones that are currently in place.

- ***Sub-Research Question 2:*** *Can global port initiatives/incentives be implemented in the Port of Gothenburg's current strategy?*

The second sub-research question aims to provide insight to enhance current initiatives/incentives or implement new ones at the Port of Gothenburg.

1.5 Research Focus and Delimitations

Due to the time constraint for the development of this thesis the following delimitations have been determined. Primarily, the master thesis will focus on the Container Freight Transportation from and to the Port of Gothenburg on the inland leg i.e. terminals and routes. Since the actors involved and interviews carried are located in the City of Gothenburg; the study will have a focus using an inside-out directional model perspective (Wilmsmeier et al., 2011) which will be elaborated in *Chapter 3.* Furthermore, this research project will intend to identify initiatives/incentives that are currently implemented in several ports throughout the world that may not represent global port trends. Finally, the study will intend to discuss if the initiatives/incentives implemented in other ports around the world are applicable to the Port of Gothenburg in order to promote a more environmentally sustainable transportation.

1.6 Research Target Groups (TG)

This research will target the following actors in order to conduct the study since they may have power in order to influence initiatives/incentives within the inland transportation sector. These are identified actors and the reason why they might be influential: Swedish Shippers (Producers, Manufacturers, Carriers i.e. Brokers and Freight Forwarders), Port and Government Authorities are the primary targeted groups for the purpose of this master thesis project. The Port (i.e. service quality level, initiatives/incentives, promotions, etc.) and Government Authorities (i.e. rules and regulations, funding etc.) are targeted since they may influence Swedish Shippers (e.g. they are the party conducting transportation or creating demand) mode decision-making when selecting their transport route and mode.

CHAPTER 2

This chapter includes the methods utilized in order to develop and answer the research questions. Firstly, an overview of the Study Site will be introduced; Secondly, the Research Strategy will allow the identification of which type of research will be adopted for this study. Thirdly, the Data Collection Method will enable researchers to gather and analyze data. Finally, the quality of the study will be assessed through Reliability, Validity and Generalizability.

2 METHODOLOGY

2.1 Study Site

2.1.1 Gothenburg Municipality - Västra Götaland County

Gothenburg is Sweden's second largest city with a population of 580.000 people, while the metropolitan area population surpasses 1 million citizens. Gothenburg is located on the west coast in the southwestern part of Sweden; due to the advantageous location the city is a major trade and shipping hub considered the biggest of its region, Västra Götaland. Further, the City of Gothenburg is essential for Sweden's economy. (worldpopulationreview, 2020; Valencia, 2019)

The municipality is administered by the government and is in-charge for several crucial areas i.e. transport infrastructure and environmental protection. The city council is the primary decision-maker entity regarding the above areas and the people appointed are elected by the citizens. (Gothenburg, 2014; Valencia, 2019)

The transport strategy developed by the City of Gothenburg is the governing document which communicates official information of the transport system development to the stakeholders, it outlines the objectives and challenges regarding the transport sector for the next 20 years and the goals that were previously mentioned. The figure below illustrates the in-progress infrastructure projects the City of Gothenburg is working on to mitigate and resolve the current challenges due to the high importance of this city and the overall impact to the economy of Sweden. Since the beginning of the projects in 2013, they established a strategic timeline that would allow them to complete all projects by 2035. (Gothenburg, 2014)

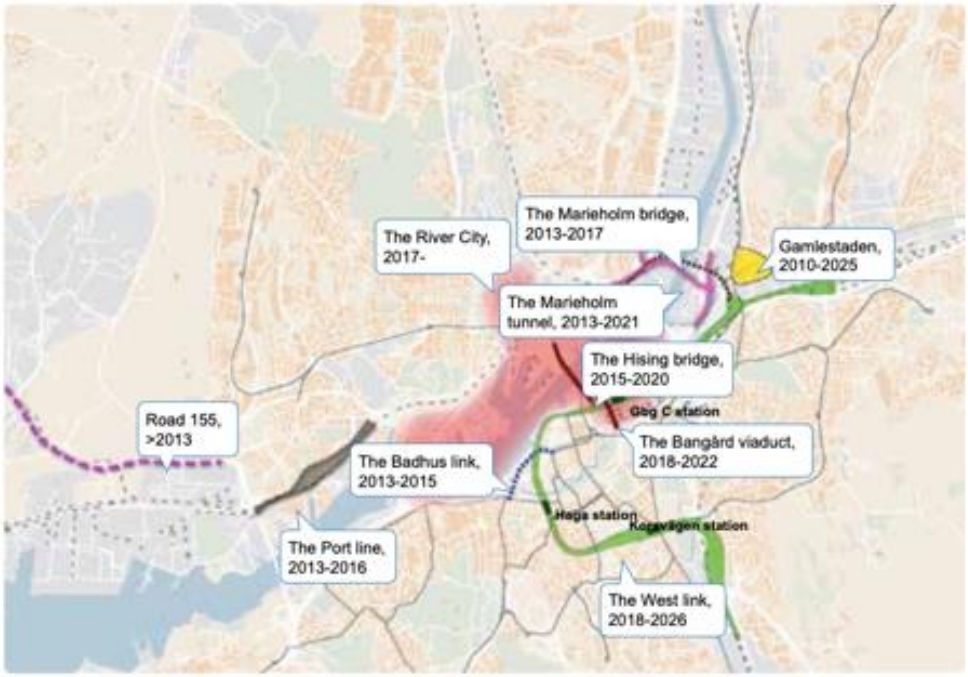

Figure 3: Infrastructure Projects (Gothenburg, 2014)

2.1.2 Port of Göteborg (Gothenburg)

Port sector institutions have made intense modification in the past years due to high global competitiveness for economic growth. Therefore, port ownership management models have been altered and reconstructed mostly through reform policies. On a global scale management and ownership of ports have transitioned from public to private with the "landlord model" being the dominant model. (Roso, Russell, Ruamsook & Stefansson, 2015). This model is the most globally frequently utilized. Port authorities retain ownership of the land, however, the infrastructure (terminal) is leased to a private company. A concession agreement is used as a method of long-term lease where the port authorities grant the private company (terminal operator) the rights to carry out business in exchange for monetary compensation (rent). Furthermore, costs related to any modification/expansion or equipment of the terminal will be absorbed by the private operator. (Rodrigue, 2020). In October of 2011, APM Terminals was granted a concession agreement for a period of 25 years. (APM Terminals, 2020)

The Port of Gothenburg is located on the west coast of Sweden and is considered one of Baltic Sea's largest container port terminals as well as the largest port in Scandinavia. The port is strategically located which allows direct road connectivity to major markets i.e. direct calls from the Far East, North America and important cities i.e. Oslo, Copenhagen and the northern industrial parts of Sweden. Approximately 70% of the Scandinavian industry and population falls within a radius of 500 km from the Port of Gothenburg (including countries capitals i.e. Oslo, Stockholm and Copenhagen). (Gothenburg, 2014; Port of Gothenburg, 2020). The current terminal operator at the Port of Gothenburg is a division within A.P. Moller-Maersk, the terminal land capacity is 80 hectares with a capacity to handle one the world's largest vessels e.g. Post-Panamax. The container terminal offers a variety of logistics services i.e. warehousing, transhipment as well as depots. In 2016, the construction of a logistics park

was underway that would increase accessibility to road and railway with approximate transit times from 1 to 2 days to anyplace in the Scandinavian area. The port has a well-developed railway system which allows them to handle 70 shuttles daily of which 25 are containers. In addition, around 30% of the total Swedish foreign trade and more than 50% of total traffic transits through this port. (Port of Gothenburg, 2020; APM Terminal, 2020)

The below chart illustrates the yearly Swedish container throughput from and to the five largest ports. We are able to see that Sweden's total throughput (TEU) from 2010 to 2018 fluctuated from approximately 1.4M to 1.65M, with a traffic peak in 2016 and began dropping in 2017 to 1.57M, however, the decrease occurred due to a dispute between the Swedish Dockworkers' Union and APM Terminal at the Port of Gothenburg (Wee, 2018). In contrast, the global trade container yearly throughput increased approximately by 8.8% (World Bank, 2020). Further, no values were found from the period 2016 to 2019 with the exception of the Port of Gothenburg. The values were extracted from the Port of Gothenburg, Index Mundi and The World Bank official reports of their respective websites.

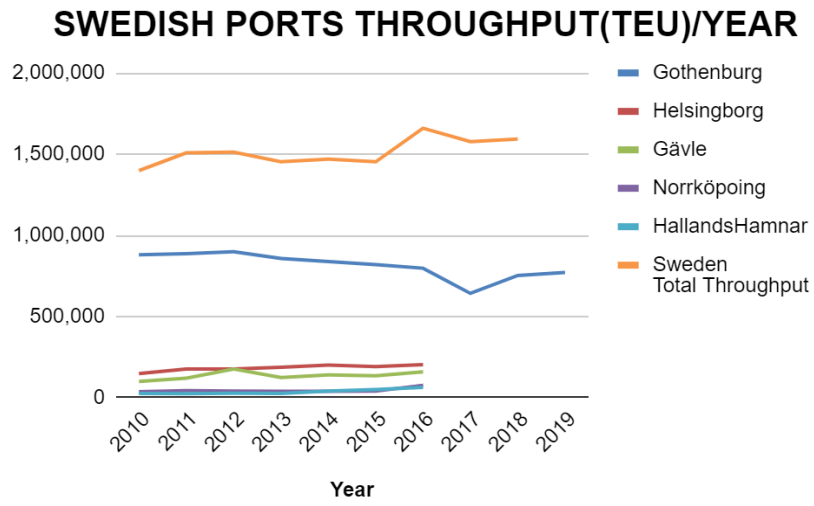

Figure 4: Sweden's and Ports Throughput (TEU)

Sweden is a country that practices and actively promotes sustainability in all aspects. For this reason, it is not unusual for the Port of Gothenburg's clients and the public authorities to be concerned with the port's sustainability involvement, methods and externalities induced e.g. pollution (noise, air, water), traffic congestion and infrastructure degradation. (Port of Gothenburg, 2019)

In 2019, the container terminal at the Port of Gothenburg established environmental goals to reduce Carbon Emissions (CO_2) by 70% throughout the entire City of Gothenburg area by 2030 (base year 2014). The initiative consists of decreasing the overall internal operations and the extended areas emissions. To achieve the goal the following adjustments and changes were established and in-process i.e. electrically operated cranes and gates, terminal buildings (heated) and operating equipment which will utilize alternative fuels. Furthermore, the current vessel management at berth will be optimized in order to avoid time slot delays and consequently avoid speed increase; the implementation of the new goal will allow for an overall decrease in vessel fuel consumption. Also mentioned was that in order to achieve CO_2 decrease

a transportation shift from road to rail is necessary. (Port of Gothenburg, 2017; Port of Gothenburg, 2019)

2.2 Research Strategy

The research methodology is a strategy that allows researchers to apply a plan that will help them recognize, decide, process and study all the data gathered regarding their study subject. Further, it will help assess the reliability and validity of the research study. (Kabir, 2016)

The motivation for this research thesis is to be able to identify the current initiatives/incentives that are in place in other global ports in order to see if they are possible to be considered for implementation at the Port of Gothenburg by the collaboration of Government and Port Authorities to influence Swedish Shippers to consider modal shift for a more environmental sustainable transport. Furthermore, this area regarding initiatives/incentives at the Port of Gothenburg from the Port towards the inland leg in the transportation sector has not been fully developed with an existing lack of focus from an academic perspective. Therefore, the researchers have decided that the purpose of this study is an "Exploratory Research". (Collis & Hussey, 2014)

"Exploratory Research" This research type is utilized by researchers to identify possible causes and issues regarding a subject that has not been investigated in depth and where understanding is unclear. Further, this research will help recognize patterns, enhance knowledge and help reach decision-making goals within the topic. Additionally, exploratory research helps to identify if further research should be performed since investments may be required. (Collis & Hussey 2014)

Additionally, the process of the data gathered and analyzed is a combined approach of both "Qualitative Data Research Method" and "Quantitative Data Research Method".

"Qualitative Data" is data gathered in this category is mostly nominal or descriptive i.e. text. This type of data usually gives the researchers an opportunity to comprehend emotions, feelings or attitude toward a subject. In addition, it helps to grasp "how" a result was obtained and evaluate the changes in their ability to interpret situations. Therefore, the gathering of this type of information i.e. interview (face-to-face and phone), literature review and surveys will help answer the Main Research Question: Is the Port of Gothenburg able to influence Swedish Shippers mode decision-making in order to promote environmentally sustainable transportation? and Sub-Research Question 1: Does the Port of Gothenburg have initiatives/incentives that can promote a more environmentally sustainable inland transport? "Quantitative Data" the data gathered in this category are in the form of numbers. Surveys is a method of quantitative data collection; however, it lacks the ability to identify and clarify relations in a problem. Furthermore, the outcome of this method is usually easy to compile, correlate and generalize. The generalization from the sample to the entire population is the goal of this method Sub-Research Question 2: Can global initiatives/incentives be implemented in the Port of Gothenburg's current strategy? For this reason, the researchers have considered Quantitative Research as a solution to address RQ3 based on the questions developed and incorporated to the surveys i.e. score scale 1-5 regarding important issues (e.g. reliability, nighttime logistics). (Collis & Hussey, 2014)

Furthermore, the research outcome may be classified as "deductive". Collis and Hussey (2014) utilize this research to connect this logic model by shifting from general

observations to the examining empirical findings. The reason for this classification is that the theoretical framework of the research was developed prior to empirical findings analysis e.g. Global Ports (general) to Port of Gothenburg (particular).

Finally, since the purpose of the study has an exploratory aspect, the research paradigm which refers to the foundation that leads to "how" the research should be conducted based on beliefs and assumptions which inclines towards an "interpretivism paradigm"; therefore this paradigm is based on subjective perception which is shaped by the researchers point of view. However, it is important to note that the "Positivism Paradigm" is also utilized in order to gather factual information (survey questions rating scales) that leads to the "Interpretivism Paradigm". (Collis & Hussey, 2014)

2.3 Research Data Collection

According to Collis & Hussey (2014) and Kabir (2016) Research Data Collection is separated into two categories qualitative and quantitative. Additionally, each category consists of sub-category which include "Primary Data" and "Secondary Data".

"Primary Data" is data that is gathered by researchers (first-hand), which is not published meaning original. Interviews and surveys are part of methods being used to collect primary data and "Secondary Data" refers to data that is gathered from sources that have been issued or broadcasted through different forms. Secondary data are essential, as they can provide information from past activities since they are unable to be collected from surveys or interviews. In addition, literature review is a part of this data collection method. Finally, "Triangulation" is utilized by researchers to collect data from various sources for comparing and combining the outcomes (e.g. surveys and interviews). (Collis & Hussey, 2014; Kabir, 2016)

2.3.1 Literature Review

Literature Review allows researchers to acquire relevant information regarding the study being conducted (secondary data) further it will allow them to identify gaps in literature and deepen their knowledge regarding the research topic. In order to gain a broader understanding of the current situation within the transportation sector articles related to the area of study were gathered (Collis & Hussey, 2014). The areas are related to Global Ports, Port of Gothenburg, Intermodal transportation, Mode Decision-Making, EU and Swedish (transportation and environmental goals). Pertaining to the Global Ports and exploratory research was conducted in order to gather the current initiatives/incentives. In the situation related to the Port of Gothenburg the information was collected with the intent to identify gaps regarding the initiatives/incentives. Information regarding Intermodal Freight Transportation was to understand the link between modes and environmental sustainability aspects. Mode Decision-Making information was necessary to understand the criteria Shippers consider when selecting transportation. Further, to attain knowledge regarding environmental regulations and policies of EU and Swedish government sector data was collected.

The process for the data collection is as follows: research material was obtained via Google Scholar as well as "Supersearch" a student research tool provided by the University of Gothenburg. The research tool is used by entering keywords to find literature i.e. articles and journals that match the topic of study. In our research important keywords i.e. "Intermodal", "Intermodal Transportation", "Swedish Shipper's", "Swedish Carriers", "Port", "Port Authority", "Hinterland", "Port Terminals", "Intermodal Terminals", "Port Incentives", etc. to mention a few. By entering the listed keywords, it permitted the researchers to gather sources allowing for a better understanding regarding their study to further continue with their research. Utilization of the search tool engine gave access for the retrieval of relevant articles, and due to the short abstract that the articles contain allowed for a rapid sorting to further download only the relevant ones in order to support the literature portion of the study. Furthermore, research material was gathered from Port Authority, companies' official websites and the University library.

2.3.2 Interviews

Due to the research conducted through an "Interpretivist Paradigm" the interviews were with the purpose to explore and understand the actors opinions (feel, do or think) that are related to the topic studied in order to find differences and common aspects.

Interviews are considered in this case as qualitative primary research data. In addition, this study was conducted utilizing a "Semi-Structure" format to allow both interview and interviewees to engage and discuss in a formal setting. In order to carry out this type of interviews, the interviewers formulate a list of guidelines that will be followed during the meeting. Further the discussion can deviate from the original guidelines prepared should the interviewer consider that may be relevant to the topic. (Collis & Hussey, 2014)

Further, when utilizing interviews as a source of gathering information data for the research study; it is essential for the researchers to keep in mind the entire ethical aspect surrounding the study. This means "how" the study is being developed and "how" the findings are recorded. Therefore, the research study should not implicate the interviewee in any aspect; further, the interviewees should be informed prior to the interview any information that will be discussed; moreover, information regarding anonymity and confidentiality should be established. Finally, the interviewee has the right to decide when the interviewee has concluded. (Collis & Hussey, 2014)

Further, while conducting interviews "Anonymity and Confidentiality" are two critical areas the interviewee should be aware of in order to be able to carry a very close open transparent interview. By offering "Anonymity" the interviewees can express themselves with open responses and deepening within the subject without compromising their identity. Additionally, "Confidentiality" provides guarantee to the interviewee that any information provided will not be traceable by any entity. The importance of both approaches is that Anonymity and Confidentiality is that the

information is sensitive and there may be conflict of interest and opinions regarding the area of research. (e.g. IWW actors would want to promote their transport area; however, the Port may be interested in promoting the other modes as they may have higher priority). (Collis & Hussey, 2014)

Selected Interview Guidelines

For this reason, the researchers in order to deepen their understanding regarding the study, selected to conduct semi-structured interviews with the help of a formulated questionnaire that were developed after fully understanding the literature gathered; all questions were related to the subject and expertise of the transportation actor. In addition, the interview will be conducted with the participation of two (2) researchers and one (1) interviewee to ensure that all information gathered during the interview is fully explored. The interviewees for this master's thesis will be different actors that are involved in City of Gothenburg's transportation development, Port of Gothenburg as well as other actors in different cities of which their expertise can be used to understand the general Swedish transportation situation i.e. procedures, goals, challenges and future development areas. The researchers will notify the interviewees via email confirming time of call or in-person meeting. Interviewees were offered both anonymity and confidentiality for the interviews. Meaning not of the information provided nor personal opinions would be disclosed or traceable. By providing this information prior to the interview would allow for a more transparent response. Noted for the research study, the interview time length average was 40 minutes. A sample of the interview questions will be annexed to the Appendix 1.

# of Interviews	Sector	Area of Expertise
1	Port Authority	General Port
2	Port Authority	Environmental
3	Trafikverket	Inland Waterways
4	Business Region	Infrastructure and Logistics
5	Port Authority	IWW and Management

Figure 1: Interview List

2.3.3 Surveys

The design of the survey was developed after the gathering and understanding of the literature regarding the study. In order to formulate the questions that would address important factors that would aim to answer the questions of the study. Furthermore, the aspects of "Anonymity and Confidentiality" from the Interviews Section applies to the Surveys. For this type of survey the questions elaborated can be "Open and Closed", "Multiple Choice", "Rating Scale". "Open" are questions that permit the participant to express their opinions; "Closed" questions allow the participant to select answers from provided limited answers. Additionally,

"Multiple Choice" are questions that allow the participant to choose from various answers offered. Finally, the "Rating Scale" is when the participants rate (e.g. 1-very low to 5-very high) a question in order to measure the importance of a factor. (Collis & Hussey, 2014)

Selected Survey Guidelines

For this reason, the researchers decided to formulate a survey with the following type questions for their study: "Open and Closed", "Multiple Choice" and "Rating Scale". The survey questions were composed to gather responses from actors that are involved in the topic. They are commonly used for statistical analysis; however, exceptions exist i.e. sample size is small. The surveys are convenient as they have standardized answers and lack the complexity of a conversation. Furthermore, surveys were sent to Swedish Shippers (Producer, Manufacturers and Freight Brokers - generating transport demand) and Carriers (Freight Forwarder - satisfying transport demand generated) to understand their perspective when it comes to transportation demands. The survey for the Swedish Shippers was composed of a total of 26 questions and the Carrier survey consisted of 25 questions both surveys were sent via "Google Forms". The companies for both surveys were collected through an investigation to identify companies conducting business only in these categories. The step by step process: From the company official websites (appropriate contact person, position, email, phone, location) was extracted for survey. A total of 50 Swedish Shippers and 70 Carriers information was gathered and a survey was sent. The researchers established one week for replies, after the due date they considered follow-up calls to all companies within their list as the responses from the surveys were Zero (0). In addition, after the follow-up calls the researchers managed to acquire 4 responses from the Swedish Shippers and 0 response from the Carriers.

To conclude interviews and surveys will be analyzed and included in the findings area of the research, for further studies and improvements concerning the topic. (See Appendix 1 & 2)

2.4 Research Study Quality

This section will explain the importance of the Reliability, Validity and Generalizability aspects of a research study.

2.4.1 Reliability

Collis & Hussey (2014) states that in order for a research study to be reliable "if" replicated by different researchers, the result acquired/obtained should be the same at any given point. Further, this same repeated outcome is the credibility level of the research. When measuring the reliability it is important for the study, however, not sufficient for validity. Additionally, reliability is independent from validity, meaning that accuracy and precision of measured data could be valid but not necessarily reliable or vice versa. In interpretivist paradigm reliability is less significant than positivism as the qualitative measures (interviews) are not necessarily able to achieve the exact results; this is a crucial part because researchers might compromise the outcome of the study. Consequently, therefore, creating procedures as well as protocols is essential for authenticity purpose.

Reliability of this Study

The reliability of this study will be accomplished by gathering literature information from peer review articles, experts within the field (authors) and official entities further all the information collected will allow to develop the study framework. For "Interview Reliability" it is difficult to estimate since it is related to the interviewee (personal view, level expertise and situational aspects). For this reason, as explained in the interview section the interviewees are high positioned staff members within their organizations and the selected interview guidelines (topic) were established prior to the interviews. This information allowed the interviewees to be prepared for the interview scheduled day in order to increase the reliability of the study. Additionally, for "Survey Reliability" it was critical for the researchers that all elaborated questions followed the selected guideline previously mentioned to measure what is intended to be measured without compromising the results. Further, for increasing the reliability of the survey the interviewees were positioned within their company in the field of logistics and transportation departments.

2.4.2 Validity

Collis & Hussey (2014) mentions that Validity is the degree the test of a study is measuring what is intended to be measured; therefore, contrary to reliability. Irregularities in the sample i.e. small sample size, wrong question phrasing, large number of non-responses etc., being studied can undermine validity. Further, validity can be assessed in different ways: "Face Validity" which refers to both interviews and surveys, measuring what they intend to measure. "Construct Validity" is all the factors that are not cannot measured (i.e. emotional aspects e.g. anxiety, happiness, etc.) which categorize them as "hypothetical construct"; these are existing factors that are unable to be accounted for; further in order for them to be valid the researchers must be able to illustrate the observations. Another aspect to consider for the validity purpose is "doubt factor" as the established interview and survey questions may contain "errors factor" i.e. incoherent phrasing, emotional change e.g. boredom (causing non-responses from the interviewee/participant), these factors may compromise the validity of the research as the importance of questions being addressed are of critical part to entire study. (Collis & Hussey, 2014)

Validity of this Study

The validity of the research will increase as the questions provided to the interviewees and participants conform to the purpose of the study further the summary presented to the respondents prior to the interview dates and survey introduction to ensure this factor. Additionally, by providing summaries the researchers engage the interviewees to want to participate and be part of the study. In order to prevent a disengagement from the interviewees, the interview began with semi-structured questions that led to an open discussion for interview relevance regarding the topic. Surveys were limited in order for higher response (approximately 5 minutes) the surveys were formulated in this matter for participants to not lose focus or interest when responding; allowing for a higher response rate. However, due to the current Pandemic situation and the irregular working factors the responses were limited. Finally, the "triangulation" method will be used in data collection from interviews and surveys to investigate the topic (e.g. several of questions during the interviews and survey were similar) to ensure validity. (Collis & Hussey, 2014)

2.4.3 Generalizability

According to Crowther & Lancaster (2008) "Generalizability" is an important part of the quality in validity of a research because it connects "outcomes" from the data gathered that may be generalized for the use in other studies. Further, they note that data collected is essential for two reasons: *"Data Sample Generalizability"* and *"Extended Generalizability"*. Firstly, when it is *"Data Sample Generalizability"* refers to evaluating the sample results as it may be generalized to the population that the sample was extracted from. Secondly, *"Extended Generalizability"* refers to the results of the data that may be applied in other settings or populations.

Generalizability of this Study

The Generalizability for this research is due to the results as they are associated with a specific context and environmental aspect e.g. Port of Gothenburg or Transport Sector (Context) and Pollution (environmental aspect). The researchers have acquired a deep knowledge and understanding regarding their research subject; however, the participants' cognitive aspects (e.g. physiological, intellectual, etc.) may affect the outcome without the researchers awareness. (Collis & Hussey, 2014)

Finally, the researchers have considered that the results of their studies can be generalized and implemented on a broader level thus, adding value to other research studies and within the transportation sector.

CHAPTER 3

This chapter provides a more in-depth explanation regarding the reason's ports require to reconsider their current inland development strategies. In addition, Global Port development strategies in the form of initiatives/incentives are described. Also included in this chapter are Freight container Transportation e.g. intermodality and terminals, Sweden's current inland transportation network and Transportation Tendencies e.g. mode decision-making factors. Finally, the overall emission goals of the EU and Sweden are presented.

3 LITERATURE REVIEW

3.1 Directional Development Approach

Wilmsmeier et al. (2011) states that the directional approach is related with the "Spatial Directional Development Framework" of transportation infrastructure depending on the corridor and inland terminal relation. This means that "Spatial Development" describes the direction from where the integration is derived from.

This approach is divided into two categories:

(1) Inside-Out: Inland terminals growth is driven from inland entities with the assistance from public authorities (landside directional development) e.g. inland terminal development may be influenced by Barge, LSP or Rail-Road operator and Government Authorities.

(2) Outside-In: This concept is utilized from the ports (i.e. Port Authorities and Operators) towards the inland section in order to capture the inland transport market share (seaside directional development) e.g. inland terminal development may be developed by Port Authorities, Port Terminal Operators or Sea Carriers.

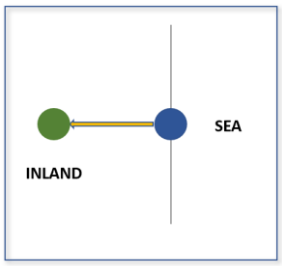

Figure 2: Modified based on Directional Approach (Wilmsmeier et al., 2011)

Major sea operators seek to acquire a share of the hinterland profits by incorporating a vertical integration into their strategy. However, prior to their investment decision-making operators will take into consideration an essential factor which is the existing infrastructure; allowing them at times higher returns in comparison to their sea operations. (Shobayo & Hessel, 2019)

Port selection today is considered of secondary importance due to the increased investments in the inland sector and the decrease of political influences. These changes have reshaped the entire transportation network. Further, a shift from a vertical physical to vertical cooperation integration has occurred. Therefore, the port inland related operations have become of interest and focus of many studies. (Shobayo & Hessel, 2019)

Sweden is considered to have an Inside-Out directional development approach since their municipalities goals are environmental mitigation from the increase of modal shift and the development of the city e.g. increase job opportunities and local industry growth. However, the municipality does not intend to acquire full control of the operations but provide the "assistance" e.g. regulations or funding required. (Wilsmeier et al., 2011)

Further, municipalities ambition to gain benefits has led to the inclination of terminal construction in areas where it is unnecessary. Additionally, Sweden's Inside-Out approach has increased the inland development speed, risk competition between municipalities and reducing economies of scale. Therefore, regulations from government authorities or regions, and the cooperation between all parties involved is crucial; this, in order to increase the overall efficiency of the transportation network i.e. increase modal shift and decrease in overall emissions. (Wilmsmeier et al., 2011)

Inland terminal policies are considered complicated due to the different goals of the involved parties and leading sometimes to unequal competition; thus, creating monopoly in the sector. Consequently, the Inside-out approach is frequently utilized by public authorities compared to the Outside-In development; further, it is difficult for all these entities i.e. EU, National Governments, Regional Authorities and Municipalities to align as their priorities differ. (Wilmsmeier et al., 2011)

3.2 Global Port Initiatives/Incentives

Partial effects surrounding environmental problems are within the port area or the adjacent zone. These environmental problems arise from external factors i.e. selected transportation modes, transport network inefficiency, fuels being utilized in the inland part of transportation network etc. Based on studies Rail and IWW modes have the possibility to mitigate environmental impacts as they are more energy efficient, less polluting and alleviate pressure from road networks and thus being more sustainable. (Aregall & Bergqvist, 2017)

Due to increased environmental awareness and many impacts caused by the transportation network sector, ports and government authorities have redirected strategies to help remediate the damage caused in the inland transportation to or from the port.

Further, Aregall & Bergqvist (2017) classified their study in two categories from a macro and micro perspectives. The macro perspective included government both domestic and international policies targeting general transportation i.e. initiatives implemented, and the micro perspective was focused on i.e. hinterland area specific (strategies, policies and plans) from government, ports and private actors. Some of the initiatives covered on the macro perspective were "EU White Paper" (roadmap for future initiatives to create a competitive transport system), World Port Climate Initiative (WPCI - commitment among major ports to decrease GHGs emission), EcoPorts Foundation (main EU environmental initiatives to promote awareness), EcoBonus (to promote modal shift from road to sea), etc. The following are some of the micro perspective initiatives Port of Los Angeles Clean Air Action Plan, Rotterdam Climate Initiatives, etc. (Aregall & Bergqvist, 2017; European Commission, 2020; EcoPorts, 2020; Sustainable World Ports, 2020)

Based on our literature review we were able to identify a lack of studies regarding initiatives/incentives regarding the micro perspective however, the only study that we identified was the one conducted by Aregall & Bergqvist (2017). Their study demonstrated that the majority of initiatives/incentives goals were regarding actors' own interest concerning infrastructure, decrease emissions by improving engine vehicle performance, new technology implementation in order to reduce traffic and the vehicles distance from the port should be related to their emissions levels. The study also listed the least utilized strategies were regarding subsidy funds, differentiated port dues and general lack of knowledge within the sector. The initiatives/incentives targeting air pollution, intermodal transportation and modal shift are considered as more sustainable solutions. In contrast, initiatives/incentives targeting noise pollution and traffic are considered a less sustainable solution. Although all the initiatives listed above require further addressing the reality for any of them to be successful entails the need for collaboration of all stakeholders.

3.3 Relationship between Maritime Trade, Seaports and Intermodal Transportation

Maritime trade became the essential part of international trade, due to the standardized containerization concepts to allow efficient flow of goods by linking all transportation modes to areas that had limited access to the market. The maritime transport distance covers the majority of any shipping transportation network. In addition, due to reasons i.e. ship vessel size increase, shipping alliances, focus on better

network transportation designs, new development in technology (e.g. automation and slow steaming), has led maritime shipping to reduce cost (economies of scales and improve efficiency). Further, modal choice is considered a key element in the network transportation design at the level of tactical decision-making strategy. (Brewer, Button & Hensher, 2008; Bouchery, Woxenius and Fransoo, 2020)

Although these results have a positive impact in transportation development it also requires the rest of the actors i.e. rail operators (rail network system, infrastructure e.g. double-stack) to invest significantly to adjust and improve in their areas for intermodal transport to be considered an adequate alternative. (Monios & Bergqvist, 2016)

Chen, Cullinane and Liu (2017) and Brewer et al. (2008) states that seaports are crucial in order for international logistics and globalized economy to be efficient and it directly affects local/regional/national economic growth since it connects sea shipping and inland transportation. As a result, due to worldwide business growth and the transfer to a door-to-door business concept (transportation from point of origin to final customer with minimum interruption/delay), the transportation stakeholders (shippers, carriers, government) have shifted their attention to the hinterland- terminal portion in order to reduce overall costs.

Overtime intermodal transportation has been highly influenced by the increase in standardization e.g. containers, handling equipment. Thus, having a positive impact in both the domestic and international shipping i.e. business practices, information transparency (related to IT and communication); which allows a more integrated logistics supply chain. (Monios & Bergqvist, 2016)

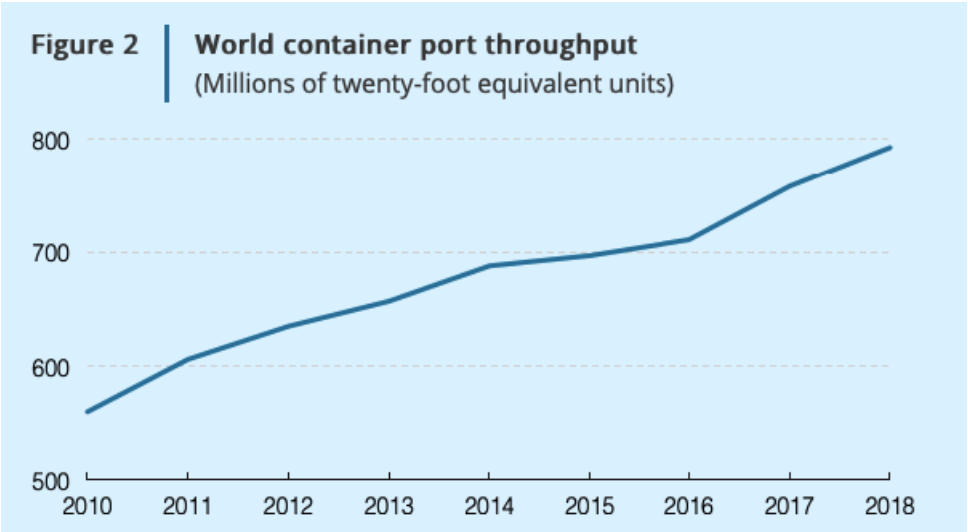

Figure 5: World Container Throughput (World Bank, 2020)

As illustrated in the above graph we note that container throughput has increased over the past 10 years; this includes empty containers (World Bank, 2020).

Furthermore, Bouchery et al. (2020) states that the container inland transportation cost of the total transportation cost is between 40%-80% and vessel size led to this increased cost.

3.4 Intermodal Freight Transportation

In the transportation sector it is noticed that the road is the most economic (cost), flexible and agile compared to the other modes. However, this transportation mode also entails constraints due to traffic congestion, fuel price volatility, local/states taxes and the high recognition of the importance of environmental problems. In addition, studies show that if the transportation sector utilizes rail and inland waterways it will decrease burden from the road sector and thus will decrease environmental pollution i.e. CO_2. In order for intermodal transportation to be a good alternative solution within the transport sector rail transport cost should be competitive to road. (Gharehgozli, De Vries, and Decrauw, 2019)

Freight transportation development is associated with the relationship between manufacturers and customers' demands and transportation distance. Manufacturers require the goods to be transported according to the customers' needs, consequently the shippers (i.e. producer, manufacturer, broker) are generating the transportation demand. The role of the Carriers (e.g. railways, freight forwarders) is to provide adequate transportation solutions to the Shippers; the role of the Government is pertaining to the infrastructure (i.e. the development of transport corridors, regulations in various areas), and taxation within the sector. (Crainic & Kim, 2007)

Intermodal Freight Transportation is defined as a multimodal network, consisting of container usage and transport services. This network connects the original shipper to the end customer by utilizing a container (door-to-door service) and is performed involving long distances. Further, to conduct intermodal freight transport a combination of carriers and modes may be required (Crainic & Kim, 2007). Intermodal transport in order to be seamless it requires a high level of collaboration between land and sea transport. In addition, the sea and land transport characteristics (both physical and information flow) differences must be abolished in order for it to be considered a seamless intermodal journey otherwise it could not be treated as an integrated logistic surface. (Monios & Bergqvist, 2016; Crainic & Kim, 2007)

Below are listed some of the intermodality challenges mentioned by Bergqvist & Monios, (2016):

1. Short distance - Intermodal transportation is not cost viable for short distance - Cost viability-break even 450km.
2. Flexibility - transportation routes, pick-up, drop-off, notice time (elaborated more in the non-economic section) this is lower in comparison to road transportation.

3. Development - Due to high fixed costs of rail operators and the need of consolidation causes difficulty in developing rail transport services.
4. Last-Mile Transport - regarding Pre-Post Haulage (PPH) in intermodal transportation which is supplying an empty container to the shipper and further transport of a full container to the intermodal terminal. The PPH accounts for approximately 25-40% of the total cost of container transportation therefore due to mainly this high cost it cannot compete against road haulage.

However, there are several advantages in Hinterland Intermodal Transportation (HIT) due to containerization e.g. easy transhipments, reduction in road traffic congestions and decreases in accidents, making it a more environmentally sustainable transportation solution. Further, this leads to competition among seaports as the location's distances become secondary. (Bergqvist & Monios, 2016)

It is for this reason that port container terminals have focused on the development of strategies concerning logistics networks capacity that can alleviate the increase of container volumes transported by road. Consequently, leading to new developments which are taking place in the hinterland leg regarding i.e. inland terminals, dry ports, extended gates and intermodal terminals. (Bouchery et. al, 2020) The standardized unit in intermodal transportation is called "Intermodal Transport Unit" (ITU) e.g. "International Organization for Standardization" (ISO) maritime container, a swap body or a semi-trailer that can be temperature controlled. The critical factor for intermodal transportation successful development was due to the increased standardization. Research shows that the implementation of containerization was a lengthy process to achieve a proper model that met all purpose requirements. Among the containers, the mostly utilized are the 20 ft and 40 ft long unit due to their height and weight capacity. (Crainic & Kim, 2007)

Further, Swap Bodies and Semi-Trailers are utilized in intermodal transportation and can facilitate transition from road to rail and vice versa to another, however, one negative aspect is that they are not apt for stacking nor for sea-vessel transport (i.e. special handling equipment, lifted by the bottom). (Crainic & Kim, 2007)

3.4.1 Associated Implications of Containerization

According to The Institute of Logistics and Transport - ILT (2008) although the container has improved and facilitated international trade activities it has also brought forth unexpected challenges. To better understand below are listed several of these consequences.

1. **Terminal Investments**

Container terminals in order to meet customer demand have required intense improvements in the area for the handling of goods, however, these modifications need a large amount of capital investment. These include investments of high cost equipment i.e. yard and dockside gantry cranes; straddle carriers, machines to transfer containers

in storage areas. In addition, at the seaport dredging is required to accommodate the new size vessels. In rail, seaport and in the road terminals these equipments do not vary (similar). (ILT, 2008)

2. Required Expansions in Terminal Areas

Due to an increase in container traffic, massive expansions are required at the terminals to accommodate the high-volume throughput of containers. Expansions in areas that have been affected by this growth are manoeuvring and turning in the daily operation activities i.e. automation of machinery, storage areas. This effect has influenced modifications throughout the entire intermodal terminal network (rail–road and seaport terminals). Furthermore, the space required for these expansions is difficult to attain due to i.e. government regulation and property regimes. (ILT, 2008)

3. Logistics Hubs

Hubs are central points within a transportation network where transfer activities are handled e.g. loading/unloading/storage etc. For the cost (capital) to be justified the sea, rail and air freight sectors had to develop a hubbing network. Further, due to the consolidation required in order to reach economies of scale the number of hubs in the transport network is limited and decreasing over time. Still, improvements are required in every node of the transport network due to technological and organizational changes i.e. door-to-door instead of port-to-port solutions. Due to intermodality, companies' business models have been redefined in order for all actors to be able to compete by offering sea and inland solutions e.g. vertical integration of shipping lines/sea terminals acquiring inland terminals. Therefore, in order for all the modifications to work among nodes and enhance connectivity, actors have to collaborate with each other e.g. integration of infrastructure, information and operations. (Roso et al., 2015)

4. Increase in Mode Capacity

Due to high volumes of container and their flexible staking characteristics it has influenced the different modes of transport to invest in capacity, however, their viability is being re-evaluated for their ability to reach economies of scale i.e. in the shipping industries vessels size have increased. Further, it is important to mention that not all container ports will be capable of accommodating the new large vessels. In the railway sector double stacking has been developed in certain countries in order to transport more goods; while in the countries were unable to develop e.g. due to high monetary investments required, unable to modify current tunnel heights, preferring passenger over goods. (ILT, 2008; Rajamanickam, 2019)

5. Freight Sector Market Share Competition

Many concerns have developed surrounding the new modification in the transportation sector. As a result of the intense changes and competitions from a shipper’s perspective it is critical to embrace uncertainties that arise i.e. technology and cost. Further, it forces smaller companies to be unable to adapt to the rapid changes, making them vulnerable in the sector and at times causing them to cease. On the

contrary, many of the larger companies have formed alliances in order to monopolize the sector. (ILT, 2008)

Affected Areas within the Transportation Network	
Terminal	High Capital Investment Expansions at sites
Network	Logistics Hub
Modes	Capacity Increase
Shippers	Competition

Table #1: Affected Areas within the Transportation Network.

The above table summarizes the areas that were affected by container standardization.

3.4.2 Terminals

According to the article written by Rodrigue, Comtois and Slack (2013), a "Terminal" is defined by many researchers depending on the *location* and *function*. Also stated that a terminal is defined as "any location where freight and passengers either originate, terminate or are handled in the transportation process". Additionally, in 2017 the Conference of European Directors of Road Report (CEDR) defines terminal as "a place where goods are consolidated between sub-modes, e.g. from light to heavy trucks, or transhipped between two or more modes (road, rail, IWW, sea or air). In addition, Dasgupta (2019) differentiated ports from terminals noting that "Port" are locations that are strategically situated at the borderline of land and a waterbody i.e. ocean , rivers, sea and lakes whereas "Terminal" refers to a physical location (site) where handling of cargo takes place depending on type of the goods being transported i.e. bulk, container and Liquefied Natural Gas (LNG). Also mentioned by Rodrigue et al. (2013) is that terminals may be divided according to mode and the commodity type i.e. bulk, containers and general cargo. Furthermore, the researchers will utilize a geographical and commodity type (mixed) definition for terminal for this study.

In shipping as a result of the tendency towards freight consolidation and the 2008 crisis we are able to identify that the sector is highly influenced by a very small selective group of companies i.e. for Terminal Operators: Hutchison Port Holdings and APM; and Shipping Carriers: The Alliance, Ocean Alliance and 2M. Approximately 63% of the total containers being shipped globally were handled by the alliances mentioned above. Further, 36% of the global container throughput (TEU) were managed by the top 10 port terminal operators. (Monios & Bergqvist, 2016)

In the case of intermodal transportation different actors are involved as listed below: (VTI, 2017)

Pre and Post-Drayage Operators:	Conduct transportation process via road, IWW or rail to/from terminals for short distances as a portion of longer overall transport movement (short haul).
Pre and Post-Carrier Operators:	Conduct transportation process via road, IWW, rail, or sea between terminals.
Terminal Operators:	In-charge of the transshipment portion between the transportation modes.
Infrastructure Management Operators:	In-charge of the overall infrastructure logistic connectivity among the different modes.

Table #2: Intermodal Transportation Actors

Further according to Monios & Bergqvist (2016) and Roso et al. (2015), the following activities may take place in the terminal:

1	Container load unload and berthing (Shipping)
2	Receiving/Delivery outside of terminal (Road/Rail)
3	Storage/Container Handling (Yard Area)
4	Container Maintenance
5	Track and Trace
6	Custom Clearance

Table #3: Terminal Activities

Terminal Types

1. Rail-Road Terminals (Inland Container Terminal - ICT)

Rail-Road terminals are composed of different spaces for the different modes. The rail-road terminal has parallel lanes in the form of a rectangle (yard); these lanes are dedicated for road or rail. In addition, a buffer land utilized for the Intermodal Transport Units (ITUs) (VTI, 2017). Also, gantry cranes operate within the space (rectangle) in order to transfer containers between rail-roads.

The length of the train and yard must be of equal length in order to prevent splitting the train when arriving at the terminal. Further, connectivity between modes is necessary for the terminal to operate in an efficient manner. In order for smooth transition in and out of the yard without the use of extra diesel locomotives the electric tracks must be at both ends of the yard. In addition, reach stackers may be used for access to and from the different yards. The movement of the containers from truck to rail that occur at the terminal railway it only refers to intermodal transportation. These containers upon arrival are either immediately placed (stack) in the queuing area or put on a rail car. Containers that are in the queuing area will then be picked up and placed

into groups reading to be loaded onto the railcar. However, when the containers arrive via rail to a terminal the activities will be performed in reverse. (Monios & Bergqvist, 2016; Monios & Bergqvist, 2017)

Depending on the products or the modes of transportation, the design or the size of the terminals is diverse; thus, offering at times customization as required. In these terminals different activities take place i.e. the load/unload, consolidation, sorting, modification of modes and transfers of units between the different modes etc. The goods inside of a container are not handled during the transport. Transfer may occur from different modes. (Monios & Bergqvist, 2016)

Inland terminals may be classified i.e. Dry Ports, Inland Container Depots, Logistics Centers (LC), Inland Ports, Freight Village and Inland Clearance Depots, according to their roles and services being provided. (Roso et al., 2015)

2. Inland Waterway Terminals (IWW)

IWW terminals refer to terminals located at rivers, lakes or canals which may or may not be connected to the sea; in the quay area containers can be stacked in order to maximize space utility. Further, should the inland waterways and road-rail terminals be located to close proximity then the container storage area will most likely be exploited by both terminals (if same operator). However, machinery required for operations is more costly and dimensions differ (larger/higher) in order to be able to transfer the containers from vessel to quay. (VTI, 2017)

3. Seaport Container Terminals

Sea Port Container Terminals are an essential part of a logistics network. The location of the terminal must be strategically placed in order for all transfers of containers to be seamless (from sea to Road/Rail/IWW or reverse). Sea terminals are part of a port where vessels dock to load and unload containers for transport. The majority of ports are in close proximity to large cities. (Monios & Bergqvist, 2016)

The most important activity provided by a seaport container terminal is to allow a seamless transfer among sea vessels and road/rail. In order to perform these operations, it requires various types of equipment and procedures due to its complexity. A container terminal is divided into three areas: sea-side (quays and cranes), land-side (receiving gates, loading/unloading area and the related equipment for the operations within this area) and yard (where the stacking of containers take place). (Monios & Bergqvist, 2016; Monios & Bergqvist, 2017)

The process of the container at the terminal starts from the vessel arrival at the port where quay cranes unload/load the containers to/from Automated Guided Vehicles (AGVs), next containers are transferred via vehicle between ship and stack area and dropped off (limited time). Later picked up and taken to the next connecting mode takes place (barge, ship, road or rail) and reversed. Most ports still have terminals with equipment operated by people i.e. multi-trailers, cranes, straddle carriers, etc, however,

new technology innovations are being implemented i.e. automated straddle carriers. (Monios & Bergqvist, 2016)

Major Container Terminal Operators

According to Container-Exchange (2020) and Wee (2018) the following are the major port terminal operators around the world:

APM Terminals is a multinational subsidiary of A.P. Moeller-Maersk from Denmark with headquarters (HQ) located in The Netherlands. The company operates in approximately 78 terminals and offers inlands services on a global scale. Revenues were approximately $4.13 billion in 2018.
Hutchison Ports Holdings is a container terminal operator with HQ in Hong-Kong. Operations take place in more than 51 ports (26 countries) globally. Known for being the first terminal operator to reach a 1.3 billion in total throughputs.
PSA International formerly known as Port of Singapore Authority. The company's HQ is located in Singapore. The company operates more than 45 terminals globally. They have also invested in the terminals to accommodate mega containerships.
DP World (HQ) is located in Dubai. Operates more than 52 container terminals globally with rapid growth. In 2018, the company purchased Unifeeder shipping line as a terminal operator.
In addition, *Cosco Shipping, CMA, Yilport Holding, China Merchant Port Holdings, MSC/TIL* are also considered important operators.

Table# 4: Major Global Container Terminal Operators

3.5 Sweden Transportation Network (Inland)

3.5.1 Sweden's Rail-Road Transportation

The total number of rail yards in Sweden are eleven and 7 of them are highly important. A reduction over time has occurred because of decreased needs of industrial facilities to have rail tracks and the increase of feeder transport to combi terminals that do not require rail yards. The number of combi terminals are above 30 and handle shifts between rail and road (container, trailers and swap-bodies). The majority of these terminals are established in the southern part of the country and few in the north. Truck and combi terminals have reduced in numbers however, their size has increased. In certain cases, the owner of the terminal may be a public or private entity. Specialized terminals have emerged to replace the smaller ones that could not survive. Sweden Railway transportation has easy access to both domestic and international nodes; and a very small number of them start and end in the same region. (Regeringen, 2018)

Since 1990, railway load capacity has decreased even though rail wagons are getting larger. Nowadays, Sweden has approximately over 500 towing vehicles and 14000 rail wagons. The EU train lengths are longer than in Sweden, therefore, it is recommended to use equal length for cross-bordering (Regeringen, 2018). According to Trafikanalys (2016), Rail transportation accounted for 10% and Road Transportation accounted for 64% of the total goods transported in tonnes for the year 2014.

In Sweden in general more than 50% of freight is moved less than 50 km, approximately 25% is moved around 50-149 km and less than 10% transported to 150-299 km the portion of more than 300 km is small. The longer distance the freight is moved the heavier is the average weight of the cargo. In 2014, Foreign Vehicles accounted for 4% of total goods transport in Sweden. In 2016, the number of foreign trucks (cabotage - goods or people transportation in the same country conducted by a foreign operator) accounted for approximately 1.35% of the total Swedish trucks. In 2016, the volume being transported was 1.6% of total domestic road goods transport. However, trucks with registration numbers not of the EU were not part of the above statistics. In Sweden, the majority of transport is conducted by foreign trucks (for cross-border trade). Furthermore 82% of the cargo volume carried by road was performed by foreign trucks. (Regeringen, 2018)

Sweden's freight transportation has been very steady among modes. Lorry transportation accounts to approximately 8% (28 million tonnes) of domestic goods moved more than 300 km; due to break even distance of cost between road and rail is recommended to be performed by rail or ship. However, shift to rail or ship is not always feasible. Further the majority of long-distance transportation takes place between Stockholm, Göteborg, and Malmö, modal shift in this network is limited due to high traffic. (Regeringen, 2018). Since 2007, the heavy goods trucks in Sweden have remained stable at approximately 80000, however, their load capacity has increased (Load-bearing class 4-BK4). Simultaneously during this period, the number of light good trucks increased steadily and at the end of 2018 were above 555,000 trucks. (Trafikverket, 2019; Regeringen, 2018)

3.5.2 Sweden's IWW Transportation

Inland Waterways Transportation is considered a sustainable transport system that can substitute and alleviate the road transportation sector. In addition, this method of transportation can avoid congestion, bottlenecks, it is energy efficient, reduces noise pollution, diminishes accident levels and increases the reliability factor. For this reason, Sweden has implemented initiatives i.e. INTRASEA project part of the 2010 "EU White Paper" initiative which promotes a more sustainable environmentally friendly method for transporting goods via IWW (maximize capacity by using river-sea solutions) as shippers do not consider IWW an efficient or productive method of transport. Figure #5 below illustrates the IWW of Sweden. (Dreamforce Infomedia AB & Swedish Maritime Administration, 2005)

Figure 5: Sweden's IWW (Sjofartsverket, 2006)

Sweden IWW Routes

In 2014, Sweden began conducting transport through their IWW routes, however, vessels required certification and with EU standards. Transportation of goods is currently only possible in Göta River, Lake Mälaren and Lake Vänern (Trafikverket, 2019). Sweden IWW routes are Södertälje Canal (Stockholm's Norvik Port and Mälarhamnar Port new cooperation) (Hansson, 2020) and Trollhätte Canal used for commercial/tourist transport, 7 canals (tourist only). Göta Canal has 58 locks and is considered the most important one (Sjofartsverket, 2005). Further, due to low traffic, lack of clients, high cost, fees and the lack of port-to-port inland connections (feeder traffic) the profit margin is very low. It is for this reason, that Sweden has focused on developing projects regarding IWW, however, study results demonstrate that they are not cost competitive to road transport and therefore difficult to find viable solutions. In order for IWW to be successful it will require all actors/parties to be highly involved. In 2011-2016, Sweden's domestic freight average via inland waterway transport was 2% while in European Union list it represents 6% of the total freight transport. Sweden's goal is to double their IWW traffic (Trafikverket, 2018; Regeringen, 2018).

3.6 Global Transportation Development Tendencies

Based on the literature review performed we were able to identify that in the last decade the articles written have increased their attention to environmental

sustainability and intermodal transportation. According to Bask & Rajahonka (2017), the focus of previous literature was on finding the most efficient transport solution by maximizing the utility of the mode for the decision makers. However, Lammgård & Anderson (2014) mentioned in her study that the importance given to sustainable environmental aspects has been stable over time but it is imperative to point out that Lammgård's research was only for the years 2003 and 2012 and based on only Swedish shippers preferences.

Transportation is a necessary activity of an economy; however, it is the primary reason for the deterioration of infrastructure and the diminishment of natural resources. Green Paradoxes which are discrepancies in the relationship between environment and logistics have been recognized i.e. cost, time/flexibility, network, reliability and warehousing. As a result, green paradoxes can be influenced by shifts from road to other modes which are more environmentally efficient (Lammgård, 2012).

GREEN PARADOXES	
Cost	A company's approach is to minimize cost; however, the environmental costs are far from being internalized.
Time/Flexibility	Increased emissions due to extended production and the demand of energy.
Network	Due to development and extension of a logistic network consequently led to intensification of environmental pollution i.e. cluster of vehicles.
Reliability	Road is considered the primary reliable mode of transport; however, it is one of the most polluting.
Warehousing	Inventory shift to road transport will lead to an increase of traffic in the network and to other consequences.

Table #5: Green Paradoxes (Lammgård, 2012)

Rail and Water mode transportations are more energy efficient than road transport and lead to less externalities per tonne/km performed. Statistics also indicate that road and air are the two modes with highest emissions For this reason, a modal shift from road to rail or water is seen by the different stakeholders (i.e. Governments, European Commission and Non-governmental Organization-NGOs) as a solution to reduce CO_2 emissions. (Elbert & Lowis, 2017)

In 2016, the EU transport report stated that inland waterborne only accounted for 4% and rail only for 12% of total transportation illustrating that these two modes are less utilized within the sector. (Bask & Rajahonka, 2017). Furthermore, Lammgård (2012) states that additional reasons for promoting Intermodal Transportation other than environmental image marketing are cost savings (due to volatility of oil prices), low risk (oil pricing dependency), competitive advantage and improved performance.

According to Hoen, Tan & Fransoo (2014), there are two reasons for companies to decrease their carbon footprint (1) Willingly Engagement: due to customer demands, environmental groups and voluntary initiatives; (2) Governmental Policies.

The allocation of freight among transport modes which is called Mode Choice is one of the most contentious arguments in the logistics sector, as externalities i.e. environmental impacts and safety are not taken into consideration when selecting transport modes. Therefore, depending on the mode chosen since they consist of different attributes, the efficiency and the overall performance of the logistics network will be affected. Hoen et. al. (2014), identified that the traditional trade-offs when selecting transport modes were between lead-time and transportation costs. Additionally, Kim & Van Wee (2011) also stated that, due to the constraint of trade-offs shippers are unwilling to change their transport decision-making attitude.

Nevertheless, in order for intermodal freight transport road-rail to be considered as an alternative choice instead of road transport then all the obstructions in mode selection have to be eliminated, therefore it is vital to identify factors and challenges that can boost the transition to intermodal transport. (Elbert & Lowis, 2017)

3.6.1 Economic Factors and Non-Economic Factors

Below are the most important factors that may influence a shipper's decision-making when selecting intermodal transportation.

1. **Economic Factors**

Cost is often the most important criteria as shippers do not care about the mode being used as long as their requirements are being fulfilled (Elbert & Lowis, 2017; Lammgård & Anderson, 2014). Lammgård & Anderson, (2014) and Bergqvist & Monios, (2016) state that as the transport distance increases then the cost of intermodal transport decreases faster compared to road; therefore, distance is recognized as a facilitator in intermodal transportation development. Further, the break-even distance is noticed at 450-500 km however is highly dependent on market situation i.e. fuel prices and transhipment cost; in addition, another factor that affects cost is the shipment sizes. Due to higher load capacity of intermodal transport (Rail and IWW) economies of scale can be achieved and the probability of decision makers to select intermodal transport increases as the shipment size increases and vice versa. The cargo attributes i.e. value, commodity type and physical size can further affect mode decision making negatively or positively (Elbert & Lowis, 2017).

Further, it is mentioned that shippers value service rate and reliability equally to transport cost; a positive outcome of road mode selection is due to low freight rates, flexibility, transport speed and last-minute scheduling requests. (VTI, 2017; Elbert & Lowis, 2017; Kim & Van Wee, 2011). This economic factor is of greater influence in mode selection than non-economic factors i.e. delivery time, flexibility or frequency which lead to the conclusion of cost minimization of freight transport. As mentioned

above, these factors of importance are determined based on circumstantial manners (Elbert & Lowis, 2017).

2. Non-Economic Factors

Qualitative Factors

The qualitative factors influencing shippers mode decision-making are reliability, frequency, transport safety, transport time and flexibility. These qualitative factors are rated as the second most influencing criteria after transportation cost. (Lammgård & Anderson, 2014; Elbert & Lowis, 2017; VTI, 2017; Arencibia, Feo-Valero, García-Menéndez and Román, 2015)

Researchers have shown that qualitative factors i.e. transport *"Reliability"* (agreed transport time) if further enhanced, the companies are willing to pay more for the service provided. In Intermodal Transport the reliability level is higher compared to road, as it is "related to" punctuality and scheduling planning capabilities i.e. rail (depending on the region e.g. prioritized, dedicated tracks). Consequently, due to punctuality, planned capabilities the sector of sensitive goods can promote an increase in modal shift. However, the perception of reliability is ambiguous and shippers associate it to flexibility thus having a low opinion. (Arencibia et al., 2015; Elbert & Lowis, 2017)

"Frequency", which is the number of offered transport services per time unit, is a factor that was regarded as less influential in decision-making. Today, it is believed that higher frequency could improve the modal shift rate (i.e. shuttle train) however, transport frequency in rail is limited due to the priority of passenger services. (Elbert & Lowis, 2017)

"Transport Safety" of goods - Acceptance Risk Borderline - increases if transportation cost or transportation time decreases; further, it will depend on the value of goods. Therefore, when considering Intermodal transportation as alternative modal shift solution the transhipment damage risk should be low in order to shift to rail. Furthermore, dangerous goods due to the higher level of risk in road transportation can promote modal shift to rail. (Woxenius, Persson & Davidsson, 2013) *"Transport Time"* is a less influencing factor than reliability, frequency and transport safety, however, shuttle trains can be used in order to improve transport time between the port and the hinterland. In order for this to be possible, we need to take into consideration that the transport time should not affect the value of goods being transported i.e. sensitive goods, fast fashion goods. In addition, (the importance of transport time in mode decision-making will decrease as the transport distance increases (Elbert & Lowis, 2017).

Lastly, *"Flexibility"* pertains to transport routes, Pick-up/Drop-off and notice time is for unpredictable orders to meet customers' needs within a volatile and short-time-unit (Cullinane and Toy, 2000; Elbert & Lowis, 2017; Reis and Macario, 2019). Due to increased importance of concepts i.e. Just-in-Time (JIT), decentralized production, as well as, the volatility in the markets; flexibility significance has gained momentum (Bergqvist & Monios, 2016). However, due to flexibility limitations in

certain transport modes (e.g. rail) then its importance in intermodal transport will decrease when compared to road decision-making selection.

Furthermore, we can identify secondary aspects that have impacted the increase in transportation in general i.e. Connectivity (e.g. from port to hinterland) and Proximity. *"Connectivity"* refers to the feasibility connection of a node to the existing nodes within a network (Monios & Bergqvist, 2017). The interrelated network between port and land has made the hinterland connectivity an essential part of a company's competitive strategy. This is due to an increase in freight traffic, the movement of goods and distribution through intermodal transportation has been challenged (IVL, 2013). *"Proximity"* refers to the closeness regarding distance and time between nodes. It is therefore, that the proximity factor may cause an increase or decrease in intermodal transportation mode decision-making due to its interrelation with cost factor (break-even). As a result, proximity of terminal location and shippers can contribute to cost savings as well as a lower environmental impact. (Bergqvist & Monios, 2016; Bouchery and Fransoo, 2015)

In order for shippers to consider a shift to intermodal transportation as an alternative availability, cost and quality must be equal to the other modes established by the company to be accepted. For this reason, customer acceptance is the primary factor, however, the other three (availability/quality/cost) are prerequisites for a company to favour the selection. In addition, if low-efficient performance and service quality are lower than the perceived opinion it will consequently lead to the selection of a different mode; hence service level and cost should be of equal importance. (Lammgård & Anderson, 2014).

Thus, the economic and non-economic factors within intermodal transport illustrated above are critical factors that shippers take into consideration when selecting their transportation modes. Researchers have shown that even if rail-road transport is of lower cost (cheaper), road transport is selected due to higher quality factors as stated above (Bask & Rajahonka, 2017; Lammgård, 2012; Bergqvist & Monios, 2016; Bouchery & Fransoo, 2015; Elbert & Lowis. 2017; Arencibia et al., 2015; VTI, 2017)

Infrastructure

Researchers seem to agree that infrastructure, transportation demand and transportation cost factors have a major impact on mode decision-making; however, there are many points of view when referring to infrastructure. (Kim & Van Wee, 2011; Elbert & Lowis 2017). According to Woxenius, Persson & Davidsson (2013), international trade growth has led to an increase in road transportation mode selection due to limitations in infrastructure i.e. rail. Physical requirements i.e. terminals, rail infrastructure and transhipment technology are prerequisites in order to promote intermodal transport.

Furthermore, adjacency to production sources can reduce transport cost and emissions due to pre-post haulage cost reduction; however, the lack of rail infrastructure in areas beyond the major corridors or intended delivery markets has created a negative

impact in promoting intermodal transport. Furthermore, different standards i.e. rail gauges and technologies (e.g. electrification, signalling systems, etc.) have an impact in modal shift as it complicates the interoperability of different networks. (Elbert & Lowis, 2017). However, in Europe there are several phase projects underway to enhance the railways to increase operations, efficiency, safety as well as cost reduction throughout Europe e.g. the project of the European Rail Traffic Management System (ERTMS); however, they will address it segments and Sweden will be integrated by 2035. (European Commission, 2020; Traffikverket, 2020). It is for this reason that in order for intermodal transportation to be considered as an alternative and competitor to road transportation then the infrastructure must be well-established for it to be efficient (Elbert & Lowis, 2017).

Sustainability and Mode Decision-Making

Sustainability as a non-economic factor refers mainly to environmental aspects i.e. air, water and noise pollution as well as to traffic congestion which are important factors that can affect a sustainable modal shift decision-making. Studies demonstrate that a great part of environmental pollution pertaining to freight transport occurs in the port zone or adjacent to the port area. (IVL, 2013)

Although the EU has extensively increased awareness towards a more sustainable transport sector the results have been minimal despite the efforts. Furthermore, it has been unsuccessful to understand what factors are taken into consideration when shippers or Logistic Service Providers (LSPs) determine their mode choice; it is unclear if intermodal transport or environmentally sustainable perspectives are of any significance for shippers in decision-making and selecting their choice of mode. This area is of extreme importance as Shippers and LSPs are considered key influencers in order to accomplish this sustainable environmental goal. (Bask & Rajahonka, 2017)

Rail transport is very energy efficient and enables economies of scale, and thus, an effective solution to reduce emissions (Elbert & Lowis, 2017; Woxenius et al., 2013; Monios & Bergqvist, 2016). However, policies that have a goal to increase weight and length of vehicles have also led to an increase in competitiveness of road transport pertaining to cost and environmental efficiency. In addition, Eastern Europe's road transport company’s shares have increased due to low wages and thus have had a negative impact in sustainable modal shift (Bask & Rajahonka, 2017).

The model established by Hoen et al. (2014) which incorporated carbon tax, Emissions Trading System (ETS) and hard constraint on emissions i.e. government regulation; concluded that, in order for the decision maker to select a different mode than the one in use then one of the following factors (weight, distance or unit cost) has to be very large and additionally the emission costs have little to no influence in mode selection. Also, fuel efficiency and vehicle fill rates are very important factors that can be used in influencing modal choice compared to policies in contributing to the mitigation of environmental externalities (Lammgård & Andersson, 2014).

Lammgård & Andersson (2014) demonstrate that shippers' mode choice concerning environmental factors are the last aspects they consider as the selection is

based on traditional economic performance goals. Furthermore, shippers' environmental requirements are lower than those offered by intermodal transport therefore, their decision can be influenced further by regulations and policies. In addition, Bask & Rajahonka (2017) state that, the reason for the negative outcome is due to lack of standards methodology for measuring environmental impacts and the development of common sustainability goals between companies.

Moreover, as stated by Lammgård (2012) and Monios & Bergqvist (2016), shippers' strategies should be associated with a proactive environmental sustainability rather than await regulation to proceed. Additionally, it was demonstrated that the lack of collaboration among partners led to a negative result. It is for this reason that cooperation is essential in order to promote intermodal transportation i.e. increase loading rates.

Furthermore, mode selection decision-making involves the comparison of prospective gains and prospective losses i.e. a delay is perceived as a greater loss than an early arrival gain leading to the conclusion that barriers have more negative impact than the facilitators provided gains (Elbert & Lowis, 2017). Lastly, Lammgård (2012) states that the customers purchasing power and behaviour can influence the shipping industry to practice a more environmentally sustainable transport method; this method of practice adds value to transport operations.

3.7 EU and Sweden's Overall Emission Goals

The environmental impact of the transport sector has attracted a great amount of attention as it is a major source of Greenhouse Gas Emissions (GHGs). GHGs is a term widely used today which refers to several gases i.e. CO_2, methane and Chlorofluorocarbons etc. (IPCC, 2014).

Transport companies have noticed the emerging problem of carbon footprint management and its importance as the failure to do so can lead to viability issues as regulations/legislations have been enacted and getting stricter with monetary penalties under way (European Commission, 2020).

The transport sector's incapability to reduce GHGs emissions is due to intensive use of fossil fuels, with road transport emitting 70% of the total gases in 2014 and 21% of CO_2 in 2016 in Europe (Emberger, 2015; European Commission, 2020).
From 1990 to 2014 in Europe GHGs in the EU were reduced by approximately 23% except for the transport sector which showed opposite behaviour, increase of emissions (Emberger, 2015; Andres & Padilla, 2018).

IPCC (2011) observed that economic growth (GDP mainly) and GHGs emissions are strongly related and decoupling these two factors is essential in order to reduce GHGs emissions. Andres & Padilla (2018) noticed that GHGs emissions are closely correlated with the energy sector, as the consumption of energy in the transport decreased then emissions also declined, furthermore he emphasized that emissions in the transport sector are not only connected with the volumes being transported but also

its characteristics like energy intensity, modals characteristics, energy source mix and economic activity; which are the main objectives of either governmental or organizational policies.

The GHGs emission goal was set to 60% reduction by 2050 (reach carbon neutrality) with base year 1990, and strategies recommended by this paper were related with transport efficiency, energy efficiency, modal shift and use of alternative fuels.
So, by investing in infrastructure development which can promote modal shift, increase of vehicle energy efficiency by technological innovations and use of alternative environmentally friendly fuels like electricity and biofuels can push the GHGs reduction to the desired levels. (IPCC, 2014)

However, the above strategies were based on the assumption of a steady economic growth and technological development/innovation which can complement and support each other and consequently reduce emissions without taking in consideration economic recessions and the ability of these strategies to be effective under pessimistic circumstances (Emberger, 2015).

In 2019 standards for heavy duty vehicles (mainly lorries) CO_2 emissions were set in force which according to European Commission will contribute in CO_2 reduction for this decade, this are 15% reduction from 2025 and 30% from 2030 (the period 2019 to 2020 average percentage was set as base), in the first step will consist only of large lorries which are responsible for ¾ of CO_2 emissions from heavy duty vehicles. Financial penalties will be placed in cases of non-compliance and the monitoring will be achieved through mandatory Vehicle Energy Consumption Calculation Tool (VECTO) software implementation (European Commission, 2020).

In Sweden, the transport sector was responsible for 14% of the total carbon footprint (Hu, Wood, Tukker, Boonman & De Boer, 2019). It was the first country to establish an Environmental Protection Agency in 1967 (EPA) and the emissions as a total global percentage is less than 0,2% however the goals established by the Swedish government are clear and strict. Sweden's goal is to reduce emissions by 2030 by 63% and eliminate fossil fuels, by year 2040 to reduce emissions by 75% and by 2045 to have neutral GHGs emissions (Klimatpolitiskradet, 2020; Sweden, 2019).

CHAPTER 4

The following chapter will present the findings gathered from primary and secondary data obtained through interviews and surveys conducted to stakeholders and their roles within the inland transportation sector in connection with environmental sustainability areas. Further, the descriptions and goals of these initiatives/incentives is considered by the researcher as empirical material and further included in this chapter and not in the literature review.

4 EMPIRICAL FINDINGS

4.1 Presentation of the Stakeholders

Government – Municipality

Regulations and Policies are established by the State Authorities i.e. Government, Parliament and other Public Agencies in Sweden. These state authorities are in charge of infrastructure development. Furthermore, the government is responsible for any negotiations related with the EU and UN; and for the administration of the municipalities. Municipalities are provided rights from the Government to manage their regions e.g. transport infrastructure, environmental protection among other responsibilities. (Valencia, 2019)

Trafikverket

Trafikverket is Sweden's Transport Administration entity that develops and manages the entire area of transportation sectors i.e. infrastructure road, rail, sea and air. Some of their tasks include maintenance, operations, building developments e.g. road and railways. One of Trafikverket's targeted goals is to increase accessibility within the entire transportation network since the population's well-being is affected. Furthermore, the principal objective is that the transportation network being developed takes every aspect into consideration which includes the environment and society. Therefore, in order to accomplish these objectives collaboration among all the stakeholders is a key factor. (Trafikverket, 2019)

Business Region Göteborg (Municipality - Gothenburg)

Business Region Göteborg is entirely owned by the City of Gothenburg and their task is to oversee the area of business development within Gothenburg and all their 13 municipalities. This company is a non-profit entity which does not conduct or take part in any commercial activities. Counts with a total of 9 members in their Board of Directors Committee. The company's financing is generated by the support of the City of Gothenburg, additional funding is provided by Västra Götaland region, other government agencies and private entities; further, funding depends on the projects related. Business Region Göteborg provides value to the City of Gothenburg due their involvement creating job opportunities, a more sustainable trade and industry

development. In addition, the company provides information and knowledge for future start-up businesses within the region. (Business Region Göteborg, 2020)

Port of Gothenburg

Port of Gothenburg's main activity is to manage infrastructure e.g. land, quays, facilities to maintain a competitive position (Landlord Model). Further, activities surrounding safety, efficiency, marketing (promoting traffic) and environmental sustainability is their primary focus. This port is the largest within the Scandinavian area. The Gothenburg Port Authority is owned by Göteborg Stadshus AB - City of Gothenburg; financing of the Port Authority is derived from client base, concessions, charges (port and freight), rent and leasing agreements; means that the port is self - financed. Further, if the profits exceed the annual budget the difference between them will be allocated to the City of Gothenburg. (Port of Gothenburg, 2020)

Container Terminal - APM Terminals

The Container Terminal Operator (APM) in 2011 signed a concession with the Port of Gothenburg to conduct business for a period of 25 years. Based on the concession terms APM Terminal is responsible for all costs related to terminal development and equipment. In addition, the terminal operator offers a variety of logistics services i.e. depots, loading/unloading services, storage, and logistics services (e.g. rail shuttle connectivity) which add value to the terminal operating company and promote railway; thus, providing a more sustainable transportation network. (APM Terminal, 2020).

Due to the Port Authority Sector concerned with all aspects in regards to environmental sustainability and commitment to UN sustainable development goals; the terminal operator has committed to perform improvements within the operating and seaside areas. Further, due to the high volume of container throughput of approximately 772 000 TEUs and with the ambition to double this amount, the Port of Gothenburg is continuously working on new forms of improvements that would enable them to reach their targeted goals pertaining to their sustainable perspective. Several of the improvements are electric operating cranes and automated gates, heated facilities, the use of alternative fuels for operating machineries and berth management optimization. In the case of automated gates e.g. Optical Character Recognition (OCR). The OCR software operates by automatically scanning the container information e.g. container number, seals, and warning labels which allows for efficiency and accuracy; the current turnaround time is 25 minutes opposed to the average turnaround time of 56 minutes in the other European ports. In order to decrease CO_2 both Port Authority and Terminal Operator have shifted their focus in promoting rail transportation. Additionally, investment railway infrastructure development e.g. double track rail, cross-docking terminals with the collaboration of terminal and Port Authority and Railport Scandinavia. Finally, the initiatives being implemented on the seaside leg and internal operating areas are not considered as targeting the hinterland leg of the network. (Port of Gothenburg, 2019)

Inland Waterway - Port Authority

This port authority is owned by the Municipality with a similar organizational structure as the Gothenburg Port Authority. Several of the services provided by the entity are driven by customer demand; these services offered are handling, storage of containers among others etc. Some of the areas that this port authority covers are within the areas in Lake Mälaren which has access to the Baltic Sea. (Målarhamnar, 2019)

Furthermore, research has shown that if IWW is utilized by the transportation sector it will help decrease the impacts from the road transportation sector. Consequently, decreasing the environmental footprint and increasing a more sustainable transport. (Gharehgozli et al., 2019)

Stakeholders	Role	Topic of Discussion
Trafikverket	Infrastructure Development	Rail/Road/IWW
Business Region Göteborg	Business Development	Transportation and Mode Decision-Making
Port of Gothenburg (2 Stakeholders)	Infrastructure Development	Port of Gothenburg and Sustainablity
IWW Port Authority	Infrastructure Development	IWW and Environmental Sustainability

Table #6: Interview Actors

The above table illustrates the stakeholder, role and topic of discussion during the interviews.

4.2 Global Initiatives/Incentives Description and Goals

The following are several of the initiatives/incentives that have been implemented or considered for future implementation in seven (7) major ports across the world (Belgium, Germany, Netherlands, Spain and United States of America). Furthermore, these initiatives/incentives are potential solutions to be considered at the Port of Gothenburg as their context may be adopted.

Further, the different initiatives/incentives will be categorized in five aspects depending on the targeted issues which are: air pollution, noise pollution, congestion, modal shift and cargo consolidation these surrounding road, rail and inland waterways transportation. In addition, each initiative/incentive will be described.

4.2.1 Air Pollution

The following initiatives/incentives are solutions surrounding air pollution improvements that are currently in place with the exception of "Transpower Zero Emissions Technology" in the Port of Los Angeles (currently in-process).

"Synple Platform" The initiative was developed in 2017, it derived from the Mainport Innovation Fund II (collaboration of Port Authorities, Government

and Private entities) in the Netherlands. The initiative is an information system platform that enables different Carriers to combine cargo and to exchange rides by matching freight transportation with capacity. Further this initiative can improve environmental sustainability as it reduces empty mileage by 50%. (Port of Amsterdam, 2017)

"EcoCalcultor" Is a software tool utilized in the Port of Barcelona to help reduce CO_2 emissions from the hinterland which allows route optimization and the selection of the most environmental friendly mode of transport - by comparison; it is recommended to the Shippers. (Port of Barcelona, 2020)

"Maasvlakte 2 Air Quality Agreement" was implemented for the reduction of traffic congestion and the improvement of air quality by the Port of Rotterdam. The initiative enforces a low emissions zone where traffic is restricted to only clean trucks- Government initiated (Air Quality Action Plan). (Government.nl, 2020)

"Clean Air Action Plan and Clean Trucks Program" In 2006, the Port of Los Angeles adopted the "Clean Air Action Plan (CAAP)" which developed measures that are implemented by the port regarding the decrease in emissions (all port related operations). In 2008, the "Clean Truck Program (CTP)" incentive derived from CAAP was implemented for the reduction of truck numbers that were not in compliance with the United States Environmental Protection Agency (EPA) restricting the use of trucks with engines prior to 2014 (currently). The incentive provides funding for operators to replace their trucks and the funding's are generated partially by fees pertaining to the loaded cargo of a truck that did not comply with the EPA restrictions. In 2018, after the implementation some of the initial results were air emissions reduction: Diesel Particulate Matter (DPM) by 97%; reduction of Nitrogen Oxides (NOx) by 78% and Sulfur Oxides (SOx) by 92% in comparison to 2005. In addition, "***Transpower Zero Emissions Technology***" initiative is being currently developed with the purpose of integrating a battery charger inside the trucks to eliminate the need of an external battery charging stations and utilizing roads for charging; this initiative will be able to support a truck with a 100-150 mile range. Furthermore, it will allow close distance from the port to warehouse/intermodal container terminals. (Port of Los Angeles, 2017)

The following two programs at Port of New York-New Jersey (1 initiative and 1 incentive) are similar to the Port of Los Angeles. "Drayage Truck Engine" initiative to eliminate any trucks with engines prior to 1995 (entire port area) and 1997 or older (no access to terminal area). "Truck Replacement Program" the goal of the initiative is to help freight forwarding companies to replace trucks engines that are not up to standard with the 2007 federal emission regulations. Further, in order to qualify for the incentive a

company must at least have a total of 150 port calls or more during the last year and must serve the port for a minimum of 5 years after the replacement. This

initiative can provide funding up to $25, 000 USD or 50% of the replacement cost (lower amount of two). (Port of New York-New Jersey, 2020)

"Promoting Green Fuel" this initiative (also incentive) implemented in the Port of Amsterdam promotes the use of renewable fuels which have a lower environmental impact than the fuel currently used i.e. LNG. The initiative is also funding the development of new renewable fuels i.e. Hydrogen. Furthermore, if vessels choose to use these alternative fuels the initiative offers additional discounts on their harbour dues. In addition the Green award certificate provides discounts in port dues for inland vessels (Port of Amsterdam, 2019)

"Green Award" initiative/incentive implemented in the Port of Rotterdam which offers a full discount (incentive) towards inland port charges for all vessels that have acquired the certificate in addition to having Nextlogic as an optimization planning tool. In order to obtain the certificate, the vessel must operate on electricity, or on fuel cell 50% of the time or 3 hours/per day. Green Award is implemented also in the Port of Amsterdam offering discounts (Port of Rotterdam, 2020)

4.2.2 Noise Pollution

In this category initiatives/incentives the researchers identified improvements surrounding noise pollution that are currently in place at the Port of Hamburg.

"Whispering Wheels" initiative developed by the Port of Hamburg is related to the rail track portion. Since the implementation of the initiative 1,700 kilometers of rail have been modified to reduce noise emissions (glass walls around the tracks). Manuela Herbort (2018) - Government Rail Official stated that the initiative is a crucial factor for model shift from road to rail. Furthermore, approximately 58,000 building components have been replaced or incorporated to reduce noise i.e. sound resistant windows. Thus far, the initiative has invested a total of 43.6M Euros allocating the funds between sound protection walls in the rails and 1,800 apartments with sound reduction modifications (Port of Hamburg Magazine, 2018). Additionally, Deutsche Bahn- DB Cargo a private company developed their own initiatives concerning the road-rail transhipment portion (freight cars) Another initiative, "Whispering Brakes" was developed in 2017, where approximately 2/3 of trucks were retrofitted in order to reduce noise levels and by the year 2020 the company's goal is to make the entire fleet noise neutral. (Port of Hamburg Magazine, 2018).

4.2.3 Congestion

In this category diverse programs seek to reduce congestion from Road Transportation i.e. in the case of the City of Antwerp.

In 2019, ***"Night-time Logistics"*** was implemented in the Port of Antwerp, this initiative was created for several port terminals to operate 24 hours a day in order to absorb container transport peeks. The initiative would decrease traffic congestion within the road network. (Port of Antwerp, 2020). In addition, the ***"SMARTPORT"*** initiative is utilized as an Information Technology (IT) solution for optimization of port efficiency regarding traffic flows, infrastructure and flow of goods. i.e. Blockchain. Furthermore, *"Nxt Port"* application that facilitates the exchange of data among the various actors involved; allowing for a faster and more efficient data transaction with real time information i.e. enables drivers for real time container slot pick up at the port area, thus, eliminating congestion and idle times (Port of Antwerp, 2017).

4.2.4 Modal Shift

In this category we have identified programs that can have an impact on modal shift by encouraging road to rail or IWW solutions.

"Sustainable Rail Package" (named by the Thesis researchers) in the Netherlands (cargo flow to and from the Port of Amsterdam), is an agreement with government authorities and all parties involved in rail transportation in order to increase rail freight traffic. The incentive provides a considerable fee reduction; thus, improving the environmental life quality of the surrounding residents and complying with the European Railway Traffic Management System (ERTMS) project regarding railway safety systems. (Port of Amsterdam, 2018)

The Port of Barcelona ***"European Railway Cluster Initiative (ERCI)"*** is an initiative that consists of enhancing EU railways with the collaboration of all the actors involved. Furthermore, it aims to help increase the participation of Small-Medium Enterprises (SMEs) to modal shift to rail; and increase transportation capacity for a seamless operation of rail transportation of goods and services. The initiative is composed of 80 entities within the European Rail Network (Clustercollaboration.eu, 2020)

"Rail Incubator" as a result of an increase in rail freight traffic, the Port of Rotterdam was given the opportunity to collaborate with various operators in a co-investment for the development of new railway connections and the increase of frequencies of rail shuttles. Current rail shuttles are approximately 250/weekly. Another initiative is "Empty/Full Journeys - Overmeer" their goal is to shift the last-mile of transport to the local railway service "Port Shuttle";

this collaboration with Port Shuttle allows a decrease of inefficient truck journeys (Port of Rotterdam, 2015; Leijen, 2019)

"Modal Shift" In 2017, the Port of Antwerp agreed to invest 1.4 million euros towards projects that would help reduce the number of annual truck trips; the number of truck trips would be reduced by 250 000/per year. The following are a few examples of the projects that would take place. "Delcatrans: shift to barge" sustainable and reliable reefer platform to help decrease the number of truck trips by utilizing barge mode; thus lowering truck trips by 5400/per year (Port of Antwerp, 2017; Luppova, 2017; Knowler, 2017).

4.2.5 Cargo Consolidation

The following initiatives are being implemented in collaboration between the different actors in Belgium and the Netherlands.

"Hakka NV: Avoiding Empty Truck Trips" digital platform developed in Antwerp which provides real time information to freight forwarders to find potential clients to maximize full capacity of trucks; this will help reduce truck trips by 120 000 per year (Port of Antwerp, 2020). In addition, "Synple Platform" also serves as a solution in the area of cargo consolidation. (Port of Amsterdam, 2017)

"West-Brabant Corridor (Lean and Green Europe)" initiative supported by Port of Rotterdam and Amsterdam due to the increased volume of container throughput of 250 000/per year in the Amsterdam-Utrecht-Rotterdam route. This initiative consists in the consolidation of container cargo in various terminals with a capacity of consolidating a minimum of 150-200 containers at each terminal. In turn, it will lead to a lower client demurrage, detention costs and reliability as well as an increase in modal shift from road to barge (lower emissions). (Port of Rotterdam, 2018)

Global Initiatves/Incentives				
PORT	**NAME OF PROGRAM**	**TYPE INCENTIVE OR INITIATIVE**	**CATEGORY**	**COLLABORATIVE YES/NO**
Amsterdam	Synple Platform	Initiative	Air Pollution/Consolidation	Yes
	Promoting Green Fuel	Initiative/Incentive	Air Pollution	Yes
	Sustainable Rail Package	Incentive	Modal Shift	Yes
Antwerp	Night Time Logistics	Initiative	Congestion	Yes
	SMARTPORT	Initiative	Congestion	No
	Modal Shift	Initiative	Modal Shift	Yes
	Hakka NV: Avoiding Empty Trips	Initiative	Consolidation	Yes
Barcelona	EcoCalculator	Initiative	Air Pollution	No
	ERCI	Initiative	Modal Shift	Yes
Gothenburg	SMARTPORT	Initiative	Congestion	No
Hamburg	Whispering Wheels	Initiative	Noise Pollution	Yes
	Whispering Brakes	Initiative	Noise Pollution	No (Private Company)
Los Angeles	Clean Truck Program	Incentive	Air Pollution	Yes
	Transpower Zero Emissions Technology	Initiative	Air Pollution	Yes
New York-New Jersey	Truck Replacement Program	Incentive	Air Pollution	Yes
Rotterdam	Green Awards Platinum Certificate Compliance	Initiative/Incentive	Air Pollution	Yes
	Rail Incubator	Initiative	Modal Shift	Yes
	Maasvlakte 2 Air Quality Agreement	Initiative	Air Pollution/Congestion	Yes
	West Brabant Corridor (Lean and Green Europe)	Initiative	Consolidation	Yes

Table #7: Global Initiatives/Incentives

The above table shows Initiatives/Incentives of major Ports around the world and the initiatives the Port of Gothenburg currently has in place; however, the Port may also have initiatives/incentives that the researchers have not been able to identify. Therefore, for the purpose of the study the researchers will assume that the initiative listed above is the only existing one. As illustrated, there are many initiatives/incentives currently in place around the world with ports having a leading position in these programs. These programs have an Outside-In directional development approach as they are developed in their majority by ports towards the Hinterland. Further, in the table above there is a distinction between initiatives and incentives; the initiatives are driven either by regulations or technological innovations, whereas in contrast, the incentives are geared towards providing financial support (funding or discounts). Additionally, these initiatives/incentives are offered to inland terminal operators (end result benefiting the shippers) and directly profiting the shippers, collaboration between the different actors is a common characteristic (i.e. Port Authority, Terminal operator, government and Shippers).

4.3 Interviews Results

4.3.1 Port of Gothenburg - Overview

Interviewee #1 has extensive experience within the Maritime field and currently working at the Port of Gothenburg. Further, general information and facts regarding the Port of Gothenburg were provided in addition stating that it is the largest port in Scandinavia. Mentioned also, that the port is divided into four major operations: *Container, Ro-Ro, Finished Vehicle and Energy & Oil*. Further, it was stated that due to high volumes of throughput it comes with high levels of carbon footprint. Due to this the port focuses heavily on environmental issues and efficiency of operations i.e. calculate vessels emissions from the time they enter to the fairways as well as the internal area of operations. One of the goals of the port is to attract more volumes. Consolidation at the port decreases empty/full journeys thus, avoiding environmental impact therefore is important for the port.

4.3.2 Initiatives Process Development

Interviewee #2 as stated above is part of the Port of Gothenburg Authorities. During our interview he stated that initiatives are at times suggested directly from the shippers however, they may derive from other actors. Further, any initiative that is to be considered to be implemented the shipper has to be onboard. Pilot projects are usually supported by the Port of Gothenburg; however, they are shipper driven and government financed e.g. of a pilot project was the onshore power supply. For the most part companies desire to be part of the new projects; however, they are costly and the Port does not provide financial support. Although financial support is not granted by them, they do assist companies regarding infrastructure and applying for funding (European or National). When considering the development of new initiatives, the shippers first concern is regarding if the initiative will be successful long-term e.g. the LNG initiative took a long time prior for the first vessel to implement. The LNG project shipper felt that it was a high-risk decision for the switch to occur; due to purchase and modifications of vessels are expensive. For this reason, Interviewee #2 reiterated that the *"Risk Factor"* applies to all new port projects as the future is uncertain. Therefore, since the shippers have the ultimate decision-making the ports tend to their needs. In addition, it was stated that for the most part all actors involved tend to agree that sustainable developments should take place, however, it is always in question "how" it will be accomplished. ***Interviewee #1*** stated that one of the Initiative implemented at the Port was regarding seaside operations i.e. LNG discount. In addition, "automated gates" at the port are in place for the decrease of truck waiting times (queuing time) by providing assigned slots. Internal areas of operations at the port are green oriented "automation" changes have been established e.g. "Nightrider" straddle which operates during the night facilitating loading/unloading of containers for morning shifts.

4.3.3 Road-Railway Transportation

Road

Interviewee #4 Gothenburg nor Sweden currently do not have congestion issues maybe slightly during peak hours. ***Interviewee #1*** stated that one problem that Sweden currently faces is that the country allows old trucks that cause higher environmental impacts as no regulations are established e.g. most of these vehicles are coming from other parts of Europe. Also mentioned by interviewee #1 that Cabotage (is the right of a company from a European country to conduct business in another country) is not considered from the sustainability aspect and it is an area that should be studied and considered further.

Railway

Interviewee #4 Also discussed during the interview is that The City of Gothenburg does not have any issues relating to rail capacity as development is underway, however, the issue arises in the rest of the Swedish network as there are priority issues e.g. passenger. Furthermore, in the rail sector there has been no investments during the past years and stated it was a problem. ***Interviewee #1*** stated that the railway network system is overcrowded and bottlenecks occurring outside of the city limits as passengers are prioritized. ***Interviewee #5*** stated that due to climate changes a shift from road to rail is occurring, however, there is a lack of capacity in rail. Furthermore ***Interviewee #4***, stated that there are alternative mode transportation solutions, however terminal operators goals as well as the City of Gothenburg goals may differ i.e. profit vs. sustainability, which may hinder their business operations leading to customer loss; terminal operators obviously are not willing to do so. Finally, ***Interviewee #2*** mentioned that developments are taking place inside the Port of Gothenburg surrounding modal shift (rail efficiency increase).

4.3.4 IWW Transportation

Interviewee #3 has an extensive private and government background with both local and international projects. During the interview it was stated that green initiatives have been a focus since 2014. Further, it was stated that projects i.e. Ecobonus which offers discounts to shippers can have a high impact in promoting modal shift to IWW as this is extremely important to Sweden to have alternative transportation mode other than road and rail. The interviewee stated that Sweden is currently an automobile industry therefore, the majority of funding goes to those projects and the focus from promoting business in waterside had decreased since the shipyards and coastal fleet have disappeared. The citizens don't understand the benefits of conducting business on the waterside, however, if they would be aware they would be able to influence government decisions. ***Interviewee #5*** also described initiatives (e.g. On-Shore Power supply) being implemented at the port, in order for vessels to utilize, are under consideration, however, are not a critical matter for the ports. Furthermore, there is

currently no market demand regarding these matters and if in the near future there would be market and demand then the port will proceed with changes. Stated by ***Interviewee #3*** was interested regarding the "Nighttime Transportation" as established in Paris for the goods transportation within the city waters. In addition, a strategy they would like to consider is "Traffic Restrictions" of heavy vehicles, therefore, taking advantage of the IWW i.e. in Stockholm and the Netherlands. Furthermore, this same interviewee mentioned that a modal split percentage set by the government like in the case of Netherlands (Clean Air Agreement) can be a potential solution to shift traffic from road to IWW as rail is already congested. Finally, Sweden government has no way of steering ports as municipalities are in-charge of developments.

Interview #3 stated that the country lacks infrastructure in IWW making it more difficult to promote the mode and is the reason why shippers turn back to road. Additionally, Interviewee **#5** mentioned that there is a lack of traffic (volumes) and infrastructure in order for it to be considered as an alternative. Furthermore, ***Interview #3*** stated that IWW at the present time is a more expensive mode of transportation. Another area that requires attention, and makes it may become difficult to develop and promote the IWW sector is due to the lack of established guidelines (certificates, permissions, flag registrations) in addition to the high fees for vessel operating companies.

Finally, ***Interviewee #5*** re-emphasized during the entire interview that collaboration and intervention from the Swedish Government is necessary in order to achieve a modal shift from road to IWW or Rail. Further, it was mentioned that all stakeholders related to IWW and politics make it more challenging to promote modal shift. This interviewee concluded that in the past it was believed that the market (road vs. IWW/Rail) would be regulated on its own but that has not been the case. It was also mentioned that in the past conversations surrounding regulations were not a topic of discussion, as they are today.

4.3.5 Mode Decision-Making

Interviewee# 4 stated that there is a clear distinction between Small and Large companies in their knowledge regarding transportation taking place. The smaller companies are not interested in how their goods are being transported (they contact transport companies which are in-charge of fulfilling their customers' needs) thus, making mode-selection not a concern for them. In addition, the interviewee mentioned that the larger companies are more familiar with all the environmental aspects occurring. Further, it was discussed that cost and reliability are the most important factors, but cost is the primary driver. Also, stated that transportation time (lead time) is of equal importance. Furthermore, due to the reliability importance in the mode selection and lack of maintenance in the railway network, shippers are concerned more about their goods getting stranded within the network. For this reason, selecting road transportation as their preferable mode allows them for an easier solution should an incident occur. Some examples provided were the ongoing projects regarding IWW

i.e. Lake Vänern where traffic can be diverted from road to IWW. The interviewee also stated that the economic situation is a major concern therefore trucks are continuing to be selected as they are cost efficient. Furthermore, ***Interviewee #1*** stated that reliability, lead-time and frequency are some of the deciding factors when shippers select rail as an alternative mode choice. The reliability factor is not a concern when goods are not time sensitive then shipper decision-making is not affected e.g. forest products do not have this issue. As a general rule shippers do not trust the system in place and thus, have the "biasing" effect when selecting modes.

SWEDEN IDENTIFIED TRANSPORTATION PROBLEMS	
ROAD	Old Vehicles (European)
RAIL	Capacity
	Passenger Prioritized over Freight (Bottlenecks).
	No Infrastructure Development (past years).
	Port Terminal Operators goals *differ* from Public Authorities goals
IWW	Funding Issues
	Method *not promoted* from an Environmental Sustainability aspect
	No Market Demand,
	Lack of Infrastructure
	High Cost for Shippers (price)
	Lack of Guidelines for Operators
	High fees for Operators
	Lack of Collaboration between Stakeholders
	Lack of Initiatives/Incentives ("Ecobonus"/ "Nighttime Transportation"/ "Modal Split" Restrictions)
MODE DECISION-MAKING	Lack of *knowledge* and *concern* of Small Businesses regarding transportation.
	Railway Network Reliability Issues
	No Cost Competition between Road and Rail/IWW
	Biased regarding Rail

Table #8: Sweden's Identified Transportation Challenges

4.4 Survey Results

A confidential response survey was created utilizing google forms; the survey consisted of 26 questions (Shippers - Producer, Manufacturers and Service Providers) and 25 (Carrier - Freight Forwarders); the questions were of multiple choice, fill-in (optional) and check mark selection. Further, in order to achieve responses, the researchers gathered companies' information via the internet (contact person, email, type of business, phone number) to be able to send surveys. A total of 50 Shipping

Companies and 70 Carriers information was collected; however, replies were zero for both until the deadline established by researchers. Therefore, the researchers decide to contact the companies directly (via phone). After the due diligence, a total of 4 responses from Shipping companies were acquired and 0 from the Carries.

Below are the survey results from the Swedish Shippers (Producer, Manufacturer and Service Providers):

The company's size ranged from Micro to Large; 50% were medium and 25% were Micro and 25% Large. All Shippers are conducting their transportation through intermediaries (below Figure 7). Further, 75% of companies issue Annual Reports; and 50% issue Corporate Social Responsibility Reports (CSR). All companies from the survey are presently conducting some type of business through the Port of Gothenburg. Their port selection is 50% company decided and 50% service provider decision.

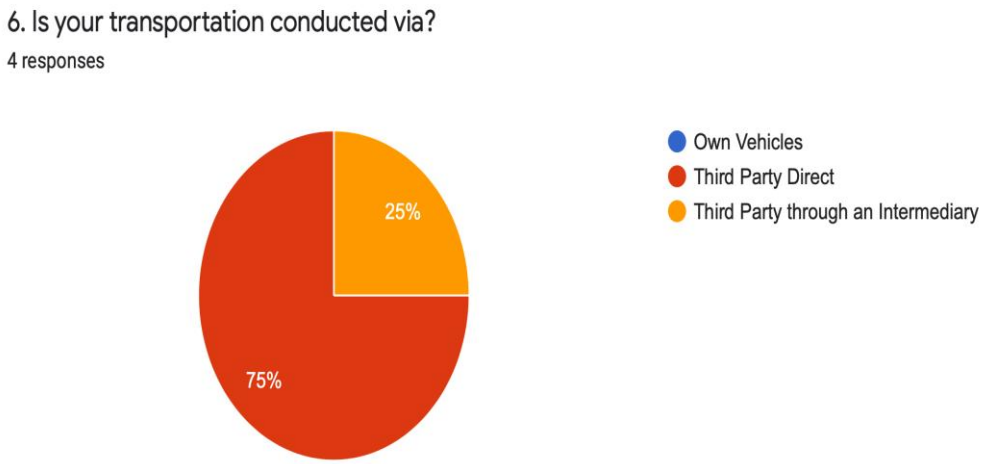

Figure #7: Own Vehicle/Third Party Transportation

Figure 8 below illustrates that reliability, cost and safety are the most important factors when Shippers select ***Road*** as their mode of transportation. Further, the environmental sustainability importance is low.

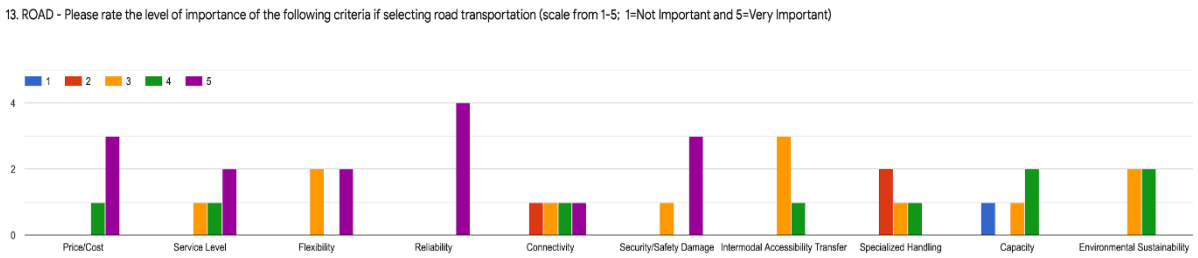

Figure 8: Road Criteria Level of Importance

The Figure 9 below demonstrates that reliability, cost, safety and intermodal accessibility transfer are the most important factors when shippers select ***Rail Transportation***.

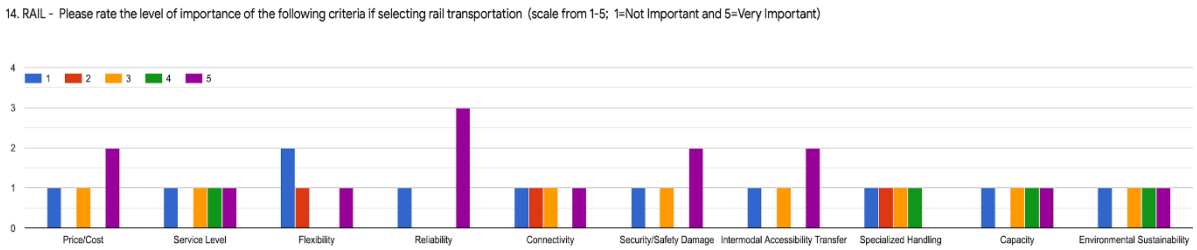

Figure 9: Rail Criteria level of Importance

In addition, the most important factors are price, flexibility, reliability, connectivity, and safety when selecting ***IWW Transportation*** (figure#). However, none of the companies are presently utilizing IWW as a mode of transportation. Further, 50% of the responders would consider IWW as alternative mode if available.

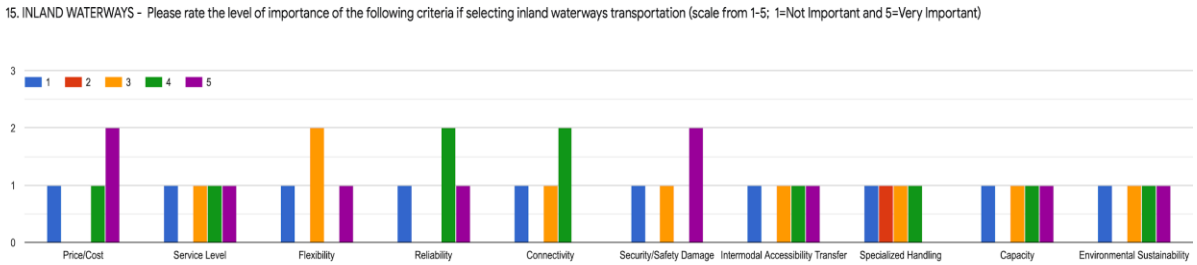

Figure 10: IWW Criteria level of Importance

The results illustrated that it is important for all shippers to work with carriers that are utilizing green transportation modes. However, 50% are aware and 25% are unaware of in place initiatives/incentives provided by the transportation companies and 25% that no information was provided regarding this (Figure 11).

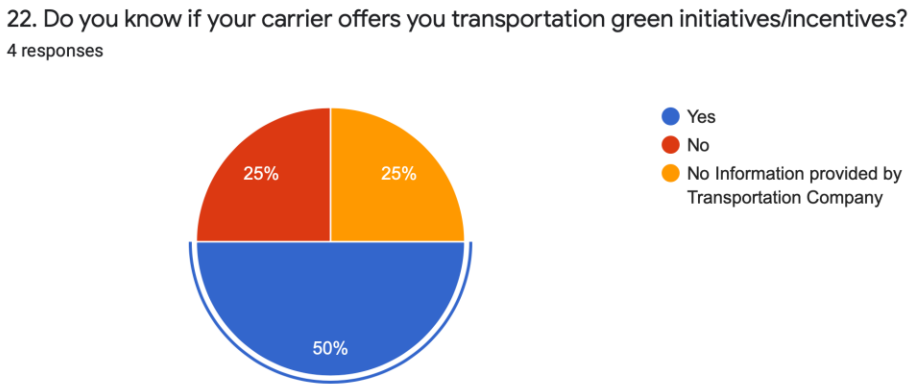

Figure 11: Green Initiatives/Incentives Awareness

Regarding the suggested Initiative/Incentives table 9 demonstrates the results as follows:

INITIATIVES/INCENTIVES LEVEL OF IMPORTANCE		
1	"Night-time Logistics"	Low Interest from Shippers
2	"Digital Platforms"	50% Highly Interested
3	"Zero Emissions Technology"	50% Highly Interested
4	"Truck Replacement Program"	Wide-Range of Preferences
5	"Sustainable Rail Package"	Majority 75% Interested
6	"Empty/Full Journeys"	Majority 75% Interested

Table 9: Initiatives/Incentives Level of Importance

Finally, 1 respondent replied that for them to utilize green transportation modes then the lead-time and price should be competitive to road transportation.

CHAPTER 5

The following chapter will present a full analysis that includes a brief overview of the City of Gothenburg, Port of Gothenburg and Swedish transportation sector and how they may benefit from initiative/incentives. In addition, the road, rail and IWW current situation and challenges are analyzed. Furthermore, initiatives/incentives that were gathered are analyzed based on the results from the literature reviews, interviews and surveys that were collected.

5 ANALYSIS

The port's role in the transportation sector has evolved due to the impact it causes on both the inland and sea legs since they are able to drive and shape the entire transportation structure i.e. provide support to the inland transport sector (e.g. maintenance and expansions). In addition, in the past the importance and the level of vertical cooperation of ports with inland terminals was low, nowadays, this has changed due to the existing risk of sea shipping companies to neglect ports and collaborate with inland terminals for value added services. (Shobayo & Hessel, 2019; Wilmsmeier et al., 2011). Therefore, the City of Gothenburg and Port of Gothenburg need to consider a deeper involvement and focus surrounding its Inland Transportation Sector, in order to position themselves as a Strategic Logistics Hub in the Scandinavian region (dominant position) (Gothenburg, 2014). In addition, for both entities to achieve this leading position in the Scandinavian region further investments are required in the inland transportation sector. These investments should be applied in the form of initiatives/incentives that will target the inland transportation stakeholders i.e. Swedish Shippers, Carriers and Inland Terminal Operators by motivating them in utilizing a more environmentally sustainable mode and methods of transportation. Further, it is important to note that the initiatives/incentives may derive from any of the stakeholders within the transportation sector, however, in most cases derives from the shippers' demand. Due to the risk factors when developing these initiates/incentives the shippers are not willing to take the first step. (Interviewee #2). Therefore, it is crucial for the City of Gothenburg to address and adapt to all the evolving changes that occur with the sector. Additionally, by positioning as leading actors in initiatives/incentives the City of Gothenburg, Port of Gothenburg, Swedish Transportation Sector and Shippers will benefit in every aspect.

The City of Gothenburg through the development and implementation of the new initiatives/incentives will be to consolidate its position and become a leading logistics hub in the Scandinavian region. In addition, increase the business development sector, create new job opportunities and address environmental sustainability impacts regarding the transportation sector. Further, the Port of Gothenburg will gain an increased port selection position within the Swedish Trade Market; thus, increase customer and container traffic volumes e.g. *Increase Revenue*. Consequently, these initiatives/incentives from the Port will offer the opportunity to the Inland Terminal Operators and Carriers to further develop their businesses e.g. domino effect and compete with road transportation. The City of Gothenburg and the Port of Gothenburg will gain marketing brand recognition and become a more attractive city

and port to conduct business both at a National and International levels from an Economic and Environmental perspective.

Additionally, the entire Swedish Transportation Sector will benefit by attaining a competition balance between Road and Rail or IWW primary for cost factors. Consequently, promoting environmentally sustainable transport as well as mitigating the impacts caused by the sector. Lastly, it will allow the opportunity for Swedish Shippers and Citizens to consider not only the sourcing of their products but also the transportation services from the environmental aspect.

5.1 Road Transportation

Emberger (2015) and European Commission (2020) state the importance of why a shift from Road to other transportation modes e.g. Rail and IWW is required. This is due to the difficulties of Road transportations decreasing the vast amount GHGs emitted. Furthermore, Sweden's interest in increasing a shift in transportation from Road to Rail or IWW, is intended to be accomplished by increasing the vehicle carrying weight and to have a greater focus towards their main network corridors.

According to Gharehgozli et al (2019) Road transport is the most economic, flexible and agile in comparison Rail and IWW. This transport method is highly dependent on traffic, fuel prices, taxes and low freight rates and comes with environmental problems. Therefore, in order for the other modes to be considered as alternatives the cost and qualitative factors should be on a competitive level with Road. In addition, Interviewee *#4* stated that cost is the primary driver when selecting transportation modes, reliability and transport time are behind but still very important deciding factors. Furthermore, *Interviewee #4* stated that there is a distinction between large and small companies when selecting a mode of transportation; large companies are familiar and concerned regarding environmental issues from their mode selection. In contrast, the small companies do not care how their carriers are transporting their goods and neither the environmental problems caused by them. According to Bask & Rajahonka (2017), Lammgård (2012) this is an important issue as shippers and service providers are considered key influencers in establishing a sustainable transport sector. *Interviewee#1* stated that there are old vehicles that are still operating in the country therefore this issue may be caused by small size companies who are selecting transportation based on the cost factor. Furthermore, as stated by Bask & Rajahonka (2017) another reason may be that the eastern Europe transport companies which are in the majority trucking companies are offering prices that other sustainable transport companies cannot compete.

Therefore, in order for a decrease or utilization of more environmental sustainable vehicles, government intervention in form of restrictions and regulations is necessary i.e. in the case of Netherland (Maasvlakte air quality agreement) or Stockholm as stated by *Interviewee#3* further Aregall & Bergqvist (2017) agree that vehicles with low environmental performance should be allocated further from port and city boundaries.

5.2 Rail Transportation

Railway Transportation is considered as a more energy efficient method causing less externalities in comparison to road (per tonne/km performed) enabling economies of scale. Therefore, modal shift from road to rail is viewed as an important area of focus by the stakeholders involved both in the transportation sector and non-transportation sector (NGOs); since road transportation is the leading environmental emissions generator and to reduce the volume of goods transported by this mode (Elbert & Lowis, 2017; Monios & Bergqvist, 2016). Further, in 2016 the EU reported that rail transportation accounted for 12% of the total transportation mode utilization. (Bask & Rajahonka, 2017). In addition, according to Trafikanalys (2016) illustrated that Sweden's Rail Transportation accounted for approximately 10% of total volumes of goods transported. The goal of the Swedish Government is to increase railway capacity efficiency and connectivity. Further, the City of Gothenburg intends to increase capacity utilization and partly prioritize over passengers in certain specific routes.

Gharehgozli, De Vries, and Decrauw (2019) state that in order for rail transportation to increase its sector transportation share it must be cost competitive to road. In addition, Elbert & Lowis (2017) emphasize that the current barriers surrounding this sector must be eliminated prior to being considered as competitive to road. Moreover, Elbert & Lowis (2017) and Woxenius (2013) reiterate that infrastructure is a critical growth factor for rail transportation to be considered by Shippers.

However, *Interviewee #1* and *Interviewee #4* agreed that the Swedish networks have lacked government investments for the last few years and there are priority issues which lead to bottlenecks and congestion. Furthermore, *Interviewee #5 stated* that a lack capacity is existent in the Swedish rail network. *Interviewee #4* mentioned in addition that the goals of the different actors involved who are able to influence this mode of transportation development differ and thus not align. This interviewee also discussed that due to the lack of maintenance there are many reliability issues from the Shippers perspective (untrustworthy) therefore, road being the solution. *Interviewee #1* mentions that reliability, lead-time and frequency are the main factors for selecting rail transportation as an alternative method.

According to the results of the survey conducted *Reliability* is the first factor followed by *Cost*, then *Safety* and finally *Accessibility* when Shippers select Rail as their mode of transportation. Further, Arencibia et al., (2015) and Elbert & Lowis, (2017) emphasize that in Rail Transportation the "Reliability" is very important and if further enhanced then Shippers are willing to pay a higher price for the services offered.

Bergqvist & Monios (2016) states that shippers' decision-making regarding rail selection is affected by distance, shipment size and cargo attributes. Furthermore, transport cost, safety and accessibility are considered of high importance in promoting rail as an alternative to road. Therefore, the results obtained from the survey are aligned with the literature reviewed and gathered by the researchers. According to the above analysis both Sweden and the City of Gothenburg's goals to promote a shift to Railway Transportation entails several challenges that need to be addressed. *Interviewee #3*

mentioned that modal split percentage restrictions can increase the shift from road to rail, however, infrastructure development, priority issues and efficient capacity utilization issues need to be addressed prior to any regulation or restrictions implemented in order for the Swedish Transport Network to be efficient.

Finally, Lammgård (2012) mentions that rail is selected as a transportation mode for the purpose for Shippers to market their environment image and not necessary for environmental purposes. Based on both survey and theory the researchers conclude that the environmental aspects for rail and the other transportation modes are not listed as a priority in mode decision-making as illustrated in the findings.

5.3 IWW Transportation

Sweden is a country that consists of a wide-range of Canals and Lakes that connect with the Baltic Sea passing through major port cities; however, inland waterways transport in Sweden has a minimal utilization in comparison to Rail Transportation.

Inland Waterways transportation is considered to be a sustainable transportation system and if utilized it can alleviate traffic and help reduce environmental impacts from the road sector. This transport method can avoid congestion, bottleneck and diminish traffic accidents furthermore it is energy efficient and reliable. (Gharehgozli et al., 2019; Aregall & Bergqvist, 2017). Among the Swedish government goals in 2018 was to double the IWW traffic and in 2019 to promote IWW as an alternative to road transportation (Trafikverket, 2019; Trafikverket, 2018; Regeringen, 2018). In addition, there are issues pertaining to IWW development as there is a lack of traffic, lack of clients, low profit margin and the most important issue is that it is not cost competitive to road transport therefore, not considered as a viable transportation solution (Regeringen, 2018). Moreover, Regeringen (2018) states that collaboration by all actors involved is required for this transport method to be successful.

During the interviews, *Interviewee #5* due to the automobile industry dominating in Sweden the majority of the funding from the government are allocated to the industry. Therefore, the waterside development is a less concerning priority for the Swedish government. Furthermore, interviewee added that there is a lack of citizen awareness that leads to a lack of pressure towards government authorities to promote and regulate this transportation method. Interviewee #3 said that the lack of infrastructure in IWW and high cost is a strong reason for Shippers to continue selecting Road over IWW. Also, mentioned by Interviewee #5 is fact that collaboration between the stakeholders involved in the IWW transportation is difficult to achieve due to Swedish Government, Municipalities, Port Terminal Operators among others have different agendas. Moreover, Interviewee #3 stated that there is a lack of established guidelines and high operating fees for carriers that want to conduct transport business in IWW.

Based on the survey results indicate that the Cost, Safety, Reliability, Connectivity and Flexibility in the order listed are the most important factors for

Shippers if and when selecting IWW transportation methods. Further, none of the survey respondents are currently utilizing IWW as a transportation method however, 50% mentioned they would consider it if improvements are made. Sweden has started to focus on the IWW transportation through the participation in projects conducted by the EU e.g. INTRASEA that promotes short sea shipping and IWW development in the Baltic sea region; and development of IWW routes e.g. Lake Mälaren and Port of Norvik (Hansson, 2020).

Therefore, in order for the IWW transportation sector to be able to compete with road transportation it requires further infrastructure development, established/new guidelines must be created both for old and new operators, collaboration between the stakeholders involved and government supporting shippers transport cost (e.g. discounts) in order to be considered as an alternative transportation solution.

5.4 Initiatives/Incentives

This section will provide an overview of the initiatives/incentives gathered for the study related to the literature review in addition to the responses obtained from both interviews and surveys. Furthermore, the researchers have identified that the Port of Gothenburg at the present time has *only* the *"SMARTPORT"* initiative on the inland leg pertaining to transport efficiency of vehicles *from* and *to* the Hinterland area. Additionally, the initiatives/incentives listed below may be considered for future implementation as they are able to motivate Shippers to collaborate and benefit from the port.

The initiatives/incentives concerning ***Air Pollution*** i.e. Maasvlakte 2 Air Quality Agreement, Promoting Green Fuel, Synple, Hakka NV: Avoiding Empty Truck Trips, EcoCalculator, Clean Truck Program, Transpower Zero Emissions Technology, Green Awards Platinum Certificate Compliance are regulatory, information system platforms and financial support that can be considered for implementation by the Port of Gothenburg as they have the highest impact on sustainability. However, Aregall & Bergqvist 2017 mentions that in the *"Truck Replacement Program"*, in order for the network system to reduce environmental impacts it must rearrange the current network e.g. by placing vehicles with newer engines in port adjacent areas and older ones in further areas; since the distance and size of the transport network have a negative effect on the city environment. Additionally, the implementation should be supported by Government regulation and applied on National level e.g. old vehicle restrictions in port city areas (Port of New York-Jersey, 2020). The results of the survey conducted regarding the "Truck Replacement Program" the importance level to the Swedish Shippers *differed* due to the fact that none of the companies had their own vehicles as they were utilizing third party transport services. Further, this incentive will benefit both the Port of Gothenburg and Road Carriers due to the long-term contract agreements established. Consequently, an increase in customer loyalty and the road carriers will be financially supported, engine replacements and be more environmentally sustainable.

"*Promoting Green Fuel" and "Green Awards Platinum Certificate Compliance"* incentives can offer discounts for vessels port dues when entering the Port areas. These incentives can be implemented by the collaboration with inland waterways vessel operators by offering the opportunity of discounts consequently reducing their operating costs. Further, the incentives are similar to the "Ecobonus" offered at the Port Seaside leg and ***Interviewee #3*** agreed that these kinds of discounts are beneficial in promoting IWW modal shifts. As previously stated, Inland Waterways is viewed by researchers to be an environmentally sustainable mode of transportation (Elbert & Lowis, 2017; Woxenius et al., 2013; Monios & Bergqvist, 2016; Lammgård, 2012). Further, prior to these incentives to be considered for implementation the port needs to view it from the stakeholders standpoint, as many feel reluctant. This is due to the high-risk factors e.g. cost and long-term conversions that may not work in the long-run due to rapid technological changes. In addition, financial support is required from government authorities for it to be successful as stated by ***Interviewee #2*** and also mentioned by ***Interviewee #5*** as they are not considered critical to port strategies. For this reason, the researchers consider that this type of incentives implementation is difficult to achieve.

"Synple Platform" technological innovation can be implemented by the Port of Gothenburg as it can offer opportunities for SMEs to reduce their transportation cost by consolidating their cargo and thus lowering emissions e.g. reducing empty journeys by 50%. (Port of Amsterdam, 2017). Another technological information platform is Hakka NV: Avoiding Empty Truck Trips allows capacity maximization by providing real time information to freight forwarders. Furthermore, these technological innovations may add value towards IWW modal shift as it currently lacks volume traffic and thus alleviates traffic from road transportation as stated by ***Interviewee #5***. The survey results indicated that half of the respondents were highly interested in this technological platform (transport demand perspective). Roso et. al., (2015) stated that in order for these types of initiatives to work, collaboration among actors is necessary allowing for integration regarding information and their operations. For this reason, the researchers consider that such technological innovations for implementation are practical and thus enhance the entire network e.g. increase cargo consolidation, decrease transport time, reduce empty journeys and consequently have a less environmental impact. Finally, these initiatives are highly utilized in The Netherlands and do not require government funding.

"EcoCalculator" or similar software can be used by the port and to promote it via their official websites. The software will help identify the best combinations of routes and modes available that are less polluting. The EcoCalculator allows clients to view the different amounts of GHGs that are emitted by the mode they select for transporting their goods; thus, creating awareness and responsibility e.g. Port of Barcelona currently utilizing the tool. (Port of Barcelona, 2020). The researchers consider the tool would be a good initiative for implementation at the Port of

Gothenburg since currently *only* the seaside and internal operating area has something similar.

"Transpower Zero Emissions Technology" initiative is in the development process in the Port of Los Angeles and may be considered for future implementation. The initiative requires the participation of Technological experts and large companies in order to be developed. Further, it is considered as a proactive strategy to mitigate environmental externalities (Lammgård, 2012). Based on the survey results 50% of the Shippers were highly interested in this initiative; however, none of the companies own their transport vehicles (outsourcing). The motives behind the survey results may be interpreted in different manners e.g. future purchasing vehicles or personal opinion. Further, similar to the "Promoting Green Fuel" incentive the "Transpower Zero Emissions Technology" risk factor is high and requires extensive funding. In order for this initiative to be achieved it requires the participation of a large technological stakeholder as stated by *Interviewee #2***.**

"Maasvlakte 2 Air Quality Agreement" this regulation was established by the Government and implemented by the Ports in The Netherlands to help purge old vehicles with no access to the low emissions zones (Government.nl, 2020). *Interviewee #1* agreed that these types of regulation should be enforced at a National level with the participation of the Port; unclear on why these restrictions are not currently in place in Sweden. Furthermore, *Interviewee #3* agreed that these restrictions should be applied the same manner as the Netherlands. These restrictions are already considered by the EU to be enforced with fines for non-compliant (European Commissions). Therefore, the researchers agree that these restrictions should be enforced from a National standpoint

The initiatives/incentives concerning ***NoisePollution*** for future implementation e.g. "Whispering Wheels" and "Whispering Brakes" could be considered if the problems arise within the City of Gothenburg. The Port of Gothenburg does not state Noise Pollution as a current problem for the city (Port of Gothenburg, 2019).

In regard to ***Congestion*** the City of Gothenburg does not have problems regarding road transport. For future implementation "Night-Time Logistics" may be considered as it will enhance the current efficiency of the port operations; however, based on the results of the survey Shippers presently show low interest this may be due to respondents utilizing third party transportation service and thus, unclear of the method being utilized. In addition, *Interviewees #1 and #4* stated and agreed that the city does not currently have congestion problems. Finally, as previously mentioned the Port of Gothenburg currently has in place "SMARTPORT".

The initiatives/incentives concerning ***Modal Shift*** as the name states has the goal to shift traffic from road to rail or IWW.

“Sustainability *Rail Package*” is an incentive for motivating Swedish Shippers to shift their cargo to rail. Therefore, the incentive will further boost a shift from road to rail to achieve the goals set (Trafikverket, 2019). According to the survey results the majority of the Shippers 75% are interested in this type of initiative. Like many of the other incentives’ government assistance is required (Port of Amsterdam, 2018). However, the based on the study conducted regarding infrastructure and capacity in the railway network needs to be addressed in order for the customer to trust the system.

"European Railway Cluster Initiative (ERCI)” Existing collaboration. Presently considered a Non-Problem factor.

"Rail Incubator" or “Empty/Full Journeys” This collaborative initiative between various stakeholders aims to increase capacity utilization, connectivity and frequency of rail shuttles (Port of Rotterdam, 2015; Leijen, 2019). Based on the survey conducted the majority of the respondents 75% were interested in this type of initiative. Further, the initiative in combination with the information platform (e.g. Synple) will allow for the consolidation of goods consequently, increase frequency of rail shuttles and traffic from/to the port .

"Modal Shift" currently at the Port of Antwerp by investing and promoting a shift from road to IWW with the collaboration barge operators (Port of Antwerp, 2017; Luppova, 2017; Knowler, 2017). Therefore, this proactive strategy implemented by this port is recommended as it will benefit the port from the less utilized mode of transport in Sweden, promote IWW as mode choice and promote a more environmentally sustainable branding of the port.

"West-Brabant Corridor (Lean and Green Europe)" This ***Consolidation*** initiative from the Port of Rotterdam and Amsterdam has as goal the collaboration of these ports in order to reduce their carbon footprint by maximizing capacity utilization. Furthermore, this will increase the reliability of IWW transport (Safety4sea.com, 2019). Therefore, this initiative is directed as a branding strategy in relation to environmental awareness and promoting collaboration among ports.

CHAPTER 6

This chapter will conclude this master's thesis research by answering the proposed questions formulated by the researchers at the beginning of the study.

6 CONCLUSION

The Port's role is crucial as their activities can provide various benefits to a country's economy. In addition, Ports are essential nodes within the transportation network as they are strategically positioned by connecting the seaside and landside. Further, in the past their development focus was towards internal operations; however, presently Ports and many of the stakeholders have had to reconsider their current strategies to address not only the economic perspective but also deepen their focus towards the hinterlands and environmental externalities surrounding the transportation sector.

The purpose this master's thesis study was to acquire a deeper understanding of the importance of Port development towards the hinterland leg. Therefore, the Port of Gothenburg was the central focus for this research. Further, in order to answer the research questions an investigation was necessary pertaining to the entire transportation network which included port terminals and development strategies (initiatives/incentives), container freight transport, mode decision-making and the current goals of the different stakeholders involved.

The researchers have decided that in order to be able to address and thoroughly elaborate on how they have achieved the answers to the main research and sub-research questions; firstly Sub-Questions 1 & 2 will be answered and secondly, followed by the Main Research Question to provide a logical flow of the findings.

Sub-Questions:

- ***Sub-Research Question 1****: Does the Port of Gothenburg have initiatives/incentives that can promote a more environmentally sustainable inland transport?*

After material gathered from the literature review, empirical findings regarding Global Port Initiatives/Incentives and interviews, the researchers cross examined all the information with the Port of Gothenburg and determined that it currently only has in place the "SMARTPORT" initiative which facilitates traffic within the port area. Further, it was identified that there is an existing lack of interest in development from

the port and stakeholders towards the inland leg and currently no initiatives/incentives applied within this area.

- ***Sub-Research Question 2:*** *Can global port initiatives/incentives be implemented in the Port of Gothenburg's current strategy?*

From the information gathered from literature review and the analysis of the empirical findings the researchers conclude that there are several port initiatives/incentives where Ports are the leading actor for the inland leg development and the collaboration from different transportation stakeholders were in place. For this reason, the researchers agree that many of the initiatives/incentives investigated (e.g. information systems platforms, promoting green fuel, truck replacement program, etc) may be applied at the Port of Gothenburg to enhance the ports' growth and benefitting all the stakeholders and concur with the Interviewees and Survey participants opinions. As a result, the implementation of these projects will promote a more environmentally sustainable transportation sector.

Main Research Question:

- ***Main Research Question:*** *Is the Port of Gothenburg able to influence Swedish Shippers mode decision-making in order to promote environmentally sustainable transportation?*

As previously mentioned the involvement of the Port of Gothenburg is necessary in order to influence Swedish Shippers mode decision-making as they are now only focused on the seaside and internal operating areas. Further, by adopting a strategy that incorporates more initiatives/incentives they will obtain an enhanced environmentally sustainable method of conducting business and continue to maintain a leading position within Scandinavian region. In addition, all these initiatives/incentives can be initiated by the Port or any of the transportation stakeholders; these projects require the collaboration between actors due to the existing regulations, funding and misalignment of their goals. In the case of Sweden and their ports the researchers have identified that there are challenges within the entire transportation network requiring attention. Further, regarding the challenges the researchers find that there is an unclear knowledge of the actual role of the stakeholders, lack of a leadership actor and few guidelines this is mainly due to the risk factors that are associated with the initiatives/incentives. In addition, the Swedish Shippers showed interest in several of the presented initiatives/incentives being implemented in other global ports; however, it was identified that cost factor is their primary concern. Finally, the researchers consider that the Port of Gothenburg is able to influence Swedish Shippers Mode Decision-Making by implementing the initiatives/incentives presented to their

interviewees and participants in the surveys consequently, benefiting the Port and Shippers interest as well as contributing towards a more green transportation sector.

PROSPECTIVE RESEARCH

Based on the research results from information gathered pertaining to the inland development strategies of ports, the researchers identified that there is a lack of motivation from all the stakeholders involved which lead to transportation sector challenges and misalignment of goals; however, by implementing the initiatives/incentives it can increase the overall efficiency of the transportation sector. Although, the main focus of this master's thesis research study was the Port of Gothenburg; the results may be applied to other ports around the world. The researchers strongly agree that there is a lack of academic studies regarding the role of port development in the inland transportation sector with a focus in environmental issues. Finally, it is recommended that further research in this area must be conducted.

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APPENDICES

Appendix 1: Interviews

Interviewee #1	
Interview Date:	12.02.20
Sector:	Port Authority
Area of Expertise:	General Port
Discussion Topic:	Port of Gothenburg and Sustainability
Interview Type:	In-Person
1	Can you please tell us what are some of the goals the Port has in place?
2	Would it be possible for you to share current port initiatives/incentives?
3	How is the Swedish transportation network current situation?
4	Is this CoronaVirus affecting the Port? and How are you dealing with it?
5	What do you consider to be the important factors when Shippers decide what mode to utilize?

Interviewee #2	
Interview Date:	15.04.20
Sector:	Port Authority
Area of Expertise:	Environmental
Discussion Topic:	Port of Gothenburg and Sustainability
Interview Type:	Phone Interview
1	Are shippers demanding more environmental initiatives since it is chain reaction from customer all the way to the Port?
2	What type of environmental requirements are customers demanding from the Port?
3	From the initiatives you currently have in place, have the customers started utilizing them? (Outcome)
4	Are your initiatives Customer or Government driven?
5	How difficult is it to implement the initiatives? a. Leading Initiative Actor b. Economic factors – Funding c. Responsible for Development and Implementation
6	What is the Port of Gothenburg's level of involvement when implementing a green initiative?
7	What is the Port of Gothenburg's relationship with terminal operators? a. Bids b. How many container terminal companies does the Port work with? c. What are your thoughts regarding this? d. Second terminal future development.

Interviewee #3	
Interview Date:	23.04.20
Sector:	Trafikverket
Area of Expertise:	Infrastructure Development
Discussion Topic:	Rail/Road/IWW
Interview Type:	Phone Interview
1	What is the role of public authorities such as Trafikverket when it comes rail sector? In addition, how does Trafikverket deal with the implementation of regulations?
2	What kind of intiatives/incentives does Trafikverket can offer to Swedish Shippers?
3	Does Trafikverket collaborate with Port Authorities regarding modal shift?
4	How does Trafikverket deal with increases in volumes of goods, rail share (shippers/passengers)?

Interviewee #4	
Interview Date:	23.04.24
Sector:	Business Region Göteborg
Area of Expertise:	Business Development
Discussion Topic:	Transportation and Mode Decision-Making
Interview Type:	Phone Interview
1	What does your role entail when it comes rail and road sectors?
2	What is the current situation regarding road/rail traffic and infrastructure?
3	Can you tell us of any projects being implemented with the goal to modal shift from road to rail? i.e. incentives/initiatives
4	Do Port Authorities help in promoting modal shift? How? and Are they efficient?
5	What are the critical challenges that need to be overcome when trying to develop and implement a strategy that would favor modal shift?

Interviewee #5	
Interview Date:	28.04.20
Sector:	IWW Port Authority
Area of Expertise:	Infrastructure Development
Discussion Topic:	IWW and Environmental Sustainability
Interview Type:	Phone Interview
1	How can public authorities help promote green initiatives in your IWW Port? In addition, how does the port deal with the implementation of regulations? and What are your Challenges?
2	What kind of initiatives/incentives/projects does the port offer to Swedish Shippers in order to motivate them to modal shift to rail or IWW?
3	How is the rail network contributing to the development of your new Inland Waterways and Barge projects?

Appendix 2: Surveys

Carrier/Freight Forwarder Transportation Modes Decision-Making

Transportation Mode Decision-Making

We are Master of Science Logistics and Transport Management students at the University of Gothenburg. We are currently conducting a research regarding "Port Environmental Initiatives" that may affect the flow of goods from and to Swedish ports. The following survey is to obtain information regarding Shippers in Sweden (i.e. freight forwarders, carriers, and Logistic Service Providers - LSP) and their perspective regarding our research topic. The survey will take approximately 6 minutes.

We thank you in advance for your cooperation regarding this matter.

Kind regards,

Gissel Ruiz and Dimitris Soumpasis

*Required

1. 1. Please provide company type. *

   Mark only one oval.

   - ◯ Freight Forwarder
   - ◯ Logistics Service Provider
   - ◯ Carrier
   - ◯ Other: _____

2. 2. Please provide your company name (Optional - this information will be kept confidential)

   _____

3. 3. What is your position at your company? *

   Mark only one oval.

   - ◯ Managerial
   - ◯ Non-managerial

4. 4. What is your company size category? *

   Mark only one oval.

   - ◯ Micro (<10 employees)
   - ◯ Small (<50 employees)
   - ◯ Medium (<250 employees)
   - ◯ Large (=>250)

5. 5. What is your company's yearly revenue? (Optional)

   Mark only one oval.

   - ◯ ≤2M Euros
   - ◯ ≤10M Euros
   - ◯ ≤50M Euros
   - ◯ >50M Euros

6. 6. Is your transportation conducted via? *

   Mark only one oval.

   - ◯ Own Vehicles
   - ◯ Third Party Direct
   - ◯ Third Party through an Intermediary
   - ◯ Other: _____

7. 7. Does your company issue Annual Reports? *

   Mark only one oval.

   - ◯ Yes
   - ◯ No

8. 8. If Yes, when was the year of your first Annual Report? (Optional)

_____

9. 9. Does your company have a Corporate Social Responsibility (CSR) report? *

Mark only one oval.

- Yes
- No

10. 10. If yes, please provide the year of the first CSR report. (Optional)

_____

GENERAL TRANSPORTATION DECISION-MAKING

11. 11. Which are the Ports your company works with? (May check more than 1) *

Tick all that apply.

- [ ] Gothenburg
- [ ] Helsingborg
- [ ] Gävle
- [ ] Stockholm
- [ ] Other: _____

12. 12. What is the main reason for your port selection? (May check more than 1) *

Tick all that apply.

- [ ] Cost
- [ ] Connectivity
- [ ] Proximity
- [ ] Frequency
- [ ] Other: _____

13. 13. ROAD - How do you rate the following criteria based on your customer requirements (scale from 1-5; 1=Not Important and 5=Very Important) *

Mark only one oval per row.

	1	2	3	4	5
Price/Cost	◯	◯	◯	◯	◯
Service Level	◯	◯	◯	◯	◯
Flexibility	◯	◯	◯	◯	◯
Reliability	◯	◯	◯	◯	◯
Connectivity	◯	◯	◯	◯	◯
Security/Safety Damage	◯	◯	◯	◯	◯
Intermodal Accessibility Transfer	◯	◯	◯	◯	◯
Specialized Handling	◯	◯	◯	◯	◯
Capacity	◯	◯	◯	◯	◯
Environmental Sustainability	◯	◯	◯	◯	◯

14. 14. RAIL - How do you rate the following criteria based on your customer requirements (scale from 1-5; 1=Not Important and 5=Very Important) *

Mark only one oval per row.

	1	2	3	4	5
Price/Cost	◯	◯	◯	◯	◯
Service Level	◯	◯	◯	◯	◯
Flexibility	◯	◯	◯	◯	◯
Reliability	◯	◯	◯	◯	◯
Connectivity	◯	◯	◯	◯	◯
Security/Safety Damage	◯	◯	◯	◯	◯
Intermodal Accessibility Transfer	◯	◯	◯	◯	◯
Specialized Handling	◯	◯	◯	◯	◯
Capacity	◯	◯	◯	◯	◯
Environmental Sustainability	◯	◯	◯	◯	◯

15. 15. INLAND WATERWAYS - How do you rate the following criteria based on your customer requirements (scale from 1-5; 1=Not Important and 5=Very Important) *

Mark only one oval per row.

	1	2	3	4	5
Price/Cost	◯	◯	◯	◯	◯
Service Level	◯	◯	◯	◯	◯
Flexibility	◯	◯	◯	◯	◯
Reliability	◯	◯	◯	◯	◯
Connectivity	◯	◯	◯	◯	◯
Security/Safety Damage	◯	◯	◯	◯	◯
Intermodal Accessibility Transfer	◯	◯	◯	◯	◯
Specialized Handling	◯	◯	◯	◯	◯
Capacity	◯	◯	◯	◯	◯
Environmental Sustainability	◯	◯	◯	◯	◯

16. 16. What modes of transport does your company currently use? (May check more than 1) *

Tick all that apply.

- [ ] Road
- [ ] Rail
- [ ] Sea
- [ ] Inland Waterways

17. 17. Does your company currently utilize a Route Optimization Software? (Road) *

Mark only one oval.

- Yes
- No

18. 18. If No, please provide reason.(Optional)

19. 19. Would you consider Inland Waterways as an alternative modal choice if available? *

Mark only one oval.

- Yes
- No
- Not Applicable

20. 20. If No, could you please provide the reason. (optional)

INITIATIVES/INCENTIVES

21. 21. Do you know if the port authorities currently offers you transportation green initiatives? *

Mark only one oval.

- Yes
- No
- No Information provided by the port

22. 22. If No, would you be interested to incorporate Green Initiatives in your current transport strategy if offered? *

Mark only one oval.

- Yes
- No
- Maybe

23. 23. If Yes, please name some of the green initiatives being offered by the port? (Optional)

Swedish Shippers Transportation Modes Decision-Making

Transportation Mode Decision-Making

We are Master of Science Logistics and Transport Management students at the University of Gothenburg. We are currently conducting a research regarding "Port Environmental Initiatives" that may affect the flow of goods from and to Swedish ports. The following survey is to obtain information regarding Mode Selection Preferences of Swedish Shippers (i.e. Manufacturer, Producer, etc.) and their perspective regarding our research topic. The survey will take approximately 6 minutes.

We thank you in advance for your cooperation regarding this matter.

Kind regards,

Gissel Ruiz and Dimitris Soumpasis
*Required

1. 1. Please provide company type. *

   Mark only one oval.

   - ◯ Manufacturer
   - ◯ Producer
   - ◯ Other: _____

2. 2. Please provide your company name (Optional - this information will be kept confidential)

   _____

3. 3. What is your position at your company? *

   Mark only one oval.

   - ◯ Managerial
   - ◯ Non-managerial

4. 4. What is your company size category? *

   Mark only one oval.

   - ◯ Micro (<10 employees)
   - ◯ Small (<50 employees)
   - ◯ Medium (<250 employees)
   - ◯ Large (=>250)

5. 5. What is your company's yearly revenue? (Optional)

   Mark only one oval.

   - ◯ ≤2M Euros
   - ◯ ≤10M Euros
   - ◯ ≤50M Euros
   - ◯ >50M Euros

6. 6. Is your transportation conducted via? *

   Mark only one oval.

   - ◯ Own Vehicles
   - ◯ Third Party Direct
   - ◯ Third Party through an Intermediary
   - ◯ Other: _____

7. 7. Does your company issue Annual Reports? *

   Mark only one oval.

   - ◯ Yes
   - ◯ No

8. 8. If Yes, when was the year of your first Annual Report? (Optional)

_____

9. 9. Does your company have a Corporate Social Responsibility (CSR) report? *

Mark only one oval.

- ◯ Yes
- ◯ No

10. 10. If yes, please provide the year of the first CSR report. (Optional)

_____

GENERAL TRANSPORTATION DECISION-MAKING

11. 11. Which are the Ports your company works with? (May check more than 1) *

Tick all that apply.

- ☐ Gothenburg
- ☐ Helsingborg
- ☐ Gävle
- ☐ Stockholm

Other: ☐ _____

12. 12. What is the main reason for your port selection? (May check more than 1) *

Tick all that apply.

- ☐ Company Decision
- ☐ Carrier or Broker Decision

Other: ☐ _____

13. 13. ROAD - Please rate the level of importance of the following criteria if selecting road transportation (scale from 1-5; 1=Not Important and 5=Very Important) *

Mark only one oval per row.

	1	2	3	4	5
Price/Cost	◯	◯	◯	◯	◯
Service Level	◯	◯	◯	◯	◯
Flexibility	◯	◯	◯	◯	◯
Reliability	◯	◯	◯	◯	◯
Connectivity	◯	◯	◯	◯	◯
Security/Safety Damage	◯	◯	◯	◯	◯
Intermodal Accessibility Transfer	◯	◯	◯	◯	◯
Specialized Handling	◯	◯	◯	◯	◯
Capacity	◯	◯	◯	◯	◯
Environmental Sustainability	◯	◯	◯	◯	◯

14. 14. RAIL - Please rate the level of importance of the following criteria if selecting rail transportation (scale from 1-5; 1=Not Important and 5=Very Important) *

Mark only one oval per row.

	1	2	3	4	5
Price/Cost	◯	◯	◯	◯	◯
Service Level	◯	◯	◯	◯	◯
Flexibility	◯	◯	◯	◯	◯
Reliability	◯	◯	◯	◯	◯
Connectivity	◯	◯	◯	◯	◯
Security/Safety Damage	◯	◯	◯	◯	◯
Intermodal Accessibility Transfer	◯	◯	◯	◯	◯
Specialized Handling	◯	◯	◯	◯	◯
Capacity	◯	◯	◯	◯	◯
Environmental Sustainability	◯	◯	◯	◯	◯

15. 15. INLAND WATERWAYS - Please rate the level of importance of the following criteria if selecting inland waterways transportation (scale from 1-5; 1=Not Important and 5=Very Important) *

Mark only one oval per row.

	1	2	3	4	5
Price/Cost	◯	◯	◯	◯	◯
Service Level	◯	◯	◯	◯	◯
Flexibility	◯	◯	◯	◯	◯
Reliability	◯	◯	◯	◯	◯
Connectivity	◯	◯	◯	◯	◯
Security/Safety Damage	◯	◯	◯	◯	◯
Intermodal Accessibility Transfer	◯	◯	◯	◯	◯
Specialized Handling	◯	◯	◯	◯	◯
Capacity	◯	◯	◯	◯	◯
Environmental Sustainability	◯	◯	◯	◯	◯

16. 16. What modes of transport does your company currently use? (May check more than 1) *

Tick all that apply.

- ☐ Road
- ☐ Rail
- ☐ Sea
- ☐ Inland Waterways

17. 17. Does your company currently utilize a Route Optimization Software? (Road) *

Mark only one oval.

- ◯ Yes
- ◯ No

18. 18. If No, please provide reason.(Optional)

19. 19. Would you consider Inland Waterways as an alternative modal choice if available? *

Mark only one oval.

- Yes
- No
- Not Applicable

20. 20. If No, could you please provide the reason. (optional)

INITIATIVES/INCENTIVES

21. 21. Is it important for your company to work with transportation companies that have green initiatives ? *

Mark only one oval.

- Yes
- No

22. 22. Do you know if your carrier offers you transportation green initiatives/incentives? *

Mark only one oval.

- Yes
- No
- No Information provided by Transportation Company

23. 23. If No, would you be interested to incorporate Green Initiatives in your current transport strategy if offered? *

Mark only one oval.

- Yes
- No
- Maybe

24. 24. If Yes, please name some of the green initiatives being offered by the transportation company? (Optional)