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Transportation mode decisions and the evaluation of maritime transportation in a Swedish setting – A case study

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ABSTRACT

Focus of this bachelor thesis is on examining the port located in Köping, thus a holistic view of maritime transportation is adapted in relation to the examined companies in the region and their global trade. The aim of this study is to examine the current situation and the potential to increase transportation of goods by maritime transportation and what criteria are the most important for different industrial/customer segments. The aim is divided into three research questions:

- RQ1: Which decision criteria are considered in selection of transportation mode?
- RQ2: What are the advantages and the disadvantages of the different transportation modes?
- RQ3: When is maritime transportation preferable to road and railway?

The research approach used in order to answer the aim and research questions were; literature review to gain an understanding of freight transportation in a broad context. To narrow down the area, freight transportation practice in the Swedish setting have been examined. Data collection for the Swedish setting have been collected through reports published by the national authorities. Lastly, data for freight transportation in the region of Western Mälardalen has been collected through a case study.

Several criteria were found to be of importance during a transportation mode decision, as well as interrelationships between criteria. The identified criteria were cost, reliability and time, frequency and volume and lastly specific goods need. This was found to be in line with theoretical framework, especially the fact that the mode decision is vastly complex and highly depended upon which industry is making the decision, that is the context. A comparison of the modes was made to specify the benefits and downfalls with each mode for answering research question 2. Furthermore, an important identification is the gap between transportation purchaser and providers view of the reliability criterion. This difference can create a gap making it difficult to attract customers to maritime transportation. It is recommended that a thorough investigation is needed in order to examine what aspect of reliability is achievable and realistic in maritime transportation in general and for Köping's Port in particular.

Keywords: Maritime Transportation, Mode Decision Criteria, Modal Shift.

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ABBREVIATIONS

EU	European Union
JIT	Just-in-Time
RoRo	Roll-on-Roll-of
SMA	Swedish Maritime Administration
STA	Swedish Transportation Administration
SSS	Short Sea Shipping
tkm	Ton- kilometre

1 INTRODUCTION

This chapter is initiated with the Background of this study which opens to Problem Formulation to be stated as well as the Aim and Research Questions.

1.1 Background

Globalization have increased utilization of global sourcing, which have affected supply chains. In supply chain management, logistics has a role of planning, implementing and controlling the efficiency and effectiveness of material and information flows (Jonsson, 2008). However, global sourcing contributes to a greater distance between markets, suppliers and manufacturers which complicates logistics tasks. To counteract the effects of global sourcing, logistics has a significant role of achieving efficiency in the supply chain (Zeng & Rossetti, 2003). The flow of material becomes more complex and companies must investigate more effective ways for coordination (Hesse & Rodrigue, 2004; Mentzer, Keebler, Nix, Smith, & Zacharia, 2001; Son, Patwari, Wilhelm, & Yu, 2013) as global sourcing has become a prerequisite for competitiveness (Jonsson. 2008). Transportation in itself is an extra cost for companies. Transportation mode selection must be performed with consideration of the product competitiveness in foreign markets as transportation cost leads to either an increase or a decrease of the total cost (García-Menéndez et al., 2004).

Drivers behind global sourcing are mostly price oriented as the supplier with the lowest purchasing price is preferred. Although, lack of local suppliers can contribute to the search for global sourcing (Jonsson, 2008). In fact, most of the growth in the freight transport sector is derived from globalisation. Additional growth in the international trade and competitiveness can be reached by sustainable logistics and supply chains which consider the social, environmental and economic perspectives. To achieve those demands, aspects such as efficiency, reliability, safety, environmental friendliness and cost-effectiveness must be considered. Better utilization of existing infrastructure must also be considered as expansion of the existing ones is not always a cost-effective solution or even an realistic option (Clausen, De Bock, & Lu, 2016). The increased global trade has also had a negative impact on the environment due to surface transportation caused by heavy goods vehicles, as well as shipping emissions and from aviation (OECD, 2010).

Infrastructure bottlenecks, such as congestion on roads, can jeopardize productivity of a company by for instance delaying the production. This kind logistical friction is related to scarcity of access where congested roads are one of the hinders (Hesse & Rodrigue, 2004). Especially as the largest growth in freight transport during the last decade is the road transport in comparison to other modes (Blauwens, Vandaele, Van de Voorde, Vernimmen, & Witlox, 2007; García-Menéndez et al., 2004). Road transportation has replaced a large portion of the maritime transportation (García-Menéndez et al., 2004). Besides from the immediate issues with congestion on roads per se, the environmental impact derived from the vast growth of road transportation is also creating costs for society. The prediction is that road transport will continue to grow if no proper countermeasures are taken. The continuing growth in road transportation will result in increased environmental impact as well as lower accessibility in Europe which can be followed by loss of economic competitiveness (Blauwens et al., 2007).

The effects of transportation have received the attention of the European Union (EU) and the aim is to shift 30 percent of long-distance freight transport from the road by 2030, as a method to decrease environmental emissions from the transport sector. By 2050, 50 percent of goods should be transferred from the road. Transportation of freight that travels over 300 km can instead make

use of other modes, such as rail or waterborne transport. This goal entails the need for the development of the mentioned modes and transportation networks where nodes link the combined transport by railway, sea and lorry (European Commission, 2011). Short sea shipping (SSS) is considered as the only mode that could manage the needed modal shift and handle the freight that is traveling by road today as SSS is the only mode that can keep up with the economic growth in the EU. The advantages of moving freight to maritime transportation is also of improved competitiveness and a reduction of environmental damage (Baird, 2007).

1.2 Problem formulation

The growth of road transportation leads to congested roads and environmental damage, the need to investigate opportunities of a modal shift to sea transportation is therefore pressing.

1.3 Aim and Research questions

The aim of this study is to examine the current situation and the potential to increase transportation of goods by maritime transportation and what criteria are the most important for different industrial/customer segments. The aim is divided into three research questions:

- RQ1: Which decision criterions are considered in selection of transportation mode?
- RQ2: What are the advantages and the disadvantages of the different transportation modes?
- RQ3: When is maritime transportation preferable to road and railway?

1.4 Project limitations

Although Sweden has a variety of different ports, the focus of this bachelor thesis is on examining the port located in Köping. Consequently, container freight and the ports that can handle this sort of transportation will only be mentioned briefly without an in-depth investigation. Similarly, the focus is on maritime transportation, without restrictions of Short Sea Shipping (SSS) or other methods by which maritime transportation is performed. The holistic view of maritime transportation is necessary as the freight transportation in the region is global, and SSS is performed intra-continently. Lastly, examining the different ship carriers is not within the framework of this thesis.

2 RESEARCH METHOD

This chapter provides the information regarding Research Approach, how the Literature Review and Case Study was performed. Lastly, the Analysis is described.

2.1 Research Approach

The complexity of the investigated area demands a variety of research approaches which tackles the aim and research questions from different angles. For an understanding of freight transportation in a broader context, a literature review has been performed. To narrow down the area, freight transportation practice in the Swedish setting have been examined. Data collection for the Swedish setting have been collected through reports published by the national authorities. Lastly, data for freight transportation in the region of Western Mälardalen has been collected through a case study. Altogether, the different methods used for the data collection could provide a comprehensive view and answer to the aim and the research questions.

2.2 Literature Review

The overall goal for performing a literature review is to provide the reader with a background of connections between the researched area and other relevant subjects as well as where the investigated area belong within a broader context (Oliver, 2012). The first stage of the thesis consisted of defining the problem formulation and aim which was the basis for searches of literature, as suggested by Oliver (2012). Initial searches consisted of a broad area of research publications. This stage provided an overview and a confirmation that the scope of the thesis can possibly contribute to the collected body of research. As Oliver (2012) writes, if a topic has been investigated from different aspects in previous research, then there is reason to presume that the area is of importance.

The main databases for searching scientific international studies were Scopus, Emerald Insight and ScienceDirect, as these databases provides a controllable amount of hits per search. As Scopus is a citation database, the criteria for the selected research publications to be cited in other works could be ensured. References found in the introduction, or the background, of research publications which were retrieved from the main databases were instead found on Google Scholar. The latter search engine was therefore secondary and was mainly used to find research publications where the results was outside of the aim of the thesis but some of the references were relevant. The secondary database was also used in occasions when relevant research publications was not available in full text in the primary databases. The gathering of theoretical information was also performed through Mälardalens University library where books have been retrieved.

To ensure a manageable amount of hits per search, keywords such as Maritime transportation, Freight transportation, Sustainability, Decision criteria etc. were used in different combinations. To gather information on specific topics within the thesis, the mentioned keywords were combined with search words that limited the number of hits further, for example Environmental impact or Trade-offs. The criteria for research publications were firstly that they had to be relevant for the thesis, thus within the scope of the research questions. Secondly, that the majority of the gathered research publications were published within the last ten years, although exemptions from this criterion had to be made in occasions where no recent research publications was available in a specific topic. Thirdly, the research publications were supposed to be cited by other researchers, however in occasions where research publications were published in 2017, this criterion was disregarded.

2.3 Case Study

The basis for initiating a case study is a performed literature review along with carefully formulated research questions. A case study approach is meaningful when a holistic and real-world perspective is sought after for a specific case, which is especially applied in studies of areas as organizational and managerial processes or maturation of industries. A case study can aid the answering of research questions which are explanatory, and are asked in forms of why and how. The intent is to trace for instance the operational links over a period of time. The examined events are contemporary which allows data collection through observation and interviews combined with documents (Yin, 2014). For investigation of freight transportation in the Western Mälardalen region, a case study could provide a holistic and explanatory method for grasping the complex area.

2.3.1 Case Selection

According to the aim, the current situation and potential to increase transportation of goods by maritime transportation, was of interest. In line with the aim, the case company were supposed to fulfill the criteria of having an insight into maritime transportation practice. Additionally, the setting of the case study was the Western Mälardalen region. Restricted to these criterions, one company could fulfill both, that is Köping's Port. For answering research questions, two more companies were chosen for interviews. The first company was chosen based on their extensive collaboration with Köping's Port, that is Company A. Company A could contribute with their decision criterions for use of maritime transportation. Company B on the other hand, was chosen based on their utilization of other freight transportation modes except for maritime transportation in the east of Sweden. Company A and B were thus chosen based on their differences in product type and production systems, which could be valuable for the comparison of freight transportation in different industries.

2.3.2 Interviews

Interviews are an important method for collecting data and in a case study, interviews are performed in a manner of a guided conversation (Yin, 2014). A question protocol (see Appendix 1) was combined before every interview, which could work as a guideline and a tool for careful contemplation of the goal for each interview session. The open-ended interview questions were adapted for each industry, interviewee's specific knowledge and role at the company. Furthermore, the questions were design to be within the frame of the aim and research questions. To gain insightful information, the questions were posed in a how manner. According to Yin (2014) the use of a question put in a how manner can be perceived less threatening by the interviewee. In contrast, a question phrased in why can put the interviewee in a defensive mode. Two interviews were conducted at Köping's Port, see Table 1. The first one was with an account manager in sales that also has work experience of approximately 20 years as a crane operator for the same port. The second interview was with the company CEO with experience of five years at the company. Additional interviews were performed with Company A and B. Altogether, five interviews were completed during May and June 2017.

Interviewed	Position	Date	Duration	Location
<i>Köping's Port</i>	Account Manager in Sales (AMS)	May 5 th	1 hour 23 minutes	On site
<i>Köping's Port</i>	CEO Mälarhamnar AB	May 29 th	1 hour, 20 minutes	On site
Company A	Purchasing manager (PM)	June 9 th	43 minutes	On site
Company B	Manager Transport Network Optimization (MTNO)	June 16 th	20 minutes	Telephone
Company B	Transport & Vehicle Manager (TVM)	June 22 th	30 minutes	On site

Table 1 – Interviews

The duration of the interviews was set to a one- hour period. The interviewees were informed of the timeframe and could prepare for the interview by receiving the question protocol prior to the interview session. Patel and Davidson (2003) suggest that the interviewees are selected in the purpose to answer question without possessing insight of the need. It is therefore important to inform the interviewees of the purpose, thus create a motivation. Information should be provided in several phases in an interview study, firstly in written form but also in the beginning of an interview. For this thesis, along with the interview questions, the interviewees received information of this thesis. The information received contained the purpose of the thesis and a description of context (see Appendix 2). Each interview began with a description of the thesis and the areas of essence, which were the aim and RQs'.

The interviews were recorded after gaining approval from the interviewee. There are risks associated with using a recording device, such as failure to listen closely as informed by Yin (2014). However, the advantages overweighed the risks as the safety of recordings allowed more room for conversation without having the need for time consuming notetaking. The transcription of the recording was made in three steps. Firstly, the recordings were transcribed by listening and simultaneously writing, while pausing the recording when needed. Second step was to listen to the recording and reading the transcript as a whole, and correcting when necessary. This could assure that the transcript was as accurate as possible. The last and third step, was sorting the information into groups and combining the information into a text, which is the empirical findings in heading 4.2-4.6.

2.4 Analysis

The analysis of the interviews was initialised by reading through the transcript of an interview. During this first stage, similar patterns in the transcript was identified. Those patterns were categorised as themes. The next stage consisted out of having the themes as headlines in an Excel document. A second reading of the transcript was performed, this time the information in the interview was analysed based on where information fits according to the identified themes. This continued until all information in the transcribed was placed under one or several themes in the Excel document and unnecessary information was sorted out.

This process of analysis was perceived as non-rigid. Meaning, the themes could evolve during the process and in multiple times what was perceived as a theme revealed itself to be a subtheme, or the other way around. Thus, making the process free of predetermined opinions. According to (Bryman & Nilsson, 2011) the vast amount of data which is collected through a quantitative approach can be difficult to analyse without an appropriate analysis method. Thus, a thematic analysis, such as used in this thesis, is a valid option. A matrix out of themes and subthemes can be created, and data are categorised into the matrix. The second stage of the analysis in this thesis was a comparative study of the themes in the interview, with the Theoretical Framework findings and the official governmental reports.

2.4.1 Reliability and Validity

According to (Bryman & Nilsson, 2011), validity and reliability are connected to quantitative research approach. Validity is to actually deliver the aimed measurements which were set out to be measured, identified or observed. Further, external validity is that a study must be replicable and generalizable, this is however difficult to achieve in a quantitative study as it is problematic to attain the same result from a situation which is always changing. The internal validity on the other hand is controlled by the performer of the study as the received oral information is

interpreted. To avoid interpretation to the best possible extent, interviews in this study were recorded. Although, a complete absence of interpretation is difficult to reach, the intent was to retain an unbiased approach with the internal validity in mind. For an increased probability that the study performed in this thesis is replicable, the interview questions are presented in the appendix. However, the anonymity of the interviewees presents a probable obstacle for replicability. The three sources of data, that is the interviews, published research papers and governmental reports, is likely to increase the reliability and validity of this thesis.

3 THEORETIC FRAMEWORK

This chapter is initiated with a Transportation Modes description followed by Criteria for Transportation. The complexity of Transportation Mode Selection is presented from an industry and goods specific need perspective and Lean Transportation is described. The chapter is completed with Transportation and the Environment as well as Governmental Incentives.

3.1 Transportation Modes

The transportation mode available for goods transportation, that is external transports, are by road, rail, air and sea. The modes can also be combined to cover the whole distance to the end destination by intermodal transportation (Jonsson, 2008). The modes advantages and disadvantages are presented in the following sections, 3.1.1 – 3.1.4. Furthermore, a brief introduction of Intermodal Transportation is found in section 3.1.5.

3.1.1 Road Transportation

Road transport is used for both long and short transportation distance, as the method offers accessibility and uninterrupted transport to plants located on the same continent. The flexibility of destinations and variation of goods which are possible to transport, makes the mode suitable to apply in different markets (Jonsson, 2008). Several restrictions for other modes are non-essential for road transportation, for instance the size and value of goods, weight nor distance is a limitation, as the flexibility of the mode offers tailor made solutions (Jonsson, 2008; Reis, 2014). The flexibility of road allows it to reach every customer, adjust to changes in traffic and offers the customer the control of fast adjustments of arrivals and departures (Reis, 2014). The mode specific environmental consequences are in form of exhaust emissions, noise, road safety and traffic congestion (Jonsson, 2008). Road transportation is depended upon in most developed countries for national freight transportation, even though it is the most expensive and resource-consuming option (Medda & Trujillo, 2010).

Infrastructure which is utilised by road transportation is governmentally funded and provided free of charge in many EU countries. This is slowly changing as road user charges are introduced in several EU countries, such as in Germany. The charges are aimed at recovering capital and maintenance cost. The direct financing, planning and provision of road infrastructure is controlled by the public-sector rather than the market. The favouritism of road transportation can thus be explained (Baird, 2007).

The competition between road transportation with other modes are within airfreight and railway. Airfreight and road compete regarding goods transported in small volumes and of high-value. Concerning rail, the competition arises for large volumes and low-value goods. A competitive disadvantage which the road has compared to rail or maritime transportation is of transportation of very low-valued goods over long distances. The road mode also faces a time disadvantage related to airfreight regarding very high-value goods (Jonsson, 2008).

3.1.2 Rail Transportation

The advantage of rail transportation, compared to road, is in transportation of large quantities combined with long distances and high-volume goods. The mode is capable to transport all type of goods, but high-value goods are less suitable as this can generate large amounts of tied-up capital. The mode has a disadvantage compared to road transportation regarding transportation time. Although, rail offers speed over long distance, the same route is less time consuming with road transportation. The type of goods selected for this mode are similar to maritime

transportation, such as ore or timber, and rail has a large market share of the latter (Jonsson, 2008).

Compared to road transportation, rail has a disadvantage of less frequent departures, the network is not well developed and flexibility of rail regarding time and geography is a restriction. However, the disadvantage is possible to overcome by application of combined traffic. Rails advantage is of environmental cleanliness as a large quantity of goods can be transported over long distances without direct exhaust emissions, that is if the locomotives are electric. Furthermore, the mode is energy-efficient when the fill-rate is high (Jonsson, 2008). However, the disadvantage of rail a finite capacity, track space is competing between freight and passengers and issues of connectivity across national borders. Additionally, the increase of capacity is limited by high capital cost and constrained legislation. The railway infrastructure, similarly to road, is financed, planned, maintained and owned by the public sector, thus depend on governmental subsidies (Baird, 2007).

3.1.3 Air Transportation

The advantages of air transportation are within speed over long distances. Generally, the mode is used for high-value goods and/or low weight, time-sensitive express deliveries and emergency deliveries. Consequently, these types of deliveries are used as the mode has the highest cost per ton-kilometre (tkm) i.e. quantity in tonnes multiplied by kilometres transported. Therefore, low-value goods and high volume are not suited for air transportation. Also, the mode is restricted regarding direct transportation as it is limited to terminals. The largest competitors are container ships between continents, within continent the mode competes with road transportation (Jonsson, 2008).

3.1.4 Maritime Transportation

Maritime transportation is a prerequisite to global trade, 80 percent of global goods trade are transported by ship (Berle, Asbjørnslett, & Rice, 2011). Compared with other modes, maritime transportation is the most time demanding. The transportation can be performed between ports and directly to a plant when the plant has port access (Jonsson, 2008). The port serves as a terminal or a node which enables the interchange of goods on a given route, it is the interface between sea- and land-based modes, or a transshipment of goods between ships (Baird, 2007). Ports can have the advantage of scale economies but still be limited by lacking infrastructure and facility space. An expansion can be hindered by lack of space, policy or funds (Hesse & Rodrigue, 2004).

Ships are usually adapted to transport specific types of goods and routes. The varieties are container ships or Roll-on-Roll-off (RoRo) rolling carriers (trucks, trailer, cassettes and railway wagons). The goods transported by both methods are similar, but the RoRo traffic is most commonly used within continents, whereas containers are shipped between continents. The economy of scale focusses the container flows to ports which are equipped with cranes and facilities to handle the container traffic. Container traffic is therefore common in ports which can handle large trans-oceanic ships. Bulk ships are equipped to transport solid goods, such as ore, whereas tanker ships carry liquid loads. The loading and unloading time for bulk is usually short (Jonsson, 2008).

The competitive advantage of the mode is within shipping of low-value bulk loads combined with long distance of transportation, in this segment the competitor is the railway. The majority of transported goods are of petroleum variety, but goods in bulk is also common. For mid-value goods, container shipment is commonly applied (Jonsson, 2008). Maritime transportation present

the lowest operations cost per tkm, as well as the advantage of loading capacity compared to other modes. Nevertheless, related to the high energy consumption, the emissions are relatively high (Jonsson, 2008). Certain advantages of maritime transport are specific for the mode, such as lack of traffic congestion and that capacity can be increased in a multiple ways by increasing size and/or speed of ships or addition of more ships (Baird, 2007). Flexibility offered by the mode is considering transportation routes (Jonsson, 2008) but flexibility regarding response to unexpected demands is restricted (Beuthe & Bouffioux, 2008).

Maritime transportation is more environmental favourable than other modes (Jonsson, 2008) and the advantaged of low cost maintenance of infrastructure is offered as the waterway are often free of charge (Baird, 2007; Jonsson, 2008). Countries are making substantial investments in roadway and railway infrastructures, and overlooking to tend to seaway as it risks to be mistakenly assumed to be a cost free highway (Medda & Trujillo, 2010). In fact, the competitiveness of maritime transportation has been weakened over the time period in which the investment focus have been on road and railway infrastructure development (Baird, 2007). Market share of maritime transportation can be improved by increasing the transit time performance (García-Menéndez et al., 2004).

3.1.5 Intermodal Transport

Using one single load unit, such as a container, which is reloaded between multiple modes before arriving at the end destination, is referred to as intermodal transportation (Dekker, Bloemhof, & Mallidis, 2012) or combined transportation (Jonsson, 2008). Generally, the handling of goods is considered as the main inefficiency which can be reduced with the use of containers or trailers and is common especially for intercontinental supply chains. Transportation by land is covered by either truck, rail or inland barge (Dekker et al., 2012). The movement of the unit is performed by two or more successive modes of transportation without handling of the actual goods (Agamez-Arias & Moyano-Fuentes, 2017). Global supply chains are more complex to plan regarding transportation as a need for intermodal transportation is often involved (Son et al., 2013).

3.2 Criteria for Transportation

Location of a production facility determines which transportation mode is relevant to utilize. Other aspects of a mode decision is the modes transit time and material flow cost derived from both the location and the possible connection to infrastructure (Son et al., 2013). The goal of logistics is to create competitiveness and high performance which is achieved by improvement of efficiency and effectiveness, by which the profitability of a company can be affected. To evaluate performance, a company can set and follow up goals regarding certain variables, such as customer service, flexibility and time. Different modes have various characteristics which can help to achieve the goals of the supply chain and logistics that a company might have (Jonsson, 2008).

3.2.1 Cost

The total cost of transportation includes carrying, transferring/transshipment, loading and unloading, thus cost arises from performed activities (Beuthe & Bouffioux, 2008; Jonsson & Mattsson, 2011). Transport lead to tied-up capital during transportation, further cost is derived from stock-keeping, capacity-related costs and shortage-and delay costs. The different sources of cost demands a holistic perspective as adjustment and decrease of cost in one activity, often leads to transference of the cost to another activity (Jonsson & Mattsson, 2011).

The cost aspect is weighed highly, approximately 60 percent, by decision makers regarding transportation mode selection. Competitive pricing is therefore an important aspect to consider as a transport provider. Rail and inland waterways lead to higher costs; however, the additional costs of the modes are more beneficial over long transportation distances where they can be more cost competitive. Road transportation is dominated over short distances. Moreover, if the transportation distance is less than 300 km, total cost is more important than transport time. The cost aspect is also important in distances longer than 700 km, this distance is where rail and maritime transportation has an increased probability of selection (Beuthe & Bouffioux, 2008).

3.2.2 Time

Transit time is correlated with cost. Shorter transit time provided by for instance air will result in a higher cost, and longer transit time provided by for instance rail is less expensive. Shorter transit time will however provide the supply chain with operations with less need for inventory and fewer backorders, leading to lower costs of the material flow. Backorders can be a result from a longer transit time as there is a correlation between transit time and the order quantity when replenishing the inventory (Son et al., 2013). Time is weighed as the next most important criterion (Beuthe & Bouffioux, 2008) especially by the transportation provider as the gains of fast transportation is more to the advantage of the provider than the purchaser (De Jong et al., 2014). Additionally, time criterion is rated higher for high-value goods over short distances (Feo-Valero, García-Menéndez, & Garrido-Hidalgo, 2011).

3.2.3 Frequency

The variable of frequency can affect the mode selection decision (García-Menéndez et al., 2004). The delivery frequency is defined by the number of transports performed during a time duration. A high frequency enables the transportation purchaser to adapt to sudden variation of demand, with the benefit of an increasing flexibility in the supply chain. Additionally, stock capacity in the companies can decrease leading to a decrease of stock-keeping costs (Naim, Potter, Mason, & Bateman, 2006). Delivery flexibility is considered to be an important service attribute, and means the capacity to adapt to and comply with changing customer requirements. The flexibility to changes of delivery volume or time is commonly requested. Flexibility has an indirect consequence on customer service as well as the cost and tied-up capital, which can be achieved by offering the option of variation of delivery volume. Delivery flexibility can thus create customer value (Jonsson, 2008).

Maritime transportation has a bargaining disadvantage against road transportation freight forwarders as the offered frequency varies in comparison, to the advantage of road transportation. Generally, a mode selection decision is connected to the frequency variable, the more frequency a mode can provide, the higher probability of selection. The bargaining power increases further when frequency is connected to a high volume capacity (García-Menéndez et al., 2004).

3.2.4 Reliability

Reliability is defined as an average transportation delay (Arencibia, Feo-Valero, García-Menéndez, & Román, 2015) and can be seen from two dimensions. Either a need from a JIT buyer to receive the goods within an acceptable time window related to the production process input, or the reliability needed to reduce buffer stock by which the cost of keeping inventory is minimized (Brooks, Puckett, Hensher, & Sammons, 2012). Backorders can affect customer satisfaction which can compromise trust and loyalty and thus the relationship between a company and their customers. This can be prevented by keeping a higher level of inventory (Son et al., 2013). Reliability and flexibility are of importance when transportation purchasers are using the road transportation in distances of less than 300 km for those attributes, which makes a modal

shift unlikely as the focus is rather on optimizing the road transportation (Beuthe & Bouffioux, 2008). Additionally, the reliability criterion is perceived differently by transportation provider and transportation purchaser. The latter ranks reliability higher than the former (De Jong et al., 2014).

3.2.5 Trade-offs

Among the above-mentioned criteria, cost, transit time and frequency are rated as the most important ones but cost and time are prioritised (García-Menéndez et al., 2004). Even though cost is weighed highly, the importance of time, reliability (Beuthe & Bouffioux, 2008) and speed (Punakivi & Hinkka, 2006) factors are varied among different industries (Beuthe & Bouffioux, 2008; Punakivi & Hinkka, 2006). Speed is the most important factor in products that has high price/kg ratio or with products with short life cycles, price is not of importance in those scenarios. Price becomes the most important factor when the delivery distance is short (Punakivi & Hinkka, 2006).

A study in the Australian context provides the trade-offs that decision-makers must make for inbound and outbound goods. Freight frequency is perceived as equally important compared between different modes such as truck, rail and SSS. Although the choice of truck is preferred among the alternatives, a delay of one day or more could be an issue. The allocation of rail or SSS is sensitive to the reliability of the service to meet a delivery window that is within three hours of schedule. Rail also poses an issue of range of transit times within the mode. The use of integrated SSS, with a door-to-door delivery, increase the preference of the mode (Brooks et al., 2012). During negotiations, manufacturing companies and the transportation providers have different bargaining power. The manufacturing company often settles regarding the volume of the freight, whereas the transportation provider has the power to decrease costs and/or improved conditions (García-Menéndez et al., 2004).

3.3 Transportation Mode Selection

In logistics management, an important decision is that of mode selection for transportation of inbound and outbound goods. The focus areas in decision making and aspects of importance are often narrowed down to cost and transit time (Meixell & Norbis, 2008). Transportation mode selection is complex and cannot be limited to the dimension of cost, as the qualitative aspects must be fully understood, especially regarding a modal shift. The qualitative aspects are of service characteristics which includes reliability of delivery, service frequency, transportation time, risk of losses and flexibility of the transportation provider to meet changing demands (Beuthe & Bouffioux, 2008). The decision is complex due to the differences of criteria between companies, industry and even within the companies own facilities. There is also a significant difference of mode choice for inbound and outbound transportations (Meixell & Norbis, 2008). The context of the transport can also influence the mode selection, that is the value of the goods, distance, freight sizes etc. The qualitative attributes are weighted to 36 percent of the total mode selection decision, the attributes should therefore not be neglected (Beuthe & Bouffioux, 2008).

3.3.1 Industry and Goods Specific Needs

A Finnish case study provides the insight of different transportation needs among the industries specialized in electronics, pharmaceutical trade market, heavy machinery production industry and constructional production industry. The criteria for the different industries examined by Punakivi & Hinkkas (2006) are presented in Table 2 below.

Criteria ranked by importance	Electronics	Pharmaceutical	Machinery	Construction
1	Quality	Speed	Price	Price
2	Speed	Convenience	Reliability	Scheduling
3	Price	Safety	Punctuality	Punctuality
4	Convenience	Fluency	Speed	Convenience

Table 2 – Mode election criteria, modified from Punakivi & Hinkka (2006)

The electronic industry is associated with gaining their competitive advantage through flexibility and experience of global markets operations. The logistic service providers for this kind of industry must have the same capabilities in providing the service. The need for high flexibility and variability of transportation modes along with direct and frequent connections are criteria that must be met. Specific for the industry is also the need for high service quality, delivery accuracy and a global service network. Air freight mode has issues meeting these demands due to safety regulations which can cause delays. Electronic industry has products of high value or high price/kg with short product life cycles and global. Short product lifecycle is correlated with the need for rapid transportation, so is the high price/kg. Speed is therefore a greater need than cost, as is quality and safety (Punakivi & Hinkka, 2006). High value goods that also has a significant inventory carrying cost are more dependable of the efficiency in transportation which can reduce total cost as well as reducing risks. Reliability is therefore an issues in these type of goods (Brooks et al., 2012). Speed can also be considered as a factor in scheduling in occasions when express deliveries are not considered. Most common selection of mode is therefore air and express intercontinental deliveries, the latter in occasions when destinations lack scheduled or direct flights. Whereas road transport is considered to neighbouring areas and rail was not considered at all (Punakivi & Hinkka, 2006).

The pharmaceutical trade markets have a set of other needs. This industry is driven by import in Finland and is therefore intercontinental with a wide selection of products and an open price competition in-between. The logistic service needs are of punctuality and speed in smaller deliveries lots, in both domestic and international trade markets. Problems in air- and road freight has arisen. The issues in airfreight are similar to the electronic industry and road freight has shown capacity issues. The industry specific issue is also with availability of thermos units. Pharmaceutical trade has needs regarding intercontinental deliveries where speed and quality are of major concern, more so than cost. Transportation in Europe is performed by road as air requires more handling which reduces the value added of speed. Regarding products of lower price, sea freight is considered (Punakivi & Hinkka, 2006).

Price is however of importance for the heavy machinery production industry, if the prerequisite of reliability and punctually is fulfilled. Here road transport is most frequently utilized especially in European supply chains. Other modes are also used in intercontinental supply chains, where sea freight is leading due to the size of the products. Airfreight or express deliveries are used in for instance spare part deliveries or as results from unplanned production stops. In the heavy machinery production industry, the set of needs are of issues concerning product size and the lack of suitable equipment for transportation. Problems in sea freight has also been identified, those are of inaccuracy in schedules and product damage during transportation (Punakivi & Hinkka, 2006).

In constructional product industry the issues in logistics services were dispersed information and material flows as well as the fluctuations of demand during different seasons. The low price/kg relation in the construction production industry result in a price driven selection of mode. The market is usually local, which leads to the selection of road freight as a natural choice (Punakivi & Hinkka, 2006).

Reliability is not considered to be an important criterion in maritime transportation for steel products transportation. Cost is more important in the steel industry, which can be explained by the long transportation distance. However, concerning minerals, fertilisers and agricultural products, the most important criterions are of time, reliability and flexibility (Beuthe & Bouffieux, 2008). The probability of selecting road over sea transportation is high, especially for most of the agroindustry sector. This can be explained by the requirements of transportation for most of agroindustry products, which can be of short transit times and refrigeration during transport. Most of the agroindustry products in a Spanish setting are perishables, and thereby unsuitable for sea transportation (García-Menéndez et al., 2004). The weighting of transportation criterions are provided by Beuthe and Bouffieux (2008), see Table 3.

Criteria ranked by importance	Criteria	Percent
1	Cost	63,7
2	Time	16
3	Reliability	8,5
4	Flexibility	5,6
5	Frequency	3,16
6	Safety	3,15

Table 3 - Weighted criterions for transportation, modified from Beuthe and Bouffieux (2008).

The cost aspect is always of importance, disregarding the industry, with the lowest weigh of 46,1 percent. Additionally, cost was especially important within industries that were willing to shift modes for transportation. A correlation was identified of unwillingness to change modes and the importance of cost, in such industries time and reliability was ranked as more important than cost (Beuthe & Bouffieux, 2008). Industries which value criterions of flexibility, reliability, safety and frequency, are more probable to select road transportation as it is perceived to be more beneficial for fulfilment of the criterions (Beuthe & Bouffieux, 2008; Feo, Espino, & García, 2011). Reliability is affecting the transportation selection in regard to delays of transportation, and increase of delays, which lowers the demand of the mode (Arencibia et al., 2015).

In relation to the product type, transportation time can be a crucial factor which can be an effect derived from distance. Intercontinental supply chains require transportation either by sea or air. Continental transportation presents other options such as truck, airplane, train or short sea shipping. The choice of mode of transportations is in reality limited to the type of goods that is to be transported, and in which manner the specific type of products can be transported, that is in bulk, liquid or package (Dekker et al., 2012). As sea transportation is more time consuming in comparison to other modes, the suitable goods are raw material and goods in bulk (Punakivi & Hinkka, 2006). When suitability of maritime transportation aligned with production strategies is examined, the prerequisite to apply the mode is reached for high-value goods only when the goods flow is predictable. Predictability can be affected by contingencies in demand or in the production itself (Morales-Fusco, Saurí, & De Melo, 2013).

The risk for damage is a variable which can affect mode selection. A correlation of the risk for damage exist with the commodity that is transported, such as within the ceramics industry. In comparison, the probability of damaging textile goods is low, as the goods require a low degree of handling and transport restrictions. Risk for damage is in that case not significant (García-Menéndez et al., 2004).

Frequency is important in wood manufacturing and furniture as well as ceramics sectors (García-Menéndez et al., 2004). For middle-value goods and intermediate distances (300 to 700 km), the time and reliability attributes are especially important criterions. All transportation modes have the highest competition among each other in this customer segment. Rail and maritime transportation must therefore improve on the mentioned attributes in this distances (Beuthe & Bouffioux, 2008). The delivery time and reliability of commitment fulfilled of delivery times, are both important aspects of customer service (Jonsson, 2008). Low value goods are connected to the total cost aspect which creates a concern. The mode selection is often of rail or maritime transportation, if the transportation distance is long. Mid-value goods are connected to the criterions of time and reliability, the selected transportation mode is therefore one that can provide the criterions. Lastly, for high-value goods service flexibility and safety is the major criterions, making road transportation the preferable choice (Beuthe & Bouffioux, 2008).

3.4 Lean Transportation

Lean production is based on Toyota Production System which can be summarized as follows. The process begins with defining customer value and the value stream, concentrate on making it flow by pulling from the customer, while striving for excellence (Womack & Jones, 2003). In a pull system, the replenishment in one process is initiated only when the safety stock in the process is down to a few parts, which signals the previous process to send more parts. This is an important principle in the Lean production as it enables Just-In-Time (JIT) (Liker, 2004). By manufacturing according to customer orders, the desired effects are of shorter lead times, focus on customer satisfaction while use as little resources as possible. To enable this strategy, the logistics can be seen as an important asset to create competitiveness. From a logistic perspective, to facilitate lean production and make small batches possible, partnership relationships between suppliers have to evolve according to a long-term perspective in order to achieve small and frequent flows (Jonsson, 2008).

The ambition of Lean is to eliminate waste. Excess inventory is one of the 7+1 wastes which includes; excess of raw material, transportation and storage costs as well as delays. The idea of lowering inventory, and to only use small buffers, reveals quality problems when they occur, and defects are easily traced to the original source. Waste of overproduction is also important to eliminate as producing products when they are not ordered by the customer leads to overstaffing, increase of storage and transportation cost as a result of excess inventory. The other wastes are of waiting, unnecessary transport or conveyance, overprocessing or incorrect processing, unnecessary movement, defects and unused employee creativity (Liker, 2004).

3.4.1 Just-In-Time

The concept of JIT entails that deliveries should cover short-time needs, which can contribute to several transports of small quantities (Dekker et al., 2012; Fahimnia, Bell, Hensher, & Sarkis, 2015). JIT is the delivery of right goods to the right place and in right quantity. It is a set of principles, tools and techniques with the aim to meet specific customer needs (Liker, 2004). Ideally the concept of JIT is applied where the manufacturer and supplier is located close to each other, this is however not always the case as JIT is also applied when the distance is more than

100 kilometres (Dekker et al., 2012). Industries with JIT strategies, are more inclined to select road transportation as the mode offers to fulfil the attributes which are perceived to be necessary for JIT. The attributes sought for are speed, flexibility and reliability (Runhaar & van der Heijden, 2005).

3.5 Transportation and the Environment

Transportation has a direct environmental impact regarding the exhaust emissions, evaporation of fuel into air, water and ground. Spillages, leaks and maintenance/cleaning causes emissions into water and ground, whereas normal operations also contributes by wear of tyres and scrapes of ships' antifouling paint (Jonsson, 2008). The emissions can decrease when fill-rate of the lorries is increased as the number of transports becomes lower (Jonsson & Mattsson, 2011).

The transported units size has a correlation with the amount of CO₂ emissions, that is the bigger the unit, the fewer emissions per g/t/km. As the amount of goods that can be transported by water is larger in comparison to other modes, water transportation is more CO₂ efficient than other modes. Similarly, rail is more CO₂ efficient than trucks, whereas airplane is not CO₂ nor SO_x efficient regardless of the carrying capacity. Maritime transportation is however accountable for the high NO_x emissions. Waiting at nodal points, such as ports or facilities, is associated with inefficiency as well as negative environmental consequences. This can concern moored ships or trucks that keep the engine running while waiting, which contributes to much higher emission levels compare to normal fuel consumption. Regarding ships, ports need to introduce requirements of using electricity from onshore installations (Dekker et al., 2012). The emissions of a ship have correlations with the speed, when reducing speed by ten percent the arrival time is not compromised. The gains are of monetary savings derived from reducing fuel consumption and therefore also cost. Lower fuel consumption leads to lower emissions and the environmental emissions can be reduced by 19,4-24,3 %. The upper percentage limit is achieved by using optimal speed at each sailing leg (Fagerholt, Laporte, & Norstad, 2010).

Environmental significance is a variable which shows positive rating by companies examined by García-Menéndez et al. (2004) whom furthermore claims that environmental restrictions could lead to an increase of selection of maritime transportation over road transportation. Such restriction could be of an ecotax on road transportation.

3.6 Governmental Incentives

Maritime transportation is sensitive to both changes in their own cost as well as changes in road transportation costs. Out of the two sensitivities, the road cost is more prone to affect the maritime transportation. The probability of selection of sea over road decreases when shipping costs for sea are raised. Meaning that increase of road transportation prices, could increase the selection of sea transportation over road (García-Menéndez et al., 2004). A 10 percent increase of road prices, could potentially increase the demand for maritime transportation of 20 percent (Sambracos & Maniati, 2012). The sensitivity leads to a high response to governmental policies. An ecotax could potentially increase the probability of maritime transportation over road. The benefits for European roads can thus be of decongestion, decrease of environmental pollutions and a balanced intermodal goods pattern. Furthermore, an ecotax can increase the maritime transportation compared to reduction of shipping freight rates (García-Menéndez et al., 2004).

To achieve a balance market share regarding the modes of road, rail and sea, a developed policy should aim at the market segments of mid-value goods which are transported over intermediate distances. The important criterions to focus on in such a strategical policy should be of transport

time, reliability, safety, flexibility and frequency (Beuthe & Bouffioux, 2008). A prerequisite for a modal shift from road to sea, is that the existing ports are efficient, fast and well-connected (Sambracos & Maniati, 2012). The market distortion existing between the different modes, is a barrier to making sea transport an effective alternative to long-distance land transport. In order to counteract this, a public-sector intervention is necessary in which the costs of roadway and railways are raised and/or the seaway is subsidized (Baird, 2007).

4 COMPANY PRESENTATION

Köping's Port is one part of Mälardalen AB, the other part is the port located in Västerås. Container traffic is only available at the sister port in Västerås, there JIT deliveries are applied. The container volumes in the region is considered too low to justify having two ports with container traffic. Köping's Port on the other hand is specialized in handling of goods transported in bulk, liquid bulk and sacks. Two persons were interviewed at Köping's Port, firstly an Account Manager in Sales to gain insight into the day-to-day operations and goods flows as the interviewee has worked as a crane operator for the company, besides from possessed knowledge about companies in the region. The second interviewee was the CEO of Mälardalen AB who could provide the strategies of the port.

Company A is a well-established company in the Köping region, the factory has been in place in Köping since the 1940s. The company is a raw material process industry which delivers the products to their customers for further processing. The collaboration with Köping's Port has been in place approximately since the factory opened, circulates around the Port's handling of imported goods for the company. Company A delivers the processed goods globally, approximately 85 percent is exported to international customers. The company is world leading in their particular segment of goods. Both arriving and departing goods that passes through the port is in bulk.

Company B is a component production company that manufactures business-to-business products. The company has facilities located around the globe and the department in Köping has global suppliers as well as themselves supplying the components globally. The majority of suppliers are located in Europe, whereas the company supplies factories in Asia, USA, Europe and Brazil. Two persons were interviewed in Company B. The manager in Transport Network Optimization was interviewed for the purpose of gaining data of company's overall goals and methods for transportation of goods. The Transport & Vehicle Manager has a position locally in Köping, and was interviewed for insight of local decisions regarding transportation. Company B uses other means of transportation for incoming and outgoing goods than Köping's Port.

5 EMPIRICAL FINDINGS

In section 4.1 Current Situation of Maritime Transportation in Sweden, the collected data consists of reports published by Swedish authorities. Whereas adjacent sections, that is 4.2 and forward, consist of empirical data collected through interviews.

5.1 Current Situation of Maritime Transportation in Sweden

Firstly, Freight transportation and Future Demands are presented, followed by the Potential of Modal Shift to Maritime Transportation as well as the Obstacles of Modal Shifts to Maritime Transportation. This section is finalised by an exploration of how goods flows are categorised, that is Goods Flows Based on Value and Weight and Transportation Modes in Swedish Trade.

5.1.1 Freight Transportation and Future Demands

The demand of national goods transportation is likely to increase by 2050 with approximately 61 percent tkm and totally by 126 percent tkm (Trafikverket, 2012c). Additionally, a 38 percent increase of transportation of goods by lorries is forecasted by 2030. Therefore, the transfer of transportation from road to railway and sea is necessary and is a vision for a sustainable future (Trafikverket, 2012a). The probable increase is derived from increased population and urbanization, utilization of economy of scale in production, the localisation of production, and, increased frequency of transportation based on production and stock philosophy and changing consumption pattern. The effects of the increased transportation are likely to affect the existing transportation routes which will need supplement. In regard to terminal and ports, further specialisation in product category and handling method are likely to occur in order to create competitive advantage. The specialisation of ports can be an advantage as to effective exploitation of economy of scale. The driving industries are likely to be within forest- and mining. Future transportation needs will create demands where longer/heavier lorries must be permitted, and railways capacity must be expanded in order to handle larger volumes. The capacity of ports are deemed to be satisfactory, even though certain regions will need to be developed further (Trafikverket, 2012b).

International trade with Eastern Europe is estimated to reach equal amount by 2050 in comparison to Western Europe (Trafikverket, 2012c), see Figure 1.

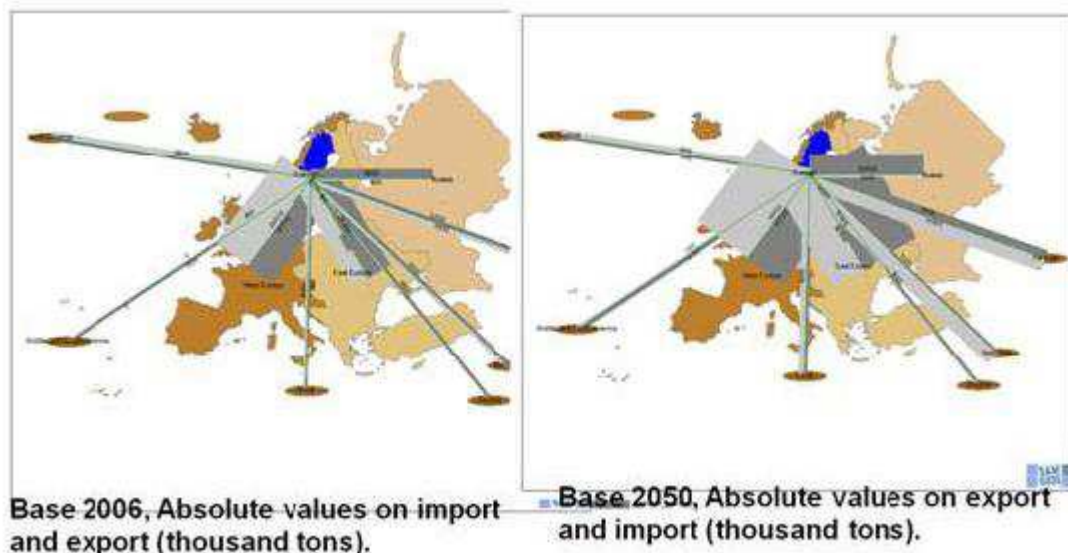


Figure 1 - Import and Export 2006 (left) and 2050 (right) (Trafikverket, 2012c)

Trade is likely to increase also with Russia and the Far East. The increase will dominate in the Eastern Europe which will be a dramatic change with effects on transportation demands. The transportation to Eastern Europe is estimated to be of low value goods and bulk resulting in an increased demand on eastern ports in Sweden as well as increased connection on land to and from the ports. The forecast for maritime transportation is overall 137 percent tkm until 2050 and 77 percent for national SSS. This increase will result in an increase of goods handling in ports with 71 percent more tons (Trafikverket, 2012c).

5.1.2 Potential of Modal Shift to Maritime Transportation

Capacity and effectivity regarding maritime transportation has different limitations compared to road transportation. Water-ways are restricted to the physical size of ships, that is when the need for a certain size of a ship to travel on a route is restricted by the size of the water-way. Capacity limitations can also be due to weather and visibility, marine traffic control and pilotage (Trafikverket, 2012b). For the shipment of goods to be more effective, an increase of the size of the ships by 10 percent lead to a fuel consumption drop of 4 percent. The shift of transportation mode from railway to ship can in turn create a larger capacity for a transfer from road to railway. This method is more plausible as the direct transfer from road to sea creates difficulties. The type of goods is more similar between railway and sea, in contrast to road and sea, regarding the value of goods and the demands for transporting them (Trafikverket, 2012a).

Swedish geography is a reason for the selection of national transportation of goods by railway and short-sea shipping in comparison to other European countries. The type of goods is a contributing factor as the amount of heavy goods, such as ore, is suitable for transportation of long distances and by these modes of transportation (Trafikverket, 2012a). National geography and the long distances for transportation, together with transportation of ore are contributing factors which explain the high share of railway in comparison to the rest of Europe (Trafikverket, 2012b). The traditional transportation of heavy goods has been stable, but transportation by road is increasing especially for high-quality goods. The development of the roads and the possibility for longer and heavier lorries, along with the flexibility of the transportation mode, has gained market shares compared with other modes of transportation. Waterborne transportation has lost market shares nationally, but international transport is increasing (Trafikverket, 2012a).

A modal shift between modes of transportation is a potential method by which the goal of lower CO₂ levels can be achieved. That is, a modal shift in itself has no value. Other benefits are of lower noise levels, increased traffic safety and decreased congestion. However, the effects of modal shift are limited in comparison to effectivization of mode of transportation by technical development. The major potential is identified in the road sector where the largest amount of carbon dioxide is originated. An overall potential of a modal shift is 4-5 million tons, that is 20 percent of the yearly transportation CO₂ emission. The lack of capacity in the Swedish railway system is one part of changes required in order to enable a modal shift. The Swedish transportation system needs effective changes, such as construction of passing loops and speed increases, which is time consuming due to governmental planning processes. A cost effective enabler for a modal shift can be governmental economic incentives (SIKA, 2008).

The limitations of other transportations modes, such as lack of capacity, is the reason behind the belief that the future is within maritime transportation as the capacity of the mode is unlimited. The limitations of maritime transportation are by factors as the width and depth of the water-way, or more importantly the ports connectiveness to roads and railway. The economy of scale and available capacity of ships serves as both an advantage of the mode and a disadvantage in regard to competitiveness. The competitive advantage of maritime transportation is dependent

upon the fill-rate of the ship, a low-fill rate leads to a competitive disadvantage. The demand to fill a ship is therefore of vast importance as a higher quantity of goods is required than for other modes. The fill-rate leads to other demands, such as storing capacity and available time for loading and unloading ships. The effects on the total logistics cost are present, even though transportation cost of maritime transportation can be low. This scenario is also affecting railway when competing with road transportation (Trafikverket, 2012b).

Capacity and sustainability issues can be tackled by attracting more freight from roads and lorries to sea and railroad. This approach is however depended upon several factors. The total cost must be attractive, most importantly reliability regarding time and safety must be fulfilled according to the transport purchaser’s demands. Additionally, the transition between modes must be performed in a time- and cost-effective manner simultaneously as the environmental performance is beneficial (Trafikverket, 2012b). The factors which are of importance when selecting a transport provider are provided in Table 4 which is modified from Trafikverket (2012b). The ranking from a transport purchaser’s perspective as well as transport providers perspective is portrait in the table.

Rank	Transport Purchaser	Rank	Transport Provider
1	Reliability	1	Reliability
2	Transport time	2	Transport price
3	Transport price	3	Customer service
4	Risk of damage	4	Transport time
5/6	Customer service	5	Flexibility
5/6	Flexibility	6	Frequency
7	System of information	7	System of information
8	Frequency	8	Risk of damage

Table 4 – Comparison of transport purchaser/provider’s ranking, modified from Trafikverket (2012b)

Reliability is ranked highest by both transport providers and purchasers, whereas the same factors of importance are included in both sides of the table but ranked differently (Trafikverket, 2012b).

5.1.3 Obstacles of Modal Shift to Maritime Transportation

The possibility of a modal shift can be overestimated. The logistic system can be affected of a modal shift in several levels. The transport purchaser can for instance be affected when shifting modes by the pressure to produce in larger quantities or be able to handle larger incoming quantities of goods. This can affect the company, their suppliers and the customers (Trafikverket, 2012b). Stock and production strategies are factors which must be considered regarding a modal shift. Other obstacles which have a major influence on the transportation mode selection are environmental, transportation purchaser’s demands and total cost perspective (SIKA, 2008).

Infrastructure and company's location is also connected to hurdles. The location aspect is a restriction according to the possibilities of transportation available. Transportation of goods services are generally based on a long-term contract which is based on a company's overall logistics. The modal shift potential is therefore lower in a short-time setting. Overall, three barriers are identified; the prerequisite structures, technical prerequisites and laws, administration structures (SIKA, 2008) see Figure 2.

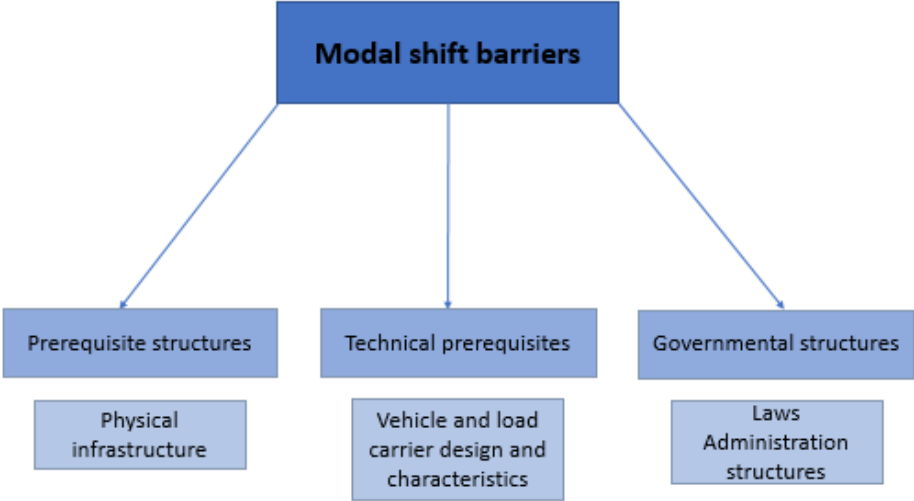


Figure 2 - Identified barriers to modal shift, developed from SIKA (2008)

Transshipment can be a part of the prerequisite structures in Figure 2. According to SIKA (2008), the appeal of a intermodal transportation chain can decrease due to the risks associated with the method. Transshipment increases cost as well as additional resources. Risk to damage goods are also increased in comparison with uninterrupted direct transportation. A structural prerequisite for a modal shift and intermodal transportation is therefore depended upon the attractiveness and effectiveness of terminals. The infrastructure aspect is also resulting in a lack of capacity as well as the manner in which the capacity is utilized in Swedish railway system. The capacity issue in the railway results in a hurdle to the possibility of a modal shift from road transportation to railway and sea.

Governmental structures in Sweden can prevent transportation modes to be regarded as part of a complementary system. Instead transportation modes are competing. For instance, Sweden (and Finland) have an exemption from EU regarding the heavy lorries length and weight. The maximum length is 18,75 meters and 40 tons gross weight, the exemption allows for 25,25 meters and 60 tons. The consequence of the exemption is an extended capacity in road transportation which can affects the competition but benefit the industry when economy of scale is utilized leading to lower transportation costs as well as more effective transportation. This can be a benefit from the environmental aspect, for instance lower emission if two longer lorries can replace three shorter ones (SIKA, 2008).

5.1.4 Goods Flows Based on Value and Weight

International trade of goods is transported mostly by maritime transportation, which accounts for 90 percent, this amount is thus handled by a Swedish port. The international maritime transportation is under continuous growth, a trend that is not mirrored in national growth which is constant at circa seven percent annually. The amount of transportation of goods has small variation but is relatively stable, however, the amount of tkm has increased (Trafikverket,

2012b). The difference can be explained by the increase of the average transportation distance as industries are taking advantage of economy of scale. Furthermore, change in consumption patterns can also affect transportation. The advantages of economy of scale in production are outweighing the disadvantages of increased transportation, as does decrease of stock and small but frequent transportations (Trafikverket, 2012b).

A few classes of goods and industries are respectively dominating international or national transportation. Classes of goods and the industries are differentiated by the market and if value or weight of the goods are in focus. Goods in bulk are standing out in the weight aspect. In national freight transportation, regarding the weight aspect, the most commonly transported goods are of forest variety. Focusing on value aspect, the most common nationally transported goods are Food, Beverages and Tobacco products (Trafikanalys, 2017) see Table 5.

Destination	Goods based on Weight	Goods based on Value
National	Round wood (36%) Soil, stone, gravel and sand (9 %)	Food, Beverages and Tobacco products (9%)
Export	Ore products (29%) Refined Petroleum Products (23%) Forest Industry products (Wood, Wood products, Cork etc.) (22%)	Metal goods (15%) Transportation equipment (14%) Machines and tools (14%) Forest Industry products (Wood, Wood products, Cork etc.) (14%)
Import	Coal, Crude oil, Natural gas (37%) Refined Petroleum Products (27%)	Transportation equipment (19%) Refined Petroleum Products (14%) Machines and tools (13%)

Table 5 - Types of goods based weight, based on Trafikanalys (2017)

Trafikanalys (2017) present that 181 million tons were nationally transported during 2016, which had a value of 1293 billion SEK. Of the total national transportation, 84 percent were transported exclusively by road transportation. The export of goods were 84 million tons and a value of 837 billion SEK. The import to Sweden were 57 million tons, and a value of 542 billion SEK.

The start and end destinations of goods flows are different and depending on if value or weight is measured. Overall, the majority of goods exporting from Sweden (64 % of total goods weight and 66% of total goods value) have the end destination in another EU country (Trafikanalys, 2017), see Table 6 for the precise distribution.

Departing goods from Sweden		Based on Value [%]	Based on Weight [%]
EU	Germany	15	12
	Benelux – countries	12	16
	Great Britain and Ireland	12	8
EFTA and non-EU	Norway	7	9
Globally	Asia	15	11

Table 6 - Export from Sweden, based on Trafikanalys (2017)

According to Trafikanalys (2017) the majority of arriving goods to Sweden has the start location in an EU-country (55 % of the total goods weight and 69 % of the goods value), see Table 7.

Arriving goods to Sweden		Based on Value [%]	Based on Weight [%]
EU	Denmark	8	12
	Benelux – countries	-	10
EFTA and non-EU	Norway	5	12

Table 7 - Import to Sweden according to start destination, based on Trafikanalys (2017)

However, based on the monetary aspect of goods flows, the major start location is Germany, South Easter Europe and Benelux- counties (Trafikanalys, 2017).

5.1.5 Transportation Modes in Swedish Trade

During 2016, 84 percent of all national freight transportation was transported by road, both when weight or value of transported goods are measured. In export, maritime transportation is the dominating mode of transportation with 31 percent transportation of goods weight and 15 percent of goods value. Regarding import, 69 percent of goods weight and 26 percent of goods value is transported to Sweden by sea (Trafikanalys, 2017), see Table 8.

	Export from Sweden [%]		Import to Sweden [%]	
	Weight	Value	Weight	Value
Maritime transportation	31	15	69	26

Table 8 - Maritime transportation distribution in import/export, based on Trafikanalys (2017)

Compared with the Commodity Flow Survey made by Trafikanalys in 2009 (Trafikanalys, 2010), the distribution of transportation modes is presented in Table 9. Concerning the export, maritime transportations is responsible for 8 percent of goods based on weight, and 3 percent base on value. Corresponding percentage of import is, 66 and 22 percent respectively. Road transportation is superior to other modes regarding the export where 71 and 70 percent is transported. However, regarding import, the mode has 11 and 29 percent. The percentage of import of goods based on value is greater in the combination of road and sea (32 %) compared to road alone (29 %).

Mode of transportation	Export from Sweden [%]		Import to Sweden [%]	
	Weight	Value	Weight	Value
Road	71	70	11	29
Road and maritime	7	14	17	32
Air or combination with other modes	0	4	0	8
Railway or railway in combination with other modes	13	5	3	5
Maritime	8	3	66	22
Unknown	1	3	2	5

Table 9 - Mode of transportation in import/export during 2009 (based on Trafikanalys, 2010)

During 2014, the majority of goods transportation was national, 68 percent and the international import and export of goods transportation was 32 percent. Which transportation mode that was used, varied between national and international transport. Nationally, Swedish lorries was dominating with 88 percent, railroad had 9 percent and maritime transportation 3 percent. Internationally, the dominating transportation mode is maritime transportation with 70 percent, whereas railroad and road transportation had 15 percent each (Trafikanalys, 2016), see Figure 3.

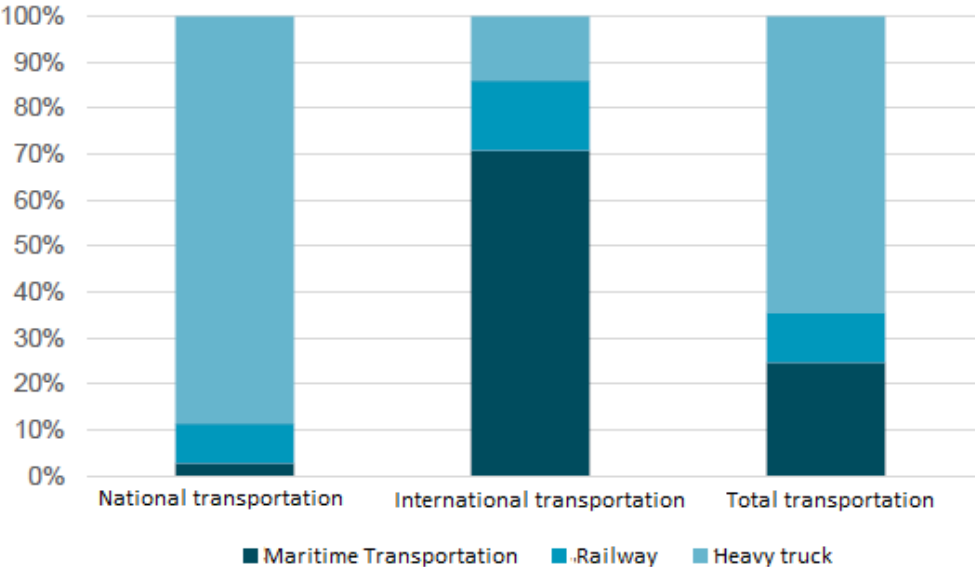


Figure 3 - Transportation modes national/international trade, modified from Trafikanalys (2016)

Railway transportation has the most evenly distribution of amount of tones transported nationally and internationally, 37 million tons and 31 million tons respectively (Trafikanalys, 2016). The distribution of maritime, railway and road transportation are found in Table 10.

Mode of transportation	National	International		
		Sum	From Sweden	To Sweden
Maritime	11 515	144 154	64 809	79 345
Railway	37 331	30 704	-	-
Road	379 992	28 684	13 530	15 154

Table 10 - Transported goods amount in thousands of tons 2014, modified from Trafikanalys (2016)

5.2 Köping's Port – A Mälardalen CEO Perspective

The CEO of Mälardalen has a background of working in railway for approximately twenty years. The current position of CEO has been held for five years. Mälardalen collaborates with other ports in the east of Sweden to create awareness regarding the potential of maritime transportation. During the last five years, the maritime transportation is more on the agenda but still there is more to be done on both local and national level concerning shifting transportation of goods from road and railway to maritime transportation. This issue needs to be further developed and actively worked on to define what kind of transportation will be needed in the future. The following headlines elaborates the issues that has been observed by the CEO.

5.2.1 Competition on Uneven Conditions

The answer to the question regarding how to achieve a better situation on road and railway is in many instances to apply maritime transportation. This realization of the need and necessity to shift goods from roads and rail must reach the politicians, professionals and the business world. The development in Europe show trends pointing in this direction. For instance, in Norway where industries can apply to get monetary refund when switching to more environmental friendly ship motors or shift goods from roads to maritime. Or in Holland where only a certain percent of goods can be transported by road and rail to avoid a fee, and maritime transportation is encouraged. Other distance based fees are present in road transportation in parts of Europe to encourage shifts to maritime. Whereas in Sweden it is more affordable to use roads and rail and allow heavier lorries on the roads compared to the rest of Europe. The pressure is to create more infrastructure as it is the cheapest alternative and disregarding the available capacity in maritime transportation. The solution is not a complete termination of road utilization or stop to invest in roads, rather a better utilization and during shorter distances.

Other ports are competing to attain the available goods volumes, a part of this is reasonable in regard of proximity as goods from the region must be transported by road or rail for long distances. As expressed by the CEO:

“Those [goods] should be directed according to ‘nearest port is best port’ way of thinking. To have incentives that it should be transported by the shortest possible route. Regarding from some form of optimal transshipment.”

The desire is not to compete with other ports, rather with the long-distance transportations and make use of Mälardalen geographical position. the competition with road transportation is not on the same conditions.

5.2.2 Barriers for Maritime Transportation

The Swedish Maritime Administration (SMA) is funded by fees whereas Swedish Transportation Administration (STA) is funded by the government. STA does not take out fees for road transportation, leading to industries demanding more development of infrastructure. SMA on the other hand takes out a pilotage fee of approximately 40 000 SEK which is indirectly charged to the buyer of the transport. Such a method of funding is considered in the rest of Europe as problematic, and administrative measures are developed to discourage road transportation. This is viewed as necessary countermeasure to steer the flow of goods as it is not likely that companies will voluntary make the shift from roads. However, this countermeasure is viewed as to expensive for the industries, leading to the impend of outsourcing their production.

Another barrier is STA providing exemptions to transports which are better suited for maritime transportations. These kinds of exemptions are regarding large goods which are allowed to occupy capacity on roads or rail. Such as a company that transports goods on rail to a neighbouring port on railways which are partly read, meaning the capacity it is full. Whereas a transportation to ports in Västerås or Köping provides yellow or green capacity on the railway.

The minimal storage keeping of companies is considered to be a barrier. Companies are working hard to have as little stock as possible and applying moving stock in lorries or railway cars instead. Thus, minimizing the stock at the production site. In this manner, industries put pressure on the infrastructure to provide the capacity. This behaviour has developed during the latest 15-20 years and replaced the need to have a proper logistic planning.

5.2.3 Attract customers to the Port

Several ports, besides Mälärhamnar, has offered companies a competitive cost assessment without a result of convincing them to shift goods to maritime transportation. If proper incentives or fees are created, a better behaviour can be formed in companies which will lead to a better utilization of existing infrastructure and logistic planning.

Existing customers utilizes Köping's Port to a limited degree as several customers have flows to other ports as well, where the goods could theoretically departure from Köping's Port. However, it is cheaper for companies to tranship goods at Köping's Port to railway cars, which are transported by rail to other ports, have the goods transhipped once more and then departure by sea. This is more economical in comparison to using Köping's Port for maritime transportation, disregarding the cost of handling the goods at multiple occasions. The available volumes in the region are huge, but the infrastructure is misused.

If about three of the large companies in the region could be attracted to use the services of Mälärhamnar, that is companies in both Köping and Västerås, then by having those companies as a customer could attract even more smaller companies. The large customers are important as are the smaller ones as their flows could aid to fill out ships, as expressed in an analogy by the CEO:

“The big actors are necessary to assure that the 'bus' is coming and going to Västerås and Köping, making sure that a number of small travellers can hop on or hop of”

This situation has taking place in a neighboring port where a large company decided to locate their central warehouse near the port and use their services. In the first year the flow of the port increased by 60 percent, and 30 percent the following years first three months.

Mälärhamnar has been in contact with most companies in the region but are faced with explanations such as JIT, more departures in the west coast, etc. However, shipping companies usually have approximately two departures a week and industries have one acquired shipping company. This could be explained by the power of habit and the low cost of other modes.

5.2.4 Vision of Köping's Port and Maritime Transportation

Mälärhamnar as a whole, handle $2,8 \times 10^6$ ton of goods yearly. 80 percent of the total is import, whereas 20 percent is export, but a more balanced flow is preferred. If given opportunity, the available capacity could be tripled or quadrupled on a yearly basis as the amount of volume and goods is currently present in the region. The type of goods is non-essential, neither if it is

transported in bulk, container or sack. The only limitation is the lack of container capacity in Köping’s Port. The ports of Västerås and Köping are on the other hand flexible and can exchange customers among themselves if needed. In theory, Köping’s Port could apply Roll on Roll off trailer transportation, however the need for this kind of flows have not been identified in the region.

The vision of Köping’s Port is a vivid port where the production is according to two shifts, the manpower can be available without a hurdle. In the long-run there is a need to add more storing facilities which is a scarce commodity, but with more ships leaving the port there could be more turnaround of stock. The amount of volumes is present in the region, but the goods are transported to either other ports or by other modes than maritime transportation. A market analysis performed on behalf of Mälardalen, indicated that there is a large amount of available volume in the region. The region is both production and consumption intensive.

5.3 Köping’s Port – An Account Manager in Sales Perspective

The interview with the Account Manager in Sales (AMS) provides a practical insight to the routines of handling incoming and outgoing goods in Köping’s Port. Furthermore, an approximate goods distribution is provided by the AMS, see Figure 4.

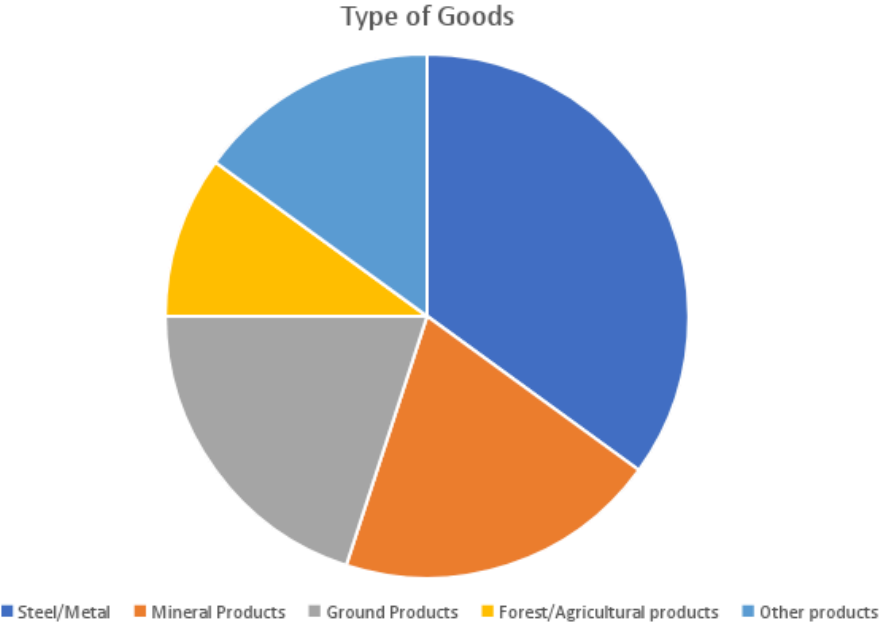


Figure 4 - Type of goods handled by Köping’s Port

The majority of goods type is of steel/metal variety, followed by the mineral products, ground products and forest/agricultural products. All goods are transported in bulk or sack. In the category of other products, the transportation manner and product type are unknown.

5.3.1 Köping’s Port role in the region

The port is considered as the large asset in the region for other organisations, whether the goods are received to the port by ship or railway car. There is a great deal of goods that is both transported to and from the port by railway. Those goods are transported to other ports in eastern or western Sweden for departure by sea. Nevertheless, the port is considered to have a significant role for companies in the region.

Type Of Service Performed by Köping's Dock

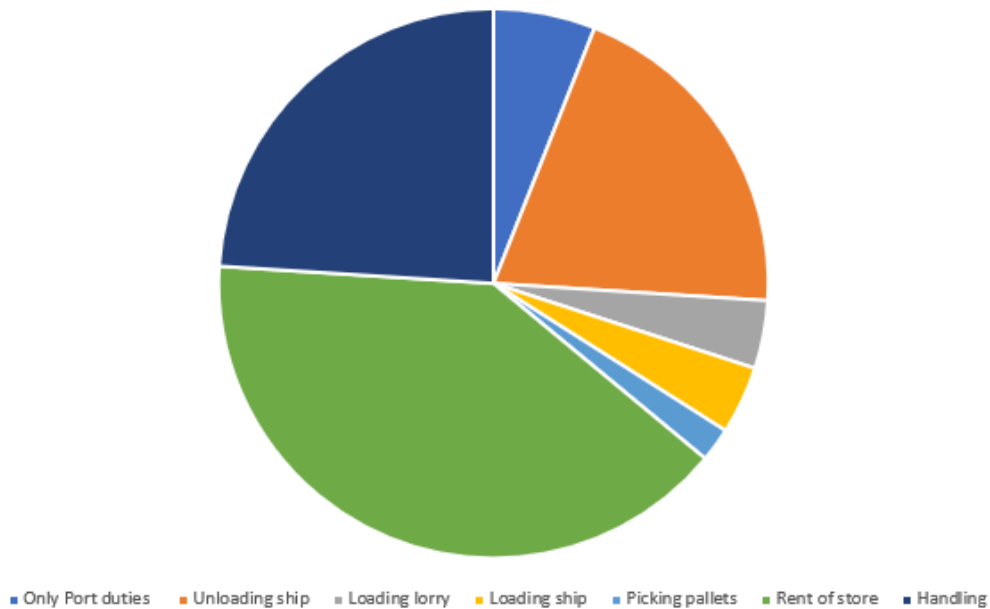


Figure 5 - Type of service provided by the Köping's Port

The services performed by the Port are approximately presented in Figure 5. The largest percentage is rent of storage space, followed by handling of goods and unloading of ships.

5.3.2 Keeping inventories

The port keeps inventories for companies in the region. One company even has their central storage at the port. Majority of the outgoing goods are kept in inventories before they are shipped out. The scenario where goods are arriving at the same time as the ships are loaded is not a realistic one. The capacity of transporting approximately 4000 tons by lorries simultaneously as the ships are loaded is unfeasible. The goods are therefore arriving to the port by lorries or railway cars in a period of days. The same method is applied for incoming goods by ship, as the volume could be of 2000 tons per ship, the goods must be kept in inventories after unloading. Every type of incoming and outgoing goods is therefore kept in inventories. The type of goods which are kept in inventory are presented in Figure 6. The majority of storekeeping is steel/metal products.

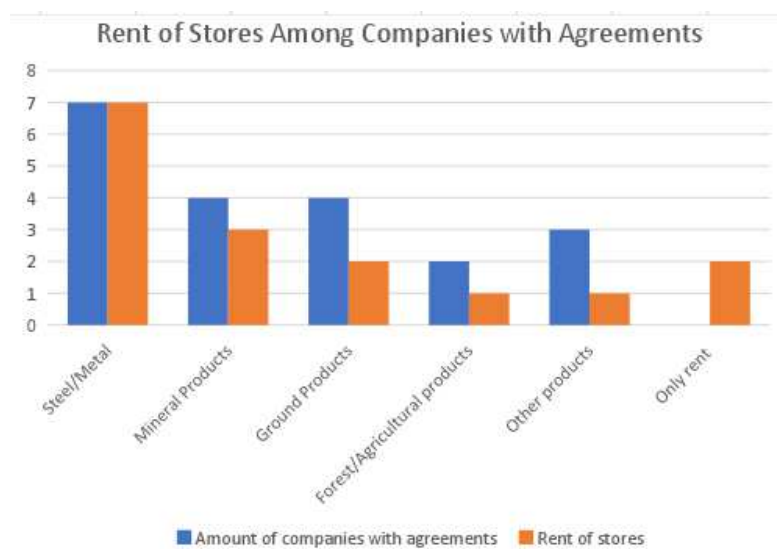


Figure 6 - Store rent based on Type of goods

5.3.3 Receiving goods from local companies

Goods are received from local companies by different modes of transportation. In some cases, by lorry that can carry approximately 40 tons. The goods are tipped into piles that are arranged by a loader so that the goods are not taking up more space than necessary. The port also provides a service where operators from the port arrive at local companies with a lorry to load sacks with produced goods. The sacks are delivered to inventory at the port.

5.3.4 Incoming goods by ship

In the case of pig-iron, almost every delivery starts of in Brazil and is reloaded in a port in Europe into a smaller ship chartered by a local company in Köping. When the ship has arrived at Köping's Port it is reloaded immediately. About five or six lorries usually queue under the crane, when one is loaded it heads to an industrial scale located at a nearby company to be weight as the material is expensive and there is a need to know the exact mass. The lorry returns to the port and tips the pig-iron into a pile and heads back into the queue until the ship is unloaded.

The pig-iron is stored at the port at different piles which depends on the quality of the material. When foundries at various locations in Sweden order the material from the local company, the latter notifies the port that a lorry is scheduled to arrive to pick up a certain amount at the port. The lorry is directed by the front desk to a pile with the requested quality.

5.3.5 Outgoing goods from the port

Outgoing goods are either in bulk or in sacks. When an appropriate amount of sacks is stored at the port, the local company charters a ship. The process of loading the sacks is by driving the sacks to the crane by a loader. The crane can load the ship in amount of three at a time. Not all sacks which are stored at the port are transported by ships. The port loads the sacks to railroad cars which are transported by railway to other ports, due to availability of larger ships. The same goods that are in the sack from that particular local company are also loaded into containers, a service not provided by the port.

5.4 Company A – A Purchasing Manager's Perspective

The role of Köping's Port is three folded regarding services it provides for Company A according to the Purchasing Manager (PM). Firstly, the Keeping Inventories, and handling of goods for both Incoming Goods by Ship and Outgoing Goods from the Port.

5.4.1 Keeping Inventories

Incoming goods are directly transported to Company A when arriving to Köping's Port. A portion of outgoing goods on the other hand, is transported to Köping's Port for storage. The company has available storage space at the Port as part of the service that the Port is providing to Company A.

5.4.2 Incoming Goods by Ship

The company receives goods via Köping's Port at a regular basis, and multiple times a month. At each occasion they receive between 3-5000 ton of bulk by ship. The existing production has however expanded. Besides from the scheduled incoming goods, one other sort of goods is transported by ships. Although, the other sort of bulk goods is less frequent and only existent when another segment in other locations of the company has a surplus of it. The same system is in place for occasions when Company A has a surplus, which is transported by ship to other locations. These two types of goods demand handling from the Port concerning import. All other

components and requisites which are needed for production is transported mainly by lorries. Railway is also used for transportation to the local area, however then a transshipment must be made to lorries for the last leg of the transportation distance.

A future possible change in the company is more frequent deliveries of goods which is posing demands on Köping's Port. The time for unloading a boat with this kind of goods is approximately one day and due to safety reasons, two personnel from the Port must be present during the full duration. The boat is owned by the company and is unloaded and send back for more goods for continues production. The frequency for delivery is mainly controlled locally at the company and the delivery can be chosen to be delayed in occasions of planned production stops. The only bottleneck for deliveries is that the Port has personnel present for handling of goods, as the boat can arrive any day during a week. This demands flexibility and excellent communication.

The company has an approximate buffer of one-day production between the deliveries, an unplanned stop of deliveries can therefore have vast consequences. This too sets demand on the Port, especially if more frequent deliveries are realized. In the worst occasion, the boat containing Company A's goods had to wait half a day for unloading. However, the company perceives to be prioritized by the Port.

5.4.3 Outgoing Goods from the Port

The Port is utilized to export certain types of bulk goods on a monthly basis. Although, other ports are also used. The company produces approximately 2-3 thousand tons a year, and about 2/3 are transported to other ports. One restriction with Köping's Port is the lack of container transportation which is otherwise used within Company A. Another restriction is the size of the boats allowed into the Port, which can only carry up to 5000 tons. When a customer orders 7-8000 ton, an additional transshipment is avoided by using another port where there is no size limitation. There is however a possibility to transfer some of the flow of outgoing goods to Köping's Port when the Mälarpject is finished.

Containers are sealed using tamper-proof devices, and transported to other ports by railway or lorries. Which port to use is decided according to where the customer is located in each occasion. Unnecessary transshipments of goods are avoided due to safety reasons, especially in places where the company have little to no control. If a boat is loaded with goods, the cargo area is sealed and cannot be opened until the boat has reached the final destination. The quality of service must therefore be secured. The cost aspect is also considered when selecting which port to choose for outgoing goods as other ports have lower port charges.

5.5 Company B – A Manager of Transport Network Optimization's Perspective

The Manager of Transport Network Optimization (MTNO) has a general transport responsibility within the Swedish market of Company B. In Criteria for Transportation, the manager provides information regarding company's overall policies and strategies when selecting a transportation service company. In the headings Incoming Goods to the Factory and Outgoing Goods from the Factory, information regarding the flows of goods to and from Company B is provided. The managers role in the company is to optimize the flow of external logistics, that is flows in and out of factories.

5.5.1 Criteria for Transportation

Several basic criteria must be fulfilled to be included in a primary consideration to provide transportation to Company B, which concerns both in-and outgoing transportation. The most important criterion is accuracy of time for deliveries. A goal can be that 98 percent must be delivered according to the time specified in the contract. Other criteria that transport providers must deliver on the basic level are fulfilment of environmental requirements. Also, to provide a service with stability, precision and quality. When the basic demands are fulfilled, a comparison is performed according to cost of service.

Deliveries to the right place, and in the right time is the motivation behind the selection of road transportation. Road transportation enables to fulfil the criteria of time as well as flexibility. Especially as deliveries from Company B requires daily transportation and road transportation is the only mode which can fulfil the requirement.

5.5.2 Incoming Goods to the Factory

Goods are transported from suppliers located in Europe primarily by road. A portion of flows of goods are also transported by maritime transportation, however those suppliers are located in Asia. The possibility of deliveries by air is present in occasions where there is a need for rapid transportation compared with the scheduled ones. This is restricted to situations where an alarm is triggered in production with an acute shortage of supplies, or as a solution for shortening lead times in production.

5.5.3 Outgoing Goods from the Factory

The local company in Köping is a provider of business-to-business products. The goods which are outgoing from Company B are delivered to other segments within the same corporation for further production before reaching the final customer. As Company B produces unique products, they are delivered globally.

For international transports of goods from Company B, the goods are transported to a port in Göteborg. A single transportation company is responsible for deliveries between the two cities as the volume from Company B is high. The flow of goods is based on a predetermined time table and are packed in containers.

A strategy of cross stocking of containers is applied in Göteborg. Meaning goods from the same corporation is jointly loaded in containers which are headed to the same destination in the purpose to obtain a high degree of filling. For instance, if the end destination is in USA and other segments of the company in Europe and Sweden have goods heading there, then the company is aiming to cross stock the goods. This is however depended upon the available volume.

One flow of goods is to Russia. Which transportation mode is selected depends primarily on the delivery volume. In some occasions, the goods are delivered to Göteborg for cross stocking. When the volume has increased, maritime transportation was selected from port in eastern Sweden to Latvia. The company has revised ports in the eastern Sweden, however determined that required lead time could not be fulfilled regarding flows of goods to America and Asia. Göteborg is regarded as a hub for components within the company.

5.6 Company B – A Transport & Vehicle Manager’s Perspective

The second interview with Company B was performed with a local Transport and Vehicle Manager (TVM), in the Köping region. The responsibilities of who it is to compile the transportation needs into requirements which are communicated to the company’s Logistics headquarters in Sweden. The requirement from all factories are the basis for a requirement specification which is used in acquisition of transportation services. Company B is thus able to specify the frequency of the transportations. In some occasions when there is a cost benefit for the company as a whole, the local Company B can adjust to those conditions. The framework concerning the transportation has been in place for approximately 25-30 years and is focused on consensus.

5.6.1 Criteria for Transportation

Criteria are based on a mix out of cost, JIT and environmental aspects. Regarding environmental aspects, the company as a whole has demands on the service providers to have lorries with a certain environmental class. The cost aspect is derived from the cost to keep stock along with the balance of JIT as Company B is a part of a JIT chain.

Lorries are the primary transportation mode as reliability is highly prioritized. Lead times are a crucial factor which is difficult to achieve with other modes. The company could for instance apply maritime transportations from Germany as the volumes of raw material are large. The issue is with transportation time of maritime transportation as it probably takes double the time to reach the end destination. Then it is viewed as a large moving stock. This is the issues with matching maritime transportation with the production in Company B which demands high frequency of departures/arrivals, short lead times and the capability to handle multimodal transportation, that is trailers or containers. Railroad has been applied previously, similar issues as with maritime transportation had occurred and the lead times was not suitable for the production.

5.6.2 Incoming Goods to the Company

Transportation acquisitions are formed according to arrangements with the transportation provider. Meaning, Company B is responsible for purchasing transportation capacity which is needed to collect goods at the suppliers. The transportation flows are owned by Company B which makes the company a large asset from the transportation service perspective as the company is transporting large volumes which is beneficial for both parts.

Scaled down to the local Company B in the Köping’s region, the company has the largest suppliers in Germany, the largest flows of goods to the company is thus from Germany. However, there are some flows of goods from suppliers in Austria and in Sweden. The latter being a relatively small supplier. The incoming goods to the company is processed raw material packed on pallets. The raw material need further processing in the company and constitutes the largest flows from the suppliers. The company is also supplied with components which is purchased and assembled.

The goods are packed into either lorries or trailers. The goods to the company is transported either solely by road or via Gent, Belgium to Göteborg by ferry craft and by road for the last mile. The company has a large procurement with a ferry craft provider which delivers scuttle service between the two cities. The utilization of the ferry craft is both out of cost and environmental perspective as the ferry craft can carry approximately 500 trailers. In this manner the transportation by road is avoided in western Europe.

The production has increase by approximately 1/3, with an extremely high takt time as a result. In this situation, the company accepts a higher degree of stock to ensure a continues production. However, the consequence is that the production is therefore sensitive to disturbances derived from material shortage.

5.6.3 Outgoing Goods from the Company

The largest flows from the local Company B to their suppliers are to Göteborg, Belgium and France. Railway has been applied previously but it is difficult to obtain the needed capacity. From the local Company B, between five and seven trailers are departing per day. The trailers from Company B goes to Göteborg and the factory there, or continues from Göteborg by ferry craft to Gent. The approximate distribution of end destination is according to the Figure 7 below:



Figure 7 - Distribution of destination for outgoing goods from Company B

As a result of being a part of a JIT chain, Company B must deliver to their immediate customer approximately two days in advanced. As the Transport and Vehicle Manger expressed:

“We deliver tonight what is supposed to be used the day after tomorrow in another factory [...] the parts we are sending tonight, they will receive on Monday and on Tuesday the part is used in production”

The same sequence of production in Company B is matched with other factories to reach the immediate customer in the same order as the final product is assembled. The components produced in Company B are therefore individually matched against the final product which triggers the production at Company B. The same procedure is applied throughout the company as a whole.

The higher production rate results in demands for material handling and transportation. JIT chain could be tightened even more than the todays transportations frequency. However, the frequency of two days allows room to miss a transport or if a transport is delayed. The balance to achieve reliable transportation is therefore highly prioritized.

6 ANALYSIS AND DISCUSSION

This chapter is initiated by the Selection of Transportation Mode, followed by a comparison of the modes in Advantages and Disadvantages of Transportation Modes and the Preference of Maritime Mode is examined. The chapter is finalized with Practical Implications.

6.1 Selection of Transportation Mode

The first research question was; Which decision criterions are considered in selection of transportation mode? The identified criterions are; Cost, Reliability and Time, Frequency and Volume, and lastly, Specific Goods Needs. Furthermore, secondary criterion of Environment was identified, however, the criteria is not investigated fully as the empirical finding were not sufficient. The findings are summarized in Table 11.

Selection criterions	Theoretical Framework	Empirical Findings	Analysis
Cost	Most important criteria (Beuthe & Bouffioux, 2008). Cost is prioritized in industries where goods have low price/kg (Punakivi & Hinkka, 2006).	Company A: selection of ports is based on a comparison of port charges. Company B: cost only regarded when other basic criterions are fulfilled.	The importance of the cost aspect differs between industries, and the type of goods. Prioritized in Company A but only regarded in Company B when other criterions are fulfilled.
Reliability and Time	Short transit times promotes lower cost (Son et al., 2013). Time, next most important criterion (Beuthe & Bouffioux, 2008). High value goods with short life cycles are connected to speed (Punakivi & Hinkka, 2006).	Company A: safety is valued. Company B: part of a JIT chain. Road is selected based on the reliability criteria. Transport must fulfil the lead time. Köping´s Port, AMS: bulk requires inventory time at the port.	Correlation of time, reliability and goods value is identified. Cost is not prioritized in this segment. Road transportation preferable as it enables the companies to reach targets of reliability, that is that deliveries are at the right time and in the right place.
Frequency and Volume	Selection of a modes is more probable if it offers frequency in combination with volume capacity (García-Menéndez et al., 2004). High frequency enables increased flexibility in the supply chain, decreased stock capacity and thus stock keeping costs (Naim et al., 2006).	Company A: available volume at Köping´s Port is a limitation. Company B: delivery volume affects mode selection. Frequency is difficult to achieved with maritime transportation. Köping´s Port: perceived by the industry that ports on the west coast are more frequent.	A correlation of frequency and volume is identified. High frequency paired with high volume capacity increases the chance of selection. For Company A, the frequency of the port suits its needs, the available volume capacity on the other hand is a limitation.
Specific Goods Needs	The context affects mode selection (Beuthe & Bouffioux, 2008). Selection is limited by the type of goods and manner it is transported in (Dekker et al., 2012). Qualitative aspects verses cost driven mode selection (Beuthe & Bouffioux, 2008).	Company A: lower price/kg in bulk, all other products by road. Company B: high value goods in package/container, national transportation by road, international by road/sea. Köping´s Port: type of goods is non-essential. Lack of container in the port.	Transportation mode decisions are highly dependent on the context of the transportation. Different goods within the same company have different demands of transportation. The ports view is that the type of goods is non-essential, the contrary is identified in Company A and B.
Environment	Maritime transportation is more CO2 efficient (Dekker et al., 2012).	Company B: basic fulfilment of environmental requirements. International transportation by sea.	The environment criterion is not investigated fully, which prohibits a proper analyses.

Table 11 - Summarization of the analyses of RQ1.

6.1.1 Cost

The most important criterion for decision makers regarding mode selection is cost which is weighted highly (60 %) in comparison to other criteria (Beuthe & Bouffieux, 2008). The additional cost of transshipment which is followed by the Port's handling of goods at several occasions, where goods is reloaded transported to other ports by rail, is more economical in comparison to direct departure from Köping's port (Köping's Port, CEO). This is the case for the Company A, although the multiple transshipment is viewed as a result from limitations in Köping's Port. The lack of container possibility and the size of the available ships are the reasons for using other ports. As the available capacity of one ship is maximum 5000 tons, if a customer order exceeds the availability, an additional transshipment is avoided by transferring the goods to other ports without a size limitation. The cost aspect is additionally regarded by Company A when selecting ports, this is based on the comparison of port charges. The selected port is the one with lower fees although another criterion for selection of port is the location of the customer (Company A, PM). Location determines the mode which is relevant to utilize (Son et al., 2013) and is a restriction according to which transportation modes are available (SIKA, 2008).

In the case of Company B, as described from the Manager of Transport Optimization Network, the cost criterion is only regarded when all other criteria and basic needs are satisfied (Company B, MTNO). Furthermore, the view of the local Transport & Vehicle Manager states that the selection of transportation is based on a mix out of cost, JIT and environmental aspects (Company B, TVM). The cost criterion is therefore a part of the selection; however, it is not prioritized. Punakivi and Hinkka (2006) present other industries segments where the criterion of cost is considered but not prioritized. In the pharmaceutical industry, speed, punctuality and quality is the major concern compared to cost, thus road transportation is selected. In the heavy machinery industry, cost is only considered when the prerequisite of reliability is fulfilled, in this industry road is therefore used in European supply chains. However, industries which prioritizes the cost criterion are for instance the construction industry where the products are of low price/kg leading to price driven selection of mode. Beuthe and Bouffieux (2008) suggest that the cost criterion is also important in the steel industry which in this case could be explained by the long transportation distance. Lastly, Jonsson and Mattsson (2011) argue for a holistic view of costs as decrease in one activity can result in increase in another.

6.1.2 Reliability and Time

Brooks et al. (2012) state that reliability has two dimensions, that is of the JIT buyer is receiving goods within an acceptable time limit which is connected to the production process input. The second dimension is the reliability needed to reduce buffer stock. By reducing the buffer stock, the cost of inventory can be minimized. Liker (2004) explains that excess inventory is viewed as a waste in terms of Lean production, which leads to among other things increased storage costs. Company B is according to TVM and MTNO a part of JIT chain. This have consequences for transportation of both inbound and outbound goods. For outbound goods, the company must assure that deliveries are reaching their immediate customer approximately two days before the customer needs to use the goods in their production. For inbound goods, Company B is sensitive to disturbances due to material shortening as the production rate has an extremely high takt time which allows the company to have a slightly higher stock degree. The cost of keeping stock must therefore be balanced with JIT (Company B, TVM). This is in line with Brookes et al. (2012) who claims that a delay of one day or more could be an issue, as well as Son et al. (2013) who states that backorders decrease customer satisfaction which can be prevented by a higher level of inventory than ordinary. Dekker et al. (2012) and Fahimnia et al. (2015) also state that JIT leads to deliveries which cover short-time needs, which can contribute to a high amount of transport of small quantities. However, JIT is applied as a part of Lean transportation and

according to Jonsson (2008) by manufacturing according to customer orders, shorter lead times and a focus on customer satisfaction can be achieved while using as few resource as possible. This is also part of overproduction as a waste according to Liker (2004) as production without customer order has several consequences of costs. Conclusively, one can argue that JIT and reliability are connected, thus there is an importance of a holistic view when discussing reliability.

According to Punakivi and Hinkka (2006), the electronic industry also has a need for high service quality and delivery accuracy. Also, the pharmaceutical industry has a need for punctuality and speed of small delivery lots. Jonsson (2008) state that time and reliability of delivery times are both important aspects of customer service and Arencibia et al. (2015) adds that increase of delays lowers the demand of the mode.

Road transportation is preferred among the alternatives as rail and maritime transportation are sensitive to the reliability of service to meet the delivery window (Brooks et al., 2012). This is true for Company B. The TVM expressed that lorries and road transportation is the primary transportation mode due to the prioritization of reliability as the company values lead times. The required lead times are difficult to achieve with other modes of transportation (Company B, TVM).

For Company A, as expressed from the Purchasing Manager, the buffer allows one-day continuous production between deliveries. However, an unplanned stop due to material shortages creates vast consequences also for Company A. The demand on the Köping's Port to prioritize the unloading of ships with goods for the company, this is also realized as in the worst-case scenario the company must wait one day for unloading. Furthermore, the aspect of safety is identified in Company A. Safety is required in the container shipping. Containers are sealed using tamper-proof devices and unnecessary transshipments are avoided where the company cannot reassure complete control. This requires quality of service as well as container availability. If a boat is loaded with the bulk goods from the company, the cargo area is sealed until the ship arrives at the final destination (Company A, PM).

A correlation of time and reliability has been identified as both criteria affect the stock level. Son et al. (2013) writes that short transit time enables the operations in the supply chain to function with less inventory, fewer backorders and lower cost of the material flow. According to Beuthe and Bouffioux (2008) time is the next most important criterion after cost. Furthermore, Punakivi and Hinkka (2006) write that speed is the most important criteria in high value goods with short life cycles, cost is not of importance in this goods segment. Compared to the empirical findings, Company B and MTNO, explained that deliveries to the right place, in the right time is the reason for selection of road transportation. Besides from enabling to fulfil the criterion of time, road transportation is also flexible. The combination of criterions is especially appealing as deliveries from Company B requires daily departures which is only fulfilled by road transportation. Further, the company has revised the port in eastern Sweden, however, the ports lacked the necessary requirement of fulfilling the lead time regarding flows to Asia and America. The TVM in Company B also adds that by application of maritime transportation, the company views as the long transportation time would end up as a large moving stock. This view of maritime transportation correlates with Punakivi and Hinkka (2006) and Jonsson (2008), that maritime transportation is slower in comparison with other modes, thus suitable for goods such as raw material and bulk.

Jonsson (2008) writes that loading and unloading bulk usually requires a short amount of time. Whereas AMS of Köping's Port problematise the processes before and after loading/unloading. Additional time is required by the maritime transportation, the AMS of Köping's Port express that all incoming and outgoing goods which are in bulk requires inventory time at the port. The capacity of simultaneously transporting ca 4000 tons of goods as the ships are loaded/unloaded is unfeasible. The goods are therefore transported to the port in a period of days, the same is necessary for unloaded goods which are delivered by ships (Köping's Port, AMS).

6.1.3 Frequency and Volume

The probability of selecting a mode is higher if the mode offers frequency (García-Menéndez et al., 2004). High frequency enables the transport purchaser to adapt to sudden variation of demand, leading to increased flexibility in the supply chain, decreased stock capacity and thus stock keeping costs (Naim et al., 2006). Flexibility is an important service attribute which enables adaptation to changing customer requirement (Jonsson, 2008). The bargaining power increases even more when frequency is connected to a high volume capacity (García-Menéndez et al., 2004). In the case of Company B and the flow of goods to Russia, which transportation mode that is selected depends upon the delivery volume (Company B, MTNO). Furthermore, the criterion of flexibility is perceived equally important in all modes, that is truck, rail and SSS (Brooks et al., 2012). The port has been in contact with most companies in the region and a common explanation for not using maritime transportation, besides from JIT and cost, is the available frequency of departures. It is perceived by the industries that ports on the west coast of Sweden have more frequent departures. However, shipping companies have circa two departures and industry usually acquire the services of one shipping company. The barrier is explained by the power of habit and low cost of other modes (Köping's Port, CEO).

According to TVM at Company B, the selection of maritime transportation is prevented by the issue of matching the mode with the companies demand for high frequency of arrivals and departures. Other barriers for selecting maritime transportation is also the demand for short lead times and capability to handle multimodal transportation as the company utilizes trailers and containers. Furthermore, production rate demands the transportation frequency of two days for incoming goods (Company B, TVM). Company A on the other hand, has one incoming shipment per week which can be intentionally delayed by the company itself related to planned production stops. The requirement is however to have available port personnel present which could possibly be a bottleneck which can be solved with excellent communication and flexibility (Company A, PM).

6.1.4 Specific Goods Needs

The difference of primary criteria for Company A and B could be explained by Beuthe and Bouffieux (2008) who states that the context of the transport can influence the mode selection decision. The context can include, among other things, the value of the goods, the distance of transportation and freight size. Dekker et al. (2012) states that the choice of mode is reality limited by the type of goods which is to be transported and the manner of transportation, that is in bulk, liquid or package. The difference in the type of goods between Company A and B is therefore essential based on this reasoning. As Company A has products of a lower price as the goods are transported in bulk, according to Punakivi and Hinkka (2006) and Jonsson (2008) sea transportation is considered in products of this segment. Trafikverket (2012a) and Jonsson (2008) also states that the type of goods and the weight that is to be transported, such in the case of ore, is suitable for railway and maritime transportation. Beuthe and Bouffieux (2008) further states that low value goods are connected to the cost aspect, in a correlation with low value goods and a long transportation distance, the mode selection is often of rail and maritime transportation,

which in parts is also supported by Jonsson (2008). For mid-value goods, the important criterion are time and reliability, mode selection is thus the one which can satisfy the criterions (Beuthe & Bouffieux, 2008). Trafikverket (2012a) states that road transportation is increasing for high-quality goods whereas the heavy goods transportation is stable.

Brooks et al. (2012) states that products of high value have a significant inventory carrying cost and is therefore dependable of the efficiency in transportation. Efficiency can lower the total cost and the risk for the company. Punakivi and Hinkka (2006) argue that a high price/kg and short product lifecycles is correlated with the need for rapid transportation. This leads to the prioritization of speed as well as quality and safety over cost. In this category of goods, the reliability criteria are therefore more important. However, Beuthe and Bouffieux (2008) connect high value goods to service flexibility and safety, making the road transportation as the preferable choice. The prioritization of reliability in Company B is explained by MTNO as accuracy of delivery time is the most important criteria when selectin transportation provider. The company can have a goal for delivery time accuracy of 98 percent, the transportations service must also be stable, and provided with precision and quality (Company B, MTNO). Other goods specific criterions are those of product size connected to available suitable equipment for transportation and fluctuation in demand during different seasons in construction industry (Punakivi & Hinkka, 2006). In minerals, fertilizers and agricultural products, the most important criterions are of time, reliability and flexibility (Beuthe & Bouffieux, 2008).

According to Beuthe and Bouffieux (2008), the qualitative aspects are weighed to 36 percent of the mode decision. As Company A receives goods in bulk, maritime transportation and Köping’s Port is used. However, all other components and requisites needed in the production are delivered to Company A by road (Company A, PM). Thus, even within the same company the variety of goods that is transported has a differentiation of needs for transportation. As goods in bulk is suitable for maritime transportation, all other components, which are presumably transported in other manners than bulk, have needs which cannot be fulfilled by maritime transportation. The view of the Köping’s Port is however that the type of goods which is suitable for maritime transportation is non-essential. Maritime transportation can be applied if the goods are transported in bulk, container or sack. The only limitation of Köping’s Port is the lack of container availability (Köping’s Port, CEO). The difference of specific goods needs is presented in Table 12.

Decision variables	Type of Goods	
	Weight (Low price/kg)	Value (High price/kg)
Manner of transportation	Bulk/Liquid/Sack	Package/Container/Trailer
Goods specific needs	Requires inventory time at the port.	High inventory carrying cost Need for rapid transportation Short life-cycle
Selection criterions	Cost driven	Reliability and Time driven. Flexibility also valued.
Preferred transportation mode	Maritime/rail transportation	Road transportation

Table 12 - The difference between the type of goods, based on the Weight and the Value categorisation.

Different industries also have different transportation needs (Punakivi & Hinkka, 2006). For instance, within the ceramics industry the risk of damage is avoided, thus the selected transportation mode must lower that risk (García-Menéndez et al., 2004). Industries which value reliability, flexibility, safety and frequency, are more likely to select road transportation (Beuthe & Bouffieux, 2008; Feo et al., 2011). The industries which were used to exemplify different

criteria show on the complexity of transportation mode selection. Even within the same industry, different transportation modes are required based on goods specific needs.

6.1.5 Environment

The criterion of environment was present in empirical findings of Company B. The company selects transportation service providers which have lorries with a specific environmental class (Company B, TVM). The service providers must deliver basic fulfilment of environmental requirement (Company B, MTNO). Furthermore, the company utilizes maritime transportation in international transportation. To destinations in Europe, ferry crafts are used to Gant, which is performed from a cost and environmental perspective. A ferry craft can carry circa 500 trailers, simultaneously, road transportation is avoided (Company B, TVM). Emissions decrease when fill-rates of lorries increase (Jonsson & Mattsson, 2011). The amount of goods which can be transported by sea is larger compared to other modes and maritime transportation is more CO₂ efficient (Dekker et al., 2012).

6.2 Advantages and Disadvantages of Transportation Modes

The second research question was; What are the advantages and the disadvantages of the different modes of transportation? The summarization of the analysis is presented in Table 13. The headlines below are categorized by mode, beginning with Road Transportation.

		Theoretical Findings		Empirical Findings	
		Advantages	Disadvantages	Advantages	Disadvantages
Road		Accessibility, variation of goods, to most destinations, direct deliveries (Jonsson, 2008). Flexibility to size, value nor weight of goods, tailor made solutions (Jonsson, 2008; Reis, 2014). Funded by public-sector (Baird, 2007).	Capacity issues in road (Punakivi & Hinkka, 2006) Exhaust emissions, noise, road safety, traffic congestion (Jonsson, 2008). Most expensive and resource-consuming (Medda & Trujillo, 2010).	Flexibility (Trafikverket, 2012a), Reliability (Company B, TVM). No road fees (Köping's Port, CEO). Uninterrupted transportation (SIKA, 2008).	
	Rail	Environmental cleanliness when electric, energy efficient when combined with high fill-rate (Jonsson, 2008). Public-sector funded (Baird, 2007).	More time-consuming compared to road, less frequent, less flexible, underdeveloped network (Jonsson, 2008). Capacity, track space, connectivity (Baird, 2007).		Railroad has been applied previously, lead times was not suitable for the production. Difficult to obtain the needed capacity (Company B, TVM). Lack of capacity, needs effective changes (SIKA, 2008).
Air		Used in spare part deliveries or as results from unplanned production stops (Punakivi & Hinkka, 2006). Speed over long distance (Jonsson, 2008).	Requires more handling which reduces the value added of speed. Safety regulations can cause delays (Punakivi & Hinkka, 2006). Highest cost per tkm. No direct transportation (Jonsson, 2008).	Need for rapid transportation, an alarm is triggered in production with an acute shortage of supplies (Company B, MTNO).	
Maritime		Sea freight is preferred due to the size of the products (Punakivi & Hinkka, 2006). Lowest operation cost per tkm, loading capacity, environmental favourable (Jonsson, 2008). Low cost maintenance, waterways are often free (Baird, 2007; Jonsson, 2008), capacity can be increased (Baird, 2007). Flexibility (Jonsson, 2008).	More time-consuming in comparison to other modes (Jonsson, 2008; Punakivi & Hinkka, 2006) Inaccuracy in schedules and product damage during transportation (Punakivi & Hinkka, 2006). No direct deliveries, high energy consumption (Jonsson, 2008). Lack of flexibility (Beuthe & Bouffioux, 2008).	Unlimited capacity (Trafikverket, 2012b). Fill rate, competitive advantage (Trafikverket, 2012b).	Lead times was not suitable for the production (Company B, TVN). Pilotage fee (Köping's Port, CEO). Select port according to port charges (Company A). Limitation of width and depth of waterway, connectiveness to other modes. Fill rate, competitive disadvantage (Trafikverket, 2012b).

Table 13 - Summarization of analysis of RQ2

6.2.1 Road Transportation

Road transportation has gained market share compared to other modes (Trafikverket, 2012a), the flexibility of the mode (Jonsson, 2008; Reis, 2014; Trafikverket, 2012a) enables tailor made solutions (Jonsson, 2008; Reis, 2014). Possibility to use longer and heavier lorries has also enabled the growth of the mode (Trafikverket, 2012a). The mode allows for uninterrupted transportation, that is decreases the number of time the goods are transhipped. Transshipment is not preferred as it increases cost, resources and the risk for damage (SIKA, 2008). According to

Company B, road transportation is selected due to the fulfilled criteria of reliability of the mode, as lead time are difficult to achieve with other modes. However, Punakivi and Hinkka (2006) claim that lack of capacity affects the punctuality and speed of smaller delivery lots. Other disadvantages are presented by Jonsson (2008) who mentions environmental consequences of exhaust emissions, noise, road safety and traffic congestion. Medda and Trujillo (2010) also mention that the mode is the most expensive and resource-consuming. Trafikverket (2012b) state that the capacity and sustainability issue can be undertaken by attracting freight from the road to sea and railway. According to CEO of Köping's Port, road transportation has the advantage of being free from fees (Köping's Port, CEO). This is in line with (Baird, 2007) who states that the favouritism of road transport is based on that roads are provided free of charge in many EU countries, as funding, planning and control of the road infrastructure is performed from the public-sector rather than the market.

6.2.2 Railway Transportation

The advantage of rail is of environmental cleanliness when locomotives are driven by electrical power as the mode allows for large quantity of goods to be transported over long distances. Furthermore, combined with high fill-rate, the mode is energy-efficient (Jonsson, 2008). In Company B, railway transportation has been applied previously. However, the lead times could not be met by the mode and the difficulty to obtain needed capacity were disadvantages which could not be overcome (Company B, TVM). Capacity is lacking but issues exist also in track space and connectivity between borders (Baird, 2007). Lack of capacity in the Swedish railway systems also affect the possibility of modal shift. The mode is in need of effective changes, such as construction of passing loops and increase of speed limit. This is however time consuming due to governmental planning processes (SIKA, 2008) as rail is funded by the public-sector and depends on governmental subsidies (Baird, 2007). Other disadvantages are less frequent departures, underdeveloped network and restrictions in flexibility regarding time and geography. Also, compared to road, rail is more time consuming even though the mode offers speed over long distance (Jonsson, 2008).

6.2.3 Air Transportation

Limited focus was laid on air transportation during both Theoretical Framework and Empirical Findings. During interviews, no specific questions were asked about air transportation, the subject arose organically in Company B which applies the mode. MTNO explained that the possibility of air transportation exists within the company, however, this only occurs in situation where a need for rapid transportation is present. The need is presented when an alarm in production is triggered with an acute shortage of supplies (Company B, MTNO). This is in line with Punakivi and Hinkka (2006) and Jonsson (2008), as airfreight is commonly used for express deliveries of spare parts or as a result of unplanned production stops. Jonsson (2008) explains that the mode is usually used for goods of high value and or low weight, as the mode offers high speed over long distances but also highest cost per tkm. Low-value goods and high volumes are not suitable. This are one identified correlation between theory and practice regarding the advantages of the mode. The disadvantages of the mode are presented also by Punakivi and Hinkka (2006) who explains that industries which are in need for high quality of transportation service and delivery accuracy are not likely to select airfreight as the mode can cause delays due to safety regulations. Furthermore, air requires more handling in comparison to other modes, which reduces the value added by speed. Jonsson (2008) writes that the mode is restricted regarding direct transportation. Intracontinental competitor is road, whereas intercontinentally air competes with container ships.

6.2.4 Maritime Transportation

The advantage of the mode is that sea freight is preferred in goods where the size is a limitation for other modes. The capacity of transported goods disregarding its size is an advantage compared with other modes (Punakivi & Hinkka, 2006). Additional advantage is that the mode presents an unlimited capacity. This advantage is, in relation to the limited capacity in other modes, the reason of the belief that the future of transportation is within maritime transport Trafikverket (2012b). Capacity can be increased by either increasing the size and/or speed of the ship or adding more ships (Baird, 2007). The lowest operation cost is provided by maritime transportation as well as it is more environmentally favourable than other modes, but compared to the high energy consumption, the emissions are relatively high. Regarding flexibility in transportation routes available for the mode, this provides an advantage (Jonsson, 2008). However, a disadvantage regarding flexibility is the inability to respond to unexpected demands (Beuthe & Bouffieux, 2008).

Disadvantages of the mode are that sea freight is more time-consuming compared with other modes (Jonsson, 2008; Punakivi & Hinkka, 2006) and lacks direct transportation (Jonsson, 2008). The mode is also connected to inaccuracy of schedules and product damage (Punakivi & Hinkka, 2006). According to Company B (TVM), the mode is not suitable for the company as the it cannot meet the lead times necessary for production.

Maritime transportation is regarded as a low maintenance infrastructure as the waterways are usually free (Baird, 2007; Jonsson, 2008). This is however not the case of the inland waterway and Köping's Port as the pilotage fee increases the total cost for the transport buyer. In a comparison with other ports in the east of Sweden, companies are likely to select a port without the pilotage fee (Köping's Port, CEO). This is true for Company A, especially when customer orders overreach the capacity of the port (Company A, PM). Trafikverket (2012b) explains that the limitation of a maritime transportation is the width and depth of the waterway and more importantly the connectiveness to road and railway. The economy of scale and available capacity has a doubled meaning for the competitiveness of the mode. At one hand, the competitive advantage is the fill-rate of the ships, on the other hand, low fill rate lead to a competitive disadvantage. The method by which the CEO of Köping's Port is hoping to apply for using the economy of scale to reach a competitiveness advantage is therefore identified as the "Keep the bus coming" analogy. The aim is to attract large companies to the region, which can lead to attracting smaller companies with fewer goods which can increase the fill rate of ships.

6.3 Preference of Maritime Transportation

Lastly, research question 3 were examined: When is maritime transportation preferable to road and railway? Value of Goods and Transportation Distance is identified as an important aspect when considering maritime transportation and when the mode is preferred. A Gap of Transport Provider and Transport Buyer is also identified regarding the criteria of reliability and its effects on maritime transportation. Lastly, Modal Shift Through Incentives is examined. The analysis of RQ3 is summarized in Table 14.

Identified criteria	Theoretical Framework	Empirical Findings	Analysis
Value of Goods and Transportation distance	Road dominates in <300 and >700 km, cost overweight time. In intermediate distance, reliability and time (Beuthe & Bouffioux, 2008). See also Table 15.	National transportation are dominated by road (84-88 %) (Trafikanalys, 2016, 2017). Value or weight is not a considered variable in national transport (Trafikanalys, 2017).	Cost is the most important criteria in short and long distances. This is the reason for dominance of road and sea respectively.
	High-value goods suit sea transportation when aligned with predictability of the flow (Morales-Fusco et al., 2013).	International transport is dominated by sea (Trafikanalys, 2016). The largest share is of goods based on weight in both import/export (Trafikanalys, 2017).	National transport is dominated by road, whereas international by sea.
Gap of Transport Provider/Buyer	Reliability is not perceived as important by maritime transportation (Beuthe & Bouffioux, 2008).	Köping´s Port, CEO: minimal stock keeping principal is a barrier to sea transport. Cost is not enough to attract.	Reliability is valued by the industries, it is perceived as a barrier by the Port, the contrast creates a gap. Can be an issue when attracting companies.
	Reliability is ranked higher by transport purchaser (De Jong et al., 2014).	Reliability is ranked equally by transportation purchaser and provider (Trafikverket, 2012b).	
Modal shift through Incentives	Industries were cost is important are connected to willingness to modal shift, were time and reliability are important, it is related to unwillingness (Beuthe & Bouffioux, 2008).	Köping´s Port, CEO: incentives could lead to an improved transportation behaviour.	Although incentives are a cost-effective way to achieve modal shift, the consequences to transport purchaser can be of importance to consider as it would affect the entire supply chain. Also, goods in rail and sea are more similar to road and sea. This should be considered.
	Sensitivity for governmental incentives in maritime transportation, increased cost of road can lead to selection of sea (García-Menéndez et al., 2004)	Plausible method for mode shift is achieved by shifting goods from railway to sea (Trafikverket, 2012a).	
		Modal shift can lead to several consequences for transport purchaser (Trafikverket, 2012b). Governmental incentives are a cost-effective method (SIKA, 2008).	

Table 14 - Summarization of analysis of RQ3.

6.3.1 Value of Goods and Transportation Distance

The Swedish geography enables the utilization of railway and maritime transportation in national transportation of goods (Trafikverket, 2012a). However, road transportation is dominating in distances shorter than 300 km where the total cost aspect predominates the time aspect (Beuthe & Bouffioux, 2008). When delivery distance is short, price is the most important factor. Additionally, if the market of a company is local, the selection of transportation mode falls naturally on the road (Punakivi & Hinkka, 2006). Also, time is rated higher for high value goods over short distances (Feo-Valero et al., 2011). In intermediate distances of 300-700 km and for mid-value goods, the criterions of time and reliability as especially important (Beuthe & Bouffioux, 2008). The statistics from both 2014 and 2016, provided from Trafikanalys (2016;2017) displays the national transportation distribution. The national transportation of goods is mainly transported by road, that is 88 and 84 percent respectively. According to

Trafikanalys (2016) during 2014, 9 percent of national transportation was performed on the railway and 3 percent on sea. Furthermore, Trafikanalys (2017) state that the national road transportation was selected, disregarding both the weight and value of the goods. Disregarding the national geography, the preferable transportation mode is road for national transportation. The distance factor of less than 300 km and the related cost in the distance could be a reason for the selection. However, the Swedish geography has intermediate transportation distances where the reliability and time aspects should affect the mode selection. Disregarded from the variation of distances, the national freight transport is dominated by the road. How transportation distance and related to the preferred mode is represented in Table 15.

Transportation distance	Transportation modes			Comments
	Road	Rail	Maritime	
< 300 km	X			Cost is the most important criterion in this distance (Beuthe & Bouffioux, 2008; Punakivi & Hinkka, 2006). Local market leads to selection of road (Punakivi & Hinkka, 2006). Time is rated higher for high value goods over short distances (Feo-Valero et al., 2011)
300 – 700 km	Highest competition between modes (Beuthe & Bouffioux, 2008).			For mid-value goods in this distance, most important criteria is time and reliability (Beuthe & Bouffioux, 2008).
> 700 km		X	X	Cost is important, rail and sea are more cost beneficial in this distance (Beuthe & Bouffioux, 2008).

Table 15 - Transportation distance related to selection of mode.

The cost aspect is important in transportation of a distance over 700 km, in this category, maritime and rail is more probable to be selected. Although the cost of rail and waterway transportation is higher in comparison to road transportation, the additional cost of the modes are more beneficial over long distances where they can be competitive compared with road transportation (Beuthe & Bouffioux, 2008). High-value goods flows in maritime transportation is more probable when the goods flow of a company are predictable (Morales-Fusco et al., 2013).

During 2014, the dominating transportation mode in international trade was sea, with 70 percent whereas road and rail was used 15 percent each (Trafikanalys, 2016). Divided into export and import during 2016, maritime transportation is the domination mode, however here the aspects of value and weight are specified. In export, maritime transportation was used for 31 percent of transporting of goods based on weight and 15 percent of goods based on value. In import the weight is even more dominating with 69 percent and 26 percent of value (Trafikanalys, 2017). The distribution of export and import is present also in Köping´s Port, which has 80 percent import and 20 percent export (Köping´s Port, CEO). Which is in line with Punakivi and Hinkka (2006) findings, that products of lower price, such as for certain products in the pharmaceutical industry, sea transportation is considered.

A correlation might exist between the weight of the goods and the majority of sea transportation as both export and import of goods based on weight is exceeding the goods based on value by more than the double percentage. The gap of value and weight could possibly be explained by the specific product needs for transportation discussed in section 5.1. Furthermore, as rail and maritime transportation has higher cost, the competitiveness from the modes are reached with transportation over a long distance. This can therefore be the explanation with the deviations of national and international mode selections. Maritime transportation is preferred over long distances where it can be competitive with other modes of transportation.

Other variables, besides from the aforementioned, are also contributing for maritime transportation selection over other modes. Punakivi and Hinkka (2006) for instance write that the size limitation of products in the heavy machine industry are suitable for sea transport. Trafikverket (2012a) also write that although maritime transportation has lost market share nationally, the international trade is increasing. Maritime transportation is also used by Company B, from Göteborg's port, this port is chosen as the company is applying the strategy of cross-stocking the international shipments (Company B, MTNO). However, international trade shipments via Göteborg, the transportation by road to and from the company's facilities in Köping is considered to be a "last mile" shipment (Company B, TVM). As Company B has facilities in Göteborg, the international trade is cross-stocked at the western port and, ferry to Gent is applied for some transportation to facilities in Europe, the port in Göteborg can be considered a hub. It can therefore be argued that the transition to an eastern port is not likely to occur in the company. Considering the geography of Sweden, if an eastern port is used, then the last mile of road transportation would not decrease but rather occur in Europe in contrast to Sweden. Also, Köping's Port is limited by lacking container and trailer availability, which Company B is applying for their shipments.

6.3.2 Gap of Transport Provider and Transport Buyer

The reliability criterion is of great importance for several types of industries, as seen in heading 5.1.2 Reliability and Time. However, reliability is not considered as important by maritime transportation (Beuthe & Bouffieux, 2008). In contrast, minimal stock keeping principle which has developed during the last 15-20 years and have replaced proper logistic planning, is perceived as a barrier for maritime transportation. Companies are striving to have minimal stock levels at the production site and apply lorries and railway cars as moving stock. The infrastructure is thus pressured to provide the necessary capacity (Köping's Port, CEO). The stock keeping strategies of companies which apply Lean are affected by waste elimination. One of the wastes are excess inventory as the effects are cost of raw material, transportation and storage cost (Liker, 2004). The average distance of transportation has increased, whereas the amount of goods is relatively stable. Industries take advantage of the economy of scale as the increase of production is overweighing the disadvantage of increased transportation, decrease of stock and small and frequent transportations (Trafikverket, 2012b).

The reliability need which is expected from the industries, in combination with the belief of maritime transportation that reliability is a barrier, creates a gap between the transport provider and transport buyer. This gap might be an issue when attracting companies to maritime transportation. The vast amount of industries which values the reliability criterion might not be attracted to the mode if the ports use the cost criterion as a primer attraction tactic. How cost criterion is used is exemplified by the CEO of Köping's Port. The experience from the CEO, is when companies are offered competitive cost assessments this is not enough for attracting them to maritime transportation (Köping's Port, CEO). Additionally, as industries take advantage of economy of scale, and the production is increased, the disadvantages of increased transportation is not an immediate concern (Trafikverket, 2012b). This is exemplified by Company B (TVM). The production has increased in Company B by 1/3, which results in an extremely high takt time and sensitivity to material shortages. The outbound goods are departing from the company at five or seven occasions per day.

According to the criteria ranking by Trafikverket (2012b), reliability is valued highest by transport purchasers, on second place the time aspect is found. Cost is only the third most valued criteria. From the transport provider perspective and how they perceive the criteria demanded for their services, reliability is ranked highest. Second most important criterion is price, and time

is found at fourth place. A conclusion can thus be made, what is perceived as important from the transport purchaser's perspective and what the transport provider's perceives to be important for their customer can differ. Although, both perceive reliability as the most important criterion, most other criteria are ranked differently. See also Table 4 for the exact ranking by Trafikverket (2012b). According to De Jong et al. (2014) reliability is ranked differently by transportation provider and the purchaser as transportation purchaser ranks reliability higher.

6.3.3 Modal Shift Through Incentives

According to Beuthe and Bouffieux (2008), the cost criterion is a great concern when connected to low value goods. Thus, the mode selection is often rail and maritime transportation, especially in long transportation distances. Furthermore, the authors have identified that the cost criterion was important in industries which were willing to shift modes. In contrast, the unwillingness to shift modes is connected with industries which value time and reliability over cost. Companies which use road transportation in distances less than 300 km, do so as the mode provides the necessary reliability and flexibility. The focus in these companies is of optimizing the existing road transportation, making a modal shift unlikely. Furthermore, the authors argue that where time and reliability is highly important criteria, that is for mid-value goods and intermediate distances, the competition among modes is the highest. To increase the competitiveness of rail and maritime transportation in this segment, attributes of time and reliability are crucial to improve. Brooks et al. (2012) adds that rail and maritime transportation is sensitive to the reliability of meeting the delivery window, and rail has the issue of transit times. The preference of maritime transportation could be increased with integrated service and door-to-door deliveries.

The view of the CEO in Köping's Port, is that the introduction of proper incentives or fees in Sweden, could lead to a development of an improved transportation behaviour within companies. The behaviour is connected to improved utilization of existing infrastructure and logistics planning (Köping's Port, CEO). This view is in line with the finding of García-Menéndez et al. (2004) of sensitivity to cost changes of maritime transportation. The authors found that if road cost would increase, the effect for maritime transportation could be that the modes becomes the preferred option among the two. Sambracos and Maniati (2012) adds that a 10 percent increase of road transportation, can potentially lead to a 20 percent increased demand for maritime transportation. García-Menéndez et al. (2004) concludes that maritime transportation is thus sensitive for governmental incentives, such as an ecotax for road, even more so than a cost decrease of shipping freight rates. In contrast, Trafikverket (2012a) finds that a plausible method for mode shift is achieved by shifting goods from railway to sea. Capacity in the railway can thus be created, making a shift from road to railway possible. Railway and maritime transportation have more similarities than road and sea, which can enable the shift. The similarities are of value of goods and demands for transporting them.

The benefits of an ecotax on European roads are of decongestion, decrease of environmental pollutions and a balanced intermodal pattern (García-Menéndez et al., 2004). A modal shift in itself has no value, although the effects of shifting goods from road can also be beneficial for decreasing noise level and increased traffic safety. Nevertheless, compared with effectivization of modes by technical development, the effects of a modal shift are limited. The potential of mode shift is 4-5 million tons which is 20 percent of the yearly CO₂ emission (SIKA, 2008). The possibility of a modal shift can be overestimated and affect the transport purchaser which becomes pressured to produce more with consequences across their supply chain (Trafikverket, 2012b). The modal shift also has multiple barriers, such as lack of capacity in the Swedish railway system, total cost perspective of the transport purchaser, stock and production strategies, etc. Governmental incentives are thus a cost effective enabler of modal shift (SIKA, 2008). A

prerequisite for a modal shift from road to sea is efficiency of ports, as well as connectiveness (Sambracos & Maniati, 2012). However, companies are not likely to shift modes voluntarily and competition among modes are not based on equal prerequisites, such as the pilotage fee for maritime transportation, making governmental incentives a necessary countermeasure (Köping's Port, CEO). Transportation modes are prevented from being regarded as part of a complementary system, rather the modes are competing (Baird, 2007; SIKa, 2008). The market distortion is a barrier to making sea transport an effective alternative to long-distance land transport. This can be counteracted by a public-sector intervention (Baird, 2007).

6.4 Practical Implications

Although governmental incentives or fees is a reasonable solution for shifting goods to maritime transportation, this can be a long-term solution which is not feasible currently. In the meantime, the Port has multiple options to attract customers. A reconsideration to the effects of reliability on maritime transportation can be one option, as it is found in the theoretical framework that several industries value the criteria of reliability more than they do cost. The cost approach has been exhausted by the Port in relation to the industries which they are trying to attract, and the lack of responding to the criteria. It is therefore recommended that the Port reevaluates the criteria of reliability in order to be able to connect with companies on their own term, vocabulary and preference. It is not likely that companies which value reliability will reconsider as the criteria is connected to strategies.

7 CONCLUSIONS AND RECOMMENDATIONS

The aim of this study was to examine the current situation and the potential to increase transportation of goods by maritime transportation and what criteria are the most important for different industrial/customer segments. In line with the aim, three research questions were formulated and analysed by using the finding in theoretical framework and empirical findings, that is governmental reports and the result from five interviews.

The analysis was based on the order of the research questions, the first research question was Which decision criterions are considered in selection of transportation mode? Several criterions were found to be of importance during a transportation mode decision, as well as interrelationships between criterions. The identified criterions were cost, reliability and time, frequency and volume and lastly specific goods need. This was found to be in line with theoretical framework, especially the fact that the mode decision is vastly complex and highly depended upon which industry is making the decision, that is the context. This is exemplified by the two companies which were examined. The dominance of road transportation within Company B is based on the reliability and goods value. This correlation is thus identified and is also in line with the theoretical framework. As Company B is part of JIT chain, reliability was valued as well as short transit times. A holistic view regarding the application of JIT and how the strategy is connected to Lean is thus essential.

The second research question was What are the advantages and the disadvantages of the different modes of transportation? This RQ overlaps with RQ1 and RQ3 to a certain degree. The advantages and disadvantages of transportation modes are exemplified in the first and last research questions. A comparison of the modes is however made to specify the benefits and downfalls with each mode, those are found in Table 13.

Lastly, the analysed research question was When is maritime transportation preferable to road and railway? The distance of the transportation and value of the goods are an important aspect for when the different modes are applicable in relation to cost. This is also the reason for dominance of road and sea respectively. Furthermore, an important identification, is the gap between transportation purchaser and providers view of the reliability criterion. This difference can create a gap making it difficult to attract customers to maritime transportation. An understanding of the transportation strategies related to JIT and Lean must therefore be developed. Governmental incentives were also examined. Although incentives are a cost-effective way to achieve modal shift, the consequences to transport purchaser can be of importance to consider as it would affect the entire supply chain. Also, goods in rail and sea are more similar to road and sea. This should also be considered.

The finding of the reliability impact on mode selection and the identified gap presented in RQ3, leads to a recommendation that further research could be performed. It is recommended that a thorough investigation is needed in order to examine what aspect of reliability is achievable and realistic in maritime transportation in general and for Köping's Port in particular.

8 REFERENCES

- Agamez-Arias, A.-M., & Moyano-Fuentes, J. (2017). Intermodal transport in freight distribution: a literature review. *Transport Reviews*, Online, 1–26.
- Arencibia, A. I., Feo-Valero, M., García-Menéndez, L., & Román, C. (2015). Modelling mode choice for freight transport using advanced choice experiments. *Transportation Research Part A: Policy and Practice*, 75(2015), 252–267.
- Baird, A. J. (2007). The economics of Motorways of the Sea. *Maritime Policy and Management*, 34(4), 287–310.
- Berle, Ø., Asbjørnslett, B. E., & Rice, J. B. (2011). Formal Vulnerability Assessment of a maritime transportation system. *Reliability Engineering and System Safety*, 96(6), 696–705.
- Beuthe, M., & Bouffioux, C. (2008). Analysing qualitative attributes of freight transport from stated orders of preference experiment. *Journal of Transport Economics and Policy*, 42(1), 105–128.
- Blauwens, G., Vandaele, N., Van de Voorde, E., Vernimmen, B., & Witlox, F. (2007). Towards a Modal Shift in Freight Transport? A Business Logistics Analysis of Some Policy Measures. *Transport Reviews*, 26(2), 239–251.
- Brooks, M. R., Puckett, S. M., Hensher, D. A., & Sammons, A. (2012). Understanding mode choice decisions: A study of Australian freight shippers. *Maritime Economics & Logistics*, 14(3), 274–299.
- Bryman, A., & Nilsson, B. (2011). *Samhällsvetenskapliga metoder (Second)*. Malmö: Liber.
- Clausen, U., De Bock, J., & Lu, M. (2016). Logistics Trends, Challenges, and Needs for Further Research and Innovation. In M. Lu & J. De Bock (Eds.), *Sustainable Logistics and Supply Chains - Innovations and Integral Approaches* (pp. 1–15). Springer.
- De Jong, G., Kouwenhoven, M., Bates, J., Koster, P., Verhoef, E., Tavasszy, L., & Warffemius, P. (2014). New SP-values of time and reliability for freight transport in the Netherlands. *Transportation Research Part E: Logistics and Transportation Review*, 64, 71–87.
- Dekker, R., Bloemhof, J., & Mallidis, I. (2012). Operations Research for green logistics - An overview of aspects, issues, contributions and challenges. *European Journal of Operational Research*, 219(3), 671–679.
- European Commission. (2011). White Paper Roadmap to a Single European Transport Area - Towards a competitive and resource efficient transport system. Brussels. Retrieved from <http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52011DC0144>
- Fagerholt, K., Laporte, G., & Norstad, I. (2010). Reducing fuel emissions by optimizing speed on shipping routes. *Journal of the Operational Research Society*, 61(3), 523–529.
- Fahimnia, B., Bell, M., Hensher, D. ., & Sarkis, J. (2015). *Green logistic and transportation - A sustainable supply chain perspective*. Springer International Publishing.
- Feo-Valero, M., García-Menéndez, L., & Garrido-Hidalgo, R. (2011). Valuing freight transport time using transport demand modelling: A bibliographical review. *Transport Reviews*, 31(5), 625–651.
- Feo, M., Espino, R., & García, L. (2011). An stated preference analysis of Spanish freight forwarders modal choice on the south-west Europe Motorway of the Sea. *Transport Policy*, 18(1), 60–67.
- García-Menéndez, L., Martínez-Zarzoso, I., Piñero De Miguel, D., Garc, L., Mart, I., & Pinero De Miguel, D. (2004). Determinants of Mode Choice between Road and Shipping for Freight Transport: Evidence for Four Spanish Exporting Sectors Determinants of Mode Choice between Road and Shipping for Freight Transport Evidence for Four Spanish Exporting Sectors. Source: *Journal of Transport Economics and Policy Journal of Transport Economics and Policy*, 38(3), 447–466.
- Hesse, M., & Rodrigue, J. P. (2004). The transport geography of logistics and freight distribution. *Journal of Transport Geography*, 12(3), 171–184.

- Jonsson, P. (2008). *Logistics and Supply Chain Management*. Maidenhead: McGraw-Hill Higher Education.
- Jonsson, P., & Mattsson, S.-A. (2011). *Logistik: läran om effektiva materialflöden (Vol. 2. uppl.)*. Lund: Studentlitteratur AB.
- Liker, J. K. (2004). *The Toyota Way - 14 management principles from the world's greatest manufacturer*. New York: McGraw-Hill.
- Medda, F., & Trujillo, L. (2010). Short-sea shipping: An analysis of its determinants. *Maritime Policy and Management*, 37(3), 285–303.
- Meixell, M. J., & Norbis, M. (2008). A review of the transportation mode choice and carrier selection literature. *The International Journal of Logistics Management (Vol. 19)*.
- Mentzer, J. T., Keebler, J. S., Nix, N. W., Smith, C. D., & Zacharia, Z. G. (2001). Defining Supply Chain Management. *Journal of Business Logistics*, 22(2), 1–25.
- Morales-Fusco, P., Saurí, S., & De Melo, G. (2013). Short Sea Shipping in Supply Chains. A Strategic Assessment. *Transport Reviews*, 33(4), 476–496.
- Naim, M. M., Potter, A. T., Mason, R. J., & Bateman, N. (2006). The role of transport flexibility in logistics provision. *The International Journal of Logistics Management*, 17(3), 297–311.
- OECD. (2010). *Globalisation, Transport and the Environment*. Paris: OECD Publishing.
- Oliver, P. (2012). *Succeeding with your Literature Review - A Handbook for Students*. Maidenhead: McGraw-Hill Education.
- Patel, R., & Davidson, B. (2003). *Forskningsmetodikens grunder: Att planera, genomföra och rapportera en undersökning*. Lund: Studentlitteratur AB.
- Punakivi, M., & Hinkka, V. (2006). Selection Criteria of Transportation Mode: A Case Study in Four Finnish Industry Sectors. *Transport Reviews*, 26(2), 207–219.
- Reis, V. (2014). Analysis of mode choice variables in short-distance intermodal freight transport using an agent-based model. *Transportation Research Part A: Policy and Practice*, 61(2014), 100–120.
- Runhaar, H., & van der Heijden, R. (2005). Public policy intervention in freight transport costs: Effects on printed media logistics in the Netherlands. *Transport Policy*, 12(1), 35–46.
- Sambracos, E., & Maniati, M. (2012). Competitiveness between short sea shipping and road freight transport in mainland port connections; the case of two Greek ports. *Maritime Policy and Management*, 39(3), 297–313.
- SIKA. (2008). *Potential för överflyttning av person-och godstransporter mellan trafikslag: Redovisning av ett regeringsuppdrag*.
- Son, D. H., Patwari, K., Wilhelm, W. E., & Yu, P. (2013). On the Relationship Among Facility Location, Transportation Mode Selection and Material Flow Costs in Global Supply Chains. In J. H. Bookbinder (Ed.), *Handbook of Global Logistics - Transportation in International Supply Chains* (pp. 417–444). New York, NY: Springer.
- Trafikanalys. (2010). *Commodity flow survey 2009*.
- Trafikanalys. (2016). *Godstransportflöden - Statistikunderlag med varugruppsindelning*.
- Trafikanalys. (2017). *Varuflödesundersökningen 2016*.
- Trafikverket. (2012a). *Delrapport Transporter - Underlag till färdplan 2050*.
- Trafikverket. (2012b). *Godstransporter*.
- Trafikverket. (2012c). *Prognos över svenska godsströmmar år 2050 Underlagsrapport*.
- Womack, J. ., & Jones, D. . (2003). *Lean thinking: banish waste and create wealth in your corporation*. London: Free Press Business.
- Yin, R. K. (2014). *Case Study Research - Design and Methods (5th ed.)*. London: SAGE.
- Zeng, A. Z., & Rossetti, C. (2003). Developing a framework for evaluating the logistics costs in global sourcing processes. *International Journal of Physical Distribution & Logistics Management*, 33(9), 785–803.

9 APPENDICES

9.1 Appendix 1 – Interview Questions

Question protocol for Köping's Port, CEO

Vison for Köping's dock

1. If you could choose the best possible future for Köping's dock, how would it look like?
 - a. More services?
 - b. What kind of services are possible?
2. Which are the most important companies in the region that you would like to attract?
3. Do you have the capacity to meet their needs now?
4. Is there a desire from your point of view to have other goods or to specialize more towards performing the services you provide now?

Strategy questions

5. Do you have a strategy for attracting new customers?
 - a. How do you approach new customers?
 - b. Do you have a dedicated process or employees doing that?
6. Do you have a regular dialog with the companies about their needs and inform them about the future possibilities?
7. Is it a possibility that existing customers, such as Yara, will utilize the port more for shipping instead of using the railway to Uddevalla?
8. **Ask only if it is not answered above:** Is volume the only hinder for attracting new customers or are there other reasons?
9. Have you tried to attract producing companies such as Volvo and GKN?
 - a. If so, have they explained the reason for declining the dock?
 - b. What would it take to attract those companies (investment)?

Competition

10. What ports are the biggest competitors?
11. What is their advantage compared to Köping's?
12. What kind of strategy do you have now to be able to compete with those?
13. What, besides from price, can you compete with (e.g. equipment, manpower, storage, JIT-deliveries)?
14. Are there agreements between the ports? (Köping and Västerås)

Technical / operational questions

15. Do you think there is potential to ship other products besides from steel/metal/chemicals, that is heavy goods in bulk?
16. **Ask only if it is not answered above:** Is there a possibility that access to bigger ships will attract new customers to Köping?
17. What is the reason do you think companies have for choosing shipment by sea?
18. Have you begun to prepare the docks for possible increase of capacity?
19. Is the price for shipping going to decrease, price per ton will be lower but how about the fees and duties such as coast pilot?

Question protocol for Köping's Port, AMS

About the dock

1. What is your name and position?
2. What is the company's position/role for the customer (is the company a facilitator etc)?
3. What kind of shipping do you conduct (e.g. short sea shipping, ocean shipping)?
4. To which counties/countries do you ship the goods?

5. Are certain docks more usual to ship to?

About the customers

6. How many customers/stakeholders do you have?
7. Who are your biggest customers?
8. How often do you ship for the biggest customers?
9. What kind of contracts is there between you and your customer's (over a large amount of time, periodical etc.)?
10. Can a new customer approach you for a non-recurring shipment?
11. What kind of needs does the customers have on the company?
12. Are you able to meet those needs?
13. What is the strategy for attracting new customers?
14. What are the hinders for attracting new customers?

About the goods

15. What type of goods are shipped from the port?
16. Is there a maximum volume/weight or other limitations?
17. In what amounts are those goods shipped?
18. How often do you ship goods for the largest customers?
19. How do you receive goods from your stakeholders (rail, road, mixture)?

About transshipment

20. How do you receive goods (containers, etc.)?
21. How long time does the average transshipment take?
22. What factors could affect the transshipment time?
23. Could transshipment be improved to handle larger quantities?
24. How does the transshipment and the extra time that it takes affect your customers?
25. Is transshipment a hinder for attracting new customers?

About the capacity

26. What capacity is there today?
27. What are the forecast for the future capacity (e.g. Mälarpjektet)?
28. Do you have a strategy for handling larger capacity?

Question protocol for Company A and Company B

About the company

1. What is your position in the company?
2. What kind of goods is the company manufacturing?
3. What is the company's position in the supply chain (sub-supplier, manufacturer, end customer)?
4. How long has the collaboration between Yara and Köping's Port been in place?

Purchasing

5. Can you describe the process in place for ordering goods (from order to delivery)?
 - a. Follow up questions if necessary: How often do you receive goods via Köping's Port (majority, sometimes, seldom)?
 - i. Where are your suppliers localized?
 - ii. What are you purchasing (raw material, components etc)?
 - iii. In what quantities, approximately?
 - b. Is the port your main mode for receiving goods?
 - c. Are the goods stored at Köping's Port?
 - i. How often do you retrieve goods from the Port (times per week/month)?
 - ii. If not, how is the transshipment arranged (rail, lorry)?

Outgoing deliveries

6. Can you describe the process from receiving an order from your customer to delivery of the goods?
 - a. Follow up questions if necessary: How often do you send out goods to the port (times per week/month)?
 - i. What kind of goods are sent out (finished products, raw material)?
 - ii. In what quantities, approximately?
 - iii. To where are they delivered (Sweden, Europe)?
 - b. What is done with the goods at the Port (storing, shipping, transshipment)?
 - c. How often are the goods sent out to your customer?
7. Does your customers/society/government have any demands for the deliveries (regulations, customer needs etc.)?
8. What are your main criteria for deliveries (quantity, time, environment)?
9. How is it decided which mode of transportation will be used?
10. How is it decided which port will be used?

The role of Köping's Port

11. What is the Ports main role for your delivery process?
 - a. What additional services, if any, is the Port providing for you?
 - i. Among those, are there any which could be expanded to more frequent use?
12. What are the benefits of having the collaboration?
 - a. What could be further improved from your point of view?
13. Have you considered to further utilize the port?
 - a. If so, in what manner would the collaboration become expanded?
 - b. If not, are the any hinders or reasons behind the decision?

9.2 Appendix 2 – Information provided to the interviewees

Information about the interview

In the project, Industrial Symbiosis in the West of Mälardalen 1.0, one important aspect is an identification of potential in Köping's Port. Available capacity is not utilized to its full degree. Interviews will be conducted at companies that use Köping's Port with the aim to create an understanding of the process in place for shipment of goods, particularly what role Köping's Port has in the supply chain. The examined areas are of the flow of goods to and from the port. Additionally, investigate how, or if, the port can be utilized to a further degree.

The interview will be a part of a Bachelor Thesis at Mälardalens University in the program of Civil Engineering in Innovative Production and Logistics. The thesis will be published in the web-based database Diva.

To protect the company from reviling sensitive information, the thesis will restrain from naming the company as well as disclose information that could potentially be associated with that specific company. The interviewees will be anonymous.

The following document contains a preview of questions that will be asked during the interview.

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