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CAN THE PORT OF GÖTEBORG ACT AS A TRANSHIPMENT HUB FOR THE BALTIC STATES AND RUSSIA?

A Comparative Cost/Service Analysis of Unitised Cargo

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Preface

During our studies for our Master's Programme at the School of Economics and Commercial Law at Göteborg University, we made an interesting on-site visit to the Port of Göteborg. When our professor, Arne Jensen, presented us a subject for a thesis commissioned by the Port of Göteborg, we saw an opportunity to work for an interesting organisation.

The main idea for the research topic was to study freight flows to and from the Baltic States and Russian Region (BSRR). This is interesting from a view as the imminent entry of the three Baltic States into the EU will provide new thrust to their economies and will present fascinating opportunities for businesses in the region.

Recent impetus for growth in the Baltic States, especially the added impact of liberalisation and deregulation policies after gaining independence from Russia, has given rise to an increase in sea borne trade and these countries are increasingly looking westwards. Economic and cultural links spanning over centuries of shared history further Sweden's natural interest into these states, besides a yearning to become a major regional player.

All these factors combined present a considerable challenge for the actors involved in the port and shipping business to look at the issue from new angles and perspectives.

Abstract

The purpose of this thesis is to evaluate and analyse the most cost and service efficient routes for unitised transit cargo to and from the Baltic States and Russia Region (BSRR). We have identified the most efficient route from the following three alternative transport systems: direct sea-links to the Port of Göteborg, direct sea-links to the Port of Hamburg, or sea-links across the Baltic Sea combined with a land bridge (road/rail) across Sweden to the Port of Göteborg. In order to make the calculations of costs and transit time we have created a model in Microsoft Excel.

We have got results, in terms of average cost per unit and throughput time, for LoLo and RoRo traffic in different routes between the BSRR and the ports of Göteborg and Hamburg. The most efficient routes are the direct calls to the Port of Göteborg, in terms of cost and time variables compared with direct call to the Port of Hamburg, and compared with the land bridge alternative only in terms of cost.

The Port of Göteborg is famous for excellent service and unique tailor-made customer solutions, which gives very strong competitive advantages.

For future research, we think it is a good idea to apply a cluster concept for analysing seaports, which can help us to answer the question how competitive seaports are vis-à-vis other seaports.

<u>Key-words</u>: unitised cargo, RoRo, LoLo, shipping market

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Finally we want to thank our tutor Arne Jensen, Professor at School of Economics and Commercial Law Göteborg University, for giving us guidance and ideas.

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1. Introduction

> *"The Swedish industry starts and ends where the customers are, i.e. the whole world. Therefore the shipping industry is very important" (Rolf Petrén Nilsson, Chief Editor at the Scandinavian Shipping Gazette*).

1.1 Background

A port's success does not only lie in fast and excellent service of cargo handling, but also in foreseeing and quickly adapting to new demands. The Port of Göteborg is doing just that in a vision for the early 21st century, which deals with the port's future role in the market, how to develop this role and what hardware is necessary. This vision is a discussion platform launched by the port vis-à-vis its customers and the political establishment. (www.portgot.se)

"The changes in the routing of logistic chains are attended by changes in logistics nodes, as locations of logistic activities and transhipment points of transport flows" (Klink, 1995). Can the Port of Göteborg be a transhipment hub for unitised cargo flow from the Baltic States and Russia? Do the resources and price situation decide which port will be the Baltic hub?

The feeder vessel routes connecting to the Port of Göteborg runs parallel with road and rail links. Therefore, competition not only includes the Port of Göteborg trying to attract vessels but also competition between different modes of transport. A problem in Sweden is that investments in ports are seen from a local perspective. There has to be a national perspective to make the maritime industry competitive. Swedish ports nowadays are in direct competition with each other, when they should co-operate more instead. Is the government on the right track when they invest so much money on roads and railroads and almost nothing on the waterways (Näringsdepartementet)? Somehow there is a need for a more competitive system for the fairway charges than today's system "where the southern ports have to pay for the northern ports" (Port of Göteborg, Annual Report 2000).

Sweden has a relatively long distance to bigger consumer's centres compared with population density in Europe, and that is why trade and industry in Scandinavia can be characterised by a high degree of logistical awareness. If innovative transport systems and efficiency do not overcome the distance handicap it would have a negative impact on Nordic export industry and the prices of imported goods would increase. Land access is just as important as access from the sea. “A new rail terminal, better road approaches are important ingredients in the vision, as are the deepening and widening of fairways” (Port of Göteborg, Annual report 2000). The investments envisaged are of such significance that a discussion should be confident concerning their financing. “The access investments in particular - fairways, road and rail connections - could well be shared with the National Shipping, Road and Rail Administrations” (www.portgot.se).

The Port of Göteborg has excellent resources but it is infamous for its high prices (mainly due to the state-imposed costs). Is it a precondition for the Port of Göteborg, to be an alternative and a major player, that the fees that the Swedish Maritime Administration (Sjöfartsverket) charge are removed? The “User Pay” principle will significantly reduce the channel fees in the Port of Göteborg. To compare with the Danish harbours, - the most dangerous competitor to the Port of Göteborg in the future is probably the Port of Aarhus in Denmark which has the ambition to be the central port for feeder traffic in northern Europe, - the channels are financed by public funds. (Port of Göteborg, Annual report 2000)

We believe that the Port of Göteborg should be regarded as a state asset. The sheer attendance of direct liner calls has an influence on pricing for shipping as a whole. An important concern for the Port of Göteborg is to receive as much contractual volumes as possible, which will make the port more attractive to the larger shipping lines. “Trade increases the welfare, which increases transports, which increases sea born transports. But the transport routes chosen are often the product of a political decision” Rolf Petrén Nilsson (Chief Editor at the Scandinavian Shipping Gazette).

1.2 The Port of Göteborg – with aim on the future

> *"Increase volume, increase demand, greater flexibility with unique customer adapted, often inter-modal solutions with environmental overtones: These goals are the future for Port of Göteborg AB. As Scandinavia's largest ocean port, we play a central role for the whole region and it is necessary to strengthen our position by new ventures and extensions. Therefore, the Port of Göteborg is experiencing a number of changes at present. We must concern ourselves with future-aimed actions and projects, while at the same time continue ongoing operation flows toward record-breaking levels in goods traffic."*(Port of Göteborg, Annual Report 2000)

The Port Göteborg is the largest transoceanic port in Scandinavia with regular traffic to destinations around the world. It is centrally located within the Scandinavian region (see Chapter 5.6 for more information).

The Port of Göteborg has as its business concept to load and discharge cargo and develop customer-oriented transport solutions that will direct cargo via the Port of Göteborg. In the next 10 years, the Port has as its vision, to attain:

- 1,5 million TEUs (Twenty Foot Equivalent Unit) and 700,000 trailers
- Continued strengthening of the competitiveness of the Scandinavian industry
- New terminal areas
- Safer navigable channels
- A new unit-load rail terminal
- Improved infrastructure
- More direct sailings to overseas markets
- More rational and environmental adjusted transport solutions

To attain these goals, and strengthen its position as Scandinavia's central port, the Port of Göteborg plans to work in obtaining several direct calls of oceanic ships through constant contact with shipping companies. This vision also calls for some demand management of cargo supply. In this picture, the BSRR comes as a natural source and ally.

1.3 The Baltic States and Russian Region (BSRR)

"The BSRR has the potential to become one of Europe's strongest and most dynamic growth regions" (Swedish Maritime Administration, 2001).

The BSRR is regarded as a highly interesting development area for the coming 10-15 years period because of the following factors (Euro Futures, 1999):

- The region has a big population and a growing economy.
- The ascending purchasing power within certain populations' segments of Baltic countries and Russia give rise to increased exports of consumer goods and establishing of department store chains as an IKEA department store in Moscow.
- The region has a unique potential for the structural transforming.
- The volume of trade is growing fast.
- The growth rate of economy development in Baltic States and Russia can bring the expectation of increasing manufactured goods import.
- The investments to share capital, loan and reinvestment profits are increasing.
- The region has a good transport infrastructure.
- Requirement of improved integration is increasing simultaneously with business growth between east and west.

> "*After a few years of initial difficulties and adjustment problems following independence, the Baltic States has displayed favourable economic expansion, with sharply rising growth rates and an expansion in trade that outperform the more mature EU countries in the region*" (Swedish Maritime Administration, 2001).

The tendency in the Baltic ports has showed a stable increase in total yearly value and a nearly stable annual increase for each following year in each seaport. This is obvious proof of rising confidence in the economy in these states by the international business community and an indication of development in national economic activities. "In total, freight cargo within the Baltic Sea ports has witnessed a persistent rise in volume" (Brodin, 2000). This is an indication of the rising significance of the Baltic region, both in the diversified range of products and volume of exports. (Ibid.)

1.4 Strategic Importance of the Project

This thesis is the second of three sub-projects of a larger project commissioned by the Port of Göteborg. The separate sub-projects fit the structure of the sub-problems that can be derived from the main problem. In this chapter we are going to present the structure of the project.

> "*The Port of Göteborg AB must become larger and stronger, and then a larger hinterland is a necessity. [...] If we do not succeed, then a threatening picture of large, strong ports on the continent and a degradation of the Port of Göteborg AB to a feeder port will become reality*" (Port of Göteborg, Annual Report 2000).

Driven by profit motive, every commercial concern is sensitive to threats to its position and endeavours to further strengthen it. The Port of Göteborg is no exception. The study, containing all three sub-project, will examine the cargo flows to and from the Baltic States and Russian Region (BSRR) and identify those flows that can be of commercial interest to the Port of Göteborg. This interest stems from its vision to retain its dominant position in Scandinavia and to become a major player to be reckoned with in the mainland European port market.

The project, therefore, is aimed at exploring the possibility for the Port of Göteborg to become the main or at least a major transit port for cargo originating from and destined to BSRR. The following figure (figure 1-1) serves as an illustration for our main purpose.

Figure 1-1 Illustration of thesis purpose (own creation)

1.4.1 Project Structure

The structure is as follow:

1. The first part shall take into consideration the present situation for goods flow bound for the BSRR, and how the future will develop. This part will be dealt with in a separate thesis (Coker, 2002).
2. The second part, which is this thesis, shall deal with the cost and service aspects of three alternative sea-link systems for goods moving to and from the BSRR (see Chapter 2.1).
3. The third part shall examine the alternative of a land bridge through Sweden as a way of getting goods to the Port of Göteborg to and from the BSRR. This part will be dealt with in a separate thesis (Rana, 2002).

The second and third projects have an important link between them when it comes to agreeing on which port(s) on the Swedish East Coast that should be used as links. This selection will have to be done at a fairly early stage since the future work is dependent on this. We aim to set up a number of criteria that will serve as a filter for choosing between ports. Variables included in this should be factors such as capacity, geographical location, infrastructure, etc. This will be dealt with more in detail in project 2 (Chapter 5.3 in this thesis) and sub-project 3 (Rana, 2002).

On the following pages, a brief description of the separate sub-projects will be presented.

1.4.2 Sub Project 1 - Analysis of Present Situation

The overall aim of this part of the research work is to describe the present situation as regards cargo and freight flows to and from the BSRR. The purpose is to give a detailed report of the current situation, as regards containerised cargo, which will serve as a background and help, both in understanding the present situation as well as serve as a basis for decision making for the Port of Göteborg.

Principally, this thesis will focus on: volume of freight, types of cargo, frequency of sailings, types of vessels involved, routes of sailings, origin and destination of cargo, various actors involved, port infrastructure and operations, safety and environmental records, soft issues such as social, political and economic situations in the BSRR. (Coker, 2002)

1.4.3 Sub Project 2 - Modelling of Sea-Links

In order not to confuse the reader, we feel it necessary to mention again that this part is the topic that is dealt with in this particular thesis.

The aim of this part is to identify the most cost- and service-efficient sea-link to transport goods from the BSRR to the Port of Göteborg in order for the port to act as a transit port. To do this we will create a spreadsheet-model (built in Microsoft Excel) in which we can compare variables (cost and service) of different route alternatives for goods to and from the BSRR.

We consider the Port of Hamburg as one of the biggest currently competitor to the Port of Göteborg in regard to the goods flows from the BSRR. Therefore we are going to calculate the cost and transit time for different routes for transit of cargo from BSRR to the Port of Hamburg as a comparison to our cost and transit time calculations to the Port of Göteborg.

An important aspect in this step of calculating costs is to identify the type of ship that most likely will operate on the routes. This depends very much on the volumes available, and the type of cargo. For this purpose, we have to obtain detailed information from the first sub-project that is dealing with describing the current situation.

To be able to compare the cost efficiency of the routes, we have to use a comparable/equivalent unit to distribute the result from our cost calculations. In our case, the most appropriate cost unit is the cost per cargo carrying unit. The units that we will use are trailers for the RoRo traffic and TEU (20-foot equivalent unit) for the LoLo (container) traffic (see Chapter 3.3).

Since costs are not the sole variable to make decisions on we also have to compare the level of service output of our different routes, which in our case is the transit time through the system.

1.4.4 Sub Project 3 - Land Bridge

In this part of the study, possibility of a land bridge through both modes of land transportation between east and west coasts of Sweden for sea-borne cargo originating from and destined to the BSRR shall be explored. Further, cost of port operations and transhipment involved at both points will be looked into. The main aim here is to assess the viability and consequently relative efficiency of this alternative in comparison to the existing and other possible sea-links. (Rana, 2002)

1.5 Integration of Results

Regarding the sub-projects that will perform cost calculations and service evaluations of different routes (sub-project 2 and 3), we have previously stated the necessity to use common cost/service units in order to get an output (end result) that is relevant for the main project. The cost units that will be used is the average cost per load-carrier unit (trailer or TEU) to be transported within the transport systems we are going to look at. To obtain these results, the costs of a round trip of each chosen route will be added up and then divided by the number of units, which is determined by the degree of utilisation of each vessel. As for the service variables to compare, at this stage we perceive the throughput time as the most important variable.

1.6 Limitations

Given the scope of our project, our limitations are mostly of technical and geographical nature. By technical limitations we mean that we shall not look at goods flow that the Port of Göteborg cannot handle or intends to handle in the future. More specifically, we shall not consider bulk goods, passenger traffic (ferries), or any flow of cargo that is not unitised. Therefore, we have narrowed our focus down to flows of containers and trailers.

Going further with the geographical limitations, we shall be concerned only with cargo originating and destined to the BSRR. This limits us to the countries of Russia, Estonia, Latvia, and Lithuania (see figure 1-1).

As for the sub-projects that involve elements of route calculations, these will be geographically restrained to end up in either the Port of Göteborg or the Port of Hamburg. We will not be concerned with the next stages of the transport. Perhaps it could be seen as too narrow a view, and argued that we should consider the entire transport system, applying a door-to-door concept. But that would simply be to great a task for us.

All these limitations are valid for each of the three separate projects, and therefore they will not be repeated in our separate parts, which begins from chapter 2 in this thesis.

2. Aim Of Study

Only what was described as sub-project 2 in the introduction, will be dealt with from this chapter on.

2.1 Purpose

The goal of the entire project is to examine the cargo flows to and from the Baltic States and Russian Region (BSRR) and to identify those flows that can be of commercial interest to the Port of Göteborg.

Naturally, we must take into consideration that the most efficient way for the actors (see Chapter 3.1) in the system is perhaps not to use the Port of Göteborg at all, or to a lesser degree. Therefore, we have to examine possible sea-links that do not include the Port of Göteborg, but instead go directly to a main European port. We have chosen the Port of Hamburg to act as a counterpart to The Port of Göteborg.

More specifically, the purpose of this thesis is:

> *To calculate the cost and service efficiency of three transport links for unitised transit cargo to and from the BSRR: direct sea-links to the Port of Göteborg, sea-links across the Baltic Sea combined with a land bridge to the Port of Göteborg, direct sea-links to the Port of Hamburg; and to identify the most cost and service efficient one.*

2.2 Research Model

The figure on the following page is a basic illustration of our project. As stated earlier, we will examine the sea-links between the BSRR and the ports of Göteborg and Hamburg. The links to the Port of Göteborg have two possible ways of going (see figure 2-1). Route 1 is divided into one sea-link (1a) and one land-link (1b). We will only calculate and evaluate the sea-link, since the land-link is covered separately in the third sub-project (Rana, 2002). However, we will integrate the results of this land bridge project with our own results to get a total cost result. The route marked as number 2 in the figure, which represents a direct sea-link, illustrates the second link to the Port of Göteborg. The first two routes will be compared to the alternative of going to a main European port (i.e. the Port of Hamburg), which is shown as route 3 in the figure.

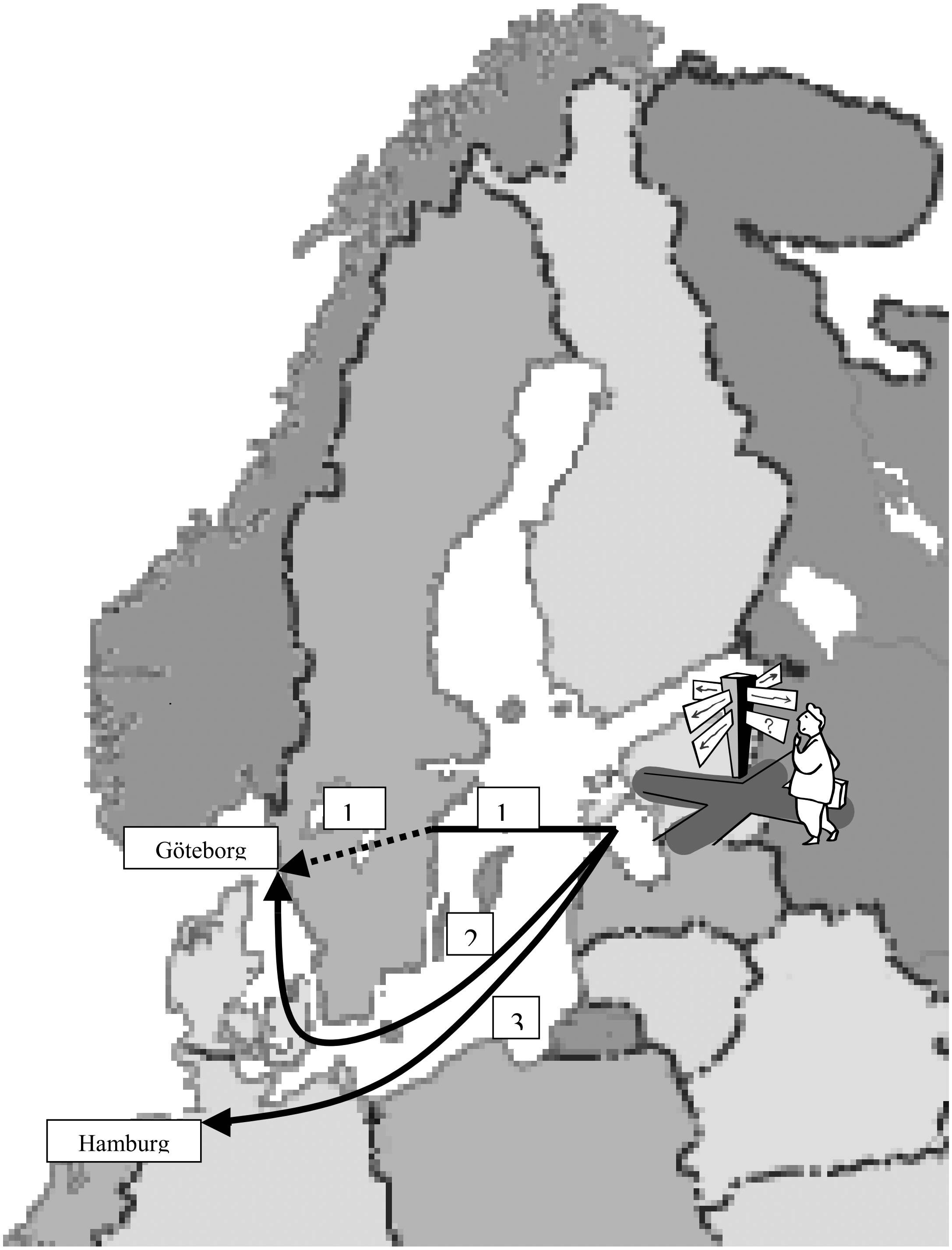


Figure 2-1 Illustration of the project (own creation)

2.3 Research Questions & Information Needs

The questions have to be relevant concerning our scope of study, our given purpose, as well as our limitations. The research questions are formulated in the manner in which we intend to work with the project. For each research question, a need for information will be generated. Below we specify our main research questions and their information needs:

- **What are the possible sea-links that we should evaluate?**

  More specifically this means that we should evaluate the sea-links that may be of strategic importance for the international goods traffic to and from the BSRR with the Port of Göteborg as a possible transhipment hub. To do this we have to review and select suitable ports in both the BSRR and on the Swedish east coast to act as nodes in our route calculations.

- **How shall we calculate the costs for the routes we have chosen?**

  To solve this, we need to gather information on possible financial and technical alternatives and decide what to focus on. For the financial part, we have to find out what cost variables are associated with a sea voyage and which of these we shall employ in our calculations. Naturally, we also have to understand how to perform calculations on these variables.

  As for technical aspects, we have already limited ourselves to only observing flows of containerised cargo and trailers. With this in mind we have to find out what type of vessels we are to use.

- **How shall we analyse the service aspect of our specified routes?**

  We have stated as regards our purpose that we, besides calculating costs, also shall make a service evaluation between the ports of Göteborg and Hamburg. This requires us to find out what actually is meant by service and also what service variables are of importance for our purpose. A major requirement, as we see it, is that the variables have to be comparable between the ports in some way. The key issue in this, given our perspective, could be formulated as to finding out why shipping lines should decide to regularly call at either the Port of Göteborg or the Port of Hamburg. We believe that the throughput time (see chapter 5.5.2) for different routes is the most important variable that can influence the decision-maker.

Here it could be in place to clarify that even though the Port of Göteborg is our thesis commissioner, our main point of view when performing our research shall be that of a shipping line. For us, it feels relevant to take the perspective of a shipping line, since they are the customers of the ports, and are the ones that in the end will operate the potential routes we are studying.

2.4 Outline of the Report

This thesis can be described as being divided into four major parts. The first part (chapter 1 and 2) deals with the background and purpose of the entire project. By entire project we refer to all three theses that cover this topic. The first part also explains the main content of the separate projects (chapter 1) as well as a more detailed description of our specific task at hand (chapter 2).

The second part (chapter 3 and 4) has a more theoretical approach, since it covers the theoretical framework necessary to understand and solve the thesis problem. It also contains a review of our chosen research design and how we aim to implement it throughout our thesis work.

Our empirical study (chapter 5), i.e. a description of how we performed our research and what our results were, constitutes the third part of the thesis.

The fourth and final part of our thesis (chapter 6, 7, 8, and 9) contains an analytical segment in where we test our results and draw conclusions. Also, we review the validity and reliability of our findings. The entire thesis ends with a section in where we give suggestions for future research within this field (chapter 9).

3. Theoretical Framework of Shipping

This Chapter will give a broad theoretical framework to the shipping industry, and the components of it that are relevant to our thesis.

3.1 Actors

We believe that the best way to start and describe the shipping industry is to clarify who the actors are (see table 3-1). Understandably, we will not make a complete coverage of all actors, but only concentrate on the actors that are of importance for the understanding of our thesis. More specifically, this means that the main focus will lie on the seaports. The following parties are involved in commissioning, organising and carrying out the transport (Interreg II C, 2001):

Manufacturer	Produces the cargo to be shipped
Consignor	Sends the cargo to the consignee
Consignee	Receives the cargo
Shipper	The owner of the cargo, who could be the manufacturer or the one which he has sold the products to, or a wholesaler
Forwarder	Organises the transport on behalf of the shipper but is increasingly involved in supplying logistics services, e.g. warehousing, product finishing
Carrier	Carries out the transport
Haulier	A road carrier
Shipping line	A sea carrier
Shipping agent	Acts on behalf the shipping line as interface to the shipper or his forwarder
Terminal operator	Carries out the transhipments of the cargo, the warehousing and other services in the terminal (in the port the terminal operator covers the port utility function)

Table 3-1 Actors in shipping (Interreg II C, 2001)

3.2 Sea Ports

Historically, the port's primary function was to transfer the cargo from/to ships, and was linked to demand for a number of services such as pilotage, fairway maintenance, towage, port entrance, stevedoring, clearance, etc. The frequency and nature of port calls evoke demand for various services. "…there is a currently homogeneous port function, in terms of both production technology and cost and the market, where location (natural geographical prerequisites and closeness to markets) can generate economies-of-scale on both the cost and revenue sides" (Swedish Maritime Administration, 1999).

Ports can be seen as nodes in a network of transportation chains linking places and actors to each other (see chapter 3.2.1). Some of these nodes provide transhipment services between various modes and directions while others represent points of origin and destination of cargo transports and travels. (Interreg II C, 2001)

3.2.1 Network model

The network model represents the structure of the physical flow of goods being transported, which consists of nodes and links (see figure 3-1) (Lumsden, 1998).

- **A node** is equivalent to a stop or where the flow of goods can be stopped, i.e. a terminal, warehouse or production facility.
- **A link** is equivalent to transporting activities connecting the nodes, i.e. a truck transport, sea-voyage or a local fork-truck transport.

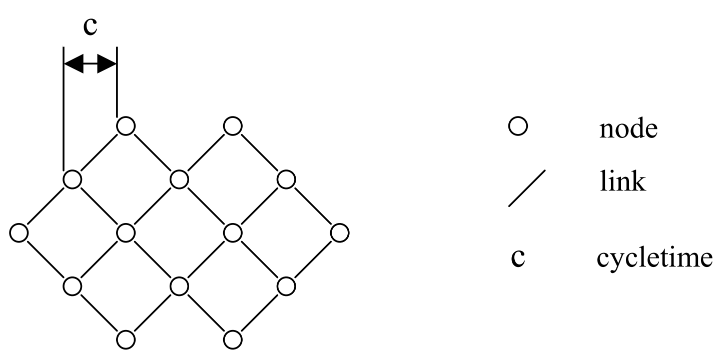


Figure 3-1 The transport network (Lumsden, 1998)

Every link is also given a time, a cycletime (see figure 3-1). The cycletime represents the time, which is necessary for a specific transport in the network. It is a sum of the link-time and the node-time. (Lumsden, 1998)

- **The link-time** is equivalent to the time required for the actual movement activities.
- **The node-time** can be divided into active time, when the goods are handled or treated internal in the node and passive time, when the goods is staying in the node without being handled (no value added to the goods) (Lumsden, 1998).

3.2.2 Port Markets

The port market in Northern Europe is very heterogeneous. Depending on the function of the port and the hinterland (trading area), the ports can be classified as (Swedish Maritime Administration, 1998):

- *Local ports* with a local hinterland
- *Regional/national import- and export ports* with a trading hinterland of national importance regarding the port's role in one or more product segments
- *Ports of transhipment*

  This term is traditionally associated with the notion that the port has direct calls carrying transoceanic goods. From the port the goods are reloaded to tonnage that is more manageable and then distributed through regional traffic.
- *Transit ports*

  Also a port of transhipment but extended to mean that the port has a hinterland larger than the country in which it is located. The transport of the transit cargo can take place with trucks and railway just as well as with vessels.
- *"Hub and spoke" ports*

  The global container operators have added this extra dimension to port categorisation. A hub is a highly effective transhipment point, where cargo is shifted from transoceanic tonnage into feeder tonnage or road/rail links, or between tonnage serving different routes. To gain hub-status, a port needs to have a strategical position in respect to how the big ocean shipping lines have their routes, and it must be able to take on a much larger commitment in order to more actively influence its own and its customer's expansion as well as its cost efficiency.

- *Feeder ports*

  These ports act as links and nodes in a regional sense, serving a larger port that act as a hub for a larger region.

The following table (table 3-2) distinguishes various types of ports in relation to their service and location characteristics. In reality several of these port-types are often to be found in the same location.

	Services	**Port function**	**Location characteristics**
Ports for high value unitised cargo	Import/export of high value goods (finished and semi-finished industrial products).	The port is a hub in a complex network of terminals and related land and waterborne services consolidating and distributing the goods.	Dependencies on good access by road and rail and on nearby terminals and markets, which normally mean locations in or close to densely, populated areas and conflicts with urban development and environmental requirements.
Passenger Ports	Ferry or cruise passengers.	The port must provide close links to urban centres and local passenger markets.	Demand for city centre location and good access by car and public transport. Conflicts with urban development and environmental requirements.
Industrial port and bulk ports	Export or import of low/medium value goods directly from /to ship.	The port is a part of the plant complex or closely related to such a site through a dedicated road, rail or pipeline.	Little dependency on services and markets apart from the fact the industrial site as such has to be served by road and rail. Mainly environmental problems.
Sea transhipment ports	Transfer of containers between overseas and feeder services.	The port must be strategically located in relation to the over-sea shipping routes.	Little relation to land transport network. Mainly environmental problems.

Table 3-2 Port types and their service profile, function and location characteristics (Interreg II C, 2001).

3.2.3 Critical Success Factors for Shipping

The competitive situation for shipping against other modes of transportation is limited in volumes and types of commodity. When it comes to transportation for shorter distances it is difficult for shipping to compete with rail and road for other cargo than high value cargo packed in unitised load carriers (e.g. containers). (Wijnolst, et al, 1993)

In order to be more competitive it is important to understand the critical success factors of shipping and how these can be influenced. According to Wijnolst (1993), eight major factors influence the success of shipping. These are:

1. Transport (transit) time
2. Transport cost
3. Frequency and flexibility
4. Reliability
5. Customer satisfaction
6. Safety
7. Environment impact
8. Political acceptability

These factors are foremost concerned with the situation of the shippers. For the specific purpose of our thesis these factors are also interesting when it comes to comparing the competitiveness between actors within the shipping industry. For us, the actors that are of main interest are the ports. In some way it could also be the shipping companies since we will be doing our cost/service evaluation from the viewpoint of the shipping companies.

The factors that we are mostly dealing with in this thesis are the transport cost (see chapter 5.4.2) and transport time (see chapter 5.5.2). The basic categories of shipping costs include the capital, operating, voyage, and cargo handling costs (see chapter 3.4). We will only focus our attention to the voyage- and cargo handling costs since these are the variable costs that are associated with a specific trip (route), while the capital- and operating costs are influenced by other factors such as the management of the shipping company.

The port authorities can influence these costs in a number of ways that would lead to a more competitive situation for the port. The voyage cost can for example be minimised by means of (Wijnolst, et al, 1993):

- Automated mooring of the vessels
- Formulating cost saving agreements with port authorities for port charges
- Central booking systems to avoid brokers commissions, etc

The cargo handling costs can be minimised by (Wijnolst, et al, 1993):

- Reduction of number of moves between the ship and the port
- Automated cargo handling systems in order: to load and discharge the vessels; transfer cargo on the terminal; load and unload trucks or trains
- Engaging shore labour only between normal working hours
- Formulating cost saving agreements with stevedoring companies for handling charges

3.2.4 Port Evaluation Criteria

The evaluation of the costs associated with sea-links from the BSRR to either the Port of Göteborg or the Port of Hamburg is only one part of this thesis. The other dimension is to evaluate the service aspect of these two ports and try to make a fair judgement in respect to certain criteria.

It is important that we realise that even though the Port of Göteborg is our commissioner the viewpoint that we have chosen to take is that of a shipping company serving these possible routes. The most important aspects for shipping company's choice of regular ports of call is based on a number of considerations, such as (Swedish Maritime Administration, 1999):

1. The port's location;

- In relation to the hinterland for potential cargo and balance between inbound and outbound volumes,
- In relation to other ports of call - the deviation aspect,
- In relation to transportation capacity to and from the port,
- In relation to the competitive situation, i.e. its competitors' ports of call and catchment areas.

2. The port's flexibility with respect to;

- Handling different types of cargo,
- Adaptation to varying arrival times overtime requirements.

3. The port's technical capacity and practical maximum capacity.
4. The port's adaptation to the latest/best/most cost-effective technology.
5. The port's quality with respect to absence of cargo damage and ability to adhere to prearranged times and other terms of agreements.
6. The port's efficiency measured in cost per TEU/ton/m 3 and time unit.
7. Stevedoring costs in the port according to tariffs and 'in reality'.
8. The level of port entrance costs and related costs (tugs, bosuns, etc.) and the cost trend over time.
9. Customer demands, e.g. when a major goods owner has a vested interest in a terminal.
10. Weather, wind, tide, and ice conditions.

Given the purpose of our study and the given time frame to work within, we have to limit ourselves as to which factors we will study.

3.2.5 Port Strategies

The port markets today are very heterogeneous. New types of ships and the development of freight carriers, handling technology and new types of cargo reinforce the processes towards increased specialisation. It has resulted in the development of different handling and production systems in the ports, which to varying degrees require access to quays, cargo-handling equipment, storage capacity, etc. (Swedish Maritime Administration, 1999)

A consequence is that the port has been divided into several ports or, rather, into specialised terminal functions, which are often concentrated or even proposed to be moved out of the centre of the city. This usually results in a tendency to decentralise and/or concentrate and specialise in order to bring about more homogeneous business areas. The commercial rationale driving the tendencies mentioned above are based on one or more out of three characteristic port business strategies (Interreg II C, 2001):

- Location/adaptation dependent on infrastructure conditions and market know-how.
- Differentiation that is dependent on the type of goods, the character of the market, customer relations and logistic demands.
- Production costs that are dependent on factor costs, handling technology, productivity and economy of scale.

The port markets can be classified according to different strategic types as shown in figure 3-2.

System Terminals Global hinterland Relatively few clients Homogenous service Direct customer contact Large economies of scale	*Industrial terminals* Regional hinterland Few clients Tailor-made services Close customer relations Medium economies of scale
General terminals Local hinterland Many clients Heterogeneous service Little customer contact Limited economies of scale	*Dedicated terminals* Industrial terminals Local reception/distribution area One client Tailor-made services Direct customer contact Low economies of scale

Business Economies of Scale

Service differentiation

Figure 3-2 strategic types of port/terminal markets (Swedish Maritime Administration, 1999).

3.3 Types of Vessels and Cargo

The commodities in sea borne trades can be shipped in different ways depending on a parcel size. A main distinction is between "bulk cargo", where the parcel size is sufficient to fill a whole ship, and "general cargo", where each parcel is too small, but where a combination of many parcels can fill up a ship. (Wijnolst and Wergeland, 1997)

As we have previously stated in our limitations (chapter 1.6), we will focus on container traffic and trailer traffic, which both are parts of the general cargo segment. In order for a unit in a transport system to function satisfactorily, the unit must be adapted to the transported cargo. This applies especially to ships where the large capacity demands an adaptation to be able to be efficiently used and the loading and the unloading operations to function. As a result, all ships are more or less adapted to the transported goods. At the same time it should be pointed out that this also demands that the goods should assume general forms, i.e. to be unitised. (Lumsden, 1998)

3.3.1 Load Carriers

In unitised cargo handling, separate parcels and or pallets are loaded together into a standardised cargo carrier unit – a container, a swap body or a trailer. The rationale for unitised cargo handling is in reducing transhipment time and cost. Further goods damage will be reduced, packing simplified and transport time could be reduced (Lumsden, 1998). For maritime vessels, port time could be reduced considerably, which is important for ship productivity (Interreg II C, 2001).

The basic technical specifications of these unitised load carriers are as follows (Lumsden, 1998):

- **ISO Container**: 8 x 8 x10, 20, 30 or 40 feet. Gross weight 10,16, 20,32, 25,4 or 30,4 tons. The average weight that we will use for containers is 14 tons for container flows that are eastbound to the BSRR and 17 tons for those that are westbound from the BSRR (authority of the Port of Göteborg).
- **Trailers** 12,2-12,7 meters; maximum 13,6 meters in Sweden. The weight is not something that can be stated with a standardised value, but for our calculations we are to use 17 tons as an average weight for trailers (authority of the Port of Göteborg).
- **Swap bodies** (for road transport, partly also for rail): 6,058 meters up to 12,650 meters. We are not considering swap bodies at all in study and will therefore not dwell any more on them. (Lumsden, 1998)

<u>3.3.1.1 Containers</u>

Containers are boxes that can be filled with cargo and can easily be transhipped from one modality to another. For transport of containers there are special container ships and special container terminals that are equipped with special container cranes. Compared to transport of the cargo separately, using containers has the following advantages, see Wijnolst & Wergeland, 1997:

- Reduction of the port time, loading/unloading speed increases because the units are bigger and stowing is faster.
- Less personnel is required for transhipment of the cargo.
- The cargo is better protected against damage during loading, unloading and transport as well as against theft.

Almost any small sized cargo could in principal be shipped in containers. Volumes of container handling are normally measured in TEU (Twenty Foot Equivalent Units), i.e. the number of standard containers 20 feet long. One 40 feet container thus corresponds to 2 TEUs (Lumsden, 1998).

3.3.1.2 Trailers

During the latest half of this century the road transport underwent explosive development. Under a period from 1960 to 1965 the number of long vehicle combinations (truck and trailer) only in Sweden increased from about 4,000 to about 18,000. The longest combination of vehicles (truck and trailer) in Sweden is not allowed to exceed 24 meters in length and 2,6 meters in width, with a maximal weight of 60 tons. (Lumsden, 1998)

A vehicle consists functionally of two different parts:

- Load carrying unit (trailer), which function is to care load capacity and generate the profit
- Technical part which functions is to move units

The characteristic feature for a semi-trailer is that the truck can be disconnected from the load carrier, which gives the possibility to avoid having en expensive technical part unproductive during terminal operations, sea voyage, etc. (Lumsden, 1998)

3.3.2 General Cargo Vessels

The general cargo vessels can be divided into a large number of variants. The vessels range between everything from conventional general cargo ship designed for non-unitised cargo, to very specialised ships designed for a certain use of unitised cargo (pallets, containers, or a combination). It is obvious that the trend is towards more and more unitisation of basically all the goods. (Lumsden, 1998)

The size of most general cargo ships is restricted by the loading/unloading speed and the port time. General cargo ships are often relatively small and have a size up to 25,000 Dwt (dead weight tons of the ship). (Wijnolst & Wergeland, 1997)

Depending on the technique deployed in handling the general cargo, the vessels can be divided into vertically operating ships, LoLo-ships (Lift on Lift off) and horizontally operating ships, RoRo-ships (Roll on Roll off). The vertical handling procedure means that the goods is lifted on board the ship, while the horizontal handling procedure involves goods being handled by trucks, wagons or some other type of rolling equipment. (Lumsden, 1998)

3.3.2.1 LoLo Vessels

The efficiency at the loading and unloading operations and the safety it brought to the goods is one of the most important reasons why large load carriers in the form of containers started to be used in the middle of this century (Lumsden, 1998).

Containers ships have box-shaped holds, fitted with cell guide, which are used for guiding and fastening of the containers (Lumsden, 1998). The number of 20-foot containers (TEU) they can carry measures the carrying capacity of container ships (Wijnolst &Wergeland, 1997).

Development and in abundance the lack of sufficiently large unitised goods have lead to the construction and practical implementation of ships where the transportation of containers is joint with another type of cargo, such as pallets or rolling gods, multi-purpose ship (Lumsden, 1998).

3.3.2.2 RoRo Vessels

RoRo is the technology for horizontal relocation (loading and unloading) of the goods, which is the most efficient way to transfer goods between different way of transportation. This technology is the basis for ships that transfer rolling units or all types of goods that have been loaded on rolling load carriers, such as cars, semi-trailers, trucks, cassettes, railway wagons, etc. (Lumsden, 1998).

For short sea transports where the demand for a short harbour-time is stressed, the horizontal handling offers very large possibilities of a rational handling of the cargo but leads however to a great deal of unutilised space on board the ship, as the space between the decks cannot be completely filled (Lumsden, 1998).

For longer distances, the demand for a high use of the volume in the ship leads to the fact that RoRo-vessels are not equally interesting, because of poor utilisation of space in the ship. The breakpoint from when to transfer from a RoRo-technique to a LoLo-technique is not obvious and furthermore quite dependent on the situation. (Lumsden, 1998)

The RoRo technology has played a significant role within the shipping industry. It holds a great advantage with its flexibility concerning cargo and efficiency in cargo handling. The continuingly fast expansion within the LoLo segment has lead to a development where many RoRo vessels have been designed to be able to handle containers. (Swedish Maritime Administration, 1998)

3.3.3 Shipping Segments

The placement of different types of ships depends on two variables economies of scale and service differentiation (see figure 3-3). One sector that is difficult to place is container shipping. On the one hand it is clear that enormous economies of scale exist, because of the very high fixed costs involved in the operation. On the other hand the level of competition and the standardisation offered by the container itself, drives it towards Commodity shipping. Some operators do offer very specialised services, so it really spans several segment types. (Wijnolst & Wergeland, 1997)

Business Economies of Scale

Contract shipping	**Industry shipping**
Few suppliers	Few suppliers
Economies of scale in fleet	Economy of scale in fleet
Fairly homogenous service	Specialised service
Liquid second-hand market	Difficult second-hand market
Close customer relation	Tailor-made customer product
Commodity shipping	**Special shipping**
Many suppliers	Few suppliers
No economies of scale	No economy of scale
Homogenous service	Specialised service
Liquids second-hand market	Difficult second-hand market
Little customer contract	Direct customer contact

Service differentiation

Figure 3-3 Strategic types of shipping markets (Wijnolst & Wergeland, 1997).

The following figure (figure 3-4) shows an attempt to position some of the vessel type into the different shipping segments.

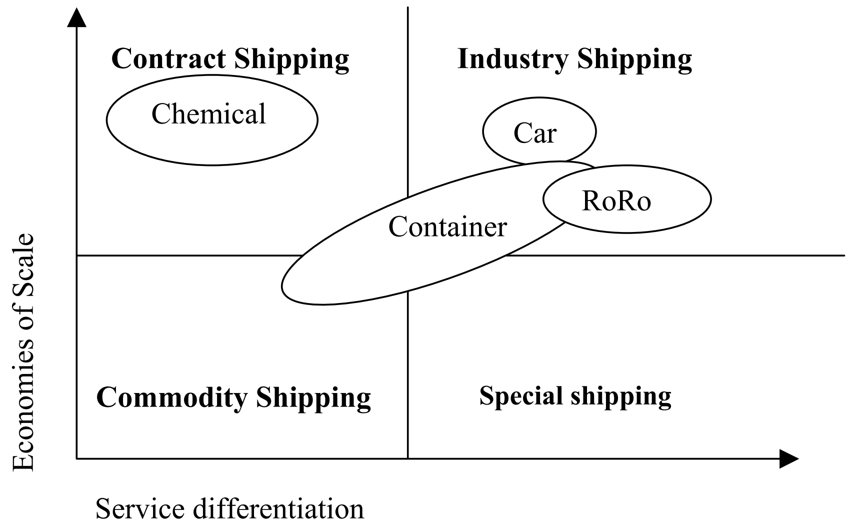


Figure 3-4 Examples of shipping segments (Wijnolst & Wergeland, 1997).

3.4 Shipping Costs

When operating a ship, there are several cost factors to consider. These components can be classified in to four main categories (Stopford, 1992): Capital costs, Operating costs, Voyage costs, and Cargo handling costs.

3.4.1 Capital Costs

Quite simply, the capital cost consists mainly of the following components (Wijnolst & Wergeland, 1997):

- The investment cost
- The financial structure for the investment
- The interest rate
- The economical life of the ship
- Tax regulations

The capital cost can vary greatly depending under what conditions the ship has been financed and built. Also, the managerial choices of each individual shipping line determine factors such as depreciation rate. (Wijnolst & Wergeland, 1997)

3.4.2 Operating Costs

The operating cost consists of the ongoing expenses of the purely operational aspects with the day-to-day running of a vessel. It is only the fixed costs that are contained in this category, i.e. the costs that have to be covered in order to make the vessels ready to sail. More specifically, operating costs include cost for manning (crew), maintenance and repairs, insurance, stores, supplies and lubricating oils, as well as management overhead, including administration. (Wijnolst & Wergeland, 1997)

3.4.3 Voyage Cost

The voyage cost is different from capital and operating costs in the sense that it is purely associated with undertaking each particular voyage, i.e. it is a variable cost. The components that constitute the voyage costs are bunker (fuel) costs, port dues, tugs and pilotage, and canal charges. (Stopford, 1992)

3.4.4 Cargo Handling Costs

These costs represent the expenses incurred when loading, stowing and discharging (unloading) the cargo. These costs represent an important component for the total cost, especially in liner shipping. The cargo handling costs can be greatly influenced by improvement in ship designs to facilitate faster cargo handling. (Stopford, 1992)

3.4.5 Time Charter

At first, we planned to use all the above cost components in our calculation model, but after a while we realised that the results of our simulations cannot be comparable between different shipping companies. The capital costs and operating costs can vary greatly due to several circumstances. For example, the fixed cost depending on the interest rates that owner or bank agrees on and investment costs depends on time and cyclical fluctuations of the maritime industry.

Furthermore, the crew costs varies greatly depending which flag (nationality) the ship is registered under, management philosophy, and tax regulations. Voyage- and cargo handling costs, on the other hand, can be calculated with variables that can be applicable for all shipping companies operating on a certain route, because it depends on distance, fuel costs, and port dues and charges. Therefore, we have decided to use the time-charter costs per day for the vessels that we have chosen to use for our calculations.

The time charter transfers many of the costs and commercial responsibilities to the charterer rather than the ship owner. The ship owner hires out his vessel to the charterer for a specified period of time, which could be anything from the time taken to complete a single voyage or for a period of months or years. During that period, the ship owner continues to pay the operating costs of the vessel (i.e. the crew, maintenance and repair), but the charterer directs the commercial operations of the vessel and pays all voyage expenses (i.e. bunkers, port charges and canal dues) and cargo handling costs. (Stopford, 1992)
Performing calculations after time-charter method, we know that different shipping companies are well aware of their own investment costs, administration costs, crew costs, etc. Therefore it would not be difficult for them to evaluate their own level of revenue for the routes that we have made calculations on.

4. Research Design

In this chapter, we explore the methodological approach to our research.

4.1 Methods for Research

A research design is the basic plan that guides the data collection and analysis phases of a research project. The framework specifies the type of information to be collected, the sources of data and the data collection procedure. The research objective logically determines the characteristics desired in the research design and this is dependent upon the stages of the decision making process for which information is needed. In this regard, three main types of research have been identified (Kinnear & Taylor, 1979):

- Exploratory
- Conclusive (i.e. descriptive and causal research designs)
- Performance-monitoring research

We have found the conclusive research design to be the most suitable for our work therefore we will only be describing this research design.

4.2 Conclusive Research

When it is desirable to provide information for the evaluation of alternative courses of action, conclusive research is often used (Kinnear & Taylor, 1979).
This is highly suitable in our case, since the background for our thesis stems from a wish from the Port of Göteborg to increase their market share, and they desire more information to base a decision on.
Our study has both elements (descriptive and causal) of the conclusive research design in it. It is descriptive in the way that we have to list and describe the service variables of the Port of Göteborg and the Port of Hamburg in order to make a comparison between them. Descriptive information often provides a sound basis for the solution of marketing problems, even though it does not explain the nature of the relationship involved (Green & Tull, 1978).
The causal side of our research, which is dominating, lies in our cost calculations. We intend to create a model in which we can test the cause and effect relationship between key variables in the system (see Chapter 5.4).

4.3 Data Collection Methods

There are five major sources for obtaining data (Green & Tull, 1978). These are secondary sources, respondents, natural experiments, controlled experiments, and simulations. The techniques that we have chosen to make use of are secondary sources, respondents, and simulations.

4.3.1 Secondary Data

Secondary data are already published data collected for the purpose other than the specific research needs at hand (Kinnear & Taylor, 1979).

When it comes to finding the appropriate theoretical framework to build a thesis on, one is faced with quite a few problems. At first, it can be hard to locate applicable literature, because it is difficult to know what to look for and where to find it. To choose suitable theories out of the literature is a second problem. Many times, the literature does not apply perfectly to the problem area at hand, and it is often difficult at the first stages of a project to know what theories are best suited for the problem. Then there is the question about whether the intended investigation will contribute to anything new in the studied area or not. Sometimes, the problem might already have been investigated, and in that case, it is important to define what perspectives the current investigation has. Maybe the new research will give new knowledge just because the perspective is different. (Svenning, 1996)

The main advantage of using secondary data is the savings in cost and time. It is possible for the researcher to obtain far more data in a given time period than if he were to gather purely primary data. This implies that any research should always start out with reviewing secondary data available before pursuing primary data (e.g. surveys). (Kinnear & Taylor, 1979)

Furthermore, secondary data can be classified as coming from internal sources or external sources. Internal data is produced within organisations/companies for their specific use while external sources come from sources such as government publications, trade association data, books, bulletins, reports, and periodicals. (Kinnear & Taylor, 1979)

As far as our investigations have stretched, we have not been able to locate any similar research to the field that we are studying. Therefore, we have to rely heavily on information that we can get from companies operating within the shipping industry to obtain the necessary information. The most up to date information within this field we have found to be texts put together by the initiative from government bodies and consultancy companies.

Naturally, we have made an extensive review of existing literature (textbooks, scientific journals, periodicals, etc.) to obtain as good an understanding of the shipping industry as possible.

4.3.2 Respondents

Conducting interviews is a much-preferred method for collecting data. The personal interview is often more flexible than other means of obtaining data. It is possible to ask follow-up questions and to get a more holistic view of the respondent and his/her values and knowledge. Also, it is normally preferred among respondents to talk to an interviewer rather than reading and filling out a form with standardised questions. Nonetheless, it is not advisable to rely solely on interviews for an investigation, since there is the problem of so-called interview-effects. By this, it is meant that it is hard to be objective when conducting an interview and not influence or affect the respondent in any way. (Rubenowitz, 1980)

There is mainly two ways in which a personal interview can be conducted: structured and unstructured. An unstructured interview is characterised by the lack of any schedule. The respondent is allowed to associate freely and talk as much as he/she wants about a certain topic. For a structured interview, the interviewer follows a more structured line of questioning, often from a detailed interview guide. When conducting several interviews for the same purpose, the exact same questions are asked each time. Either the respondent has to choose from a certain number of answers, or the question can be of an open character, where the respondent can answer the question freely. (Rubenowitz, 1980)

We have conducted several unstructured interviews with respondents that we have chosen, to represent as wide a range as possible from the shipping industry (see chapter 5.1).

4.3.3 Simulation

By simulation, we refer to "a set of techniques for manipulating a model of some real-world process for the purpose of finding numerical solutions that is useful in the real process that is being modelled" (Green & Tull, 1978). In our case, this will result in the creation of a model framework in which we can compare cost variables of different route alternatives to goods flows to and from the BSRR. We intend to construct this model in the program Microsoft Excel.

Using the simulation technique has several advantages. First, it is not necessary to make any investments in equipment. When performing a simulation, it is possible to test how a suggested change will work out and afterwards make a decision on whether it is good or bad. Second, elaboration with time and people needed in the process and analysing this in different ways is easily done, enabling a good understand of why things happen. In a simulation, you can isolate different events and see what happens in different situations. You can also be able to identify constrains. Third, the daily work in the system that is being observed is not interrupted in any way. Fourth, simulation is an excellent way to visualise a plan and make it easy for others to understand. Also, it is a good tool for preparing for changes in the future. Fifth, and finally, it is possible to make requirement specifications when designing a system, which means that it is possible to make sound and wise investments. (Banks, 1998)

The data that we have collected via interviews and secondary sources will be put to use in this model, that should generate an outcome that will make it possible for us to fulfil our purpose, that is to see whether the Port of Göteborg can act as a transit port for goods to and from the BSRR. The details and specifications of our model will be described in the section that contains our empirical study (chapter 5).

4.4 Validity and Reliability

In this chapter we will explain the concepts of validity and reliability, which we will relate our results to in chapter 8.1.

4.4.1 Validity

The validity of a measure refers to the extent to which the measurement process is free from both systematic and random error. Systematic error refers to an error that causes a constant bias in the measurements, while random error involves influences that bias measurements but are not systematic (Kinnear & Taylor, 1979).

In other words, validity is the measurement of the conformity of what a measuring instrument is supposed to measure and what it really measures (Körner, 1996). The main question that validity deals with is: Are we measuring what we think we are measuring?

Validity can be divided into one internal and one external part. The internal validity deals with the study itself and the direct connection between the theoretical framework and the empirical study. That is, the interviews shall be conducted with relevant people and the experiments shall have enough samples to answer the research questions. External validity concerns the study with all its contents in a broader perspective. This implies if it is possible to generalise from the study or not. If the study does not have internal validity, this excludes external validity as well. However, the opposite might not be true. (Svenning, 1996)

4.4.2 Reliability

Reliability is concerned with the consistency, accuracy, and predictability of the research findings (Kinnear & Taylor, 1979). This means that the measurement must be performed several times in the same way without very different results in order for the reliability to be high (Körner, 1996).

Factors that can influence reliability are wrong samples; interview-effects; and problems with standardisation in interviews as well as problems in interpretation. To achieve higher reliability, clear definitions of the concepts used in the study are important. It is also important to have several indicators to measure a phenomenon important to the study. When obtaining information from separate sources, the data is more reliable. In a quantitative study, the demand for reliability is higher than in a qualitative, because a qualitative study is more focused on exemplifying than generalising. (Svenning, 1996)

If a measurement is not reliable, it cannot be valid, and if it is reliable, then it may or may not be valid. Therefore, reliability is a necessary but not a sufficient condition for validity. Reliability is a weaker concept than validity since it involves only random errors. (Kinnear & Taylor, 1979)

5. Empirical Study

In this chapter we will present how we have structured our practical work with obtaining data. We will also describe the building of our calculation model as well as the results we have got from our simulations. Finally, in this chapter, we present our findings on differences between the ports of Göteborg and Hamburg concerning facts and variables that are of importance when we shall perform a service evaluation later on.

5.1 Data Collection

To collect information and data we have reviewed relevant literature, industry journals, company material, statistical sources, etc. Much of the information that we needed was hard to obtain from public sources, and we have had to rely heavily on primary data (i.e. interviews) from companies operating in the shipping industry.

We aimed to interview as many people as possible to make sure that we could create a well-founded understanding of the situation at hand. We have gathered information from companies within the following areas of the shipping industry:

- Port authorities
- Port/Terminal operators
- Shipping lines
- Shipping agents
- Shipping associations
- Consultancy firms

A complete list of the companies that we have interviewed or in some way gathered information from is to be found in the list of references (see chapter 10.5).

5.2 Interview Compilation

When we conducted our interviews we wanted to keep it as freely and unstructured as possible, since we believed that this would enable our respondents to speak more freely and provide us with more valuable information than what a structured interview with fixed questions would.

We had sent out e-mails to our respondents, which indicated what topics we would bring up during the interviews. The areas that we spoke about were the following:

1. What are your views on the current structure and development of the BSRR market?
2. What are your views on Port of Göteborg as a transit hub for BSRR?
3. What is the overall competitive situation for the Port of Göteborg?
4. How is the competitive situation between the ports of Göteborg and Hamburg?

The responses from these discussion areas are presented below. In the analysis chapter we will compare these opinions and views towards our results.

1. What are your views on the current structure and development of the BSRR market?

According to one of our respondents, the BSRR market is characterised by:

- Growing markets
- Unbalanced trade flows
- A lot of conventional cargo
- An increase in container usage
- Operational problems (associated with the new states)
- More manual labour (not as good IT and communication systems as in the west)
- Security problems (mostly in Russia)
- A lot of chemicals, paper, steel, and forest products on export

At another interview we were told that a major part of products to the BSRR are for outsourced production. These products are assembled/produced/etc. in the BSRR and then sent back (i.e. to take advantage of more favourable labour conditions). The outbound BSRR goods consist mainly of timber, which is mostly transported in trailers. Up to 70-80% of Russian cargo is volume-based. Therefore the rates are often based on volumes.

It is important to remember that Estonia, Latvia, and Lithuania's economy taken together is the same as for Småland and that there are less people than in the St. Petersburg region. The flows of goods today are not balanced. The flow of physical units (container, trailers) is somewhat balanced, but there is a large amount of positioning of empty containers.

One interview respondent pointed out the importance of remembering that there are goods today that are shipped in other load carriers, which in the future can be containerised. This means that the future market potential for containerised goods in the BSRR is difficult to estimate. We were also told that Russia has a very good functioning railway system to get goods to its ports. But Russia is so huge that it is not enough with the Port of St. Petersburg, therefore the other Baltic ports are used to a very large extent to ship Russian transit goods.

According to a representative of a feeder shipping line, there are problems with congestion in the BSRR, mostly in the Port of St. Petersburg. This depends greatly on problems with bureaucracy and the equipment in these ports. The infrastructure is not good either. When we spoke to yet another shipping line that is operating in the BSRR, they confirmed that the Port of St. Petersburg is often very crowded and requires new equipment. The heavy congestion there often means that vessels cannot make their timetable.

Something that all our respondents agreed on was that there is an enormous potential in the BSRR, given a long time perspective and a stable development (political).

2. What are your views on the Port of Göteborg as a transit hub for BSRR?

When we interviewed a representative from a major shipping line, he thought the idea of a direct call to the Port of Göteborg with a connection to the Port of St. Petersburg via a land bridge is a good idea that can work. But is important to realise that calling at the Port of Göteborg means 1 ½ extra day up from mainland Europe, 7-8 hours of load/discharge and 1 ½ day back.

A respondent from one of the feeder shipping lines we interviewed said that it reasonably has to be less expensive to go by boat directly to the Port of Göteborg than it would be with a land bridge. There has to be approximately 100 TEUs per week in order for it to be profitable to have a direct connection between the Port of Göteborg and the Port of St. Petersburg.

One respondent said that the Port of Göteborg can have an advantage in the fact that the situation in mainland Europe is under heavy congestion and in the future there most likely will be harder restrictions (taxes) on road and rail transport in mainland Europe.

Respondents of one of the shipping lines were very restrictive to the idea that the Port of Göteborg can act as a transit port for BSRR and by that attracting the large ocean-liners. At the shipping line they can perfectly understand that there are actors that are very interested to set up a system to transport BSRR goods, but to attract the big ocean-liners the Port of Göteborg has to have the volumes in order backup it up, which the Port of Göteborg has a problem with. Further more, railway capacity is not there to back up a land bridge system across Sweden. When we spoke to a representative from a rail operator about the possibilities of a land bridge system, he pointed out that customers demand practically functioning solutions. The rail operators are aware that the service of the rail industry is perceived negatively.

When we spoke with one of our interview respondents about the concept of a land bridge he stressed the fact that the Swedish industry produces goods and consumes these goods in very different regions. He meant that there is no use to put heavy load on the infrastructure in west Sweden to get the goods to the Mälardalen region (which is the highest populated region). Why should the goods go over land, when the feeder traffic is working fine? The feeder traffic is unbeatable as an option today that's why the idea that Sweden should act as a transit country for BSRR goods should be erased, the respondent argued.

As for possible ports to chose from to act as nodes, we were told by more than one respondent that the Port of St. Petersburg should be the Port of Göteborg's choice of port to establish connections with, either with feeder to the Port of Göteborg or with a land bridge to the ports of Oxelösund, Norrköping, Oskarshamn, or Västervik.

The Port of Oxelösund in particular seemed to be a port that many would see as a possible link. When we made an interview at a shipping journal, our respondent pointed out that the Port of Oxelösund is a good port with well functioning railway connections. But he also stressed the fact that it is important to realise that horizontal lifts are always expensive. The goal should always be to minimise the number of lifts in a transport system. We were also told that the resources and price situation decides which port will be the Baltic hub in the future.

At a maritime consultancy firm we interviewed, the respondent mentioned that the decision of what ports to call at is decided by the operators to a large extent, and not something that policy-makers influence. Our respondent did not see it as likely that the Port of Göteborg would grow into a large transhipment hub, from where goods should be distributed throughout Northern Europe.

As for the RoRo lines, we found out that these lines are not operated on any longer distances. According to a respondent, a connection such as Göteborg-St. Petersburg would never be economically feasible concerning RoRo traffic. A LoLo line on the other hand could very well be a success. Containerised cargo is generally not as time sensitive as trailer goods. RoRo traffic hardly ever goes on a route; it is always a direct connection between two ports.

3. What is the overall competitive situation for the Port of Göteborg?

The Port of Göteborg is expensive, but they are high on the scale concerning quality, productivity, flexibility, and speed, said one respondent. The employees at the Port of Göteborg are regarded as having a high standard of service quality. The same respondent also said that he believes that the fact that the Port of Göteborg is in charge of the stevedoring operation is a big advantage for the Port of Göteborg. The main task for the Port of Göteborg is to attract more direct calls from shipping lines. The volumes are crucial.

Another respondent said that there is a well functioning infrastructure in the Port of Göteborg. The capacity of the port is big and there is a high level of services available to suit the individual demands of customers.

According to one of the respondents the taxes twist competition in Swedish ports negatively towards the rest of Europe. The Port of Göteborg is thorough, the level of security is high, and they are reliable. As for major competitors, the respondent believed that Aarhus in Denmark, that has Post-Panamax cranes and the possibility and opportunity to take big vessels, could be the biggest competitor to the Port of Göteborg. Further, the respondent said that the Port of Göteborg is a very expensive port, but they are among the best in the world on service quality.

Almost all respondents argued that the price politics in Sweden must be changed in order for Swedish ports to be fully competitive, but then the Port of Göteborg must reach a "critical mass" (volume) to be able to attract more ocean-lines.

According to one representative from a major shipping line the Port of Göteborg is not strategically enough positioned to be a big hub for transit goods. The larger the container vessels (the ocean going) get, the less anxious the shipping lines will be to service the Port of Göteborg. The respondent considered the Port of Göteborg to be an "out port". There are at least two extra days associated with calling at the Port of Göteborg. Our respondent also mentioned that since the Port of Göteborg is on a geographical borderline, there is a question on whether the large vessels will go there in the future or not. Perhaps we will see a development where the vessels get so big that they will only go between two or three major hubs on each continent and nowhere else.

Another respondent mentioned the same scenario, i.e. that the development might go towards fewer main hubs on each continent, between which enormous vessels will go. In a scenario like this, a port like the Port of Göteborg will most likely not be able to attract any of these large vessels.

The main advantages of the Port of Göteborg are that they have fast lead-time in the port in comparison with the other main European ports, and high quality (good handling, low degree of goods damaged). They main downsides are that it is expensive, and that there is less frequency of direct calls to the Port of Göteborg.

The Swedish Maritime Agency (Sjöfartsverket) imposes fairway dues on all vessels, something that is unique in Europe and a disadvantage for the Swedish ports. The government is on the wrong track when they spend so much on roads and railroads and nothing on the waterways. There is a need for a more competitive system for the charges than today's system where the southern ports have to pay for the northern ports. A precondition for the Port of Göteborg to be an alternative and a major player is that the fees that the Swedish Maritime Agency charges are removed. Swedish ports are in direct competition with each other, when they should co-operate more instead. Another problem in Sweden is that investments in ports are seen from a local perspective. There has to be a national perspective to make the maritime industry competitive.

Only one respondent argued that the fairway dues are not as big a problem as it is said to be. Since you only pay for the first twelve calls to a port in a year and not anything after that, the charges are not that big.

Most of our respondents agreed that the Port of Göteborg has a geographical disadvantage towards the main North-European ports. The Port of Göteborg is a little too "off" (geographically) to be a major player. Some of them argued, though, that the Port of Göteborg actually has an advantageous location with respect to alternative locations of a port of this size in Scandinavia.

4. **How is the competitive situation between the ports of Göteborg and Hamburg?**

Several respondents said that the Port of Hamburg were not as expensive to call at as the Port of Göteborg.

According to a representative from a feeder shipping line the customs clearance procedure is better in the Port of Hamburg than in the Port of Göteborg. Containers are driven to the port with the papers, which means that no problems will arise later on. The Port of Göteborg cannot compete with the Port of Hamburg.

One respondent from a major shipping line was of the opinion that the Port of Hamburg is more developed on the IT side (EDI solutions, etc) than the Port of Göteborg.

More than one of our respondents did not think it would be possible to have the same amount of direct oceanic calls in the Port of Göteborg as in the port of Hamburg.

5.3 Port Selection

In this section we will explain how we have chosen our ports of call in our simulations and we will give a brief decryption of each port.

5.3.1 Swedish Ports

For our choice of ports on the Swedish East Coast to use in our calculations we have decided on three main factors that should guide our choice in finding suitable ports:

- Geographical location
- Infrastructure
- Capacity constraints

From one of our interviews we found out that the Port of Stockholm is more or less going to disappear (the politicians do not want heavy traffic through Stockholm). This will open up interesting new alternatives. There are ports on the Swedish East Coast that are very aggressive. All ports have potential to set up traffic to BSRR.

The ports that we have chosen are the Port of Oxelösund and the Port of Karlshamn. Both ports are on enough distance from each other to not pose immediate competitive threats to one another in the event of both being used as nodes. The ports have been deemed as good allies from the perspective of the Port of Göteborg and the ports themselves are highly interested in this scenario. The ports pose no limitations as far as our scenarios will stretch in form of capacity and capability. We have only chosen two ports and not more since it would pose to great a task for us to have too many links in our calculations.

5.3.1.1 Oxelösund

The Port of Oxelösund has previously had lines but there are no lines to the BSRR currently. The Port of Oxelösund has a strategic geographical position to serve as a link between the Port of Göteborg and the more northwards port in the BSRR in the case of a possible land bridge connection between these ports and the Port of Göteborg. The Port of Oxelösund has very good railway and road connections. (http://www.oxhamn.se)

5.3.1.2 Karlshamn

The Port of Karlshamn has existing traffic with the BSRR (a RoRo line to the Port of Klaipeda in Lithuania). Compared with other Swedish ports, the Port of Karlshamn holds a strategic location in the Baltic Sea and has large capacity and offers a wide range of services. The Port of Karlshamn is a full-service port with a complete range of transport- and logistics services available locally. (http://www.karlshamnshamn.se)

The Port of Karlshamn is located in the centre of the most industrialised area in Southeast Sweden. The location is strategic both to West and East-Europe. The port is the dominating industrial and commercial port in the south east of Sweden. There is a rail connection to the quay and direct access to the

motorways R29 and E22. Therefore, the pick-up and delivery of containers and trailers is fast and efficient. (http://www.karlshamnshamn.se)
The Port of Karlshamn ranks as the seventh largest port in Sweden (counted in cargo turnover). There are six harbour areas with a total of 3 kilometre quays and 750,000 m^2. (http://www.karlshamnshamn.se)

5.3.2 BSRR Ports

For the Ports in Baltic States and Russia we are not going to choice ports by above-mentioned criteria (see Chapter 5.3.1). The authority of the Port of Göteborg made the decision about what ports that are the most interesting ones for our study. Additionally we want to claim that in this chapter the reader will not find complete information about the port's infrastructure, throughput and growth figures.

5.3.2.1 St. Petersburg (Russia)

The Port of St. Petersburg is the biggest transportation hub in the Northwest of Russia. Suitable geographical position – the Port is located on the islands of the Neva mouth in the eastern extremity of the Baltic Sea – helps to cut transportation, transit and other expenses. (http://www.seaport.spb.ru)
During the year 1999, the port handled 150,000 TEUs and during the year 2000 about 200,000 TEUs - an increase of 29 percent. The investments in modernisation and enlarging the container terminal will lead to an annual level of 300,000 TEUs. By the year 2010, the processing capacity of the terminal is expected to be equal to 400,000 TEUs per year. (The Scandinavian Shipping Gazette, 2001, p.73)
The problems of all Russian ports cannot be separate from the problems of one particular port. In Soviet times, the freight turnover, intensive port constructions and infrastructure development, especially in the St Petersburg Major Port and its "environs" were never as high as at present. (Ibid.)
A paradox still exists that non-Russian ships have transported more than 230 million tons of Russian foreign trade cargoes in the year 2000, comprising 96 percent of the corresponding total freight traffic. It should be noted that when the USSR was in existence, the native merchant marine transported about 80 percent of exports and up to 50 percent of import cargoes. (Ibid.)
The Russian merchant marine is as good as set aside from shipping foreign trade cargoes: this year (2001) it will receive less then three percent of the

cargoes. Native seaports cannot physically be moved out of their positions to operate under “flags-of-convenience” and by using the following data the situation with seaport business in Russia can be described, according to The Scandinavian Shipping Gazette (2001, p.73-74):

- native seaports ensure the transportation of 80 percent of all Russian foreign trade cargoes;
- therefore native seaports give the opportunity to tranship 160 million tons of export-import cargoes per year;
- it is estimated that the available productive capacities are enough to tranship 250 million tons a year, and moreover;
- the successfully operating seaports of Russia - St Petersburg Port in particular - after undergoing negative experiences in recent hard times, now exceed the transhipment indices characteristic for the Soviet period;
- practically all the main seaports now operate profitably, their shares are of high liquidity;
- while the Russian budget is enriched now by 40 percent owing to custom receipts, 60 percent of them have been accumulated in seaports.

What we consider as very interesting information are the following facts: the "Euro-Asian" cargo flow is being elaborated upon now in a mutual business contact with the railroad authorities of the Russian Federation; i.e. organising regular cargo transportation on the route "Port Vostochny - Trans-Siberian railway – St. Petersburg Port", and in the reverse direction (The Scandinavian Shipping Gazette, 2001, p.74).

After receiving essential guarantees on the part of the railway authorities and administration of Port Vostochny, the commercial structures of the Port of St. Petersburg have obtained the opportunity to sell their services transporting commodity from the Baltic region to the Pacific Ocean. Some German and Japanese cargo shippers and receivers - previously using indirect and expensive ocean routes, have already manifested interest in the services. (The Scandinavian Shipping Gazette, 2001, p.74)

According to one of the members of BPO (Baltic Ports Organisation) the price tariff for transportation of one-ton cargo on the Russian railroad decrease by 50 percent recently. This situation gives large cost advantages for Russian ports, compared with the ports of the Baltic States, in fact of lower total transportation price for clients.

5.3.2.2 Tallinn (Estonia)

The Estonia mainland has a coastline of 1,017 km and more than half of the 1,450 km long border is facing the sea. Because the Estonians have accountability for a 35,000 km^2 sea area, compared with the 45,000 km^2 land area, it is no overstatement to call Estonia a maritime nation. (The Scandinavian Shipping Gazette, 2001, p.17)

The Port of Tallinn handles cargo and services passengers and is of landlord type by its nature. The country's well-developed infrastructure offers good opportunities for all transport and logistics related activities. (http://www.portoftallinn.com)

Between 1994 and 1998 the Port of Tallinn has witnessed a doubling of transit trade and over twofold increase in the number of passengers, were the interest of the tourists in St. Petersburg certainly plays an important role (The Scandinavian Shipping Gazette, 2001, p.17).

In 1999 the volume of liquid cargo and transit volumes had grown by 22,8 percent and 28,4 percent respectively. The volume of containers had been increasing and the operators think that it is quite possible to increase the volume to 140,000 TEUs. However the Port of Tallinn outlived several losses: metal has been lost to the Port of St. Petersburg, timber to smaller Estonian harbours, American grain assistance has come to an end. (Ibid.)

5.3.2.3 Riga (Latvian)

Transit shipments are of the greatest importance for the ports of Latvia. The ports form the important part of the country's transit industry. In the year 2000, the ports of Latvia handled over 51 million tonnes of cargo, of which more than 90 per cent in transit mainly from Russia and other country of former Soviet Union. (The Scandinavian Shipping Gazette, 2001, p.19)

The Port of Riga mainly processes general cargo, such as containers, various metals, timber, coal, fertilisers, chemical cargoes, oil products and food (http://www.rop.lv). The biggest container terminal of the Baltic States is located in the Port of Riga, which also has free port status on all of its territory. (The Scandinavian Shipping Gazette, 2001, p.19)

Cargo handling capacity (calculated) of the terminals operating in the Freeport is 20 million tons per annum (http://www.rop.lv).

5.3.2.4 Liepaja (Latvian)

The Port of Liepaja was one of the major and most progressive Baltic ports at the beginning of the 20th century. After World War II the Port of Liepaja become a naval base of the USSR with restrictions for civilian use (The Scandinavian Shipping Gazette, 2001, p.19).

Since 1992 the Port of Liepaja keeps developing as a multifunctional commercial port and shows the fastest rise in cargo turnover - from 100,000 tons in 1992 to 2,3 million tons in 1999, which is boost by over 23 times! The primary types of cargo handled in the Port of Liepaja are wood materials, metals and Ro-Ro cargoes. (http://www.lsez.lv)

Results produced by the Port of Liepaja over the last years and the succeeding interest by foreign partners give well-based hope for further development. Every year considerable resources are invested in port reconstruction and modernisation by both port authority and private stevedore companies.

Western location of Latvian ports makes sea transportation over the Port of Liepaja most competitive (http://www.lsez.lv). The port is located:

- 200 km to the west from Riga 400 km to the south – east from Stockholm
- 550 km to the south from Helsinki
- 550 km to the east from Copenhagen

Basic technical, economic and organisational advantages of the Port of Liepaja include:

- the port is ice-free
- shorter sailing distance to ports in Scandinavia and the continental Europe
- excellent transport infrastructure
- surrounded by large areas of land set aside for industrial development
- the commercial port is relatively new and the organisation is flexible

We think that it is an interesting fact that a few smaller Latvian ports have developed a stable annual throughput of about 300,000 tonnes, mainly by wood shipments to Sweden (The Scandinavian Shipping Gazette, 2001, p.19).

5.3.2.5 Klaipeda (Lithuanian)

As a Baltic seaport, the Port of Klaipeda is situated on the Eastern Baltic Seashore. The port is open for navigation all the year round and has a number of advantages over other ports in the region for transit (http://www.spk.lt):

- the port is the most eastern port in the Baltic Sea that can claim to be ice-free;
- the port has good road links with the only motorway standard road in the Baltic States linking a port complex to the countries of the Former Soviet Union;
- the port is the nearest port in the region to western Europe;
- the port has new, modern container and ferry terminals providing modern inter-modal facilities;
- the port is located west of the major industrial locations of Belarus and western Russia and involves no deviation from the direct route between the European Union and the main sources of freight traffic (unlike Tallinn (Estonia), Riga (Latvia) or St Petersburg (Russia)); the port is linked to the rail system of Belarus and Russia on the same rail gauge (unlike Poland).

There have been large fluctuations during the last ten years - already in the year 1993, 15,9 million tonnes were reached, but then there was a dramatic drop. In 1995 the total amount of cargo was 12,7 million tonnes (The Scandinavian Shipping Gazette, 2001, p.21), due to the Russian military transports from Germany had ended and the oil market was also weakening.

In the year 2000 for example oil shipments increased by a third, followed by the increasing oil prices on the world market boosting Russia's export. The growth was also noticed in other cargo types: The shipments of containers grew by 50 percent, metals by 25 percent (The Scandinavian Shipping Gazette, 2001, p.21).

5.4 Construction of Model

For the purpose of our study we will create a calculation model to compare the costs associated with the different sea-links that we have chosen to observe. First of all, we want to draw the attention to our research model (chapter 2.2) and research questions (chapter 2.3). With this in mind we have created our model.

In order to perform a comparative cost analysis, we have to gather information about all the relevant costs associated with each sea-link. The costs that we will use for our calculations will include cargo handling costs and voyage costs (see chapter 3.4). Naturally, the costs are not the only information that is required for the calculations. In the following section we describe our input data.

5.4.1 Input

The input data that we will use for our model consists of the following:

- Which routes we have calculated on
- Charges and dues from all the ports
- Distances between the ports in our routes
- Technical specifications for the vessels we have chosen
- Charter rates for the vessels we have chosen
- Bunker (oil) costs
- Currency rates (all results will be presented in USD)
- Weight specifications for the load carriers

We will also use input data from the other sub-project of this thesis work (Rana, 2002) that include the costs associated with hauling the cargo units from either the ports of Oxelösund or Karlshamn to the Port of Göteborg. For a detailed description of our input data, we refer to Appendix 2.

5.4.2 Output

It is important that we end up with an output that follows a standardised cost structure in order to be able to make any comparison and analysis of our results.

> **The results will be presented in the form of total average cost per unit (TEU or trailer) for a one way voyage irrespective of direction.**

By total average cost per unit we mean the sum of costs (loading/discharging, voyage cost including port dues and charges) divided by the total number of units for a round trip. For example, on the route Göteborg-St. Petersburg-Göteborg we sum up the loading cost in the Port of Göteborg, the voyage cost to the Port of St. Petersburg (including port dues and charges), discharging cost in the Port of St. Petersburg, loading cost in the Port of St. Petersburg, voyage cost to the Port of Göteborg (including port dues and charges), discharging cost in the Port of Göteborg. The total sum is divided by the total number of units that have been transported in both directions and handled in both ports.

We will only show the results as they are from our basic simulations, which are based on the assumption that the vessels have a 60% utilisation degree in both directions on a round trip voyage, which we think is the most truthful for the current market conditions. Why we have chosen to calculate on a round trip, rather than a one-way transport link, is because we wanted to find out the average cost of transporting one unit without regard to the direction of the goods, i.e. to overcome the problem of unbalanced flows. This means that a 60% utilisation degree in both directions could be regarded as any combination of utilisation degree in either direction, which will result in an average of 60% (100%-40%, 90%-30%, 80%-20%, etc).

It is important to realise that we are viewing this from the interests of a shipping line, which in this case would be to find out the total and average cost of operating a certain route, and not just the cost for going in a certain direction.

In the next chapter (chapter 6) we will perform a sensitivity analysis, in which we will alter the degree of utilisation to test whether our findings are true and accurate enough to draw any conclusions from.

5.4.3 Assumptions

The network structure in the simulation model is built up of links and nodes. This exercise demands a number of assumptions and estimations. Individual carriers will have different cargo volumes, vessels, cost, etc. Freight rates are particularly difficult to typify since they will vary according to the extent of competition on a given route, the volume and the regularity of business, and between empty and loaded units.

We have limited us to only calculating on routes between two nodes (34 routes in total). Because of limitations in time and resources we have not been able to calculate on routes that include more than two ports. A detailed list of our assumptions regarding the costs associated with our calculations can be found in Appendix 1.

This thesis can be seen as a first step of an analysis to gain perspective of a future transport system. The results of our research can give us the answer to if the Port of Göteborg could be a competitor to one of the biggest European ports as a transhipment hub for cargo from the BSRR.

5.5 Calculation Results

In this section we will present the results of our calculations. As stated before, the results are presented in the form of total average cost (USD) per unit (TEU or trailer) for a one way voyage irrespective of direction.

Since our calculations are built on the time charter costs (see chapter 3.4.5 and Appendix 2, Charter costs), we have chosen three different RoRo (see chapter 3.3.2.2) and three different LoLo (see chapter 3.3.2.1) vessels. The key characteristics of the vessels are shown in table 5-1. The vessel characteristics are taken from actual existing vessels that are in use. The time charter costs are based on the assumption that these vessels should operate on the particular routes (see Appendix 2, Routes).

	RoRo			**LoLo**		
	RoRo1	RoRo2	RoRo3	LoLo1	LoLo2	LoLo3
GT	7817	12337	15900	3200	4000	9200
DWT	4405	8765	12300	4200	5200	13100
Lane meter	1250	2050	3000			
Average Speed	15	19	22	15	16	19
TEU capacity				300	500	1000
Trailer capacity	71	117	171			

Table 5-1 Vessel Charactersitics

5.5.1 Cost Output

The results are presented in tables 5-2 to 5-11 according to the geographical location of the BSRR ports (St. Petersburg, Tallinn, Riga, Liepaja, and Klaipeda). For each port we first present the results for all routes with LoLo vessels and then for all routes with RoRo vessels.

Route	**Göteborg – St. Petersburg - Göteborg**		
Vessel	LoLo 1	LoLo 2	LoLo3
Cost/TEU (USD)	**231,9**	**213,7**	**195,7**
Route	**Hamburg - St. Petersburg – Hamburg**		
Vessel	LoLo 1	LoLo 2	LoLo3
Cost/TEU (USD)	**279,6**	**249,6**	**219,4**
Route	**Göteborg - Oxelösund - St. Petersburg – Oxelösund - Göteborg**		
Vessel	LoLo 1	LoLo 2	LoLo3
Cost/TEU (USD)	**733,1**	**722,1**	**713,6**

Table 5-2 Results for LoLo vessels on St. Petersburg routes

Route	Göteborg - St. Petersburg – Göteborg		
Vessel	RoRo 1	RoRo 2	RoRo3
Cost/Trailer (USD)	**821,4**	**747,6**	**778,5**
Route	**Hamburg - St. Petersburg – Hamburg**		
Vessel	RoRo 1	RoRo 2	RoRo3
Cost/Trailer (USD)	**1 188,9**	**1 063,2**	**1 083,7**
Route	**Göteborg - Oxelösund - St. Petersburg – Oxelösund – Göteborg**		
Vessel	RoRo 1	RoRo 2	RoRo3
Cost/Trailer (USD)	**1 130,0**	**1 114,7**	**1 165,4**

Table 5-3 Results for RoRo vessels on St. Petersburg routes

Route	Göteborg - Tallinn - Göteborg		
Vessel	LoLo 1	LoLo 2	LoLo3
Cost/TEU (USD)	**198,3**	**185,8**	**172,9**
Route	**Hamburg - Tallinn – Hamburg**		
Vessel	LoLo 1	LoLo 2	LoLo3
Cost/TEU (USD)	**210,5**	**193,7**	**178,0**
Route	**Göteborg - Oxelösund – Tallinn - Oxelösund - Göteborg**		
Vessel	LoLo 1	LoLo 2	LoLo3
Cost/TEU (USD)	**690,0**	**686,2**	**684,5**

Table 5-4 Results for LoLo vessels on Tallinn routes

Route	Göteborg - Tallinn – Göteborg		
Vessel	RoRo 1	RoRo 2	RoRo3
Cost/Trailer (USD)	**673,6**	**616,3**	**643,2**
Route	**Hamburg - Tallinn – Hamburg**		
Vessel	RoRo 1	RoRo 2	RoRo3
Cost/Trailer (USD)	**844,8**	**771,2**	**792,5**
Route	**Göteborg - Oxelösund - Tallinn – Oxelösund - Göteborg**		
Vessel	RoRo 1	RoRo 2	RoRo3
Cost/Trailer (USD)	**989,0**	**989,0**	**1 035,5**

Table 5-5 Results for RoRo vessels on Tallinn routes

Route	Göteborg - Riga - Göteborg		
Vessel	LoLo 1	LoLo 2	LoLo3
Cost/TEU (USD)	**195,6**	**184,0**	**173,0**
Route	**Hamburg-Riga-Hamburg**		
Vessel	LoLo 1	LoLo 2	LoLo3
Cost/TEU (USD)	**202,5**	**186,3**	**172,1**
Route	**Göteborg - Oxelösund - Riga – Oxelösund - Göteborg**		
Vessel	LoLo 1	LoLo 2	LoLo3
Cost/TEU (USD)	**691,5**	**687,7**	**686,7**
Route	**Göteborg - Karlshamn - Riga – Karlshamn - Göteborg**		
Vessel	LoLo 1	LoLo 2	LoLo3
Cost/TEU (USD)	**648,1**	**641,4**	**636,8**

Table 5-6 Results for LoLo vessels on Riga routes

Route	**Göteborg - Riga – Göteborg**		
Vessel	RoRo 1	RoRo 2	RoRo3
Cost/Trailer (USD)	**672,4**	**623,1**	**649,0**
Route	**Hamburg - Riga –Hamburg**		
Vessel	RoRo 1	RoRo 2	RoRo3
Cost/Trailer (USD)	**841,2**	**776,0**	**796,2**
Route	**Göteborg - Oxelösund - Riga – Oxelösund - Göteborg**		
Vessel	RoRo 1	RoRo 2	RoRo3
Cost/Trailer (USD)	**1 015,0**	**1 018,0**	**1 062,8**
Route	**Göteborg - Karlshamn - Riga – Karlshamn - Göteborg**		
Vessel	RoRo 1	RoRo 2	RoRo3
Cost/Trailer (USD)	**1 004,6**	**991,2**	**1 034,9**

Table 5-7 Results for RoRo vessels on Riga routes

Route	**Göteborg – Liepaja - Göteborg**		
Vessel	LoLo 1	LoLo 2	LoLo3
Cost/TEU (USD)	**179,0**	**168,2**	**160,6**
Route	**Hamburg - Liepaja – Hamburg**		
Vessel	LoLo 1	LoLo 2	LoLo3
Cost/TEU (USD)	**190,6**	**175,6**	**165,3**
Route	**Göteborg – Oxelösund – Liepaja - Oxelösund - Göteborg**		
Vessel	LoLo 1	LoLo 2	LoLo3
Cost/TEU (USD)	**685,9**	**680,4**	**679,9**
Route	**Göteborg - Karlshamn - Liepaja –Karlshamn - Göteborg**		
Vessel	LoLo 1	LoLo 2	LoLo3
Cost/TEU (USD)	**631,3**	**625,4**	**624,3**

Table 5-8 Results for LoLo vessels on Liepaja routes

Route	Göteborg – Liepaja - Göteborg		
Vessel	RoRo 1	RoRo 2	RoRo3
Cost/Trailer (USD)	**581,2**	**539,9**	**561,6**
Route	**Hamburg - Liepaja – Hamburg**		
Vessel	RoRo 1	RoRo 2	RoRo3
Cost/Trailer (USD)	**719,4**	**633,4**	**665,7**
Route	**Göteborg - Oxelösund - Liepaja – Oxelösund -- Göteborg**		
Vessel	RoRo 1	RoRo 2	RoRo3
Cost/Trailer (USD)	**996,0**	**993,9**	**1 032,9**
Route	**Göteborg Karlshamn –Liepaja –Karlshamn - Göteborg**		
Vessel	RoRo 1	RoRo 2	RoRo3
Cost/Trailer (USD)	**912,2**	**907,0**	**946,6**

Table 5-9 Results for RoRo vessels on Liepaja routes

Route	Göteborg - Klaipeda – Göteborg		
Vessel	LoLo 1	LoLo 2	LoLo3
Cost/TEU (USD)	**200,4**	**191,2**	**184,8**
Route	**Hamburg - Klaipeda – Hamburg**		
Vessel	LoLo 1	LoLo 2	LoLo3
Cost/TEU (USD)	**206,7**	**193,8**	**185,6**
Route	**Göteborg - Karlshamn - Klaipeda –Karlshamn - Göteborg**		
Vessel	LoLo 1	LoLo 2	LoLo3
Cost/TEU (USD)	**385,1**	**380,7**	**380,5**

Table 5-10 Results for LoLo vessels on Klaipeda routes

Route	Göteborg-Klaipeda-Göteborg		
Vessel	RoRo 1	RoRo 2	RoRo3
Cost/Trailer (USD)	**649,5**	**615,7**	**638,5**
Route	**Hamburg - Klaipeda – Hamburg**		
Vessel	RoRo 1	RoRo 2	RoRo3
Cost/Trailer (USD)	**763,4**	**670,9**	**676,6**
Route	**Göteborg - Karlshamn-Klaipeda –Karlshamn - Göteborg**		
Vessel	RoRo 1	RoRo 2	RoRo3
Cost/Trailer (USD)	**985,4**	**986,8**	**1 027,4**

Table 5-11 Results for RoRo vessels on Klaipeda routes

5.5.2 Time Throughput

Here we present the results for the throughput time for each route and vessel. We define the throughput time as the sum of link-time and active node time (see chapter 3.2.1). The results are based on our basic assumption that the vessels are utilised to 60% of their maximum cargo carrying capacity. For the RoRo traffic we have calculated the road-haulage with an average speed of 73 km/hour (Schenker– Stinnes Logistics). We have not calculated on the option that trailers could be loaded on to a train flat. In tables 5-12 to 5-21, we present the throughput time in hours on each route for a roundtrip voyage including load and discharge in each port (four handling operations in total). To obtain the throughput time of a one way voyage with only two handling operations (load and discharge) the results in the tables 5-12 to 5-21 have to be divided by 2. In some interesting cases, we have added a diagram to graphically show the results (see figures 5-1 to 5-3).

St. Petersburg	LoLo 1	LoLo 2	LoLo 3
Göteborg	143,7	149,1	163,6
Hamburg	203,7	206,2	213,7
Göteborg - Oxelösund	126,7	135,7	158,7

Table 5-12 Throughput time (h) for roundtrip LoLo routes to the Port of St. Petersburg

St. Petersburg	RoRo1	RoRo2	RoRo3
Göteborg	137,7	122,2	119,8
Hamburg	189,8	164,4	156,9
Göteborg - Oxelösund	99,1	98,4	105,4

Table 5-13 Throughput time (h) for roundtrip RoRo routes to the Port of St. Petersburg

Tallinn	LoLo 1	LoLo 2	LoLo 3
Göteborg	114,7	123,2	145,2
Hamburg	124,4	132,6	153,9
Göteborg - Oxelösund	84,2	96,2	126,5

Table 5-14 Throughput time (h) for roundtrip LoLo routes to the Port of Tallinn

Tallinn	RoRo1	RoRo2	RoRo3
Göteborg	106,4	96,1	96,2
Hamburg	116,1	104,7	104,4
Göteborg - Oxelösund	69,3	73,4	82,9

Table 5-15 Throughput time (h) for roundtrip RoRo routes to the Port of Tallinn

Riga	LoLo 1	LoLo 2	LoLo 3
Göteborg	108,3	117,2	140,3
Hamburg	108,6	114,4	129,7
Göteborg - Oxelösund	83,6	95,7	126,2
Göteborg - Karlshamn	100,3	111,2	139,0

Table 5-16 Throughput time (h) for roundtrip LoLo routes to the Port of Riga

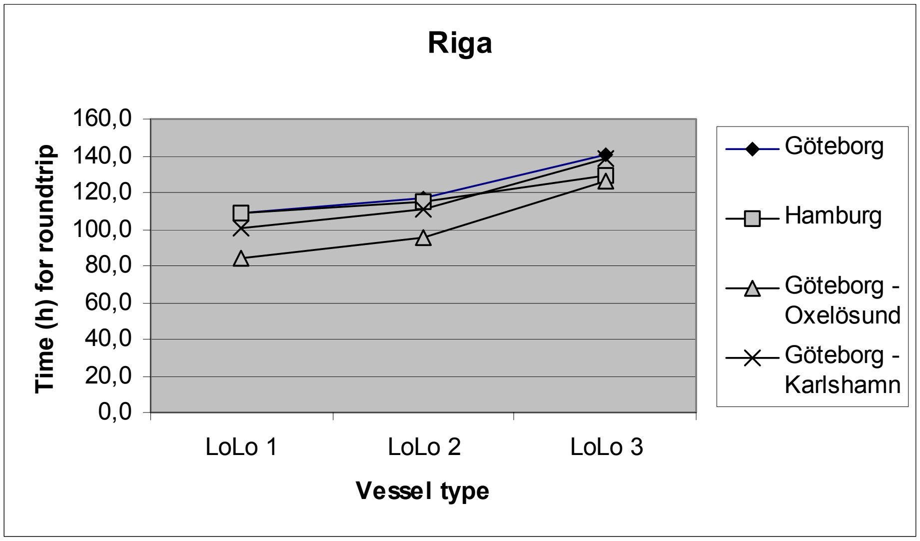


Figure 5-1 Throughput time (h) for roundtrip LoLo routes to Riga

Riga	RoRo1	RoRo2	RoRo3
Göteborg	100,0	91,2	92,1
Hamburg	109,1	99,4	100,0
Göteborg - Oxelösund	68,7	73,2	82,8
Göteborg - Karlshamn	86,6	87,2	94,8

Table 5-17 Throughput time (h) for roundtrip RoRo routes to the Port of Riga

Liepaja	LoLo 1	LoLo 2	LoLo 3
Göteborg	87,3	97,5	123,5
Hamburg	96,0	106,0	131,5
Göteborg - Oxelösund	78,2	90,6	121,8
Göteborg - Karlshamn	79,0	91,2	122,0

Table 5-18 Throughput time (h) for roundtrip LoLo routes to the Port of Liepaja

Liepaja	RoRo1	RoRo2	RoRo3
Göteborg	79,0	74,4	77,5
Hamburg	88,5	83,0	85,6
Göteborg - Oxelösund	63,3	68,7	78,8
Göteborg - Karlshamn	65,3	70,2	80,0

Table 5-19 Throughput time (h) for roundtrip RoRo routes to the Port of Liepaja

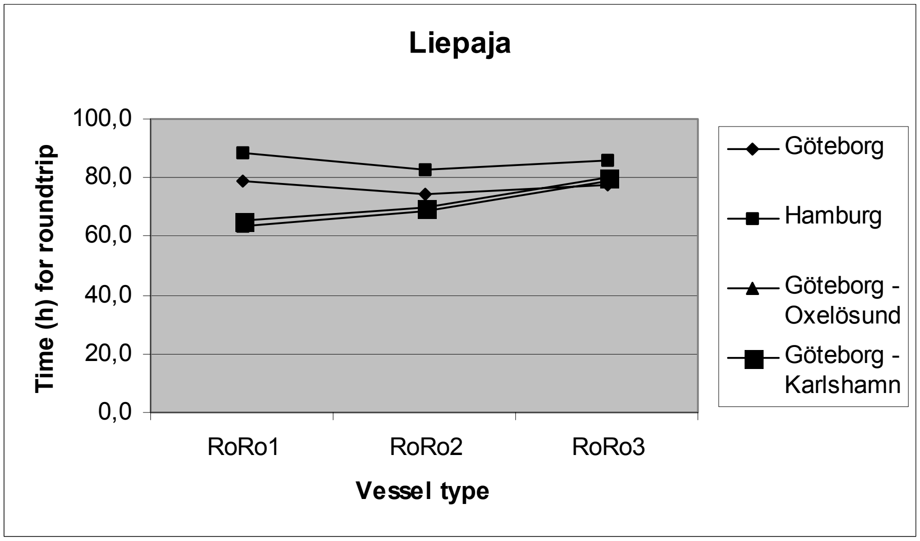


Figure 5-2 Throughput time (h) for roundtrip RoRo routes to the Port of Liepaja

Klaipeda	LoLo 1	LoLo 2	LoLo 3
Göteborg	86,5	96,7	122,9
Hamburg	96,0	106,0	131,5
Göteborg - Karlshamn	79,3	91,5	122,2

Table 5-20 Throughput time (h) for roundtrip LoLo routes to the Port of Klaipeda

Klaipeda	RoRo1	RoRo2	RoRo3
Göteborg	78,2	73,7	77,0
Hamburg	79,9	69,5	66,3
Göteborg - Karlshamn	65,6	70,4	80,1

Table 5-21 Throughput time (h) for roundtrip RoRo routes to the Port of Klaipeda

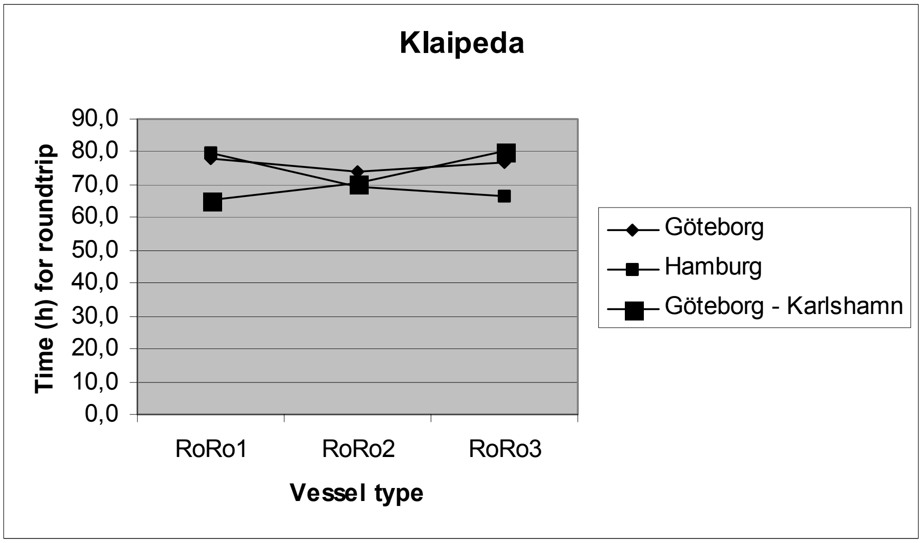


Figure 5-3 Throughput time (h) for roundtrip RoRo routes to the Port of Klaipeda

According to the results the land bridge links have the shortest throughput time in almost all the routes. It is only on a few routes and with the largest vessels that the land bride alternative is not the fastest. The routes to the Port of Hamburg have the longest throughput times, with a few exceptions.

In the analysis chapter (Chapter 6), we will add the time results to the cost results from the previous section to make a joint cost/service evaluation of the routes.

5.6 Important Facts about the Port of Göteborg and the Port of Hamburg

In this chapter we present facts about the Port of Hamburg and the Port of Göteborg as background information for the analysis of the competitive situation of the Port of Göteborg.

	1996	1997	1998	1999	2000
Hamburg	3054320	3337477	3546940	3738307	4248247
Göteborg	488636	509000	519642	624179	684981

Table 5-22 Container throughputs in TEU (http://www.hafen-hamburg.de)

The figures in table 5-22 tell us how actually huge the differences are in volumes of containers throughput in TEUs between the two ports. Container throughput in TEUs in the Port of Hamburg is over then six times bigger than container throughput in TEUs in the Port of Göteborg. Respective rates of growth in the Port of Hamburg and the Port of Göteborg are 8,0% and 6,9%.

	1990	1992	1994	1996	1998	2000
Hamburg	100,0%	115,2%	138,4%	155,1%	180,1%	215,8%
Göteborg	100,0%	105,2%	119,7%	139,0%	147,8%	194,8%

Table 5-23 Container throughput 1990=100% (http://www.hafen-hamburg.de).

In table 5-23 we can see how the increase of container throughput in TEUs has been developing under last 10 years. The Port of Hamburg has increased container throughput in TEU by 115,8% during the last 10 years, when the Port of Göteborg has increased only by 94,8% under the same period of time.

Either the Port of Hamburg or the Port of Göteborg are represented in the list of the top 20 fastest growing container throughput figures worldwide for 2000 (ContainerPort June/July 2001).

In order to make it easy to compare the two ports, we dispose gathered information in table 5-24 where left columns describes features of the Port of Hamburg and the right column describes the Port of Göteborg.

General Information	
Hamburg	Göteborg
The Port of Hamburg serves a hinterland of 400 million inhabitants (http://www.hafen-hamburg.de).	Prime catchment area for the Port of Göteborg is about 23 million people. The expanded catchment area is about 205 million people. (Port of Göteborg AB, Oct. 2001)
Gateway to the World, the most important German port, most important overseas port for Scandinavia, Central and Eastern Europe (http://www.hafen-hamburg.de).	The Port of Göteborg is the largest port in the Scandinavian area. Around 70% of the Nordic countries' industrial capacity is located within a 500-kilometre radius from the port (Port of Göteborg AB, Oct. 2001).
A transit port for Austria, Switzerland, Scandinavia, Central and Eastern Europe (http://www.hafen-hamburg.de).	The Port of Göteborg is a transit port for Scandinavia, U.K., Iceland, Germany, Russia, Central and Eastern Europe (www.portgot.se).
A breakdown of the cargo flows via the Port of Hamburg points to the outstanding significance of trade with North- and Southeast Asia, which accounts for 44% of total container turnover. Japan, Hong Kong, Singapore, Taiwan, Korea and China are among the Port's most important trading	About one-third of the general cargo shipped through the Port of Göteborg is transit cargo (www.portgot.se).

partners (http://www.hafen-hamburg.de).	
More than 200 liner services, including over 100 container and numerous roll-on/roll-off and round-the-world services, offer around 7,500 sailings a year from the Port of Hamburg to destinations all over the world (http://www.hafen-hamburg.de).	In a typical year, 12,000 vessels visit the Port of Göteborg. Short-sea ferries make most of these calls, the rest being mainly tankers, container vessels and cargo-only roll on/roll off ferries. (www.portgot.se)
Direct sailings. Four ships a day leave for Asia, three for Africa and two for America. Every 48 hours, on average, a ship departs for Australia and New Zealand (http://www.hafen-hamburg.de).	Direct sailings: Every week, there are three departures for North America, four departures for the Far East, one departure for Australia and one departure for the Latin America. Every day, there are two departures for Great Britain, eight departures for Scandinavia and six departures for Continental Europe. (Port of Göteborg AB, Oct. 2001)
The Port of Hamburg occupies the position No. 9 in the world on the "Container throughput of the world's major ports (Top 20)" list. The positions go for container throughput in TEU. (ContainerPort June/July 2001)	The Port of Göteborg has occupied the position No. 72 in the world. The positions go for container throughput in TEU. (ContainerPort June/July 2001)
The volume of containers handled during the year 2000 reached virtually 4,3 million TEUs (Port of Hamburg Handbook 2001/2002).	The Port of Göteborg reached a figure of 685,000 containers in 2000 (cassettes included). This puts the port in a totally dominant position in this particular area in the Nordic region. (Port of Göteborg AB, Oct. 2001)
Around 84 percent of the Port of Hamburg's total general-cargo turnover is now containerised (Port of Hamburg Handbook 2001/2002).	The port's cargo turnover comprises almost 40 percent general cargo (95 percent of which is unitised) (www.portgot.se).
Road traffic	
Hamburg	Göteborg
Hamburg is interspersed by 80 km of motorways and federal highways that link the city to the major international and neighbouring regional economic centres (http://www.hafen-hamburg.de). Many of Hamburg main distribution centres	Two major European motorways, the E20 and the E6, meet in Göteborg. E6/E20 southbound run to the Swedish west coast; all Denmark and Copenhagen (transit time about 4 hours) is reached by using the Öresund Bridge. The E20 westbound runs to

are located close to the E45 and E22 motorways. The E22 gives access to Stockholm via Lübeck and extends west and south towards Ruhr continuing to Spain and Portugal. (Port of Hamburg Handbook 2001/2002)	Stockholm (transit time about 5 hours). The E6 northbound runs to the Norwegian capital Oslo (transit time about 4 hours) (Port of Göteborg AB, Oct. 2001).
Rail haulage	
Hamburg	Göteborg
At least 31% of the forthcoming goods to the port is to be conveyed by rail (Port of Hamburg Handbook 2001/2002).	At least 50% of the forthcoming goods to the port is to be conveyed by rail (Port of Göteborg AB, Oct. 2001).
Most of Germanys and Austria's industrial centres can be reached by train in less than 24 hours. Centres such as Prague, Amsterdam, Basel, Copenhagen, and Zurich are also less than 24 hours away. Within 48 hours, goods can reach destinations such as Bratislava, Budapest, Göteborg, London, Marseilles, Milan, Oslo, Vienna, and Zagreb. Several transport operators currently operate "Block Trains" services carrying cargo to specific destinations with guaranteed transit and delivery times. (Port of Hamburg Handbook 2001/2002)	The railroad tracks (about 120-km) stretches from within the Port of Göteborg represent both the most frequented stretch of tracks in Sweden and the main rail cargo station. Daily trains depart and arrive at the Port of Göteborg with overnight services to all major cities in Sweden, Denmark and Norway. (Port of Göteborg AB, Oct. 2001)
The Port of Hamburg is the most important rail container hub in the whole Europe (handling over 1 million TEUs a year) (Port of Hamburg Handbook 2001/2002).	Sweden's busiest railway cargo station is located at the dockside at the Skandia Harbour, the Nordic container centre (www.portgot.se).
The marshalling yard at Alte Süderelbe has direct connections to the major container terminals at Burchardkai, Eurogate, and Altenwerder. (Port of Hamburg Handbook 2001/2002)	On the rail side, the port company co-operates with railway operators in several ways, all based on a direct dockside link to the Skandia and Älvsborg Harbours (the railway cargo station there is the biggest in Scandinavia). The Port of Göteborg AB is involved independently in rail traffic. (www.portgot.se)
Port Service	
Hamburg	Göteborg
A wide variety of services that includes container stuffing, repairs, maintenance,	A wide variety of services that includes container stuffing, repairs, maintenance,

trucking, leasing and depot storage (http://www.hafen-hamburg.de).	trucking, leasing and depot storage (interview with authorities of the port).
The terminals have integrated or external packing warehouses that can also be used for assembly operations, quality controls, transport safety measures or labelling (http://www.hafen-hamburg.de).	The terminals have integrated or external packing warehouses that can also be used for assembly operations, quality controls, transport safety measures or labelling (authorities of the port).
The Port of Hamburg's Data Communications System, DAKOSY is one of the world's top transport-related EDI systems (http://www.hafen-hamburg.de).	The Port of Göteborg communicates with most customers via EDI system (EDI-Fact Standard) (Port of Göteborg AB, Oct. 2001). One of the main projects is redesign of TICS (upgrading the containers and trailer handling system) (www.portgot.se).
The Port of Hamburg has 3 million m^2 of covered storage space for, among other things, coffee, cocoa, tea, chemicals and bulk general cargo; silo and storage capacities for around 700,000 tonnes of grain, oil seed, fodder and other suction goods (http://www.hafen-hamburg.de).	The Port of Göteborg co-operates with the Swedish west coast ports of Uddevalla and Varberg. These two ports, both about 100 kilometres away from Göteborg, concentrate on bulk cargo, break-bulk cargo and forest products, and thereby adding specialities other than those of the Port of Göteborg. (www.portgot.se)
The Port of Hamburg has 350,00 m^2 of storage sites for ores, coal, fertilisers and the like, some 2,4 million m^3 of tank-farm facilities and 3,6 million m^3 of refinery capacity for liquid cargoes, including chemicals, alcohol and petroleum products (http://www.hafen-hamburg.de).	The Port of Göteborg has storage sites only for petroleum product (authorities of the port).
The Port of Hamburg has modern, computer-controlled high-bay warehouses for order picking and processing high-quality import goods, refrigerated and air-conditioned warehouses, and high-security storage facilities for precious metals, microchips and chemicals. (http://www.hafen-hamburg.de)	The Port of Göteborg also has modern, computer-controlled high-bay warehouses for order picking and processing high-quality import goods, refrigerated and air-conditioned warehouses, and high-security storage facilities for precious metals, microchips and chemicals. (authorities of the port)
Container Service	
Hamburg	Göteborg
Third-, fourth- or fifth-generation container	Third-, fourth- or fifth-generation container

ships can be loaded or loaded at a rate of 2,000 TEUs in under 24 hours (Port of Hamburg Handbook 2001/2002).	ships can be loaded or loaded at a rate of 2,000 TEUs in less than 24 hours (authorities of the port).
Between 1996 and 2005 eight new berths for large container ships will be constructed and the necessary infra- and suprastructure measures completed as well (http://www.hafen-hamburg.de).	Additional post/superpost-panamax container cranes will be both. The container terminal is going to increase annual capacity to 1,500,000 TEUs until 2005. Depth along the key side will be increased till 15 m. until 2004. (Port of Göteborg AB, Oct. 2001)
The Port of Hamburg offers its customers four container terminals and eight multipurpose terminals that also handle containers (http://www.hafen-hamburg.de).	The Port of Göteborg offers its customers one container terminal and three multipurpose terminals that also handle containers (authorities of the port).
The leading container terminals can also deal with future-generation ships with up to 18 containers stacked next to each other on deck. These terminals ensure that even the biggest container ships can leave the Port of Hamburg again in less than a day. (http://www.hafen-hamburg.de)	The container terminals can also deal with future-generation ships with up to 18 containers stacked next to each other on deck. These terminals ensure that even the biggest container ships can leave the Port of Göteborg any time a day. The Port of Göteborg doesn’t have any tide restriction. (authorities of the port)
RoRo Cargo	
Hamburg	Göteborg
The operators of the Port of Hamburg have indented quays or RoRo ramps to handle ships with the cargo that is made "rollable", though some vessels do not require these facilities because they have their own tide-adjusting ramps (Port of Hamburg Handbook 2001/2002).	The Port of Göteborg has indented quays or RoRo ramps to handle ships with the cargo that is made "rollable", though some vessels do not require these facilities because they have their own tide-adjusting ramps (authorities of the port).
Seaworthy Packaging	
Hamburg	Göteborg
Several firms in the Port of Hamburg have specialised in seaworthy packaging. These "contract packers" exercise on the selection of the most suitable packaging material and anti-corrosion measures for each specific consignment. (http://www.hafen-hamburg.de)	Several firms in the Port of Göteborg have specialised in seaworthy packaging. These "contract packers" exercise on the selection of the most suitable packaging material and anti-corrosion measures for each specific consignment. (interview with authorities of the port)

Warehousing and Distribution Logistics Goods-Related Services	
Hamburg	Göteborg
The Port of Hamburg is one of the most important European warehousing and distribution centres for high-priced raw materials (http://www.hafen-hamburg.de).	The Port of Göteborg can not be considered as one of major warehousing and distribution centres for high-priced raw materials beside the Oil terminal in Göteborg is among the largest in Scandinavia. The port is specified as transhipment hub for unitised cargo. The port's cargo turnover comprises almost 60 percent oil and almost 40 percent general cargo (95 percent of which is unitised). (www.portgot.se)
The spectrum of services ranges from warehousing, processing, sorting, order picking and treatment of weather-sensitive products to quality controls transport arrangements, documentation, and invoicing and customs clearance. In each case, customers can choose between several service providers. (http://www.hafen-hamburg.de)	Monopolisation of stevedoring services in the Port of Göteborg, but one can find about 10 independent stevedoring companies that situated theirs facilities very closely to the port. In each case, customers can choose between several service providers. (authorities of the port)
There are special warehouses for different type of goods and high-security warehouses for microchips or precious metals (http://www.hafen-hamburg.de).	Panasonic, Cannon for instance have warehouses that are situated very close to the port area. There are no warehouses for microchips or precious metals in the Port of Göteborg. (authorities of the port)
The core of the Port of Hamburg is its Free Port, a facility whose status has been confirmed by the EU. Here, imported goods can be stored, subject to product-specific treatment or transhipped as transit goods, all without paying customs dues. (http://www.hafen-hamburg.de)	Free Port exists as well in the Port of Göteborg. Here, imported goods can be stored, subject to product-specific treatment or transhipped as transit goods, all without paying customs dues (www.portgot.se).

Table 5-24 Facts about the Port of Hamburg and the Port of Göteborg

5.7 Interview with the Authorities of the Port of Göteborg

The authority of the Port of Göteborg AB underlines the company's management experience of large projects, experiences of tailor-made systems solutions and flexibility in questions of door-to-door customer's required logistics' solutions.

The technical capacity (machines/cranes, personnel (24 hours), and financial solutions for a long term) is quite big. The capacity up to 1,5 million TEUs.

The capacity to give service to vessels any day a weak Working hours at the Skandia Container Terminal are 07.00-24.00 Monday-Friday (additional times can be arranged). As there are no simultaneous breaks for meals, etc., lift operations are continuous. Working hours at the RoRo Terminal is set in accordance with the timetables of liner operators using the facility and includes a nightshift. The Göteborg oil port has a 24-hour service.

The Port of Hamburg has a much higher degree of direct calls of deep-sea vessels. The challenge for the Port of Göteborg is to attract more shipping lines. The problem is that the volume of goods is not sufficient in this particular area. If the Port of Göteborg will be able to increase the goods volume and get large market shares in future, especially in issue outcomes of containers traffic, it will bring the port new calls and direct calls (deep-sea services among others).

The Port of Göteborg cannot compete with the Port of Hamburg on the deep-sea vessel's calls, but there is a relative large volume of goods for Far East, and USA destinations in the Port of Göteborg. Deep-sea operators choosing not to call at a Scandinavian port directly (but turning their vessels around in, say, the Port of Hamburg) can still be active in the Scandinavian freight market. Now this goods flow transported by feeder vessels to forward the containers from Scandinavia to a Continental port for transhipment. The authority of Port of Göteborg estimate that there are enough volumes of goods for at least tree more direct deep-sea containers vessels calling at the Port of Göteborg (one to USA and one, possibly two to Asia).

There is good infrastructure for the land bridge alternative in the Port of Göteborg. The 120 kilometres of railroad tracks in the port area represent both the most frequented stretch of tracks in Sweden and the main rail cargo station that is to be found in the Skandia Harbour.

Rail terminal can handle full train sets.

An enhancement of the entrance channels to the Port of Göteborg is underway. It will include the widening, deepening and straightening of fairways that will make the fairway more secure. The investment of 700 million SEK in improvement of the fairway will make it easy for big loaded vessels to call to the Port of Göteborg. The depth will be increased to 15 meters; this will be an advantage towards the Port of Hamburg. The Port of Hamburg by now has limited deep of waters.

High degree of safety during handling works in the Port of Göteborg is one of the advantages. The customers of the Port of Göteborg put them high in respect to the security of the goods (damaged goods, load security, etc.) in comparison with the Port of Hamburg.

In Göteborg there is no tide to consider that make planning easier and more flexible.

The fairway is relatively short in comparison with other big ports, which means a time saving factor for shipping line in their choice for port of call.

The owners of the Port of Göteborg are the citizens of Göteborg through the port company (Port of Göteborg AB), where the City of Göteborg is the sole shareholder. That is why traditional port authority functions and stevedoring activities are combined within one and the same body - a city-owned limited company called Göteborgs Hamn AB. This company is thus responsible for the long-term strategy formulation, planning, construction and maintenance of port facilities as well as investment in rolling stock such as cranes, trucks and tractors. It is also responsible for navigation aids and port security.

There are many different business unit /owners /companies that operate in the Port of Hamburg which might be argued to for example increase the possibilities of goods being damaged. Customers of the Port of Göteborg underlined that it is comfortable with only one contact that can order whole service package.

The fairway due is a considerable weakness to the Port of Göteborg (the fairway due is imposed from the Swedish Maritime Association).

The strategic geographic location of the Port of Göteborg in the future might be a determining factor for calls of big shipping lines. One of future scenario might be actually if Maersk Sealand or other big shipping lines would sail "butterfly" – a route that connect Far East-Europe-USA. In this case the Port of Göteborg could be the last port in Europe.

Among the short-term environmental goals for the Port of Göteborg are the creation of an environmental managing system (ISO 14001 environmental certification has already been achieved by some port divisions), the construction of an environmental database for intra-company synergetic and an investigation leading to more efficient use of energy for lighting and heating at the port. The Port of Göteborg has the quality certification ISO 9002. The Ro/Ro terminal and Oil port have environment certification ISO 14 001.

5.8 Tailor-Made Services at the Port of Göteborg

The Port of Göteborg believes in a long-lasting relationship with a few select customers. From having a conventional port/customer relationship, they have progressed to a close partnership, where they try to solve issues concerning their operations together with the customer. They are especially unique with regard to their tailor-made solutions for Stora Enso and AvestaPolarit. (Port of Göteborg, Annual Report 2000)

The solution for Stora Enso is transportation with three specially constructed ships that makes six return trips each week between the ports of Göteborg and Zeebrügge, Belgium. Special weather-protected cassettes, called Stora Enso Cargo Units (secu), are being stuffed at the paper mills. They are then forwarded by rail and sea via the Port of Göteborg to Zeebrügge in Belgium, where the units are being stripped. (www.portgot.se)

For AvestaPolarit, the Port of Göteborg has been part of putting a system called RoRail to work with the AvestaPolarit stainless steel run across the North Sea. The system offers a possibility for heavy cargo to make use of the benefits of intermodal transport. The key components are a steel platform, a special railcar, and a cassette-type undercarriage. The RoRail system makes it possible to handle the rail-sea interface without gradually transhipment. The method is not a dedicated one but offered to industry as a means of improving transport operationally as well as environmentally, but the AvestaPolarit cargo flow is the first one to make use of the RoRail technique. (www.portgot.se)

Looking at these tailor-made solutions, it is clear that the Port of Göteborg has entered into a new role, where they have gone from being the supplier to an active partner, something that has demanded both broader knowledge and increased flexibility (authority of the Port of Göteborg).

6 Analysis

In this chapter, we aim to analyse our results and test our model by doing alterations in the variables. The sensitivity analysis is to prove if our basic results are true under another set of conditions than the ones we have specified. We will also compare some specific cost components that we find of special interest. Examples of this are the differences between the ports of Göteborg and Hamburg for port- and cargo handling costs.

Please notice that we are aware that our service analysis is very subjective and has a descriptive character. Because of the lack of time and resources, we have not been able to make interviews with the authorities of the Port of Hamburg or a number of shipping lines that use services of the Port of Hamburg.

6.1 Sensitivity Analysis of the Results

Our model is built with an analytical approach from the very beginning. Since we have done calculations on three different sizes of both types of vessels (RoRo and LoLo), we have from the very start performed a sort of test for economies of scale. Besides from that, we want to investigate how a changing of the degree of utilisation on each vessel will influence the results of our calculations.

In Appendix 3 we present the outcomes of the sensitivity analysis of the average total cost per one cargo unit with different degrees of utilisation for LoLo and RoRo vessels. Figures 6-1 to 6-10 are based on the data from the tables in Appendix 3, which are presented in terms of percent of utilised capacity of the vessels (i.e. number of cargo units) and total average cost per cargo unit (see chapter 5.4.2) irrespective destination for each studied routes.

In Appendix 4 we have chosen to present the results of the sensitivity analysis for all the routes that are connected with the Port of St. Petersburg for all LoLo and RoRo vessels, in order to illustrate the relationship between average cost curves per unit for different routes. We created diagrams (see Appendix 4) from the average cost per unit output for different vessels and different degrees of utilisation in the range from 30% to maximum % according to the dead-weight of respective vessels (see Appendix 2, Vessels Characteristics).

What we have concluded is that the relationship between each cost curve for the routes follows the same pattern/tendency no matter what size the vessels are, respectively LoLo and RoRo vessels (see Appendix 4). This is valid for all the other routes, which is why we have decided not to present all the sensitivity analysis output diagrams, but only the diagrams, which could be found in chapter 6.1.1 to 6.1.5 (see figures 6-1 to 6-10) for LoLo1 and RoRo1 vessels on each route.

Our entire project is on a theoretical base, but a practical implementation of a system that would operate on one of the routes would most likely begin in small scale, both for volumes and frequency of sailings.

6.1.1 St. Petersburg routes

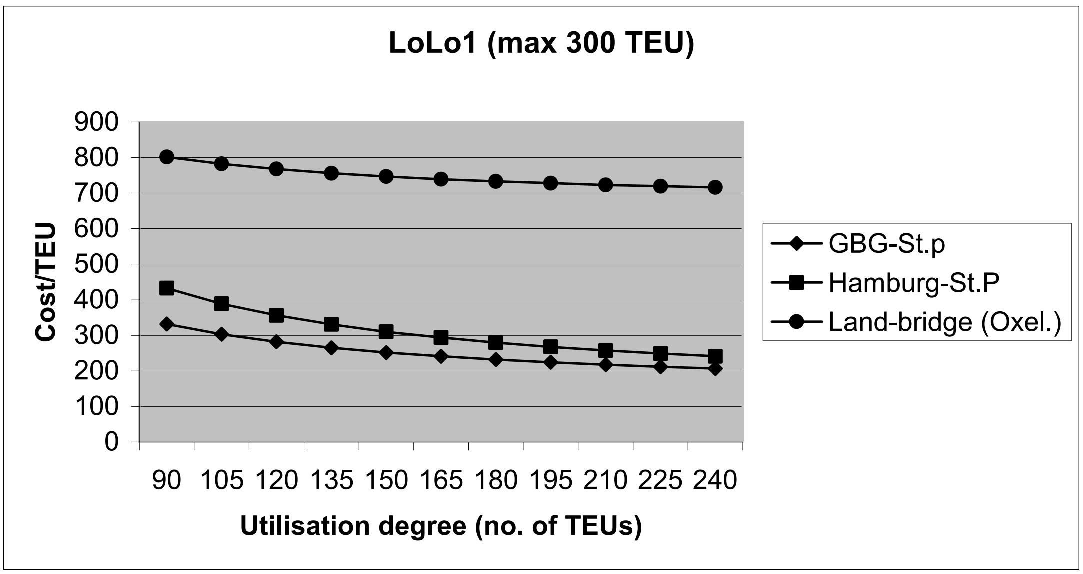


Figure 6-1 Illustration of sensitivity analysis for average cost of one TEU for LoLo1 - St. Petersburg

The most cost attractive alternative for LoLo1 is the route Göteborg–St. Petersburg–Göteborg (see figure 6-1), which has an average cost of about 341 USD/TEU at 30% utilisation (90 TEUs) decreasing to about 207 USD/TEU at 80% utilisation (240 TEUs). These average cost figures are for a one way voyage in either direction (see chapter 5.4.2).

The second most attractive route is Hamburg-St. Petersburg-Hamburg. The degree of decreasing costs is larger in the route to the Port of Hamburg than to the Port of Göteborg.

The land bridge alternative is much more expensive, which makes it less attractive. At 60% utilisation (180 TEUs) the Hamburg route is 20% more expensive than calling at the Port of Göteborg and the Oxelösund route is 216% more expensive than calling at the Port of Göteborg.

The time throughput (see Chapter 5.5.2) is lowest for the land bridge route, which is 17 hours shorter than the direct roundtrip route Göteborg - St. Petersburg – Göteborg (i.e. 8,5 hours difference for a one way voyage). We consider this throughput time difference too small to compensate the average cost difference per TEU. Also, it is unrealistic that the flow of containers between the ports of Oxelösund and Göteborg should be transported directly after the vessel has been discharged. If the vessels were to arrive fully loaded (300 TEUs) this would require five full train sets to be sent away all at once. This reasoning is valid for all intermodal solutions in our research and that is why we will not repeat this argument for every land bridge route in the future analysis.

We argue that the best alternative for LoLo1 is the direct route Göteborg - St. Petersburg - Göteborg. Following the same reasoning as in chapter 6.1, we can argue the same for LoLo2 and LoLo3 vessels. The exact figures for average cost per TEU for different degrees of utilisation for all LoLo vessels can be found in Appendix 3.

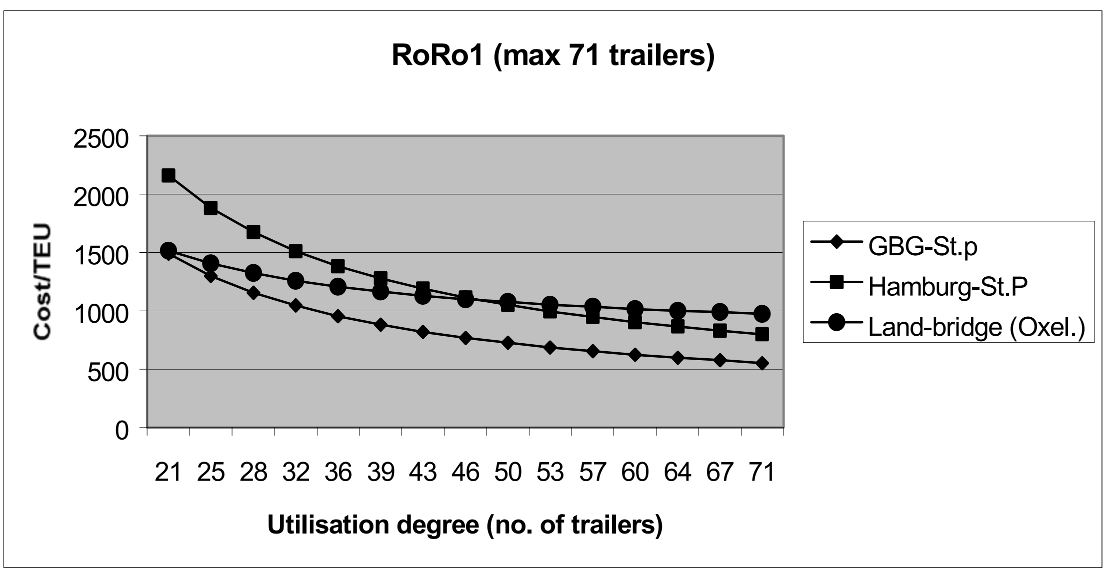


Figure 6-2 Illustration of sensitivity analysis for average cost of one trailer for RoRo1 - St. Petersburg

The most cost attractive alternative for RoRo1 is the route Göteborg–St. Petersburg–Göteborg (see figure 6-2), which has an average cost of about 1490 USD/trailer at 30% utilisation (21 trailers) decreasing to 554 USD/trailer at 100% utilisation (71 trailers). These average cost figures are for a one way voyage in either direction (see chapter 5.4.2).

The time throughput (see chapter 5.5.2) is lowest for the land bridge route, which is 39 hours shorter than the roundtrip route Göteborg – St. Petersburg – Göteborg (i.e. 19,5 hours difference for a one way voyage), and 91 hours shorter than the roundtrip route Hamburg – St. Petersburg - Hamburg (45,5 hours difference for a one way voyage).

The second most cost attractive route is the land bridge through the Port of Oxelösund. Although, at a utilisation over 65% (46 trailers), the Hamburg route becomes more cost efficient, but in reality it is perhaps not realistically to calculate with a higher degree of utilisation than 65% as an average. Also, since the route Hamburg – St. Petersburg - Hamburg has such a high throughput time, it is even less attractive.

We think that since the frequency of sailings on the direct Göteborg route will be lower than on the land bridge route due to the longer distance between the ports of St. Petersburg and Göteborg, the direct Göteborg route could decrease in degree of attractiveness. Even though the direct sea-link route to the Port of Göteborg is more cost efficient for RoRo1 than the land bridge alternative over the Port of Oxelösund, we argue that the land bridge route could be the best alternative, because of the short throughput time. Following the same reasoning as in chapter 6.1, we can argue the same for RoRo2 and RoRo3 vessels. The exact figures for average cost per trailer for different degrees of utilisation for all RoRo vessels can be found in Appendix 3.

6.1.2 Tallinn routes

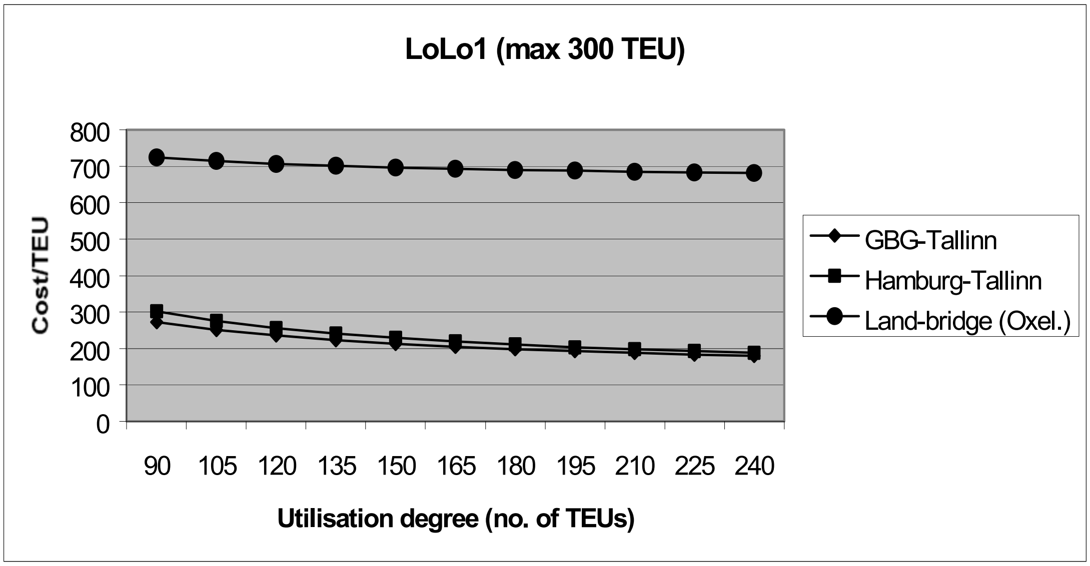


Figure 6-3 Illustration of sensitivity analysis for average cost of one TEU for LoLo1 - Tallinn

The most cost attractive alternative for LoLo1 is the route Göteborg–Tallinn–Göteborg (figure 6-3), which has an average cost of 272 USD/TEU at 30% utilisation (90 TEUs) decreasing to 180 USD/TEU at 80% utilisation (240 TEUs). The second most attractive route is Hamburg-Tallinn-Hamburg. These average cost figures are for a one way voyage in either direction (see chapter 5.4.2).

The degree of decreasing average costs per TEU is larger in the Hamburg route than the direct Göteborg route. At 60% utilisation (180 TEUs), the average cost for one TEU on the direct sea-link to the Port of Göteborg is 13 USD lower than the average cost for a TEU on the Hamburg route, but at 80% utilisation (240 TEUs) the difference is only 8 USD/TEU.

The land bridge alternative has higher average costs per TEU, which makes it less attractive. At 60% utilisation the Hamburg route is 6,5% more expensive per unit (regarding average cost per TEU) than the Göteborg route and the Oxelösund route is 248% more expensive.

The time throughput (see Chapter 5.5.2) is lowest for the land bridge route over the Port of Oxelösund, which is 15 hours shorter than the roundtrip route Göteborg – Tallinn – Göteborg (i.e. 7,5 hours difference for a one way voyage), and 40,2 hours shorter than the roundtrip route Hamburg – Tallinn – Hamburg

(20,1 hours for a one way voyage). We consider the time advantage for the land bridge too small to compensate the cost inefficiency.
From the results above we argue that the best alternative for LoLo1 is the direct sea-link between the ports of Göteborg and Tallinn. Following the same reasoning as in chapter 6.1, we can argue the same for LoLo2 and LoLo3 vessels. The exact figures for average cost per TEU for different degrees of utilisation for all LoLo vessels can be found in Appendix 3.

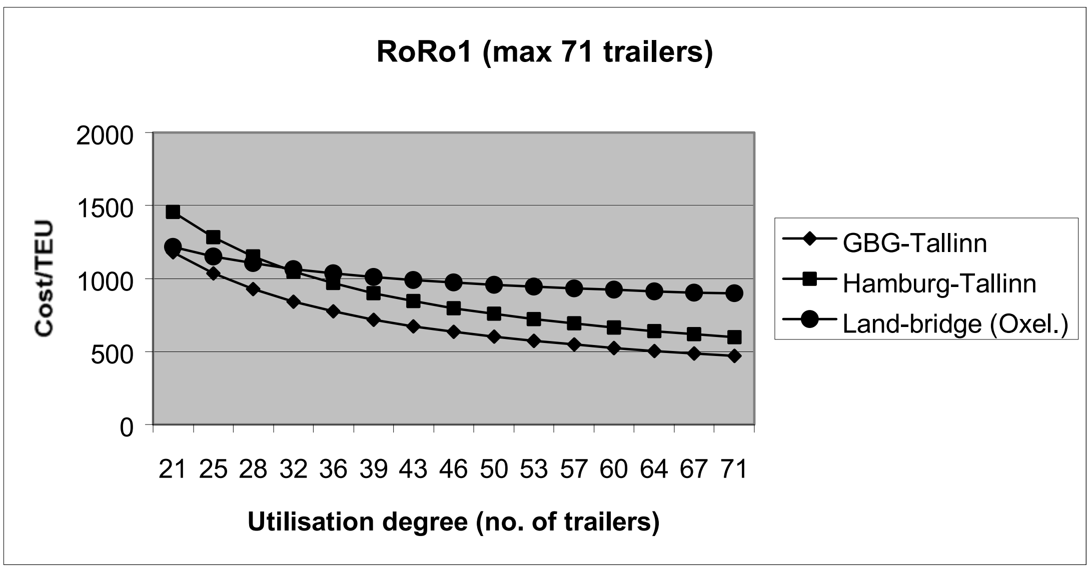


Figure 6-4 Illustration of sensitivity analysis for average cost of one trailer for RoRo1 - Tallinn

The most cost attractive alternative for RoRo1 is the route Göteborg – Tallinn – Göteborg (figure 6-4), which has an average cost of about 1179 USD/trailer at 30% utilisation (21 trailers) decreasing to 471 USD/trailer at 100% utilisation (71 trailers). These average cost figures are for a one way voyage in either direction (see chapter 5.4.2).
The second most cost attractive route is the land bridge route through the Port of Oxelösund up to 45% utilisation (32 trailers). Above 45% utilisation, the Hamburg route becomes more attractive.
The time throughput (see Chapter 5.5.2) is lowest for the land bridge route, which is 37 hours lower than the direct roundtrip route Göteborg – Tallinn – Göteborg (i.e. 18,5 hours difference for a one way voyage), and 46,8 hours shorter than the route Hamburg – Tallinn - Hamburg (23,4 hours for a one way voyage) for RoRo1.

At 60% utilisation (43 trailers), the land bridge route (see figure 6-4) is 46,7% more expensive per unit (regarding average cost per trailer) than the direct Göteborg route, and the Hamburg route is 25,3% more expensive per unit.
Even though the direct sea-link route to Göteborg is more cost efficient than the land bridge over the Port of Oxelösund, we think that since the frequency of sailing will be lower for the direct Göteborg route, it looses in attractiveness.
In this scenario, we find it difficult to say which variable (cost or time) weighs more than the other does. The decision could depend on what type of goods we are dealing with, i.e. whether if the goods are time sensitive or not. This reasoning is valid for all RoRo vessels (Appendix 3).

6.1.3 Riga routes

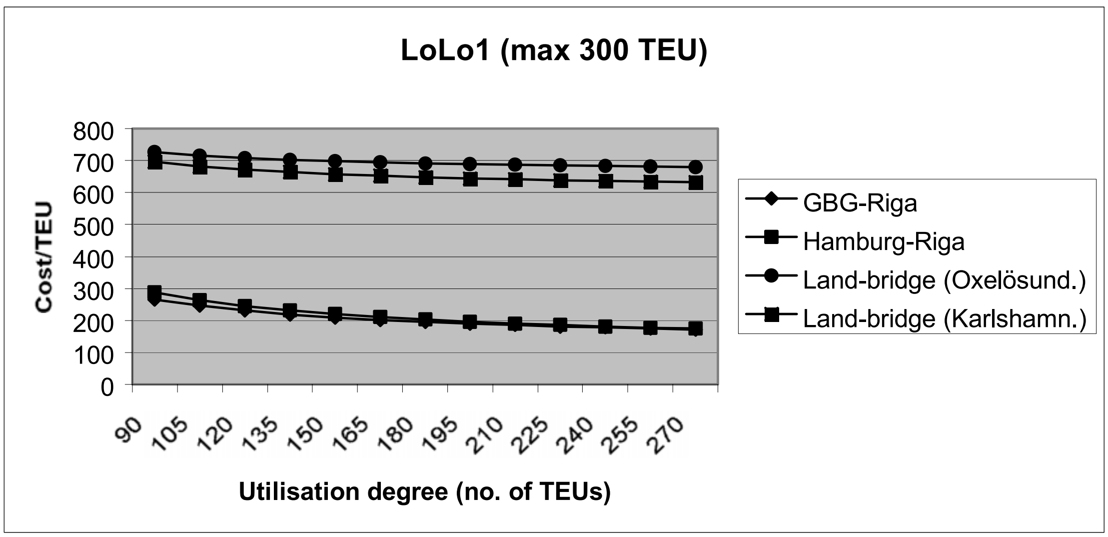


Figure 6-5 Illustration of sensitivity analysis for average cost of one TEU for LoLo1 - Riga

The most cost attractive alternative for LoLo1 is the route Göteborg–Riga–Göteborg (see figure 6-5), which has an average cost of 266 USD/TEU at 30% utilisation (90 TEUs) decreasing to 178 USD/TEU at 80% utilisation (240 TEUs). These average cost figures are for a one way voyage in either direction (see chapter 5.4.2).
The second most cost attractive route for LoLo1 is Hamburg-Riga-Hamburg, which is very close to the results of the direct Göteborg route in terms of average cost per TEU. Also, the degree of decreasing average costs per TEU is larger in the Hamburg route than the Göteborg route.

At 60% utilisation (180 TEUs), the average cost for one TEU on the direct sea-link to the Port of Göteborg is 7 USD lower than the average cost for a TEU on the Hamburg route, but at 80% utilisation the difference is only 3 USD/TEU.

At 60% utilisation the Oxelösund route is 7% more expensive per TEU regarding average cost) than the Karlshamn route, 253% more expensive per TEU than the direct route to the Port of Göteborg, and 241% more expensive per TEU than the Hamburg route.

The time throughput (see Chapter 5.5.2) is lowest for the land bridge route over the Port of Oxelösund, which is 25 hours shorter than both the round trip routes to the ports of Göteborg and Hamburg (i.e. 12,5 hours difference for a one way voyage), and 16,7 hours shorter than the other land bridge route over the Port of Karlshamn. The Oxelösund route has the lowest throughput time, but at the same time the highest average cost per unit.

From the results above we argue that the best alternative for LoLo1 is the direct sea-link between the ports of Göteborg and Riga. Following the same reasoning as in chapter 6.1, we can argue the same for LoLo2 and LoLo3 vessels. The exact figures for average cost per TEU for different degrees of utilisation for all LoLo vessels can be found in Appendix 3.

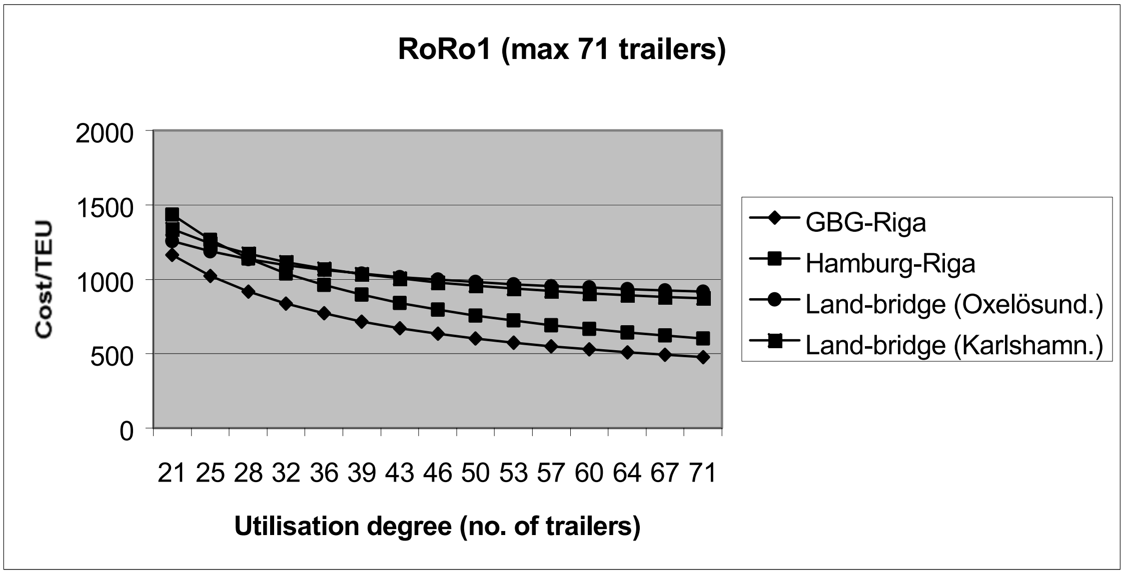


Figure 6-6 Illustration of sensitivity analysis for average cost of one trailer for RoRo1- Riga

The most cost attractive alternative for RoRo1 is the route Göteborg – Riga – Göteborg (see figure 6-6), which has an average cost of 1162 USD/trailer at 30% utilisation (21 trailers) decreasing to 477 USD/trailer at 100% utilisation (71 trailers). These average cost figures are for a one way voyage in either direction (see chapter 5.4.2).

The second most cost attractive route is the land bridge through the Port of Oxelösund up to 40% utilisation (28 trailers). Above 45% utilisation (32 trailers) the Hamburg route is more cost attractive.

The time throughput (see Chapter 5.5.2) for RoRo1 is lowest for the land bridge route over the Port of Oxelösund, which is 17,9 hours lower than the roundtrip route Karlshamn – Riga – Karlshamn (about 9 hours difference for a one way voyage), 31,3 hours lower than the direct Göteborg route (15,7 hours one way), and 40,4 hours shorter than the Hamburg route (20,2 hours one way).

From the above discussion, we choose the direct link to the Port of Göteborg as the most competitive for RoRo1. This conclusion is valid for all RoRo vessels (Appendix 3).

6.1.4 Liepaja routes

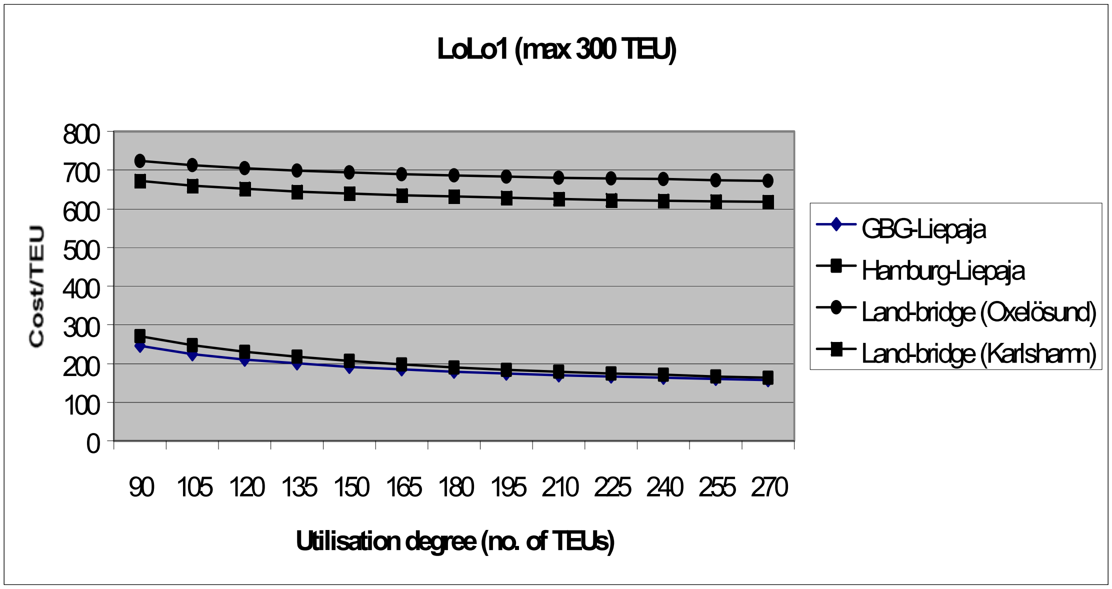


Figure 6-7 Illustration of sensitivity analysis for average cost of one TEU for LoLo1 - Liepaja

The most cost attractive alternative for LoLo1 is the route Göteborg–Liepaja–Göteborg (figure 6-7), which has an average cost of 246 USD/TEU at 30% utilisation (90 TEUs) decreasing to 163 USD/TEU at 80% utilisation (240 TEUs). These average cost figures are for a one way voyage in either direction (see chapter 5.4.2).

The second most cost attractive route is Hamburg-Liepaja-Hamburg, which is very close to the results of the direct Göteborg route. Also, the degree of decreasing average costs per TEU is larger in the Hamburg route than the direct Göteborg route.

At 60% utilisation (180 TEUs), the average cost for one TEU is 12 USD lower in the direct Göteborg route than the Hamburg route, but at 80% utilisation the difference is only 8 USD/TEU. At 60% utilisation the Oxelösund route is 9% more expensive per unit (regarding average cost per TEU) than the Karlshamn route, 283% more expensive per unit than the direct route to the Port of Göteborg, and 259% more expensive per unit than the Hamburg route.

The time throughput (see Chapter 5.5.2) is lowest for the land bridge route over the Port of Oxelösund, which is 0,8 hours shorter than the roundtrip route Göteborg - Karlshamn – Liepaja – Karlshamn – Göteborg (0,4 hours difference for a one way voyage), 9,1 hours shorter than the Göteborg roundtrip route (4,6 hours one way), and 17,8 hours shorter than the Hamburg roundtrip route (8,9 hours one way).

From this we conclude that the best alternative for LoLo1 is the direct sea-link between the ports of Göteborg and Liepaja. Following the same reasoning as in chapter 6.1, we can argue the same for LoLo2 and LoLo3 vessels. The exact figures for average cost per TEU for different degrees of utilisation for all LoLo vessels can be found in Appendix 3.

Between the routes through the ports of Oxelösund and Karlshamn, the Oxelösund route is the winner.

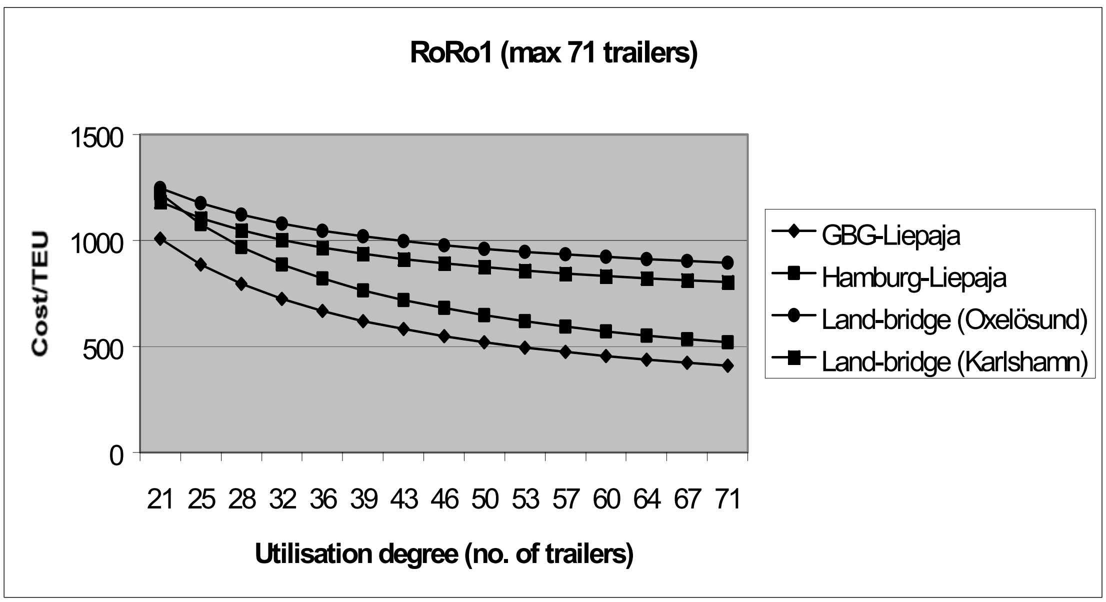


Figure 6-8 Illustration of sensitivity analysis for average cost of one trailer for RoRo1 - Riga

The most cost attractive alternative for RoRo1 is the route Göteborg–Liepaja–Göteborg (see figure 6-8), which has an average cost of 1010 USD/trailer at 30% utilisation (21 trailers) decreasing to 410 USD/trailer at 100% utilisation (71 trailers). The second most cost attractive route is the route to the Port of Hamburg. These average cost figures are for a one way voyage in either direction (see chapter 5.4.2).

The time throughput (see Chapter 5.5.2) for RoRo1 is lowest for the land bridge route over the Port of Oxelösund, which is 2 hours less than the roundtrip Göteborg - Karlshamn - Liepaja – Karlshamn – Göteborg (1 hour difference for a one way voyage), 15,7 hours less than the direct Göteborg roundtrip route (about 7,9 hours one way), and 25,2 hours shorter than the Hamburg roundtrip route (12,6 hours one way).

At 60% utilisation (43 trailers) of the RoRo1 vessel, Oxelösund is 71% more expensive per unit (regarding average cost per trailer) than Göteborg, 39% more expensive per unit than Hamburg, and 9% more expensive per unit than Karlshamn.

From these results, we chose the direct link to the Port of Göteborg as the most competitive. Second best alternative is the Hamburg route, and third best one is the Karlshamn route. These conclusions are the same for all vessel sizes of RoRo vessels (see Appendix 3).

6.1.5 Klaipeda routes

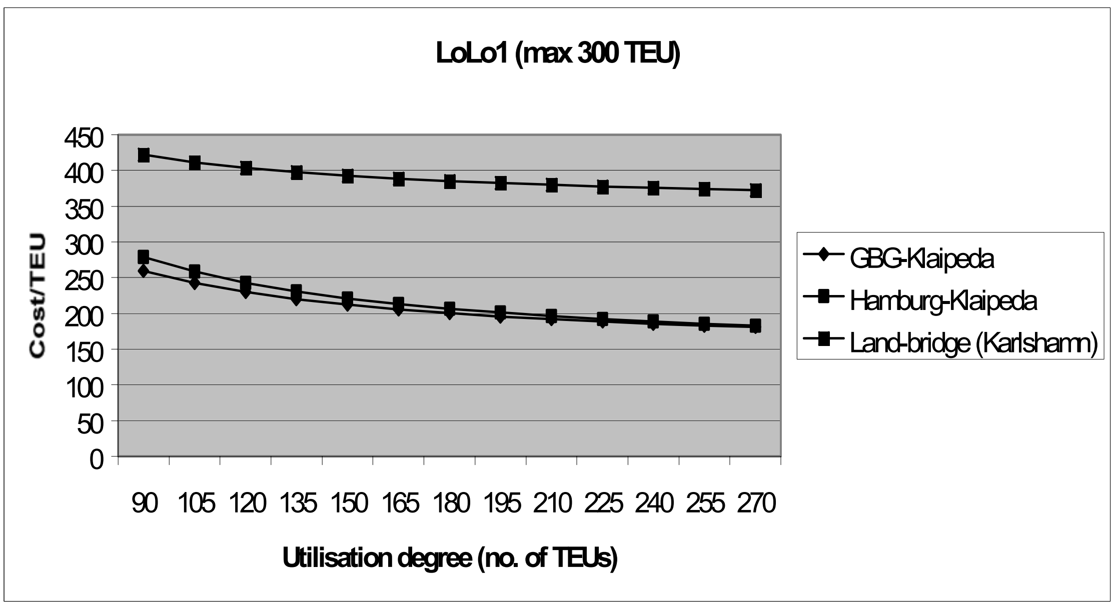


Figure 6-9 Illustration of sensitivity analysis for average cost of one TEU for LoLo1 - Klaipeda

The most cost attractive alternative for LoLo1 is the route Göteborg–Klaipeda–Göteborg (see figure 6-9), which has an average cost of 259 USD/TEU at 30% utilisation (90 TEUs) decreasing to 186 USD/TEU at 80% utilisation (240 TEUs). These average cost figures are for a one way voyage in either direction (see chapter 5.4.2).

The second most cost attractive is Hamburg-Liepaja-Hamburg, which is very close to the results of the direct Göteborg route. Also, the degree of decreasing average costs is larger in the Hamburg route than the direct Göteborg route.

At 60% utilisation (180 TEUs), the average cost for one TEU is 7 USD lower on the direct sea-link to the Port of Göteborg than the average cost for one TEU on the Hamburg route, but at 80% utilisation the difference is only 3 USD/TEU.

The most expensive route (in terms of total average cost per unit) is the land bridge over the Port of Karlshamn. At 60% utilisation the Karlshamn route is 92,5% more expensive per unit than the direct route to the Port of Göteborg, and 86% more expensive per unit than the Hamburg route.

The time throughput (see Chapter 5.5.2) is lowest for the direct roundtrip route Göteborg – Klaipeda – Göteborg, which is 7,2 hours shorter than the roundtrip route over the Port of Karlshamn (3,6 hours difference for a one way journey), and 9,5 hours shorter than the roundtrip Hamburg route (4,8 hours one way).

From this we conclude that the best alternative for LoLo1 is the direct sea-link between the ports of Göteborg and Klaipeda. Following the same reasoning as in chapter 6.1, we can argue the same for LoLo2 and LoLo3 vessels. The exact figures for average cost per TEU for different degrees of utilisation for all LoLo vessels can be found in Appendix 3.

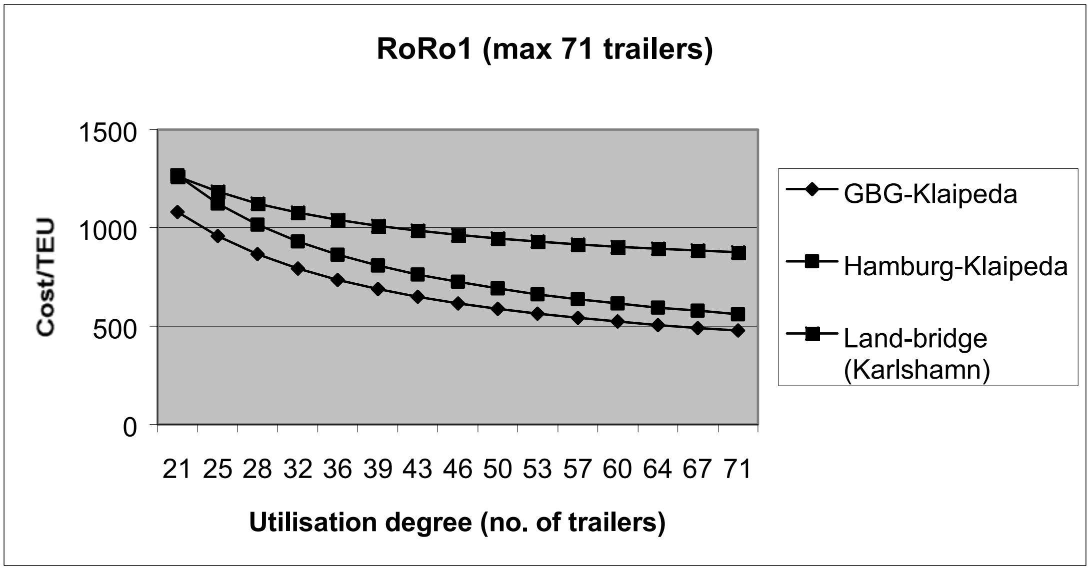


Figure 6-10 Illustration of sensitivity analysis for average cost of one trailer for RoRo1 - Klaipeda

The most cost attractive alternative for RoRo1 is the route Göteborg–Klaipeda–Göteborg (figure 6-10), which has an average cost of 1080 USD/trailer at 30% utilisation (21 trailers) decreasing to 477 USD/trailer at 100% utilisation (71 trailers). The second most cost attractive route is the route to the Port of Hamburg. These average cost figures are for a one way voyage in either direction (see chapter 5.4.2).

The time throughput (see Chapter 5.5.2) is lowest for the land bridge route over the Port of Karlshamn, which is 12,6 hours lower than the roundtrip Göteborg – Klaipeda – Göteborg (6,3 hour difference for a one way journey), and 14,3 hours lower than the roundtrip Hamburg route (7,2 hours one way).

At 60% utilisation of the vessels, the Karlshamn route is 52% more expensive per unit (regarding average cost per trailer) than the route directly to the Port of Göteborg, and 29% more expensive per unit than the Hamburg route.

We chose the direct link to the Port of Göteborg as the most competitive. Second best alternative is the Hamburg route. These conclusions are the same for all vessel sizes of RoRo vessels (see Appendix 3).

6.2 Analysis of Specific Cost Components

In this chapter we analyse specific cost components as port dues and charges, cargo handling costs, fairway dues, and the influence of economy of scale.

6.2.1 Port Dues and Cargo Handling Costs

Table 6-1 presents the differences between the Port of Göteborg and the Port of Hamburg concerning port dues and charges, which include arrival and departure of one vessel. The results are based on 60% utilisation for each type of vessel.

Port dues	**LoLo1**	**LoLo2**	**LoLo3**
Göteborg (USD/vessel)	8 773,9	13 644,9	27 043,1
Hamburg (USD/vessel)	15 586,3	23 203,6	44 620,5
% that Hamburg is more expensive than Göteborg	77,7%	70,1%	65%
	RoRo1	**RoRo2**	**RoRo3**
Göteborg (USD/vessel)	6 974,5	10 705,8	14 206,0
Hamburg (USD/vessel)	13 549,9	19 672,8	25 649,2
% that Hamburg is more expensive than Göteborg	94,3%	84%	81%

Table 6-1 Differences in port dues between the ports of Göteborg and Hamburg

Port dues in the Port of Göteborg are much lower than port dues in the Port of Hamburg for respective vessels. We can see a clear trend that the difference in port dues and charges decrease as the vessels get larger.

In table 6-2 we present the differences between the Port of Göteborg and the Port of Hamburg concerning cargo-handling costs, which include loading and discharging operations of one vessel. The results are based on 60% utilisation for each type of vessel.

Cargo handling costs	**LoLo1**	**LoLo2**	**LoLo3**
Göteborg (USD/vessel)	19 890,0	33 150,0	66 300,0
Hamburg (USD/vessel)	15 033,7	25 056,1	50 112,3
% that Göteborg is more expensive than Hamburg	32,3%	32,3%	32,3%
	RoRo1	**RoRo2**	**RoRo3**
Göteborg (USD/vessel)	4 866,9	8 020,1	11 721,7
Hamburg (USD/vessel)	9 067,1	14 941,6	21 837,7
% that Hamburg is more expensive than Göteborg	86,3%	86,3%	86,3%

Table 6-2 Differences in cargo handling costs between the ports of Göteborg and Hamburg

For the handling costs of containers (LoLo) the Port of Göteborg is 32% more expensive per vessel, but for trailers (RoRo) the Port of Hamburg is 86,3% more expensive per vessel.

6.2.2 Fairway Dues at the Port of Göteborg

Table 6-3 presents the fairway due share of total port dues and charges (excluding cargo handling charges) for one vessel callin at the Port of Göteborg.

	LoLo1	**LoLo2**	**LoLo3**
Göteborg port dues (USD/vessel)	8 773,9	13 644,9	27 043,1
Fairway dues (USD/vessel)	1 594,6	2 511,3	5 154,4
Fairway dues share of port costs	18,175%	18,404%	19,060%
	RoRo1	**RoRo2**	**RoRo3**
Göteborg port dues (USD/vessel)	6 974,5	10 705,8	14 206,0
Fairway dues (USD/vessel)	1355,14	2173,30	2942,27
Fairway dues share of port costs	19,43%	20,30%	20,71%

Table 6-3 Fairway due share of total port dues and charges at the Port of Göteborg for each vessel

These results (table 6-3) are based on our assumption that the vessel calls at the Port of Göteborg once a week, which gives us about 52 calls per year. The environmental part of the fairway due is only charged for the first twelve calls per year (see appendix 2, Göteborg port cost). Even if the frequencies for RoRo traffic can be higher than for LoLo because a good net of RoRo connections in the Baltic area, we can argue that fairway dues share still stay relatively high. This confirms the opinions we received from almost all our interview respondents. The state imposed fairway dues makes it more difficult for the Swedish port to compete internationally.

6.2.3 Port Dues at the Ports of Göteborg, Oxelösund and Karlshamn

Table 6-4 presents the cost differences concerning port dues and charges between the ports of Göteborg, Oxelösund, and Karlshamn, which include arrival and departure of one vessel. The results are based on a 60% utilisation degree for each type of vessel.

Port	**LoLo1 (USD/vessel)**	**LoLo2 (USD/vessel)**	**LoLo3 (USD/vessel)**
Göteborg	8 773,9	13 644,9	27 043,1
Oxelösund	7 902,5	12 076,5	23 856,8
Karlshamn	7 859,9	12 072,9	24 054,2
Port	**RoRo1 (USD/vessel)**	**RoRo2 (USD/vessel)**	**RoRo3 (USD/vessel)**
Göteborg	6 974,5	10 705,8	14 206,0
Oxelösund	6 691,8	10 580,5	14 112,4
Karlshamn	4 915,7	7 518,9	9 712,5

Table 6-4 Port dues at Göteborg, Oxelösund and Karlshamn

The Port of Göteborg is the most expensive port to call at for all types of vessels in our research, especially for the LoLo vessels. For the LoLo1 and LoLo2 vessels the cost difference in port dues is not that big, but for the LoLo3 Göteborg is a much more expensive alternative. For the RoRo vessels, the ports of Göteborg and Oxelösund are quite close concerning the port dues, while the Port of Karlshamn is less expensive.

6.2.4 Economies of Scale

Regarding economy of scale, a clear trend is demonstrated for LoLo vessels with decreasing cost per unit as the vessels get larger. With reservation for diseconomies of scale in ports, please note that we only consider vessels in the range between 300-1000 TEUs. For container vessels bigger than 1000 TEUs we can only speculate that the trend could be continuous until a break point is reached when diseconomies of scale in the port could influence the transport cost per unit with a negative effect. For RoRo vessels, we do not observe any relation between size of vessel and average cost per unit. For some routes, the RoRo2 vessels are more cost efficient and for some routes RoRo 2 vessels are the most expensive.

6.3 Analysis of the Interviews

In this section we will analyse the major findings from our interviews, and relate this to our other results.

First of all, the answers we received on the outlook of the BSRR market were only those of great optimism. No one seemed to doubt the future development of sea borne trade and an increase in cargo volumes in the BSRR market. Though still many complained about the BSRR ports facilities and service quality, they all said that the improvement rate during the last few years was so high that they did not foresee these problems a major problem in the future.

The respondents' views on the Port of Göteborg as a transhipment hub for the BSRR were varied to a high degree. Some seemed quite optimistic about the concept, both for the idea on a land bridge system across Sweden and a direct sea-link to the Port of Göteborg. The land bridge system although, was initially received with some scepticism due to the fact that the railways in Sweden are not functioning on a sufficiently high level that would be required to operate a system like this.

The other side of the opinions, on the notion of the Port of Göteborg as a hub for BSRR, was that of sharp critique and downright rejection. On of the most dominating arguments was that of the geographical disadvantage of the Port of Göteborg towards the dominating main North European Ports (e.g. the ports of Hamburg, Rotterdam, etc.).

Notably, it was possible to see a trend between the opposing views depending on what type of company/organisation the respondent was from. By this we mean that it was quite easy to see that those that perhaps would benefit from a future development, where the Port of Göteborg would be a hub for the BSRR, were optimistic and those that possibly would suffer or not be affected responded with scepticism or stayed neutral.

A major agreement that almost all respondents shared were that the Port of Göteborg was an expensive port to call at. According to our results, this is a truth with some modification. It all depends on what perspective is applied. Our results confirmed that the Port of Göteborg, although more expensive than the other two Swedish ports in our study (the ports of Oxelösund and Karlshamn), lies on a competitive level internationally.

Before we initiated our calculations, we were of the firm notion that the results would come out unfavourably for the Port of Göteborg. The reason why this not seems to be true, we can only speculate about. Can all the respondents we interviewed be wrong? Probably not, but we have to realise that they were most likely comparing the Port of Göteborg to other Swedish ports, which for our purposes is not that interesting. Therefore it would have been interesting to contact some of the respondents again and ask the same questions but clarify that we wanted their opinion of the cost level of the Port of Göteborg in comparison with the larger North European ports. Unfortunately we do not have the time to do this.

Regarding the views on the competitive level of the Port of Göteborg, all respondents agreed uniformly that The Port of Göteborg holds a very high service level, with consistent good quality in all respects. On the high price level, which we spoke about in the paragraph above, the state imposed fairway dues was attributed to be the main villain that should immediately be removed. As for the competitive level between the Port of Göteborg and the Port of Hamburg, Hamburg was favoured on such terms as better customs clearance procedures and more updated IT-solutions. Otherwise, many said that it is difficult to compare these two ports, since they are very different in terms of cargo throughput (the Port of Hamburg is notably larger), and are not operating towards exactly the same markets.

To summarise the analysis of our interview results:

- The BSRR market is viewed optimistically and predicted to be an interesting development area with many business opportunities.
- The opinions on the Port of Göteborg as a transhipment hub for the BSRR varied greatly.
- The Port of Göteborg is seen having a high quality of services, and a reliable performance level, although the price level is high.
- Opinions on the competitive level of the Port of Göteborg towards the Port of Hamburg, as a transhipment hub for the BSRR, favoured the Port of Hamburg.

6.4 Strategic Positioning of the Port of Göteborg and the Port of Hamburg

In this section we aim to analyse the strategic positioning for the Port of Göteborg and the Port of Hamburg with respect to the theories we presented in chapter 3.2.2 & chapter 3.2.5.

How to determine what type of port to classify the Port of Göteborg under (see chapter 3.2.2) depends on what perspective is applied. From a Scandinavian perspective, the Port of Göteborg most definitely qualifies as a hub and spoke port. If we compare to the Port of Hamburg, which we consider as a hub and spoke port, and were to look at the entire Northern Europe region, the Port of Göteborg cannot be said to be a hub and spoke port, but more towards a combination of a transit port and a feeder port to the larger North European ports.

Business Economies of Scale

System Terminals Global hinterland Relatively few clients Homogenous service Direct customer contact Large economies of scale	*Industrial terminals* Regional hinterland Few clients Tailor-made services Close customer relations Medium economies of scale
General terminals Local hinterland Many clients Heterogeneous service Little customer contact Limited economies of scale	*Dedicated terminals* Industrial terminals Local reception/distribution area One client Tailor-made services Direct customer contact Low economies of scale

Service differentiation

Figure 6-11 Strategic types of port/terminal markets (Swedish Maritime Administration, 1999)

We are of the opinion that the Port of Göteborg is most like an **Industrial terminal** (see figure 6-11), because it fulfils most of the key factors:

- *Regional hinterland*
  Within 500 km, 70% of the population within Scandinavia can be reached. The most densely populated areas (Stockholm, Oslo, and Köpenhamn) can all be reached within 6 hours (see table 5-24, General Information).
- *Few clients*
  On the Scandinavian market, the Port of Göteborg does not apply to this condition. But in comparison with the other main European ports, the Port of Göteborg has few clients. The Port of Göteborg has around 20 clients while the Port of Hamburg operates within the range of around 50 clients.
- *Tailor-made services*
  The Port of Göteborg holds a unique position with their tailor-made solutions for Stora Enso and AvestaPolarit. For more information, see chapter 5.8.
- *Close customer relations*
  The Port of Göteborg has a partnership relation with few clients.
- *Medium economies of scale*
  The Port of Göteborg is operating under medium economies of scale, since even though it is a big port with Scandinavian measure, it is still quite small in comparison with the other large North European ports. In this respect, the Port of Göteborg cannot reach the same economies of scale.

The Port of Hamburg is more like a **System Terminal** (see figure 6-11):

- *Global hinterland*
  According to the facts in table 5-24, we can conclude that the hinterland for the Port of Hamburg is much larger than the hinterland for the Port of Göteborg.
- *Relatively few clients*
  We consider the number of clients in the Port of Hamburg, which is around 50, as relatively few for such a huge European port.
- *Homogenous services*

Our opinion is that the services in the Port of Hamburg are rather homogenous, e.g. because of the lack of tailor-made solutions for the customers.

- *Direct customer contact*
  The Port of Hamburg does not have the same close co-operation with its customers as the Port of Göteborg (tailor-made solutions). We can argue that the degree of closeness in customer relationship is not as high in the Port of Hamburg.
- *Large economies of scale*
  The Port of Hamburg has large economy of scale, particularly for logistics operations for container cargoes (84% of general cargo is containerised). For example, the Port of Hamburg occupies the position No. 9 in the world (for container throughput in TEU). In comparison with the Port of Göteborg, container throughput in the Port of Hamburg is much larger (see tables 5-22, 5-23, and 5-24, General Information). According to our calculations for the handling costs of containers, the Port of Göteborg is 32% more expensive than the Port of Hamburg.

Location/adaptation	Dependent on infrastructure conditions and market know-how.
Differentiation	Dependent on the type of goods, the character of the market, customer relations and logistic demands.
Low production costs	Dependent on factor costs, handling technology, productivity and economy of scale.

Table 6-5 Business strategies

Regarding the business strategy of the Port of Göteborg, it operates with a mix of adaptation and differentiation strategies (see table 6-5). It depends on infrastructure conditions (distance handicap). The port strives towards a specialisation to unitised cargo. They work actively to influence the development of making more goods possible to unitise, which will help in balancing the flows of load-carriers.

By tradition Sweden has developed a strong export flow of heavy industry products (e.g. paper and metals) that originates from the northern parts of Sweden and is shipped out to a great extent from the Port of Göteborg throughout the world. The export and import flows from Sweden are not balanced very well. The import is not given the same attention as the exports and is not as concentrated to points of receiving. Much of the import is going through the smaller ports in Sweden today. For example, there exist firewood exports to Sweden from a few Latvian ports, which also export saw timber to the Untied Kingdom. The wood shipments from these ports can be transhipped in the Port of Göteborg for further transport to the UK, and other countries. This type of cargo can be unitised and the land bridge alternative with RoRo traffic can be attractive.

The Port of Göteborg would favour a development towards an increased concentration of the imports flows, which would enable them to have more balanced volumes for export and import.

The business strategy of the Port of Hamburg is a mix of differentiation and low production costs strategies (see table 6-5). The Port of Hamburg is (as the Port of Göteborg) highly specialised towards unitised cargo, but are operating with a much larger economy of scale than the Port of Göteborg.

6.5 Direct Calls at the Port of Göteborg

The possibilities of the entire subject of our study, i.e. the feasibility of the Port of Göteborg to act as transit port of the BSRR, depends to a great extent on whether there is sufficient capacity as regards ocean-shipping lines that have direct calls to the Port of Göteborg. This is a discussion that stretches beyond the limits of our study but we feel that it would only be proper to comment it briefly.

The entire situation is somewhat of discussion of the “chicken and the egg”. In order to attract more direct deep-sea calls from ocean liners there would have to be an increase in volumes. This could perhaps persuade the shipping-companies to call at the Port of Göteborg, but for a shipping company to add a port to an existing line or to exchange one port to another is associated with huge costs (it could be necessary to invest in new vessels, etc). Therefore the ocean going shipping lines most likely would not do this unless they can see that it would benefit them directly.

To highlight this situation, it is notable that the large ocean shipping line Evergreen stopped calling at the Port of Göteborg in 1999, a line that had been

operating for a few years. This decision was not made because there were any economically losses, but because it did not fit into Evergreens transoceanic routes.
If a shipping line were to change it's lines this could increase the throughput in the Port of Göteborg since it would attract more goods. So the question is how to get the ball rolling? Where to start? This is as far as we will dwell on this matter, but now we at least have shown that we are aware of the situation.

7 Conclusions

Here our goal is to draw conclusions based on the findings from our empirical study and the analysis.

An important thing for the Port of Göteborg is to get as much cargo volumes as possible, which can attract bigger oceanic shipping lines, and more direct deep-sea calls. With this in mind, the flows of transhipment cargo from the Baltic States and Russia Region (BSRR) present a very good possibility, as an interesting development area with many business opportunities. A broadening of the hinterland of the Port of Göteborg is a necessity. Norway, Finland, Denmark and the Baltic countries will then become natural markets, and the Port of Göteborg has a unique opportunity to become larger and stronger.

According to the results of our calculations, the direct sea-link routes between the Port of Göteborg and the BSRR ports are the most efficient alternatives for LoLo and RoRo vessels in comparison with the direct sea-link routes between the Port of Hamburg and the BSRR in terms of costs and throughput time. The land bridge alternative can be attractive because of lower throughput time in almost all cases, even if it is less cost efficient than the other route alternatives. The decision about what is the best alternative depends on what type of goods that are being transported.

We consider the fairway dues imposed by the Swedish Maritime Administration as a big part of the costs for the customers of the Port of Göteborg (about 20%, excluding cargo handling costs). If this fairway due were removed it would increase the competitive advantages for the Port of Göteborg additionally. From a national perspective, it is extremely important that the Port of Göteborg is regarded as a national asset with significant importance to keep and develop this quality

The Port of Göteborg has advantages in its more flexible planning and open hours because there is no problem with tide, which is the restriction on certain activities in the Port of Hamburg. The fairway in the Port of Göteborg is relatively short, in comparison with the other big ports, which is a time saving factor for the shipping lines. The Port of Göteborg has an efficient container handling, is as seen having a high quality of services, and a reliable performance level, which makes the port highly competitive. For the handling costs of containers (LoLo) the Port of Göteborg is 32% more expensive, but for trailers (RoRo) the Port of Hamburg is 86,3% more expensive.

We believe that one of the best opportunities for the Port of Göteborg, for developing both as a port and as a business partner towards the BSRR, is to continually work with the production of brand new tailor-made solutions and services. Since there is an inherent geographical handicap towards mainland European Ports, we believe it to be of utmost importance that work is done to find smart and effective transport solutions, involving the co-operation and co-ordination of more than one transport mode. The Port of Göteborg has shown it is good at this with the solutions for Stora Enso and AvestaPolarit. The service of the Port of Göteborg is unique and different form that of its competitors. To actively work towards a higher degree of unitisation of the large bulk flows from the BSRR, can result in new market opportunities for the Port of Göteborg.

The good experiences of working in a close customer relationship are the best tool for developing services towards clients and business partners. The improvements in service can be achieved through an extended network of connections, which will suit the needs of shippers that have global interest and needs for door-to-door services.

The politicians in Russia have been showed the direction to decrease the flow of export/import goods through the Baltic States and to heavily subsidise railroad transport, which creates a motivating factor for shipping lines in their choice of port of call. Additionally the Port of St. Petersburg has access to the Trans-Siberian railway and has obtained the opportunity to sell their services, transporting commodity to the Pacific Ocean, which makes the Port of St. Petersburg one of the most interesting choices for Russian cargo.

Our recommendation to the authorities of the Port of Göteborg is to more actively market the approaches and concepts of closer co-operation, and participate in building relationships with actors in the maritime market in order to get a foothold in the BSRR market. In order to achieve a more competitive situation, the authorities of the Port of Göteborg should actively influence collaboration with the customers.

The voyage- and cargo handling costs can be decreased by means of automated mooring of vessels, automated cargo handling systems, etc. (see chapter 3.2.3). These measurements will also improve the throughput time.

8 Discussion

In this chapter we will review our work from the concepts of validity and reliability that we covered in chapter 4.

8.1 Validity and Reliability

The main questions that validity deals with is if we are measuring what we think we are measuring. Concerning the internal validity, which has to do with the study itself and the direct connection between the theoretical framework and the empirical study, we feel that we fulfil the requirements. All conducted interviews were relevant to the aim of our study. As we say in the beginning of the analysis chapter (Chapter 6), we have not been able to make interviews with the authorities of the Port of Hamburg or a number of shipping lines that use the services of the Port of Hamburg because of limitations in time and resources.

Concerning the external validity, which encompasses a broader perspective, we cannot satisfactorily claim that it is possible to generalise from the study. Our work is to a high degree an applied research that is only valid under the conditions we have specified. However, lack of external validity does not exclude the internal validity.

Reliability, which is concerned with the consistency, accuracy, and predictability of the research findings, necessitates that the measurement must be performed several times in the same way without very different results in order for the reliability to be high. This is a requirement that we feel our work applies to. We have been using clear definitions of important concepts in our study. Also, we have tried to obtain information from as many separate sources as possible.

8.2 Data Discrepancy

For the cost associated data we have used in our calculations, we are aware that no one hardly ever pays the official port and cargo handling tariffs, but in reality are receiving different levels of discounts depending among other things on their size of operations. Besides from this, we feel that we have made as adequate assumptions as possible regarding the input data (see Appendix 1).

From sub-project three (Rana, 2002), we have received preliminary information that has made it possible to calculate and analyse the entire routes that involved a land bridge link across Sweden. After having performed our calculations, we were given updated figures. However, the new input data would not have changed the results in the analysis and conclusions, they would instead enhance our conclusions. In Appendix 2 (Land bridge Data), we have included the preliminary input figures for the land bridge related unit costs and throughput times.

9 Future Research

In this chapter we present concepts for future research that we believe would be interesting to pursue, not only from an academic approach but also for the interests of the Port of Göteborg.

9.1 Time Tables

An important and logical next step for our research would be to more realistically sketch out how a connection between the BSRR and the Port of Göteborg would look like. The major part of this task would involve exploring how the actual running of a link would act.

During our interviews, we found out that the establishing of a well functioning timetable for a route involves a great deal of work. Preferably, the vessels should arrive in each port early in the morning and depart late in the evening. We would have found it interesting to include this in our work, but due to lack of time and resources, we have to leave that to future researchers in this field.

9.2 Routes

We believe that it could be interesting to make cost- and throughput time calculations in routes that include more than two ports (nodes) in the network model of the transport systems. Routes with more than two ports can solve problems with limited goods volumes from the BSRR, which can lead to a more practical implementation of transport systems in the nearest future. This would be most interesting for the LoLo traffic.

9.3 The Value of the Cluster Concept for Analysing Seaports

The cluster concept broadens the possibility of research into seaport: seaports are not regarded “merely as nodes in transport chain, but also as regional cluster of economic activities” (De Langen, 2001).

“Geographical concentration of similar and complementary economic activities is a widespread phenomenon” (Krugman, 1991). Regions are specialised in specific economic activities. The attendance and growth of clusters of economic activities is increasing significance for the economic performance in regions. The 10 largest ports handle 40% of all cargo, which is a clear indicator of the concentration of cargo activities in a limited number of ports in Europe. The presence of cargo handling activities attracts related economic activities to considerable influence for regional economies.

De Langen (2001) defines clusters as “a population of geographically concentrated and mutually related business units, associations and public (-private) organisations centred around a distinctive economic specialisation”
The performance of a cluster depends on the presence of agglomeration (dis-) economies (Krugman, 1991). The three advantages (see figure 9-1) of locating in a cluster termed as “external economies of scale” are: 1) the presence of a large labour pool which allows training/educational program; 2) proximity of suppliers and customers offers low transport costs; 3) knowledge spillovers – rapid diffusion of innovations inside clusters. The economies of scale lead to reduction in transport cost and to the establishment of new firms that benefit form low transport costs. Such external economies can be regarded as a ”centripetal force” (Krugman, 1991), a force towards the concentration of activities in clusters.
The opposite of the concentration/agglomeration force, which promotes clustering, is the “centrifugal force” towards deconcentration/disagglomeration that hinder clustering (Krugman, 1991).

Centripetal forces	Centrifugal force
External economies including:	External diseconomies including:
- labour pool	-land rent
-suppliers	-congestion
- knowledge spillovers	
-external transport economies	
Product/market characteristics	Product/market characteristics
-internal economies of scale	-market regulation
-modularity of products	-importance of transport/communication costs

Figure 9-1 Centripetal and centrifugal forces (De Langen, 2001)

The internal competition that fosters specialisation and therefore market coverage, the entry and exit barriers that influence the performance of clusters, and the heterogeneity of the cluster population that adds to the competitiveness of a cluster are the most important structural variables in the structure of clusters.

The cluster concept broadens our understanding why “the core of the seaport cluster is the cargo handling system” (Teurelinx, 2000) that consists of all activities, which facilitate the loading and unloading of cargo, and require general facilities such as entry channels and berths.

Here we can have a discussion about congestion (train and roads), land scarcity problem and market regulation in the Port of Hamburg. During interviews with shipping lines and other actors in shipping business, the congestion problems in ports in Northern Europe and following restrictions in the traffics volumes through Europe in future were underlined. Such centrifugal forces as congestion and land scarcity are factors that limit concentration in clusters. However fairway dues in the Port of Göteborg can be considered as prophylactic measures for saving land use and extenuating environmental pollution. The conclusion can be drawn that fairway due as a market regulation decreases centrifugal forces and in this case protects agglomeration.

10 References

10.1 Articles

ContainerPort, (2001), *The Fast Show*, June/July issue, p.20-25, Maritime Content Limited

De Langen, P.W., (2001), *A Framework for Analysing Seaport Clusters*, World Conference on Transport Research (WCTR), Seoul, Korea, July 22-27, 2001

Teurelinx, D., (2000), *Functional Analysis of Port Performance as a Strategic Tool for Strengthening a Port's Competitive and Economic Potential*, International Journal of Maritime Economics vol. 2 issue II

The Scandinavian Shipping Gazette, (2001), June issue, North European Ports

10.2 Books

Banks, J., (1998), *Handbook of simulation: principles, methodology, advances, applications, and practice*, Wiley, New York

Brodin Alf, (2000), *Ports in Transition in Countries in Transition,* Landskrona

Gill, J., & Johnson, P., (1997), *Research Methods for Managers,* Paul Chapman Publishing Ltd, London

Green, P.E., Tull, D.S., (1978), *Research for Marketing Decisions*, Englewood Cliffs, Prentice-Hall, Inc.

Kinnear, T.C., Taylor, J.R., (1979), *Marketing Research*: *An Applied Approach,* McGraw-Hill

Klink, H.A., (1995), *Towards the borderless mainport Rotterdam,* Thesis Publishers, Amsterdam

Krugman, P., (1991), *Geography and trade*, Leuven University Press

Körner, S., (1996), *Praktisk Statistik* Studentlitteratur, Lund

Lumsden, K., (1998), *Logistikens grunder,* Studentlitteratur, Lund 2000

Rubenowitz, S., (1980), *Utrednings- och forskningsmetodik,* Esselte Studium, Göteborg

Stopford, M., (1992), *Maritime Economics,* Routledge, London

Svenning, C., (1996), *Metodboken*, Lorentz Förlag, Staffanstorp

Wijnolst, N., Wergeland, T., (1997), *Shipping,* Delft University Press, The Netherlands

Wijnolst, N., et al, (1993), *Innovation In Shortsea Shipping: Self-loading and – Unloading Unitload Shipsystems*, Delft University Press

10.3 Company Material

Port of Göteborg AB, *Annual Report 2000*

Port of Göteborg AB, Port of Göteborg AB - The Port of Scandinavia, October 2001

Port of Hamburg, Port of Hamburg Handbook 2001/2002, Compass Publications Limited

10.4 Reports

Coker, O., (2002), *The Viability of the Port of Göteborg as a Transit Port*, Gothenburg University, School of Economics and Commercial Law, Graduate Business School, Master Thesis 2002:22, work in progress

EuroFutures, 1999, *Östersjötangenten – snabbaste vägen till världen,* concultancy report (http://www.eurofutures.se)

Interreg II C, European Regional Development Fund, (2001), *A Common Strategic Framework - Maritime Transport in the Baltic Sea Region from a spatial development perspective*, Matros Final Report (Part 1)

Näringsdepartementet, (2001), *Infrastructure Proposal to the Parliament from the Government 2001*, http://www.naring.regeringen.se

Rana, N., (2002), *Land Bridge – As an Exponent of Inter-Modality in Trans-Ocean Shipping*, Gothenburg University, School of Economics and Commercial Law, Graduate Business School, Master Thesis 2002:26

Swedish Maritime Administration, (1998), *Svensk sjöfartsnäring hot och möjligheter 1998,* http://www.sjofartsverket.se

Swedish Maritime Administration, (1999), *Baltic maritime outlook 2000,* Swedish Maritime Administration, Norrköping, November 1999

Swedish Maritime Administration, (2001), *Action Plan For Maritime Transport In The Baltic Sea Region* – Follow up report, http://www.sjofartsverket.se

10.5 Interviews

These are the people that we have interviewed:

- Aseco, Johan Moerth
- BRAX Shipping, Mikael Lagström
- Evergreen, Björn Eklund
- Green Cargo, Jan Bergstrand
- Green Carrier, Kent Krook
- Maersk Sealand, Mats Svensson
- Mariterm, Anders Sjöbris
- Maritime Forum, Per Jessing
- Maritime Transport & Agencies AB (MTA), Christer Möller
- NYK Line, Lars Rexius
- ONYX Logistics Centre, Jan-Olov Nilsson & Johan Persson
- Port of Göteborg, Eric Nilsson, Clas Sundmark, Alf Olofsson
- Port of Oxelösund, Bo Ytterström
- SOLNiver Lines, Lars Hjalmarsson
- Stena RoRo, Olof Berndtsson
- Team Lines Sweden AB, Karl-Reidar Gundersen & Lennart Gustafsson
- The Institute of Shipping Analysis (SAI), Christopher Pålsson
- The Scandinavian Shipping Gazette, Rolf Petrén Nilsson
- The Swedish Shipowners Association, Per Sjöberger
- TransWeco Agency, Håkan Edman
- UniFeeder, Klas Lundén

10.6 Internet and other sources

The sources that we have gathered information from in the form of via web pages, fax, telephone, and e-mail, are the following:

- Port of Göteborg (http://www.portgot.se)
- Port of Hamburg (http://www.hafen-hamburg.de)
- Port of Karlshamn (http://www.karlshamnshamn.se)
- Port of Klaipeda (http://www.spk.lt)
- Port of Liepaja (http://www.lsez.lv)
- Port of Oxelösund (http://www.oxhamn.se)
- Port of Riga (http://www.rop.lv)
- Port of St. Petersburg (http://www.seaport.spb.ru)
- Port of Tallinn (http://www.portoftallinn.com)
- Baltic Ports Organisation (http://www.bpoports.com)
- EuroFutures, (http://www.eurofutures.se)
- Gothenburg Chartering
- Stena Oil

Appendix 1 – Assumptions

- We are assuming that on every route the vessels will travel at an average of once a week throughout the whole year (52 trips/year).
- We have made the assumption that there are no empty containers in the flows we are calculating. The reason for this is that many ports charge differently depending on whether the containers are empty or full. If we were to include this in our calculations it would be too much for us to put in to our model.
- We assume a split of the containers into 70% 40' containers and 30% 20' containers. This means that when we calculate costs associated with the actual number of containers handled, we have to double 70% of the TEU amount and add that to the remaining 30%. (Example, 300 TEUs would be calculated as 90 20'containers and 105 40'containers, i.e. 195 physical units.)
- On the bunker market, there are four main types of bunkers. There is IFO180, IFO380, MGO, and MDO. For our calculations on the bunker (fuel) cost, we have decided that we will use IFO380 for the main engines and MGO for the help engines.
- We have made the assumption that all of the vessels that we are calculating on are using the same bunker types. The prices are an estimated average for the period between August 2000 and August 2001. The information on this has been provided to us from STENA Oil in Göteborg.
- We have had to make the assumption that the vessels consume the same amount of fuel throughout the entire voyage regardless their speed. We are aware that the relation between the vessels speed and consumption is more of an exponential relation than a linear.
- We assume that the main engines are operating during the time at sea and during the tie in the fairways, and that the help engines are running all the time (even when the ship is performing cargo operations at a terminal).
- For our calculation on Ro/Ro traffic, we have assumed that there will mainly be trailers that will go on the assigned routes. This assumption we make on the premise that lorries (which would be the natural alternative

to a trailer) are more likely to be used on shorter distances since the driver of the lorry will be accompanying the lorry on the trip. However, since our calculation will be on routes of a longer distance we have assumed that there will only be trailers.

- For our calculation on the utilisation degree on the Ro/Ro vessels, we have derived the trailer capacity from the total amount of lane-meters. The lane meters have been divided by 14 meters (which we have taken as the average length of a trailer without a driving vehicle) and then multiplied by 0,8 to compensate for the fact that the trailers are not packed right against each other on board of the vessel.
- The average weight for a trailer we have set to 17 tons (17,000 kg). This assumption is based on estimates that we received from the Port of Göteborg AB.
- The average weight that we will use for containers is 14 tons for container flows that are eastbound (to BSRR) and 17 tons for those that are westbound (from BSRR) (based on estimates that we received from the Port of Göteborg AB).
- In the Port of Riga, sanitary dues of 0,05 USD/GT are charged for ships equipped with garbage and segregated water treatment. We assume that all the ships we use apply to this condition.
- For the sanitary dues in the Port of Liepaja we assume that no ship will ever stay longer than 10 days.
- Environmental differentiated dues in Swedish ports are multiplied by 12 (maximum number of times that dues are paid per year) and then divided by the actual number of calls, i.e. 52 (cost per call = 5 SEK x 12 / 52).
- For the ports that we have not been able to get information from regarding the productivity of the containers cranes and the time it take to unload trailers, we have used the same information that we have received from the Port of Göteborg.
- We assume that the fairway time in each port is the same for all vessel types.
- For the Port of Hamburg tonnage dues, we assume that no vessels stay longer than 24 hours.

- We are not calculating with any ice-dues at the Port of Tallinn, since it is difficult for us to put it into the model and be able to change the number of calls per year. (Ice-dues are only collected during wintertime and is only a small part of the total sum.)
- For the Port of St. Petersburg we have made the assumption that no vessel will stay for longer than 24 hours at any time.
- We assume that the agency fees that we got for the Port of Oxelösund are the same in the Port of Göteborg and the Port of Karlshamn
- We have not received any cargo handling costs for the Port of Riga, so we are applying the same as for the Port of Liepaja with the motivation that it is a port within the same country.
- For the ports of Karlshamn and Oxelösund we have assumed the same productivity as in the Port of Göteborg, since we have not been able to get any information on this.

Appendix 2 – Calculation Model

Input data

Routes

Oxelösund	-	St.Petersburg	Ro/Ro
Oxelösund	-	St.Petersburg	Lo/Lo
Oxelösund	-	Tallinn	Ro/Ro
Oxelösund	-	Tallinn	Lo/Lo
Oxelösund	-	Riga	Ro/Ro
Oxelösund	-	Riga	Lo/Lo
Oxelösund	-	Liepaja	Ro/Ro
Oxelösund	-	Liepaja	Lo/Lo
Göteborg	-	St.Petersburg	Ro/Ro
Göteborg	-	St.Petersburg	Lo/Lo
Göteborg	-	Tallinn	Ro/Ro
Göteborg	-	Tallinn	Lo/Lo
Göteborg	-	Riga	Ro/Ro
Göteborg	-	Riga	Lo/Lo
Göteborg	-	Klaipeda	Ro/Ro
Göteborg	-	Klaipeda	Lo/Lo
Göteborg	-	Liepaja	Ro/Ro
Göteborg	-	Liepaja	Lo/Lo
Hamburg	-	St.Petersburg	Ro/Ro
Hamburg	-	St.Petersburg	Lo/Lo
Hamburg	-	Tallinn	Ro/Ro
Hamburg	-	Tallinn	Lo/Lo
Hamburg	-	Riga	Ro/Ro
Hamburg	-	Riga	Lo/Lo
Hamburg	-	Klaipeda	Ro/Ro
Hamburg	-	Klaipeda	Lo/Lo
Hamburg	-	Liepaja	Ro/Ro
Hamburg	-	Liepaja	Lo/Lo
Karlshamn	-	Riga	Ro/Ro
Karlshamn	-	Riga	Lo/Lo
Karlshamn	-	Klaipeda	Ro/Ro
Karlshamn	-	Klaipeda	Lo/Lo
Karlshamn	-	Liepaja	Ro/Ro
Karlshamn	-	Liepaja	Lo/Lo

Vessel characteristics

	RoRo			LoLo		
	RoRo1	RoRo2	RoRo3	LoLo1	LoLo2	LoLo3
GT	7817	12337	15900	3200	4000	9200
DWT	4405	8765	12300	4200	5200	13100
NT	2344	3701	4500	1500	2200	5300
Conventional volume cub.m.	13511,8	21993,0	32997,9	9440,0	12252,2	30054,2
LOA (meter)	121,4	168,8	195,3	100	102	147
Beam (width in m.)	21	20,2	25,6	16	18,2	23,5
Draft (depth in m.)	5,3	6,45	6,6	5,9	6,6	8,7
Lane meter	1250	2050	3000			
Average Speed	15	19	22	15	16	19
TEU capacity	353	533	849	300	500	1000
Trailer capacity	71	117	171			
Bunker type						
main engine	IFO 380	IFO 380	IFO 380	IFO 380	IFO 380	IFO 380
help engine	MGO	MGO	MGO	MGO	MGO	MGO
Bunker consumption						
main engine (ts/day)	24	46	75	17	22	40
help engine (ts/day)	2	4	**3**	2	3	4
Ice-class	1A	1A	1A	1A	1A	1A

The vessel's conventional volume in m^3. is calculated by multiplying the values of overall length, maxim. breath and overall depth specified in the vessel's documents.

Distances

Nautical miles	Gothenburg	St. Petersb.	Tallinn	Riga	Liepaja	Klaipeda	Hamburg	Oxelösund	Karlshamn
Gothenburg		847	665	609	459	453			307
St. Petersb.	847		187	457	433	478	1200	416	591
Tallinn	665	187		291	267	316	700	245	
Riga	609	457	291		181	236	640	233	373
Liepaja	459	433	267	181		53	493	200	221
Klaipeda	453	478	316	236	53		487		223
Hamburg		1200	700	640	493	487			228
Oxelosund		416	245	233	200				
Karlshamn	307	591		373	221	223	228		

Currency

	SEK	USD	DEM	EUR
SEK	1	0,095115	0,2079	0,10636
USD	10,5036	1	2,1858	1,11819
DEM	4,80274	0,457247	1	0,51129
EUR	9,39862	0,8943	1,95583	1

Sunday 11th November 2001 (14:13)
http://se.finance.yahoo.com/m3

Weights

Unit weights	Tons (1.000 kg)
Trailers	17
Containers (from BSRR)	17
Containers (to BSRR)	14

Charter costs

RO/RO		
RoRo1	RoRo2	RoRo3
6000	9500	16500

LO/LO		
LoLo1	LoLo2	LoLo3
3500	5000	7000

charter costs per day in USD

Bunker Prices

	Bunker Type	**IFO 380**		**Marine Gas Oil**		
	Cost ($)	**125**		**232,3**		
	This is the average prices for the three markets below					
Bunker prices August 2000 - August 2001						
	Göteborg *		**Hamburg ***		**St. Petersburg**	
	IF 380	**MGO**	**IF 380**	**MGO**	**IF 380**	**MGO**
aug-00	139	280	143	278	132	266
sep-00	160	325	163	315	152	309
okt-00	167	318	170	305	159	302
nov-00	153	309	161	301	145	294
dec-00	134	284	138	275	127	270
jan-01	108	244	112	238	103	232
feb-01	123	245	125	237	117	233
mar-01	130	246	132	226	124	234
apr-01	114	232	120	225	108	220
maj-01	127	239	130	236	106	251
jun-01	126	243	128	237	112	258
jul-01	120	237	122	219	107	235
aug-01	127	241	128	213	120	243
* Please Note: All prices are in USD p/Mt						

Göteborg port costs

Port	Göteborg	
Fairway due (SEK/GRT)		
Environmental dues (SEK/GT)	5	maximum 100.000 SEK/call
Fairway dues on goods (SEK/NT)	3,6	
Fairway time (hours, one way)	1,5	
Harbour dues for ships (SEK/GT)		
container	1,7	
Ro/Ro	3	
Harbour dues for cargo		
20' container (SEK/unit)	205	
40' container (SEK/unit)	295	
Trailers (SEK/nt. of cargo)	15	
Agency fee (SEK/call)		
RoRo1	3 500,00	
RoRo2	4 000,00	
RoRo3	5 000,00	
LoLo1	3 500,00	
LoLo2	4 000,00	
LoLo3	5 200,00	
Average stevedore's tariffs		
20' container (USD/unit)	85	
40' container (USD/unit)	85	
trailer (SEK/unit)	600,0	
Productivity		
crane lifts/hour (container)	25	
trailers loaded/discharged per hour	20	

Pilotage Dues (SEK/call)						
	Gross tonnage					
Piloted time, h	2001-3000	3001-4000	4001-5000	5001-8000	8001-12000	12001-20000
1	2312	2601	3035	3468	3902	4335
1,5	2728	3069	3581	4092	4604	5115
2	3144	3537	4127	4716	5306	5895
2,5	3560	4005	4673	5340	6008	6675
3	3976	4473	5219	5964	6710	7455
3,5	4392	4941	5765	6588	7412	8235

Boatmen (SEK)		
GT	Arrival	Departure
<1300	335	168
1301-2000	472	236
2001-2600	565	283
2601-3300	680	340
3301-4000	770	385
4001-4700	863	432
4701-5400	941	471
5401-6100	1021	511
6101-6800	1135	568
6801-10200	1441	721
10201-14000	1719	860
14001-21000	2036	1018
21001-26000	2512	1256
26001-35000	2999	1500
35001-50000	3847	1934
50001-75000	5089	2545
75001-100000	7103	3552
100001-150000	9143	4572
150000>	11177	5589

Oxelösund

Port	Oxelösund	
Fairway due		maximum 100.000 SEK/call
Environmental dues (SEK/GT)	5	
Fairway dues on goods (SEK/NT)	3,6	
Harbour dues for ships (SEK/GT)		
Ordinary	2,9	
reduced for liners (-30%)	2,0	
entry fee (SEK/call)	437,5	not to be calculated with GT
Harbour dues for cargo (SEK)		
trailer (empty)	185	Harbour dues for trailers
trailer (loaded)	310	are charged in **SEK/trailer.**
20' container	150	Harbour dues for containers
40' container	250	are charged in **SEK/container.**
Agency fee (SEK/call)		
RoRo1	3 500,00	
RoRo2	4 000,00	
RoRo3	5 000,00	
LoLo1	3 500,00	
LoLo2	4 000,00	
LoLo3	5 200,00	
Fairway time (h/one way)	0,5	

Pilotage Dues (SEK/GT)						
	Gross tonnage					
Piloted time, h	2001-3000	3001-4000	4001-5000	5001-8000	8001-12000	12001-20000
1	2312	2601	3035	3468	3902	4335
1,5	2728	3069	3581	4092	4604	5115
2	3144	3537	4127	4716	5306	5895
2,5	3560	4005	4673	5340	6008	6675
3	3976	4473	5219	5964	6710	7455
3,5	4392	4941	5765	6588	7412	8235

Boatmen (SEK)		
GT	Arrival	Departure
0-999	805,00	405,00
1000-1999	1 230,00	615,00
2000-2999	1 635,00	820,00
3000-3999	1 945,00	975,00
4000-4999	2 140,00	1 070,00
5000-5999	2 445,00	1 220,00
6000-7999	2 900,00	
8000-9999	3 550,00	1 775,00
10000-11999	4 055,00	2 030,00
12000-13999	4 420,00	2 210,00
14000-15999	4 885,00	2 445,00
16000-17999	5 145,00	2 570,00
18000-20999	6 115,00	3 060,00
21000-24999	6 840,00	3 420,00
25000-28999	7 660,00	3 830,00
29000-33999	8 725,00	4 365,00
34000-38999	10 420,00	5 210,00
39000-43999	11 560,00	5 780,00
44000-48999	12 960,00	6 480,00
49000-53999	16 280,00	8 140,00
54000-58999	18 235,00	9 120,00
59000-	20 325,00	10 165,00

Karlshamn

Port	**Karlshamn**	
Fairway due (SEK/GRT)		
Environmental dues (SEK/GT)	5	maximum 100.000 SEK/call
Fairway dues on goods (SEK/NT)	3,6	
Harbour dues for ships (SEK/GT)		
Ordinary	3,55	
Reduced for liners (-30%)	2,5	
Fairway Time (h) both ways	2	
Harbour dues for cargo (SEK/unit)		
Containers	206	SEK per unit
Trailers	74,15	SEK per unit
Agency fee (SEK/call)		
RoRo1	3 500,00	
RoRo2	4 000,00	
RoRo3	5 000,00	
LoLo1	3 500,00	
LoLo2	4 000,00	
LoLo3	5 200,00	

Pilotage Dues (SEK/GT)						
	Gross tonnage					
Piloted time, h	2001-3000	3001-4000	4001-5000	5001-8000	8001-12000	12001-20000
1	2312	2601	3035	3468	3902	4335
1,5	2728	3069	3581	4092	4604	5115
2	3144	3537	4127	4716	5306	5895
2,5	3560	4005	4673	5340	6008	6675
3	3976	4473	5219	5964	6710	7455
3,5	4392	4941	5765	6588	7412	8235

Boatmen (SEK)					
ton DW	**Arrival**	**Departure**	**ton DW**	**Arrival**	**Departure**
0-500	320	140	20001-21000	2415	800
501-1000	430	160	21001-22000	2500	840
1001-1500	450	180	22001-23000	2580	855
1501-2000	495	190	23001-24000	2600	860
2001-2500	505	210	24001-25000	2625	870
2501-3000	575	220	25001-26000	3285	1085
3001-4000	720	230	26001-27000	3300	1090
4001-5000	920	300	27001-28000	3320	1095
5001-6000	1160	385	28001-29000	3445	1150
6001-7000	1225	410	29001-30000	3615	1200
7001-8000	1255	430	30001-35000	3760	1235
8001-9000	1390	460	35001-40000	4520	1485
9001-1000	1475	495	40001-45000	5035	1650
10001-11000	1570	515	45001-50000	5575	1840
11001-12000	1650	565	50001-55000	6100	2010
12001-13000	1800	610	55001-60000	6630	2180
13001-14000	1890	620	60001-65000	7150	2360
14001-15000	1960	650	65001-	7665	2535
15001-16000	2030	685			
16001-17000	2115	695			
17001-18000	2180	715			
18001-19000	2255	750			
19001-20000	2330	770			

Hamburg

PORT	Hamburg
Tonnage Dues (EUR/GT)	
minimum charge for the first 24 hours of berthing time	0,37
Weight Dues (EUR/1.000 kg of cargo)	
ships on short distance European routes	3
Agency Fee (EUR/call)	
RoRo1	1733,28
RoRo2	2748,19
RoRo3	3492,12
LoLo1	1733,28
LoLo2	1953,14
LoLo3	3609,72
Pilot Dues	
Kiel Fjord + Kiel-Canal + River Elbe + Hamburg harbour	
	(EUR for **one** passage)
RoRo1	**5475**
RoRo2	**6733**
RoRo3	**7598**
LoLo1	**3326**
LoLo2	**3928**
LoLo3	**5905**
Fairway time (both ways, in hours)	8
Handling Charges	
trailer	119
20' container	71,84
40' container	71,84
Productivity	
crane lifts per hour (container)	25
number of trailers loaded/discharged per hour	20

Mooring & Unmooring Dues (EUR)		
GT	Mooring	Unmooring
0-1000	88,96	59,31
1001-2500	153,39	102,26
2601-4000	182,53	121,69
4001-5500	269,96	179,97
5501-7500	346,66	231,10
7501-10000	423,35	282,23
10001-13500	475,50	316,20
13501-17000	745,46	496,98
17001-25000	935,66	623,78
25001-35000	1061,44	707,63
35001-50000	1213,30	808,86
50001-60000	1345,21	896,81
60000-	1490,93	993,95

St.Petersburg

For calculating all types of dues **the conventional volume** of :
Ro/Ro and container carrying vessels **is multiplied by 0,70** factor
Tankers with double bottom double skin or segregated ballast tanks are to be multiplied by 0,85 factor. Basic rates of port dues for foreign ships per m^3 In USD

Port	**St.Petersburg**	
Tonnage dues (m3)	$	
Ordinary	0,24	
Reduced	0,081	
Light Dues	0,025	
Canal Dues	0,14	has been multiplied by 2
Berth Dues (when cargo is handled)	0,0031	must be multiplied with m3
		and 24 hour's period
Anchorage Dues	0,0001	must be multiplied with m3 and
		time of service in hours
Environment Dues		
stay at port < 10 days	0,027	
stay at port 10 to 30 days	0,038	
Pilotage Dues		
Coastal	0,0486	
Harbour	0,0116	
Navigation Dues	0,013	

Fairway distance (nautical miles)	27
Fairway speed (in knots)	6
Average stevedore'starifs	
	ST.P
Vessel - terminal (terminal - vessel)	
Containers 20 TEU full	71,5
Containers 20 TEU empty	55,9
Containers 40 TEU full	79,2
Containers 40 TEU empty	59,8
Productivity	
lifts per hour	25
number of trailers loaded/discharged per hour	10

Tallinn

Tonnage dues	0,4	DEM/GT
Quay charges	GT	DEM
	1- 350	100
	351 - 500	200
	501 - 750	400
	751 - 1,000	600
	1,001 - 1,500	700
	1,501 - 2,000	900
	2,001 - 2,500	1000
	2,501 - 3,000	1200
	3,001 - 3,500	1400
	3,501 - 4,000	1700
	4,001 - 5,000	1900
	5,001 - 6,000	2100
	6,001 - 8,000	2500
	8,001 - 10,000	3200
	10,001 - 12,500	3500
	12,501 - 15,000	3800
	15,001 - 20,000	5000
	20,001 - 30,000	6000
	30,001 - 50,000	9000
	50,001 and over	9500

For container and ro-ro vessels on regular lines from tonnage dues					
and quay charges:	1-20 calls		0,2		
	21-50 calls		0,3		
	starting from the 51st call		**0,5**	%-rebate	
For container and ro- ro vessels on a regular line, the number of calls of which is					
3 and more times a week, starting from the first call			0,65		

Mooring Dues	GT	DEM
	1- 350	30
	351 - 500	60
	501 - 750	80
	751 - 1,000	100
	1,001 - 1,500	110
	1,501 - 2,000	120
	2,001 - 2,500	130
	2,501 - 3,000	150
	3,001 - 3,500	170
	3,501 - 4,000	190
	4,001 - 5,000	210
	5,001 - 6,000	230
	6,001 - 8,000	260
	8,001 - 10,000	290
	10,001 - 12,500	310
	12,501 - 15,000	340
	15,001 - 20,000	370
	20,001 - 30,000	410
	30,001 - 50,000	450
	50,001 and over	500

Pilotage, lighthouse	GT	
	100-250	40
	251-500	80
	501-1000	160
	1001-1500	240
	1501-2000	320
	2001-3000	400
	3001-5000	480
	5001-7500	600
	7501-10000	720
	10001-12500	800
	12501-15000	960
	15001-18000	1120
	18001-24000	1280
	24001-30000	1520
	30001-40000	1760
	40001-60000	2000
	>60001	2400

Fairway Time (h/one way)	1,00
Average stevedore'starifs	
Vessel - terminal	DEM
Containers 20 TEU full	115
Containers 20 TEU empty	60
Containers 40 TEU full	154
Containers 40 TEU empty	75
	DEM
Semi Trailers	88
Lorries	80
Productivity	
crane lifts per hour	20
trailers loaded/discharged per hour	10

Riga

PORT	RIGA			
Tonnage Dues	USD/GT	Liners shall enjoy rebates on **all Port Dues**:		
Vessel types		calls	10 to 20	10%
container	0,16		21 to 50	20%
ro/ro	0,13		> 50	40%
Canal Dues	USD/GT			
Vessel types				
container	0,11			
ro/ro	0,08			
Sanitary Dues	USD/GT			
	0,05	for ships equipped with garbage and		
		segregated water treatment facilities		
	0,093	for other ships		
Berthing Dues	USD/GT			
	0,1			
Pilotage Dues	USD/GT			
	0,2			
Anchorage Dues	USD/GT			
	0,012	if the vessel is not engaged in cargo operations		
	0,065	if the vessel performs cargo operations for the whole period		

Fairway Time (h/one both ways)	3,00
Cargo Dues	USD/unit
Containers 20 TEU	50
Containers 40 TEU	75
Trailers	55
Trucks	30
Productivity	
lifts per hour (container)	20
number of trailers loaded/discharged per hour	10

Liepaja

PORT	Liepaja	
Tonnage Dues	USD/GT	
Basic rate	0,26	
Ro/Ro vessels -30%	0,182	
Liner traffic -20%	0,208	
Ro/Ro liner - 60%	0,104	
Canal Dues	USD/GT	Has been multiplied by 2 (arrival and departure)
Basic rate	0,34	For the first 6 times.
Ro/Ro type ships	0,22	From the 7th call.
Ro/Ro liner rebate -50%	0,17	
Anchorage Dues	USD/GT	
	0,01	collected from ships which have stayed for more than 12 hours
Sanitary Dues	USD/GT	
	0,05	up to 10 days
	0,08	11-30 days
	0,10	over 30 days
Mooring	GT	USD
	0-600	35
	601-1400	45
	1401-2700	55
	2701-4000	60
	4001-5500	70
	5501-8000	90
	8001-11000	110
	11001-15000	115
	15001-2000	130
	20001-40000	160
	40000 and more	180
Fairway Time (h/one way)	1	

Wharfage	USD/GT
	0,08
rebate for Ro/Ro -30%	0,056

Agency Fee
liner vessels 20% rebate

GT	USD/call	GT	USD/call
up to 500	460	8000	1780
800	520	8500	1840
1000	605	9000	1895
1200	685	9500	1980
1500	765	10000	2040
1800	835	11000	2100
2000	875	12000	2160
2200	920	13000	2200
2400	960	14000	2280
2600	1050	14000	2340
2800	1105	15000	2450
3000	1155	17500	2520
3200	1180	20000	2680
3400	1200	22500	2960
3600	1225	27500	3150
3800	1260	30000	3320
4000	1305	32500	3480
4500	1350	35000	3650
5000	1420	40000	3960
5500	1480	50000	4270
6000	1540	50001 and more	4490
6500	1600		
7000	1660		
7500	1720		

Stevedore's tariffs	DEM
Trailers	55
Trucks	30
Containers 20 TEU full	90
Containers 20 TEU empty	80
Containers 40 TEU full	120
Containers 40 TEU empty	100

Productivity	
crane lifts per hour (container)	20
number of trailers loaded/discharged per hour	10

Klaipeda

PORT	**Klaipeda**		
Vessel dues (USD/GT)	0,40		
50% rebate for liners	0,2		
Tonnage dues (USD/GT of cargo)		5% rebate	more then 100000 tons
conteiner	0,5	10%	more then 200000 tons
trailer	0,32	15%	more then 500000 tons
Sanitary Dues (USD/GT)	0,054	<104 calls/year = max 240 USD/call	
Pilotage dues (USD/GT)	0,27		
	for one call/leave to the port 0,27 USD for GT *2		
Berth Dues (USD/GT)			
Container	0,08		
50% rebate for liners	0,04		
Ro/Ro	0,06		
50% rebate for liners	0,03		
Mooring dues (USD/GT)			
for each operation	0,01		
Ro/Ro	0,007		
Fariway time (both way)	2		
Stevedore's tariffs	USD		
Containers 20 TEU full	70		
Containers 20 TEU empty	35		
Containers 40 TEU full	90		
Containers 40 TEU empty	50		
Semi Trailers	85,7		
Lorries	47,6		
Productivity			
crane lifts per hour (container)	20		
trailers loaded/discharged per hour	10		

Land Bridge Data

The road haulage costs is for haulage in **one** direction plus the handling charges at the ports
Round trip road haulage distance for both the selected locations of Oxelösund
and Karlshamn from Göteborg is 772 km and 645 km respectively.
Service is charged at a price of 8 SEK per kilometre.

Mode	**Train**	**Train**
Destination	Göteborg - **Oxelösund** - Göteborg	Göteborg - **Karlshamn** - Göteborg
Cost/TEU (SEK)	3100	2800

The train haulage costs is for haulage in **one** direction plus the handling charges at the ports

The handling charges for loading/unloading of trailers from/into vessels is 310 SEK
in Karlshamn and 225 SEK in Oxelösund.

Time information

Mode	**Rail**	**Rail**
Route	Göteborg - Oxelösund	Göteborg - Karlshamn
Time (h/one way)	13,75	12,25

Mode	**Road**	**Road**
Route	Göteborg - Oxelösund	Göteborg - Karlshamn
Time (h/one way)	8,29	7,42

Average speed: **73 km/h,** according to Schenker
The times specified above are including the terminal handling at the ports.
We have assumed the same productivity at Karlshamn and Oxelösund as in Göteborg.

Output data

Göteborg - St.Petersburg - Göteborg				
Vessel		LoLo 1	LoLo 2	LoLo 3
Distance (nm)		1 694,0	1 694,0	1 694,0
Speed (knots)		15,0	16,0	19,0
Time in open sea (h)		112,9	105,9	89,2
Fairway time (h)				
St. Petersburg		9,0	9,0	9,0
Göteborg		3,0	3,0	3,0
Time in Port (h)				
St. Petersburg		9,4	15,6	31,2
Göteborg		9,4	15,6	31,2
Total time (hours)		**143,7**	**149,1**	**163,6**
TEU capacity		300,0	500,0	1 000,0
utilisation from Göteborg	60%	180,0	300,0	600,0
utilisation from St.Petersburg	60%	180,0	300,0	600,0
Time-charter rate (USD)		**20 949,4**	**31 057,3**	**47 704,4**
Fuel cost (USD)		**13 843,1**	**17 835,9**	**27 407,9**
main engines		11 061,8	13 506,5	21 074,6
help engines		2 781,3	4 329,4	6 333,3
Port cost (USD)		**11 088,3**	**16 654,1**	**34 457,2**
St.Petersburg		2 314,4	3 009,2	7 414,2
Göteborg		8 773,9	13 644,9	27 043,1
Cargo handling costs (USD)		**37 591,2**	**62 652,0**	**125 304,0**
St.Petersburg		17 701,2	29 502,0	59 004,0
Göteborg		19 890,0	33 150,0	66 300,0
Result		**83 472,0**	**128 199,2**	**234 873,5**
Number of units handled		360,0	600,0	1 200,0
Cost per unit		**231,9**	**213,7**	**195,7**

Göteborg - Tallinn - Göteborg						
Vessel		LoLo 1		LoLo 2		LoLo 3
Distance (nm)		1 330,0		1 330,0		1 330,0
Speed (knots)		15,0		16,0		19,0
Time in Sea (h)		88,7		83,1		70,0
Fairway time (h)						
Göteborg		3,0		3,0		3,0
Tallinn		2,0		2,0		2,0
Time in Port (h)						
Tallinn		11,7		19,5		39,0
Göteborg		9,4		15,6		31,2
Total time		**114,7**		**123,2**		**145,2**
TEU capacity		300,0		500,0		1 000,0
utilisation from Göteborg	60%	180,0		300,0		600,0
utilisation from Tallinn	60%	180,0		300,0		600,0
Time-charter rate (USD)		**16 731,0**		**25 671,9**		**42 350,0**
Fuel cost (USD)		**10 514,6**		**13 676,3**		**21 247,5**
main engines		8 293,4		10 097,7		15 625,0
help engines		2 221,2		3 578,7		5 622,5
Port cost (USD)		**9 684,3**		**14 706,3**		**29 078,9**
Tallinn		910,4		1 061,4		2 035,9
Göteborg		8 773,9		13 644,9		27 043,1
Cargo handling costs (USD)		**34 449,4**		**57 415,7**		**114 831,4**
Tallinn		14 559,4		24 265,7		48 531,4
Göteborg		19 890,0		33 150,0		66 300,0
Result (USD)		**71 379,4**		**111 470,2**		**207 507,8**
Number of units handled		360,0		600,0		1 200,0
Cost per unit (USD)		**198,3**		**185,8**		**172,9**

Göteborg - Riga - Göteborg						
Vessel		LoLo 1		LoLo 2		LoLo 3
Distance (nm)		1 218,0		1 218,0		1 218,0
Speed (knots)		15,0		16,0		19,0
Time in Sea (h)		81,2		76,1		64,1
Fairway time (h)						
Riga		3,0		3,0		3,0
Göteborg		3,0		3,0		3,0
Time in Port (h)						
Riga		11,7		19,5		39,0
Göteborg		9,4		15,6		31,2
Total time		**108,3**		**117,2**		**140,3**
TEU capacity		300,0		500,0		1 000,0
utilisation from Göteborg	60%	180,0		300,0		600,0
utilisation from Riga	60%	180,0		300,0		600,0
Time-charter rate (USD)		**15 787,9**		**24 421,9**		**40 922,4**
Fuel cost (USD)		**9 816,9**		**12 814,6**		**20 038,2**
main engines		7 720,8		9 410,2		14 605,3
help engines		2 096,0		3 404,4		5 432,9
Port cost (USD)		**10 089,1**		**15 288,9**		**30 824,3**
Riga		1 315,2		1 644,0		3 781,2
Göteborg		8 773,9		13 644,9		27 043,1
Cargo handling costs (USD)		**34 740,0**		**57 900,0**		**115 800,0**
Riga		14 850,0		24 750,0		49 500,0
Göteborg		19 890,0		33 150,0		66 300,0
Result		**70 433,9**		**110 425,3**		**207 584,8**
Number of units handled		360,0		600,0		1 200,0
Cost per unit		**195,6**		**184,0**		**173,0**

Göteborg-Liepaja-Göteborg						
Vessel		LoLo 1		LoLo 2		LoLo 3
Distance (nm)		918,0		918,0		918,0
Speed (knots)		15,0		16,0		19,0
Time in Sea (h)		61,2		57,4		48,3
Fairway time (h/both ways)						
Liepaja		2,0		2,0		2,0
Göteborg		3,0		3,0		3,0
Time in Port (h)						
Liepaja		11,7		19,5		39,0
Göteborg		9,4		15,6		31,2
Total time		**87,3**		**97,5**		**123,5**
TEU capacity		300,0		500,0		1 000,0
utilisation from Göteborg	60%	180,0		300,0		600,0
utilisation from Liepaja	60%	180,0		300,0		600,0
Time charter cost		**12 725,4**		**20 307,3**		**36 025,4**
Fuel cost ($)		**7 550,9**		**9 978,0**		**15 890,3**
main engines		5 861,5		7 147,1		11 107,5
help engines		1 689,5		2 830,8		4 782,8
Port cost		**12 923,5**		**18 544,9**		**36 650,7**
Liepaja		4 149,6		4 900,0		9 607,6
Göteborg		8 773,9		13 644,9		27 043,1
Cargo handling costs		**31 254,3**		**52 090,4**		**104 180,9**
Liepaja		11 364,3		18 940,4		37 880,9
Göteborg		19 890,0		33 150,0		66 300,0
Result		**64 454,1**		**100 920,6**		**192 747,2**
Number of units handled		360,0		600,0		1 200,0
Cost per unit		**179,0**		**168,2**		**160,6**

Göteborg - Klaipeda - Göteborg				
Vessel		LoLo 1	LoLo 2	LoLo 3
Distance (nm)		906,0	906,0	906,0
Speed (knots)		15,0	16,0	19,0
Time in Sea (h)		60,4	56,6	47,7
Fairway time (h)				
Göteborg		3,0	3,0	3,0
Klaipeda		2,0	2,0	2,0
Time in Port (h)				
Göteborg		9,4	15,6	31,2
Klaipeda		11,7	19,5	39,0
Total time		**86,5**	**96,7**	**122,9**
TEU capacity		300,0	500,0	1 000,0
utilisation from Göteborg	60%	180,0	300,0	600,0
utilisation from Klaipeda	60%	180,0	300,0	600,0
Time-charter rate (USD)		**12 608,8**	**20 151,0**	**35 841,2**
Fuel cost (USD)		**7 464,6**	**9 870,3**	**15 734,2**
main engines		5 790,6	7 061,2	10 975,9
help engines		1 674,0	2 809,1	4 758,3
Port cost (USD)		**13 288,2**	**20 043,4**	**40 852,9**
Klaipeda		4 514,3	6 398,5	13 809,8
Göteborg		8 773,9	13 644,9	27 043,1
Cargo handling costs (USD)		**38 790,0**	**64 650,0**	**129 300,0**
Klaipeda		18 900,0	31 500,0	63 000,0
Göteborg		19 890,0	33 150,0	66 300,0
Result (USD)		**72 151,5**	**114 714,7**	**221 728,3**
Number of units handled		360,0	600,0	1 200,0
Cost per unit (USD)		**200,4**	**191,2**	**184,8**

Göteborg - St.Petersburg - Göteborg						
Vessel		RoRo 1		RoRo 2		RoRo 3
Distance (nm)		1 694,0		1 694,0		1 694,0
Speed (knots)		15,0		19,0		22,0
Time in Sea (h)		112,9		89,2		77,0
Fairway time (h)						
St.Petersburg		9,0		9,0		9,0
Göteborg		3,0		3,0		3,0
Time in Port (h)						
St.Petersburg		8,5		14,0		20,5
Göteborg		4,3		7,0		10,3
Total time		**137,7**		**122,2**		**119,8**
Trailer capacity		71,0		117,0		171,0
utilisation from Göteborg	60%	42,6		70,2		102,6
utilisation from St.Petersburg	60%	42,6		70,2		102,6
Time-charter rate (USD)		**34 428,3**		**48 377,9**		**82 348,8**
Fuel cost (USD)		**18 282,9**		**28 968,3**		**38 244,2**
main engines		15 616,7		24 235,7		34 765,6
help engines		2 666,3		4 732,5		3 478,6
Port cost (USD)		**10 286,3**		**16 104,9**		**22 321,7**
St.Petersburg		3 311,8		5 399,1		8 115,7
Göteborg		6 974,5		10 705,8		14 206,0
Cargo handling costs (USD)		**6 988,4**		**11 516,1**		**16 831,2**
St.Petersburg		2 121,5		3 496,0		5 109,5
Göteborg		4 866,9		8 020,1		11 721,7
Result		**69 986,0**		**104 967,2**		**159 745,9**
Number of units handled		85,2		140,4		205,2
Cost per unit		**821,4**		**747,6**		**778,5**

Göteborg - Tallinn - Göteborg				
Vessel		RoRo 1	RoRo 2	RoRo 3
Distance (nm)		1 330,0	1 330,0	1 330,0
Speed (knots)		15,0	19,0	22,0
Time in Sea (h)		88,7	70,0	60,5
Fairway time (h)				
Tallinn		2,0	2,0	2,0
Göteborg		3,0	3,0	3,0
Time in Port (h)				
Tallinn		8,5	14,0	20,5
Göteborg		4,3	7,0	10,3
Total time		**106,4**	**96,1**	**96,2**
Trailer capacity		71,0	117,0	171,0
utilisation from Göteborg	60%	42,6	70,2	102,6
utilisation from Tallinn	60%	42,6	70,2	102,6
Time-charter rate (USD)		**26 611,7**	**38 023,8**	**66 161,3**
Fuel cost (USD)		**13 769,3**	**21 688,4**	**28 363,0**
main engines		11 708,3	17 968,8	25 568,2
help engines		2 060,9	3 719,7	2 794,8
Port cost (USD)		**8 709,9**	**13 143,1**	**17 486,3**
Tallinn		1 735,5	2 437,3	3 280,3
Göteborg		6 974,5	10 705,8	14 206,0
Cargo handling costs (USD)		**8 297,0**	**13 672,6**	**19 983,0**
Tallinn		3 430,1	5 652,5	8 261,3
Göteborg		4 866,9	8 020,1	11 721,7
Result		**57 387,9**	**86 527,8**	**131 993,5**
Number of units handled		85,2	140,4	205,2
Cost per unit		**673,6**	**616,3**	**643,2**

Göteborg - Riga - Göteborg						
Vessel		RoRo 1		RoRo 2		RoRo 3
Distance (nm)		1 218,0		1 218,0		1 218,0
Speed (knots)		15,0		19,0		22,0
Time in Sea (h)		81,2		64,1		55,4
Fairway time (h)						
Göteborg		3,0		3,0		3,0
Riga		3,0		3,0		3,0
Time in Port (h)						
Riga		8,5		14,0		20,5
Göteborg		4,3		7,0		10,3
Total time		**100,0**		**91,2**		**92,1**
Trailer capacity		71,0		117,0		171,0
utilisation from Göteborg	60%	42,6		70,2		102,6
utilisation from Riga	60%	42,6		70,2		102,6
Time-charter rate (USD)		**24 995,0**		**36 086,3**		**63 348,8**
Fuel cost (USD)		**12 835,7**		**20 326,2**		**26 646,2**
main engines		10 900,0		16 796,1		23 970,2
help engines		1 935,7		3 530,1		2 676,0
Port cost (USD)		**9 905,8**		**15 332,2**		**20 168,5**
Riga		2 931,4		4 626,4		5 962,5
Göteborg		6 974,5		10 705,8		14 206,0
Cargo handling costs (USD)		**9 552,9**		**15 742,1**		**23 007,7**
Riga		4 686,0		7 722,0		11 286,0
Göteborg		4 866,9		8 020,1		11 721,7
Result		**57 289,5**		**87 486,7**		**133 171,1**
Number of units handled		85,2		140,4		205,2
Cost per unit		**672,4**		**623,1**		**649,0**

Göteborg-Liepaja-Göteborg						
Vessel		RoRo 1		RoRo 2		RoRo 3
Distance (nm)		918,0		918,0		918,0
Speed (knots)		15,0		19,0		22,0
Time in Sea (h)		61,2		48,3		41,7
Fairway time (h/both ways)						
Liepaja		2,0		2,0		2,0
Göteborg		3,0		3,0		3,0
Time in Port (h)						
Liepaja		8,5		14,0		20,5
Göteborg		4,3		7,0		10,3
Total time		**79,0**		**74,4**		**77,5**
Trailer capacity		71,0		117,0		171,0
utilisation from Göteborg	60%	42,6		70,2		102,6
utilisation from Liepaja	60%	42,6		70,2		102,6
Time charter cost		**19 745,0**		**29 440,4**		**53 286,3**
Fuel cost ($)		**9 804,1**		**15 653,6**		**20 503,8**
main engines		8 275,0		12 773,6		18 252,8
help engines		1 529,1		2 880,0		2 250,9
Port cost		**12 961,1**		**19 152,2**		**24 569,0**
Liepaja		5 986,6		8 446,4		10 363,0
Göteborg		6 974,5		10 705,8		14 206,0
Cargo handling costs		**7 010,7**		**11 552,9**		**16 885,0**
Liepaja		2 143,8		3 532,8		5 163,3
Göteborg		4 866,9		8 020,1		11 721,7
Result		**49 521,0**		**75 799,1**		**115 244,1**
Number of units handled		85,2		140,4		205,2
Cost per unit		**581,2**		**539,9**		**561,6**

Göteborg-Klaipeda-Göteborg				
Vessel		RoRo 1	RoRo 2	RoRo 3
Distance (nm)		906,0	906,0	906,0
Speed (knots)		15,0	19,0	22,0
Time in Sea (h)		60,4	47,7	41,2
Fairway time (h/both ways)				
Klaipeda		2,0	2,0	2,0
Göteborg		3,0	3,0	3,0
Time in Port (h)				
Klaipeda		8,5	14,0	20,5
Göteborg		4,3	7,0	10,3
Total time		**78,2**	**73,7**	**77,0**
Trailer capacity		**71,0**	**117,0**	**171,0**
utilisation from Göteborg	60%	42,6	70,2	102,6
utilisation from Liepaja	60%	42,6	70,2	102,6
Time charter cost		**19 545,0**	**29 190,4**	**52 911,3**
Fuel cost ($)		**9 688,7**	**15 477,8**	**20 274,9**
main engines		8 175,0	12 622,3	18 039,8
help engines		1 513,7	2 855,5	2 235,1
Port cost		**13 933,9**	**21 721,6**	**28 535,2**
Klaipeda		6 959,4	11 015,8	14 329,2
Göteborg		6 974,5	10 705,8	14 206,0
Cargo handling costs		**12 167,3**	**20 050,3**	**29 304,2**
Klaipeda		7 300,4	12 030,2	17 582,5
Göteborg		4 866,9	8 020,1	11 721,7
Result		**55 334,8**	**86 440,1**	**131 025,6**
Number of units handled		85,2	140,4	205,2
Cost per unit		**649,5**	**615,7**	**638,5**

Hamburg - St.Petersburg - Hamburg				
Vessel		Lo/Lo 1	Lo/Lo 2	Lo/Lo 3
Distance (nm)		2 400,0	2 400,0	2 400,0
Speed (knots)		15,0	16,0	19,0
Time in open sea (h)		160,0	150,0	126,3
Fairway time (h)				
St.Petersburg		9,0	9,0	9,0
Hamburg		16,0	16,0	16,0
Time in Port (h)				
St.Petersburg		9,4	15,6	31,2
Hamburg		9,4	15,6	31,2
Total time		**203,7**	**206,2**	**213,7**
TEU capacity		300,0	500,0	1 000,0
utilisation from Hamburg	60%	180,0	300,0	600,0
utilisation from St.Peters.	60%	180,0	300,0	600,0
Time-charter rate (USD)		**29 709,2**	**42 958,3**	**62 333,8**
Fuel cost (USD)		**20 324,5**	**26 040,5**	**39 799,7**
main engines		16 380,2	20 052,1	31 524,1
help engines		3 944,2	5 988,4	8 275,6
Port cost (USD)		**17 900,7**	**26 212,7**	**52 034,7**
St.Petersburg		2 314,4	3 009,2	7 414,2
Hamburg		15 586,3	23 203,6	44 620,5
Cargo handling costs (USD)		**32 734,9**	**54 558,1**	**109 116,3**
St.Petersburg		17 701,2	29 502,0	59 004,0
Hamburg		15 033,7	25 056,1	50 112,3
Result		**100 669,2**	**149 769,7**	**263 284,4**
Number of units handled		360,0	600,0	1 200,0
Cost per unit		**279,6**	**249,6**	**219,4**

Hamburg - Tallinn - Hamburg						
Vessel		Lo/Lo 1		Lo/Lo 2		Lo/Lo 3
Distance (nm)		1 400,0		1 400,0		1 400,0
Speed (knots)		15,0		16,0		19,0
Time in Sea (h)		93,3		87,5		73,7
Fairway time (h)						
Hamburg		8,0		8,0		8,0
Tallinn		2,0		2,0		2,0
Time in Port (h)						
Hamburg		9,4		15,6		31,2
Tallinn		11,7		19,5		39,0
Total time		**124,4**		**132,6**		**153,9**
TEU capacity		300,0		500,0		1 000,0
utilisation from Hamburg	60%	180,0		300,0		600,0
utilisation from Tallinn	60%	180,0		300,0		600,0
Time-charter rate (USD)		**18 140,7**		**27 625,0**		**44 882,9**
Fuel cost (USD)		**11 557,7**		**15 022,8**		**23 392,9**
main engines		9 149,3		11 171,9		17 434,2
help engines		2 408,4		3 850,9		5 958,7
Port cost (USD)		**16 496,7**		**24 265,0**		**46 656,3**
Tallinn		910,4		1 061,4		2 035,9
Hamburg		15 586,3		23 203,6		44 620,5
Cargo handling costs (USD)		**29 593,1**		**49 321,9**		**98 643,7**
Tallinn		14 559,4		24 265,7		48 531,4
Hamburg		15 033,7		25 056,1		50 112,3
Result (USD)		**75 788,2**		**116 234,6**		**213 575,9**
Number of units handled		360,0		600,0		1 200,0
Cost per unit (USD)		**210,5**		**193,7**		**178,0**

Hamburg-Riga-Hamburg						
Vessel		LoLo 1		LoLo 2		LoLo3
Distance (nm)		1 218,0		1 218,0		1 218,0
Speed (knots)		15,0		16,0		19,0
Time in Sea (h)		81,2		76,1		64,1
Fairway time (h/both ways)						
Riga		3,0		3,0		3,0
Hamburg		8,0		8,0		8,0
Time in Port (h)						
Riga		11,7		19,5		39,0
Hamburg		4,7		7,8		15,6
Total time		**108,6**		**114,4**		**129,7**
TEU capacity		300,0		500,0		1 000,0
utilisation from Hamburg	60%	180,0		300,0		600,0
utilisation from Riga	60%	180,0		300,0		600,0
Time charter cost		**15 834,6**		**23 838,5**		**37 830,7**
Fuel cost ($)		**10 265,8**		**13 306,2**		**20 669,4**
main engines		8 163,5		9 983,1		15 646,9
help engines		2 102,2		3 323,1		5 022,5
Port cost		**16 901,5**		**24 847,6**		**48 401,7**
Riga		1 315,2		1 644,0		3 781,2
Hamburg		15 586,3		23 203,6		44 620,5
Cargo handling costs		**29 883,7**		**49 806,1**		**99 612,3**
Riga		14 850,0		24 750,0		49 500,0
Hamburg		15 033,7		25 056,1		50 112,3
Result		**72 885,5**		**111 798,4**		**206 514,1**
Number of units handled		360,0		600,0		1 200,0
Cost per unit		**202,5**		**186,3**		**172,1**

Hamburg - Liepaja - Hamburg				
Vessel		Lo/Lo 1	Lo/Lo 2	Lo/Lo 3
Distance (nm)		974,0	974,0	974,0
Speed (knots)		15,0	16,0	19,0
Time in Sea (h)		64,9	60,9	51,3
Fairway time (h)				
Hamburg		8,0	8,0	8,0
Liepaja		2,0	2,0	2,0
Time in Port (h)				
Hamburg		9,4	15,6	31,2
Liepaja		11,7	19,5	39,0
Total time		**96,0**	**106,0**	**131,5**
TEU capacity		300,0	500,0	1 000,0
utilisation from Hamburg	60%	180,0	300,0	600,0
utilisation from Liepaja	60%	180,0	300,0	600,0
Time-charter rate (USD)		**13 999,0**	**22 078,1**	**38 343,4**
Fuel cost (USD)		**8 493,3**	**11 198,8**	**17 853,7**
main engines		6 634,7	8 121,1	12 763,2
help engines		1 858,5	3 077,7	5 090,5
Port cost (USD)		**19 735,9**	**28 103,6**	**54 228,1**
Liepaja		4 149,6	4 900,0	9 607,6
Hamburg		15 586,3	23 203,6	44 620,5
Cargo handling costs (USD)		**26 397,9**	**43 996,6**	**87 993,1**
Liepaja		11 364,3	18 940,4	37 880,9
Hamburg		15 033,7	25 056,1	50 112,3
Result (USD)		**68 626,1**	**105 377,1**	**198 418,3**
Number of units handled		360,0	600,0	1 200,0
Cost per unit (USD)		**190,6**	**175,6**	**165,3**

Hamburg - Klaipeda - Hamburg						
Vessel		Lo/Lo 1		Lo/Lo 2		Lo/Lo 3
Distance (nm)		974,0		974,0		974,0
Speed (knots)		15,0		16,0		19,0
Time in Sea (h)		64,9		60,9		51,3
Fairway time (h)						
Hamburg		8,0		8,0		8,0
Klaipeda		2,0		2,0		2,0
Time in Port (h)						
Hamburg		9,4		15,6		31,2
Klaipeda		11,7		19,5		39,0
Total time		**96,0**		**106,0**		**131,5**
TEU capacity		300,0		500,0		1 000,0
utilisation from Hamburg	60%	180,0		300,0		600,0
utilisation from Klaipeda	60%	180,0		300,0		600,0
Time-charter rate (USD)		**12 540,7**		**19 994,8**		**35 426,8**
Fuel cost (USD)		**8 493,3**		**11 198,8**		**17 853,7**
main engines		6 634,7		8 121,1		12 763,2
help engines		1 858,5		3 077,7		5 090,5
Port cost (USD)		**19 457,1**		**28 529,6**		**56 285,3**
Klaipeda		3 870,8		5 326,0		11 664,8
Hamburg		15 586,3		23 203,6		44 620,5
Cargo handling costs (USD)		**33 933,7**		**56 556,1**		**113 112,3**
Klaipeda		18 900,0		31 500,0		63 000,0
Hamburg		15 033,7		25 056,1		50 112,3
Result (USD)		**74 424,7**		**116 279,3**		**222 678,0**
Number of units handled		360,0		600,0		1 200,0
Cost per unit (USD)		**206,7**		**193,8**		**185,6**

Hamburg - St.Petersburg - Hamburg				
Vessel		Ro/Ro 1	Ro/Ro 2	Ro/Ro 3
Distance (nm)		2 400,0	2 400,0	2 400,0
Speed (knots)		15,0	19,0	22,0
Time in Sea (h)		160,0	126,3	109,1
Fairway time (h)				
St.Petersburg		9,0	9,0	9,0
Hamburg		8,0	8,0	8,0
Time in Port (h)				
St.Petersburg		8,5	14,0	20,5
Hamburg		4,3	7,0	10,3
Total time		**189,8**	**164,4**	**156,9**
Trailer capacity		71,0	117,0	171,0
utilisation from Hamburg	60%	42,6	70,2	102,6
utilisation from St.Peters.	60%	42,6	70,2	102,6
Time-charter rate (USD)		**47 445,0**	**65 065,4**	**107 848,8**
Fuel cost (USD)		**25 799,4**	**40 701,1**	**53 810,1**
main engines		22 125,0	34 336,1	49 254,3
help engines		3 674,4	6 365,0	4 555,8
Port cost (USD)		**16 861,7**	**25 071,9**	**33 764,9**
St.Petersburg		3 311,8	5 399,1	8 115,7
Hamburg		13 549,9	19 672,8	25 649,2
Cargo handling costs (USD)		**11 188,6**	**18 437,6**	**26 947,2**
St.Petersburg		2 121,5	3 496,0	5 109,5
Hamburg		9 067,1	14 941,6	21 837,7
Result		**101 294,6**	**149 276,0**	**222 370,9**
Number of units handled		85,2	140,4	205,2
Cost per unit		**1 188,9**	**1 063,2**	**1 083,7**

Hamburg - Tallinn - Hamburg				
Vessel		RoRo 1	RoRo 2	RoRo 3
Distance (nm)		1 400,0	1 400,0	1 400,0
Speed (knots)		15,0	19,0	22,0
Time in Sea (h)		93,3	73,7	63,6
Fairway time (h/both ways)				
Tallinn		2,0	2,0	2,0
Hamburg		8,0	8,0	8,0
Time in Port (h)				
Tallinn		8,5	14,0	20,5
Hamburg		4,3	7,0	10,3
Total time		**116,1**	**104,7**	**104,4**
Trailer capacity		71,0	117,0	171,0
utilisation from Hamburg	60%	42,6	70,2	102,6
utilisation from Tallinn	60%	42,6	70,2	102,6
Time charter cost		**29 028,3**	**41 461,3**	**71 786,3**
Fuel cost ($)		**15 164,7**	**24 105,3**	**31 796,6**
main engines		12 916,7	20 049,3	28 764,2
help engines		2 248,1	4 055,9	3 032,4
Port cost		**15 285,3**	**22 110,1**	**28 929,5**
Tallinn		1 735,5	2 437,3	3 280,3
Hamburg		13 549,9	19 672,8	25 649,2
Cargo handling costs		**12 497,3**	**20 594,1**	**30 099,1**
Tallinn		3 430,1	5 652,5	8 261,3
Hamburg		9 067,1	14 941,6	21 837,7
Result		**71 975,7**	**108 270,7**	**162 611,4**
Number of units handled		85,2	140,4	205,2
Cost per unit		**844,8**	**771,2**	**792,5**

Hamburg - Riga -Hamburg						
Vessel		RoRo 1		RoRo 2		RoRo 3
Distance (nm)		1 280,0		1 280,0		1 280,0
Speed (knots)		15,0		19,0		22,0
Time in Sea (h)		85,3		67,4		58,2
Fairway time (h/both ways)						
Riga		3,0		3,0		3,0
Hamburg		8,0		8,0		8,0
Time in Port (h)						
Riga		8,5		14,0		20,5
Hamburg		4,3		7,0		10,3
Total time		**109,1**		**99,4**		**100,0**
Trailer capacity		71,0		117,0		171,0
utilisation from Hamburg	60%	42,6		70,2		102,6
utilisation from Riga	60%	42,6		70,2		102,6
Time charter cost		**27 278,3**		**39 357,1**		**68 723,8**
Fuel cost ($)		**14 154,2**		**22 625,9**		**29 927,2**
main engines		12 041,7		18 775,8		27 024,1
help engines		2 112,6		3 850,1		2 903,1
Port cost		**16 481,2**		**24 299,2**		**31 611,7**
Riga		2 931,4		4 626,4		5 962,5
Hamburg		13 549,9		19 672,8		25 649,2
Cargo handling costs		**13 753,1**		**22 663,6**		**33 123,7**
Riga		4 686,0		7 722,0		11 286,0
Hamburg		9 067,1		14 941,6		21 837,7
Result		**71 666,9**		**108 945,7**		**163 386,4**
Number of units handled		85,2		140,4		205,2
Cost per unit		**841,2**		**776,0**		**796,2**

Hamburg - Liepaja - Hamburg						
Vessel		Ro/Ro 1		Ro/Ro 2		Ro/Ro 3
Distance (nm)		986,0		986,0		986,0
Speed (knots)		15,0		19,0		22,0
Time in Sea (h)		65,7		51,9		44,8
Fairway time (h)						
Hamburg		8,0		8,0		8,0
Liepaja		2,0		2,0		2,0
Time in Port (h)						
Hamburg		4,3		7,0		10,3
Liepaja		8,5		14,0		20,5
Total time		**88,5**		**83,0**		**85,6**
Trailer capacity		71,0		117,0		171,0
utilisation from Hamburg	60%	42,6		70,2		102,6
utilisation from Liepaja	60%	42,6		70,2		102,6
Time-charter rate (USD)		**22 128,3**		**32 836,3**		**58 848,8**
Fuel cost (USD)		**8 419,3**		**9 501,2**		**14 735,0**
main engines		6 705,6		7 092,1		11 420,5
help engines		1 713,7		2 409,1		3 314,6
Port cost (USD)		**19 536,5**		**28 119,2**		**36 012,2**
Liepaja		5 986,6		8 446,4		10 363,0
Hamburg		13 549,9		19 672,8		25 649,2
Cargo handling costs (USD)		**11 211,0**		**18 474,4**		**27 001,1**
Liepaja		2 143,8		3 532,8		5 163,3
Hamburg		9 067,1		14 941,6		21 837,7
Result (USD)		**61 295,1**		**88 931,1**		**136 597,0**
Number of units handled		85,2		140,4		205,2
Cost per unit (USD)		**719,4**		**633,4**		**665,7**

Hamburg - Klaipeda - Hamburg						
Vessel		Ro/Ro 1		Ro/Ro 2		Ro/Ro 3
Distance (nm)		974,0		974,0		974,0
Speed (knots)		15,0		19,0		22,0
Time in Sea (h)		64,9		51,3		44,3
Fairway time (h)						
Hamburg		8,0		8,0		8,0
Klaipeda		2,0		2,0		2,0
Time in Port (h)						
Hamburg		2,2		3,7		5,3
Klaipeda		2,8		4,6		6,7
Total time		**79,9**		**69,5**		**66,3**
Trailer capacity		71,0		117,0		171,0
utilisation from Hamburg	60%	42,6		70,2		102,6
utilisation from Klaipeda	60%	42,6		70,2		102,6
Time-charter rate (USD)		**19 979,4**		**27 501,1**		**45 565,4**
Fuel cost (USD)		**8 182,0**		**9 037,5**		**13 873,2**
main engines		6 634,7		7 019,7		11 306,8
help engines		1 547,3		2 017,7		2 566,4
Port cost (USD)		**20 509,3**		**30 688,6**		**39 978,4**
Klaipeda		6 959,4		11 015,8		14 329,2
Hamburg		13 549,9		19 672,8		25 649,2
Cargo handling costs (USD)		**16 367,5**		**26 971,8**		**39 420,3**
Klaipeda		7 300,4		12 030,2		17 582,5
Hamburg		9 067,1		14 941,6		21 837,7
Result (USD)		**65 038,2**		**94 199,0**		**138 837,3**
Number of units handled		85,2		140,4		205,2
Cost per unit (USD)		**763,4**		**670,9**		**676,6**

Göteborg - Oxelösund - St.Petersburg - Oxelösund - Göteborg						
Vessel		Lo/Lo 1		Lo/Lo 2		Lo/Lo 3
Distance (nm)		832,0		832,0		832,0
Speed (knots)		15,0		16,0		19,0
Time in open sea (h)		55,5		52,0		43,8
Fairway time (h)						
St.Petersburg		9,0		9,0		9,0
Oxelösund		16,0		16,0		16,0
Time in Port (h)						
St.Petersburg		9,4		15,6		31,2
Oxelösund		9,4		15,6		31,2
Total time		**126,7**		**135,7**		**158,7**
TEU capacity		300,0		500,0		1 000,0
utilisation from Oxelösund	60%	180,0		300,0		600,0
utilisation from St.Petersburg	60%	180,0		300,0		600,0
Time-charter rate (USD)		**14 464,7**		**22 541,7**		**38 263,6**
Fuel cost (USD)		**9 045,0**		**11 965,2**		**19 411,1**
main engines		7 124,7		8 822,9		14 331,1
help engines		1 920,4		3 142,3		5 079,9
Port cost (USD)		**10 216,9**		**15 085,7**		**31 270,9**
St.Petersburg (USD)		2 314,4		3 009,2		7 414,2
Oxelösund		7 902,5		12 076,5		23 856,8
Cargo handling costs (USD)		**123 950,5**		**206 584,1**		**413 168,3**
St.Petersburg (USD)		17 701,2		29 502,0		59 004,0
Land bridge costs (Nasir)		**106 249,3**		**177 082,1**		**354 164,3**
Land bridge time (hours)		**27,5**		**27,5**		**27,5**
Result		**263 926,4**		**433 258,9**		**856 278,2**
Number of units handled		360,0		600,0		1 200,0
Cost per unit		**733,1**		**722,1**		**713,6**

Göteborg – Oxelösund – Tallinn - Oxelösund - Göteborg						
Vessel		LoLo 1		LoLo 2		LoLo 3
Distance (nm)		490,0		490,0		490,0
Speed (knots)		15,0		16,0		19,0
Time in Sea (h)		32,7		30,6		25,8
Fairway time (h/both ways)						
Tallinn		2,0		2,0		2,0
Oxelösund		1,0		1,0		1,0
Time in Port (h)						
Tallinn		11,7		19,5		39,0
Oxelösund		9,4		15,6		31,2
Total time		**84,2**		**96,2**		**126,5**
TEU capacity		300,0		500,0		1 000,0
utilisation from Oxelösund	60%	180,0		300,0		600,0
utilisation from Tallinn	60%	180,0		300,0		600,0
Time charter cost		**8 272,6**		**14 317,7**		**28 871,9**
Fuel cost ($)		**4 256,3**		**5 848,8**		**9 830,9**
main engines		3 158,0		3 852,9		5 997,8
help engines		1 098,3		1 995,9		3 833,1
Port cost		**8 813,0**		**13 137,9**		**25 892,6**
Tallinn		910,4		1 061,4		2 035,9
Oxelösund		7 902,5		12 076,5		23 856,8
Cargo handling costs		**120 808,7**		**201 347,9**		**402 695,7**
Tallinn		14 559,4		24 265,7		48 531,4
Land bridge costs (Nasir)		**106 249,3**		**177 082,1**		**354 164,3**
Land bridge time (hours)		**27,5**		**27,5**		**27,5**
Result		**248 399,9**		**411 734,4**		**821 455,5**
Number of units handled		360,0		600,0		1 200,0
Cost per unit		**690,0**		**686,2**		**684,5**

Göteborg - Oxelösund - Riga - Oxelösund - Göteborg						
Vessel		Lo/Lo 1		Lo/Lo 2		Lo/Lo 3
Distance (nm)		466,0		466,0		466,0
Speed (knots)		15,0		16,0		19,0
Time in Sea (h)		31,1		29,1		24,5
Fairway time (h)						
Oxelösund		1,0		1,0		1,0
Riga		3,0		3,0		3,0
Time in Port (h)						
Oxelösund		9,4		15,6		31,2
Riga		11,7		19,5		39,0
Total time		**83,6**		**95,7**		**126,2**
TEU capacity		300,0		500,0		1 000,0
utilisation from Oxelösund	60%	180,0		300,0		600,0
utilisation from Riga	60%	180,0		300,0		600,0
Time-charter rate (USD)		**8 185,1**		**14 213,5**		**28 795,2**
Fuel cost (USD)		**4 191,5**		**5 776,9**		**9 765,9**
main engines		3 104,9		3 795,6		5 943,0
help engines		1 086,7		1 981,4		3 822,9
Port cost (USD)		**9 217,7**		**13 720,5**		**27 638,0**
Riga		1 315,2		1 644,0		3 781,2
Oxelösund		7 902,5		12 076,5		23 856,8
Cargo handling costs (USD)		**121 099,3**		**201 832,1**		**403 664,3**
Riga		14 850,0		24 750,0		49 500,0
Land bridge costs (Nasir)		**106 249,3**		**177 082,1**		**354 164,3**
Land bridge time (hours)		**27,5**		**27,5**		**27,5**
Result (USD)		**248 943,0**		**412 625,3**		**824 027,6**
Number of units handled		360,0		600,0		1 200,0
Cost per unit (USD)		**691,5**		**687,7**		**686,7**

Göteborg - Oxelösund-Liepaja-Oxelösund - Göteborg						
Vessel		LoLo 1		LoLo 2		LoLo 3
Distance (nm)		400,0		400,0		400,0
Speed (knots)		15,0		16,0		19,0
Time in Sea (h)		26,7		25,0		21,1
Fairway time (h/both ways)						
Liepaja		2,0		2,0		2,0
Oxelösund		1,0		1,0		1,0
Time in Port (h)						
Liepaja		11,7		19,5		39,0
Oxelösund		9,4		15,6		31,2
Total time		**78,2**		**90,6**		**121,8**
TEU capacity		300,0		500,0		1 000,0
utilisation from Oxelösund	60%	180,0		300,0		600,0
utilisation from Liepaja	60%	180,0		300,0		600,0
Time charter cost		**7 397,6**		**13 145,8**		**27 490,4**
Fuel cost ($)		**3 608,9**		**5 040,9**		**8 660,6**
main engines		2 626,7		3 208,3		5 011,0
help engines		982,1		1 832,5		3 649,7
Port cost		**12 052,1**		**16 976,5**		**33 464,4**
Liepaja		4 149,6		4 900,0		9 607,6
Oxelösund		7 902,5		12 076,5		23 856,8
Cargo handling costs		**117 613,5**		**196 022,6**		**392 045,2**
Liepaja		11 364,3		18 940,4		37 880,9
Land bridge costs (Nasir)		**106 249,3**		**177 082,1**		**354 164,3**
Land bridge time (hours)		**27,5**		**27,5**		**27,5**
Result		**246 921,5**		**408 267,9**		**815 824,8**
Number of units handled		360,0		600,0		1 200,0
Cost per unit		**685,9**		**680,4**		**679,9**

Göteborg - Oxelösund - St.Petersburg - Oxelösund - Göteborg						
Vessel		Ro/Ro 1		Ro/Ro 2		Ro/Ro 3
Distance (nm)		832,0		832,0		832,0
Speed (knots)		15,0		19,0		22,0
Time in Sea (h)		55,5		43,8		37,8
Fairway time (h)						
St.Petersburg		9,0		9,0		9,0
Oxelösund		1,0		1,0		1,0
Time in Port (h)						
St.Petersburg		8,5		14,0		20,5
Oxelösund		8,5		14,0		20,5
Total time		**99,1**		**98,4**		**105,4**
Trailer capacity		71,0		117,0		171,0
utilisation from Oxelösund	60%	42,6		70,2		102,6
utilisation from St.Petersburg	60%	42,6		70,2		102,6
Time-charter rate (USD)		**20 626,7**		**32 406,7**		**61 090,0**
Fuel cost (USD)		**9 780,8**		**16 057,2**		**21 259,6**
main engines		8 183,3		12 887,1		18 679,0
help engines		1 597,4		3 170,2		2 580,6
Port cost (USD)		**10 003,6**		**15 979,6**		**22 228,1**
St.Petersburg		3 311,8		5 399,1		8 115,7
Oxelösund		6 691,8		10 580,5		14 112,4
Cargo handling costs (USD)		**28 994,9**		**47 780,3**		**69 832,8**
St.Petersburg		2 121,5		3 496,0		5 109,5
Land bridge Costs (NASIR)		**26 873,4**		**44 284,4**		**64 723,3**
Land bridge time (hours)		**16,6**		**16,6**		**16,6**
Result		**96 279,4**		**156 508,2**		**239 133,7**
Number of units handled		85,2		140,4		205,2
Cost per unit		**1 130,0**		**1 114,7**		**1 165,4**

Göteborg - Oxelösund - Tallinn - Oxelösund - Göteborg				
Vessel		RoRo 1	RoRo 2	RoRo 3
Distance (nm)		490,0	490,0	490,0
Speed (knots)		15,0	19,0	22,0
Time in Sea (h)		32,7	25,8	22,3
Fairway time (h/both ways)				
Tallinn		2,0	2,0	2,0
Oxelösund		1,0	1,0	1,0
Time in Port (h)				
Tallinn		8,5	14,0	20,5
Oxelösund		8,5	14,0	20,5
Total time		**69,3**	**73,4**	**82,9**
Trailer capacity		71,0	117,0	171,0
utilisation from Karlsh.	60%	42,6	70,2	102,6
utilisation from Riga	60%	42,6	70,2	102,6
Time charter cost		**13 176,7**	**22 510,8**	**45 590,0**
Fuel cost ($)		**5 478,8**	**9 099,6**	**11 798,0**
main engines		4 458,3	6 897,5	9 872,2
help engines		1 020,5	2 202,1	1 925,8
Port cost		**8 427,3**	**13 017,8**	**17 392,7**
Tallinn		1 735,5	2 437,3	3 280,3
Oxelösund		6 691,8	10 580,5	14 112,4
Cargo handling costs		**30 303,6**	**49 936,8**	**72 984,6**
Tallinn		3 430,1	5 652,5	8 261,3
Land bridge Costs (NASIR)		**26 873,4**	**44 284,4**	**64 723,3**
Land bridge time (hours)		**16,6**	**16,6**	**16,6**
Result		**84 259,7**	**138 849,4**	**212 488,6**
Number of units handled		85,2	140,4	205,2
Cost per unit		**989,0**	**989,0**	**1 035,5**

Göteborg - Oxelösund - Riga - Oxelösund - Göteborg						
Vessel		Ro/Ro 1		Ro/Ro 2		Ro/Ro 3
Distance (nm)		466,0		466,0		466,0
Speed (knots)		15,0		19,0		22,0
Time in Sea (h)		31,1		24,5		21,2
Fairway time (h)						
Oxelösund		1,0		1,0		1,0
Riga		3,0		3,0		3,0
Time in Port (h)						
Oxelösund		8,5		14,0		20,5
Riga		8,5		14,0		20,5
Total time		**68,7**		**73,2**		**82,8**
Trailer capacity		71,0		117,0		171,0
utilisation from Oxelösund	60%	42,6		70,2		102,6
utilisation from Riga	60%	42,6		70,2		102,6
Time-charter rate (USD)		**13 026,7**		**22 406,7**		**45 527,5**
Fuel cost (USD)		**5 392,2**		**9 026,4**		**11 759,8**
main engines		4 383,3		6 834,4		9 836,6
help engines		1 008,8		2 191,9		1 923,2
Port cost (USD)		**9 623,2**		**15 206,9**		**20 074,9**
Riga		2 931,4		4 626,4		5 962,5
Oxelösund		6 691,8		10 580,5		14 112,4
Cargo handling costs (USD)		**31 559,4**		**52 006,4**		**76 009,3**
Riga		4 686,0		7 722,0		11 286,0
Land bridge Costs (NASIR)		**26 873,4**		**44 284,4**		**64 723,3**
Land bridge time (hours)		**16,6**		**16,6**		**16,6**
Result (USD)		**86 474,8**		**142 930,6**		**218 094,8**
Number of units handled		85,2		140,4		205,2
Cost per unit (USD)		**1 015,0**		**1 018,0**		**1 062,8**

Göteborg - Oxelösund - Liepaja - Oxelösund - Göteborg						
Vessel		RoRo 1		RoRo 2		RoRo 3
Distance (nm)		400,0		400,0		400,0
Speed (knots)		15,0		19,0		22,0
Time in Sea (h)		26,7		21,1		18,2
Fairway time (h/both ways)						
Liepaja		2,0		2,0		2,0
Oxelösund		1,0		1,0		1,0
Time in Port (h)						
Liepaja		8,5		14,0		20,5
Oxelösund		8,5		14,0		20,5
Total time		**63,3**		**68,7**		**78,8**
Trailer capacity		71,0		117,0		171,0
utilisation from Karlsh.	60%	42,6		70,2		102,6
utilisation from Riga	60%	42,6		70,2		102,6
Time charter cost		**11 676,7**		**20 635,8**		**42 777,5**
Fuel cost ($)		**4 612,6**		**7 781,3**		**10 081,2**
main engines		3 708,3		5 762,6		8 274,1
help engines		904,3		2 018,7		1 807,0
Port cost		**12 678,4**		**19 026,9**		**24 475,4**
Liepaja		5 986,6		8 446,4		10 363,0
Oxelösund		6 691,8		10 580,5		14 112,4
Cargo handling costs		**29 017,3**		**47 817,2**		**69 886,6**
Liepaja		2 143,8		3 532,8		5 163,3
Land bridge Costs (NASIR)		**26 873,4**		**44 284,4**		**64 723,3**
Land bridge time (hours)		**16,6**		**16,6**		**16,6**
Result		**84 858,4**		**139 545,6**		**211 944,0**
Number of units handled		85,2		140,4		205,2
Cost per unit		**996,0**		**993,9**		**1 032,9**

Göteborg - Karlshamn - Riga - Karlshamn - Göteborg						
Vessel		Lo/Lo 1		Lo/Lo 2		Lo/Lo 3
Distance (nm)		746,0		746,0		746,0
Speed (knots)		15,0		16,0		19,0
Time in Sea (h)		49,7		46,6		39,3
Fairway time (h/both ways)						
Riga		3,0		3,0		3,0
Karlshamn		2,0		2,0		2,0
Time in Port (h)						
Riga		11,7		19,5		39,0
Karlshamn		9,4		15,6		31,2
Total time		**100,3**		**111,2**		**139,0**
TEU capacity		300,0		500,0		1 000,0
utilisation from Karlsh.	60%	180,0		300,0		600,0
utilisation from Riga	60%	180,0		300,0		600,0
Time charter cost		**11 053,2**		**18 067,7**		**33 385,1**
Fuel cost ($)		**6 313,6**		**8 434,0**		**13 653,8**
main engines		4 846,2		5 915,4		9 221,5
help engines		1 467,4		2 518,6		4 432,3
Port cost		**9 175,1**		**13 716,9**		**27 835,4**
Riga		1 315,2		1 644,0		3 781,2
Karlshamn		7 859,9		12 072,9		24 054,2
Cargo handling costs		**110 817,1**		**184 695,2**		**369 390,3**
Riga		14 850,0		24 750,0		49 500,0
Land bridge Costs (NASIR)		**95 967,1**		**159 945,2**		**319 890,3**
Land bridge time (hours)		**24,5**		**24,5**		**24,5**
Result		**233 326,1**		**384 859,0**		**764 154,9**
Number of units handled		360,0		600,0		1 200,0
Cost per unit		**648,1**		**641,4**		**636,8**

Göteborg - Karlshamn - Liepaja - Karlshamn - Göteborg						
Vessel		Lo/Lo 1		Lo/Lo 2		Lo/Lo 3
Distance (nm)		442,0		442,0		442,0
Speed (knots)		15,0		16,0		19,0
Time in Sea (h)		29,5		27,6		23,3
Fairway time (h/both ways)						
Liepaja		2,0		2,0		2,0
Karlshamn		2,0		2,0		2,0
Time in Port (h)						
Liepaja		11,7		19,5		39,0
Karlshamn		9,4		15,6		31,2
Total time		**79,0**		**91,2**		**122,0**
TEU capacity		300,0		500,0		1 000,0
utilisation from Karlsh.	60%	180,0		300,0		600,0
utilisation from Liepaja	60%	180,0		300,0		600,0
Time charter cost		**7 951,8**		**13 901,0**		**28 426,8**
Fuel cost ($)		**4 018,9**		**5 561,5**		**9 453,8**
main engines		2 963,2		3 623,7		5 679,8
help engines		1 055,7		1 937,8		3 774,0
Port cost		**12 009,5**		**16 972,9**		**33 661,8**
Liepaja		4 149,6		4 900,0		9 607,6
Karlshamn		7 859,9		12 072,9		24 054,2
Cargo handling costs		**107 331,4**		**178 885,6**		**357 771,2**
Liepaja		11 364,3		18 940,4		37 880,9
Land bridge Costs (NASIR)		**95 967,1**		**159 945,2**		**319 890,3**
Land bridge time (hours)		**24,5**		**24,5**		**24,5**
Result		**227 278,7**		**375 266,2**		**749 203,9**
Number of units handled		360,0		600,0		1 200,0
Cost per unit		**631,3**		**625,4**		**624,3**

Göteborg - Karlshamn - Klaipeda -Karlshamn - Göteborg						
Vessel		LoLo 1		LoLo2		LoLo 3
Distance (nm)		446,0		446,0		446,0
Speed (knots)		15,0		16,0		19,0
Time in Sea (h)		29,7		27,9		23,5
Fairway time (h/both ways)						
Klaipeda		2,0		2,0		2,0
Karlshamn		2,0		2,0		2,0
Time in Port (h)						
Klaipeda		11,7		19,5		39,0
Sweden		9,4		15,6		31,2
Total time		**79,3**		**91,5**		**122,2**
TEU capacity		300,0		500,0		1 000,0
utilisation from Karlsh.	60%	180,0		300,0		600,0
utilisation from Klaipeda	60%	180,0		300,0		600,0
Time charter cost		**7 990,7**		**13 953,1**		**28 488,2**
Fuel cost ($)		**4 047,7**		**5 597,4**		**9 505,8**
main engines		2 986,8		3 652,3		5 723,7
help engines		1 060,9		1 945,1		3 782,1
Port cost		**11 730,7**		**17 398,9**		**35 719,0**
Klaipeda		3 870,8		5 326,0		11 664,8
Karlshamn		7 859,9		12 072,9		24 054,2
Cargo handling costs		**18 900,0**		**31 500,0**		**63 000,0**
Klaipeda		18 900,0		31 500,0		63 000,0
Land bridge Costs (NASIR)		**95 967,1**		**159 945,2**		**319 890,3**
Land bridge time (hours)		**24,5**		**24,5**		**24,5**
Result		138 636,2		228 394,6		456 603,3
Number of units handled		360,0		600,0		1 200,0
Cost per unit		**385,1**		**380,7**		**380,5**

Göteborg - Karlshamn - Riga - Karlshamn - Göteborg						
Vessel		RoRo 1		RoRo 1		RoRo 1
Distance (nm)		746,0		746,0		746,0
Speed (knots)		15,0		19,0		22,0
Time in Sea (h)		49,7		39,3		33,9
Fairway time (h/both ways)						
Riga		3,0		3,0		3,0
Karlshamn		2,0		2,0		2,0
Time in Port (h)						
Riga		8,5		14,0		20,5
Karlshamn		8,5		14,0		20,5
Total time		**86,6**		**87,2**		**94,8**
Trailer capacity		71,0		117,0		171,0
utilisation from Karlsh.	60%	42,6		70,2		102,6
utilisation from Riga	60%	42,6		70,2		102,6
Time charter cost		**17 943,3**		**28 635,8**		**54 965,0**
Fuel cost ($)		**8 231,3**		**13 406,0**		**17 520,7**
main engines		6 841,7		10 604,7		15 198,9
help engines		1 389,6		2 801,3		2 321,9
Port cost		**7 847,1**		**12 145,3**		**15 675,0**
Riga		2 931,4		4 626,4		5 962,5
Karlshamn		4 915,7		7 518,9		9 712,5
Cargo handling costs		**28 128,2**		**46 352,2**		**67 745,5**
Riga		4 686,0		7 722,0		11 286,0
Land bridge Costs (NASIR)		**23 442,2**		**38 630,2**		**56 459,5**
Land bridge time (hours)		**14,8**		**14,8**		**14,8**
Result		**85 592,2**		**139 169,5**		**212 365,7**
Number of units handled		85,2		140,4		205,2
Cost per unit		**1 004,6**		**991,2**		**1 034,9**

Göteborg - Karlshamn-Liepaja-Karlshamn - Göteborg						
Vessel		RoRo 1		RoRo 2		RoRo3
Distance (nm)		442,0		442,0		442,0
Speed (knots)		15,0		19,0		22,0
Time in Sea (h)		29,5		23,3		20,1
Fairway time (h/both ways)						
Liepaja		2,0		2,0		2,0
Karlshamn		2,0		2,0		2,0
Time in Port (h)						
Liepaja		8,5		14,0		20,5
Karlshamn		8,5		14,0		20,5
Total time		**65,3**		**70,2**		**80,0**
Trailer capacity		71,0		117,0		171,0
utilisation from Göteborg	60%	42,6		70,2		102,6
utilisation from Liepaja	60%	42,6		70,2		102,6
Time charter cost		**12 626,7**		**21 906,7**		**44 777,5**
Fuel cost ($)		**5 161,2**		**8 674,8**		**11 302,0**
main engines		4 183,3		6 531,8		9 410,5
help engines		977,9		2 143,0		1 891,5
Port cost		**10 902,3**		**15 965,3**		**20 075,5**
Liepaja		5 986,6		8 446,4		10 363,0
Karlshamn		4 915,7		7 518,9		9 712,5
Cargo handling costs		**25 586,1**		**42 163,0**		**61 622,8**
Liepaja		2 143,8		3 532,8		5 163,3
Land bridge Costs (NASIR)		**23 442,2**		**38 630,2**		**56 459,5**
Land bridge time (hours)		**14,8**		**14,8**		**14,8**
Result		**77 718,5**		**127 340,0**		**194 237,4**
Number of units handled		85,2		140,4		205,2
Cost per unit		**912,2**		**907,0**		**946,6**

Göteborg - Karlshamn - Klaipeda - Karlshamn - Göteborg						
Vessel		RoRo 1		RoRo2		RoRo 3
Distance (nm)		446,0		446,0		446,0
Speed (knots)		15,0		19,0		22,0
Time in Sea (h)		29,7		23,5		20,3
Fairway time (h/both ways)						
Klaipeda		2,0		2,0		2,0
Karlshamn		2,0		2,0		2,0
Time in Port (h)						
Klaipeda		8,5		14,0		20,5
Karlshamn		8,5		14,0		20,5
Total time		**65,6**		**70,4**		**80,1**
Trailer capacity		71,0		117,0		171,0
utilisation from Göteborg	60%	42,6		70,2		102,6
utilisation from Liepaja	60%	42,6		70,2		102,6
Time charter cost		**12 693,3**		**21 990,0**		**44 902,5**
Fuel cost ($)		**5 199,7**		**8 733,4**		**11 378,3**
main engines		4 216,7		6 582,2		9 481,5
help engines		983,0		2 151,2		1 896,8
Port cost		**11 875,1**		**18 534,7**		**24 041,7**
Klaipeda		6 959,4		11 015,8		14 329,2
Karlshamn		4 915,7		7 518,9		9 712,5
Cargo handling costs		**30 742,6**		**50 660,3**		**74 042,0**
Klaipeda		7 300,4		12 030,2		17 582,5
Land bridge Costs (NASIR)		**23 442,2**		**38 630,2**		**56 459,5**
Land bridge time (hours)		**14,8**		**14,8**		**14,8**
Result		**83 953,0**		**138 548,7**		**210 824,1**
Number of units handled		85,2		140,4		205,2
Cost per unit		**985,4**		**986,8**		**1 027,4**

Appendix 3 – Sensitivity Analysis Results

St. Petersburg routes

Sensitivity analysis for total average cost of one TEU for LoLo vessels for a one way voyage irrespective direction.

LoLo1											
Utilisation degree (%)	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%
Number of TEU	90	105	120	135	150	165	180	195	210	225	240
Route											
GBG-St.P	332	303	282	265	252	241	232	224	218	212	207
Hamburg-St.P	433	389	356	331	310	294	280	268	258	249	241
Land bridge (Oxel.)	802	782	768	756	747	739	733	728	723	719	716

LoLo2										
Utilisation degree (%)	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%
Number of TEU	150	175	200	225	250	275	300	325	350	375
Route										
GBG - St.P	291,4	269,2	252,5	239,6	229,2	220,7	213,7	207,7	202,6	198,1
Hamburg - St.P	368,9	334,8	309,3	289,4	273,5	260,5	249,6	240,4	232,6	225,8
Land bridge (Oxel.)	776,3	760,8	749,2	740,2	732,9	727	722,1	717,9	714,4	711,3

LoLo3										
Utilisation degree (%)	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%
Number of TEU	300	350	400	450	500	550	600	650	700	750
Route										
GBG - St.P	250,7	235	223,2	214	206,7	200,7	195,7	191,5	187,9	184,7
Hamburg - St.P	303,6	279,6	261,5	247,5	236,2	227,1	219,4	212,9	207,4	202,6
Land bridge (Oxel.)	754,4	742,7	734	727,2	721,7	717,3	713,6	710,4	707,7	705,4

Sensitivity analysis for total average cost of one trailer for RoRo vessels for a one way voyage irrespective direction.

RoRo1									
Utilisation degree (%)	30%	35%	40%	45%	50%	55%			
Number of trailers	21	25	28	32	36	39			
Route									
GBG-St.P	1490	1299	1156	1044	955	882			
Hamburg-St.P	2160	1883	1675	1513	1383	1277			
Land bridge (Oxel.)	1515	1405	1323	1258	1207	1165			
Utilisation degree (%)	60%	65%	70%	75%	80%	85%	90%	95%	100%
Number of trailers	43	46	50	53	57	60	64	67	71
Route									
GBG-St.p	821	770	726	688	654	625	599	575	554
Hamburg-St.P	1189	1114	1050	995	946	903	865	831	800
Land bridge (Oxel.)	1130	1100	1075	1053	1034	1017	1002	988	976

RoRo2								
Utilisation degree (%)	30%	35%	40%	45%	50%	55%	60%	
Number of trailers	35	41	47	53	59	64	70	
Route								
GBG - St.P	1318	1155	1033	938	862	800	748	
Hamburg - St.P	1884	1650	1474	1337	1227	1138	1063	
Land bridge (Oxel.)	1451	1355	1283	1227	1182	1145	1115	
Utilisation degree (%)	65%	70%	75%	80%	85%	90%	95%	100%
Number of trailers	76	82	88	94	99	105	111	117
Route								
GBG - St.P	704	666	634	605	580	558	538	520
Hamburg - St.P	1000	946	899	858	822	790	761	735
Land bridge (Oxel.)	1089	1067	1047	1031	1016	1003	991	980

RoRo3								
Utilisation degree (%)	30%	35%	40%	45%	50%	55%	60%	
Number of trailers	51	60	68	77	86	94	103	
Route								
GBG - St.P	1337	1178	1058	965	890	829	779	
Hamburg - St.P	1883	1654	1483	1350	1244	1156	1084	
Land bridge (Oxel.)	1496	1402	1331	1276	1232	1195	1165	
Utilisation degree (%)	65%	70%	75%	80%	85%	90%	95%	100%
Number of trailers	111	120	128	137	145	154	162	171
Route								
GBG - St.P	736	699	667	639	614	592	573	555
Hamburg - St.P	1022	970	924	884	849	817	789	764
Land bridge (Oxel.)	1140	1118	1099	1083	1068	1055	1044	1033

Tallinn routes

Sensitivity analysis for total average cost of one TEU for LoLo vessels for a one way voyage irrespective direction.

LoLo1						
Utilisation degree (%)	30%	35%	40%	45%	50%	
Number of TEU	90	105	120	135	150	
Route						
GBG-Tallinn	272	251	235	223	213	
Hamburg-Tallinn	302	276	256	241	229	
Land bridge (Oxel.)	724	714	707	701	697	
Utilisation degree (%)	55%	60%	65%	70%	75%	80%
Number of TEU	165	180	195	210	225	240
Route						
GBG-Tallinn	205	198	193	188	184	180
Hamburg-Tallinn	219	211	204	197	192	188
Land bridge (Oxel.)	693	690	687	685	683	682

LoLo2							
Utilisation degree (%)	30%	35%	40%	45%	50%	55%	60%
Number of TEU	150	175	200	225	250	275	300
Route							
GBG - Tallinn	243	227	214	205	197	191	186
Hamburg - Tallinn	264	244	229	217	208	200	194
Land bridge (Oxel.)	712	705	699	695	691	689	686

LoLo3										
Utilisation degree (%)	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%
Number of TEU	300	350	400	450	500	550	600	650	700	750
Route										
GBG - Tallinn	212	201	192	186	181	176	173	170	167	165
Hamburg - Tallinn	227	213	203	195	188	183	178	174	171	168
Land bridge (Oxel.)	703	698	694	691	688	686	685	683	682	681

Sensitivity analysis for total average cost of one trailer for RoRo vessels for a one way voyage irrespective direction.

RoRo1								
Utilisation degree (%)	30%	35%	40%	45%	50%	55%	60%	
Number of trailers	21	25	28	32	36	39	43	
Route								
GBG-Tallinn	1179	1035	926	842	775	720	674	
Hamburg-Tallinn	1457	1282	1151	1049	967	900	845	
Land bridge (Oxel.)	1218	1152	1103	1065	1035	1010	989	
Utilisation degree (%)	65%	70%	75%	80%	85%	90%	95%	100%
Number of trailers	46	50	53	57	60	64	67	71
Route								
GBG-Tallinn	635	601	572	547	524	505	487	471
Hamburg-Tallinn	798	757	722	692	665	641	619	600
Land bridge (Oxel.)	971	956	943	932	922	913	905	898

RoRo2								
Utilisation degree (%)	30%	35%	40%	45%	50%	55%	60%	
Number of trailers	35	41	47	53	59	64	70	
Route								
GBG-Tallinn	1040	919	828	758	701	655	616	
Hamburg-Tallinn	1285	1138	1028	942	874	818	771	
Land bridge (Oxel.)	1185	1129	1087	1054	1028	1007	989	
Utilisation degree (%)	65%	70%	75%	80%	85%	90%	95%	100%
Number of trailers	76	82	88	94	99	105	111	117
Route								
GBG-Tallinn	584	556	532	510	492	475	460	447
Hamburg-Tallinn	732	698	668	643	620	600	582	566
Land bridge (Oxel.)	974	961	950	940	931	924	917	911

RoRo3							
Utilisation degree (%)	30%	35%	40%	45%	50%	55%	60%
Number of trailers	51	60	68	77	86	94	103
Route							
GBG -Tallinn	1052	935	847	779	725	680	643
Hamburg-Tallinn	1285	1144	1039	957	891	837	793
Land bridge (Oxel.)	1221	1168	1128	1097	1073	1052	1036

Utilisation degree (%)	65%	70%	75%	80%	85%	90%	95%	100%
Number of trailers	111	120	128	137	145	154	162	171
Route								
GBG-Tallinn	612	585	562	541	523	507	493	480
Hamburg-Tallinn	755	722	694	669	648	628	611	595
Land bridge (Oxel.)	1021	1009	998	989	981	974	967	961

Riga routes

Sensitivity analysis for total average cost of one TEU for LoLo vessels for a one way voyage irrespective direction.

LoLo1					
Utilisation degree (%)	30%	35%	40%	45%	50%
Number of TEU	90	105	120	135	150
Route					
GBG-Riga	266	246	231	219	210
Hamburg-Riga	287	263	245	231	219
Land bridge (Oxelösund.)	726	716	709	703	698
Land bridge (Karlshamn.)	696	682	672	664	658

Utilisation degree (%)	55%	60%	65%	70%	75%	80%
Number of TEU	165	180	195	210	225	240
Route						
GBG-Riga	202	196	190	186	182	178
Hamburg-Riga	210	203	196	190	186	181
Land bridge (Oxelösund.)	695	692	689	687	685	683
Land bridge (Karlshamn.)	653	648	644	641	639	636

LoLo2									
Utilisation degree (%)	30%	35%	40%	45%	50%	55%	60%	65%	70%
Number of trailers	150	175	200	225	250	275	300	325	350
Route									
GBG-Riga	239	233	211	202	195	189	184	180	176
Hamburg-Riga	252	233	219	208	199	192	186	181	177
Land-bridge (Oxelösund.)	714	706	701	697	693	690	688	686	684
Land-bridge (Karlshamn.)	678	668	660	654	649	645	641	639	636

LoLo3												
Utilisation degree (%)	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%
Number of trailers	300	350	400	450	500	550	600	650	700	750	800	850
Route												
GBG-Riga	211	200	192	186	181	176	173	170	168	165	164	162
Hamburg-Riga	219	206	196	188	182	176	172	169	165	163	160	158
Land bridge (Oxelösund.)	707	701	697	693	691	689	687	685	684	683	682	681
Land bridge (Karlshamn.)	664	656	650	646	642	639	637	635	633	631	630	629

Sensitivity analysis for total average cost of one trailer for RoRo vessels for a one way voyage irrespective direction.

RoRo1							
Utilisation degree (%)	30%	35%	40%	45%	50%	55%	60%
Number of trailers	21	25	28	32	36	39	43
Route							
GBG-Riga	1162	1022	917	836	770	717	672
Hamburg-Riga	1435	1265	1138	1039	960	895	841
Land bridge (Oxelösund.)	1255	1186	1135	1095	1063	1037	1015
Land bridge (Karlshamn.)	1337	1242	1171	1116	1071	1035	1005
Utilisation degree (%)	70%	75%	80%	85%	90%	95%	100%
Number of trailers	50	53	57	60	64	67	71
Route							
GBG-Riga	602	575	550	528	509	492	477
Hamburg-Riga	756	722	692	667	643	622	604
Land bridge (Oxelösund.)	981	967	955	944	935	927	919
Land bridge (Karlshamn.)	957	938	922	907	893	882	872

RoRo2															
Utilisation degree (%)	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
Number of trailers	35	41	47	53	59	64	70	76	82	88	94	99	105	111	117
Route															
GBG - Riga	1039	920	831	762	706	661	623	591	564	540	519	501	485	470	457
Hamburg-Riga	1280	1136	1028	944	877	822	776	737	704	675	650	628	608	590	575
Land bridge (Oxelösund.)	1228	1168	1123	1088	1060	1037	1018	1002	988	976	966	956	948	941	934
Land bridge (Karlshamn.)	1277	1196	1134	1087	1049	1017	991	969	950	934	920	907	896	886	877

RoRo3															
Utilisation degree (%)	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
Number of trailers	51	60	68	77	86	94	103	111	120	128	137	145	154	162	171
Route															
GBG - Riga	1048	934	849	782	729	685	649	618	592	569	549	532	516	502	489
Hamburg - Riga	1278	1140	1037	957	893	840	796	759	727	700	676	655	636	619	604
Land – bridge (Oxelösund.)	1261	1205	1162	1129	1103	1081	1063	1048	1035	1023	1013	1005	997	990	984
Land bridge (Karlshamn.)	1308	1230	1172	1126	1090	1060	1035	1014	996	980	967	955	944	934	926

Liepaja routes

Sensitivity analysis for total average cost of one TEU for LoLo vessels for a one way voyage irrespective direction.

LoLo1											
Utilisation degree (%)	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%
Number of TEU	90	105	120	135	150	165	180	195	210	225	240
Route											
GBG-Liepaja	246	224	211	200	192	185	179	174	170	166	163
Hamburg-Liepaja	271	248	231	218	207	198	191	184	179	175	171
Land bridge (Oxelösund)	724	713	705	699	694	689	686	683	680	678	676
Land bridge (Karlshamn)	672	660	652	645	640	635	631	628	626	622	621

LoLo2									
Utilisation degree (%)	30%	35%	40%	45%	50%	55%	60%	65%	70%
Number of TEU	150	175	200	225	250	275	300	325	350
Route									
GBG - Liepaja	217	203	192	184	178	173	168	165	161
Hamburg - Liepaja	237	220	206	196	188	181	176	171	167
Land bridge (Oxelösund)	709	701	695	690	686	683	680	678	676
Land bridge (Karlshamn)	656	647	641	636	632	628	625	623	621

LoLo3												
Utilisation degree (%)	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%
Number of TEU	300	350	400	450	500	550	600	650	700	750	800	850
Route												
GBG-Liepaja	196	186	178	172	168	164	161	158	156	154	152	150
Hamburg-Liepaja	211	198	188	181	175	170	165	162	159	156	154	152
Land-bridge (Oxelösund)	703	696	691	687	684	682	680	678	677	675	674	673
Land-bridge (Karlshamn)	648	642	636	632	629	627	624	623	621	620	618	617

Sensitivity analysis for total average cost of one trailer for RoRo vessels for a one way voyage irrespective direction.

RoRo1								
Utilisation degree (%)	30%	35%	40%	45%	50%	55%	60%	65%
Number of trailers	21	25	28	32	36	39	43	46
Route								
GBG - Liepaja	1010	887	796	724	667	620	581	548
Hamburg - Liepaja	1221	1078	970	887	820	765	719	681
Land bridge (Oxelösund)	1247	1175	1121	1080	1046	1019	996	977
Land bridge (Karlshamn)	1182	1105	1047	1002	966	936	912	891
Utilisation degree (%)	70%	75%	80%	85%	90%	95%	100%	
Number of trailers	50	53	57	60	64	67	71	
Route								
GBG - Liepaja	520	496	474	455	438	423	410	
Hamburg - Liepaja	648	619	594	572	552	535	519	
Land bridge (Oxelösund)	960	946	933	922	912	904	896	
Land bridge (Karlshamn)	874	858	845	833	822	813	804	

RoRo2															
Utilisation degree (%)	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
Number of trailers	35	41	47	53	59	64	70	76	82	88	94	99	105	111	117
Route															
GBG - Liepaja	902	799	721	661	612	573	540	512	488	467	449	433	419	406	395
Hamburg - Liepaja	1026	914	830	764	712	669	633	603	577	555	535	518	503	489	476
Land bridge (Oxelösund)	1210	1148	1102	1066	1037	1014	994	977	963	951	940	931	922	915	908
Land bridge (Karlshamn)	1139	1073	1023	984	953	928	907	889	874	861	849	839	830	822	814

RoRo3															
Utilisation degree (%)	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
Number of trailers	51	60	68	77	86	94	103	111	120	128	137	145	154	162	171
Route															
GBG - Liepaja	903	806	733	676	630	593	561	535	513	493	476	461	448	436	425
Hamburg - Liepaja	1045	937	856	792	742	700	666	637	612	590	571	554	539	526	514
Land bridge (Oxelösund)	1231	1175	1132	1099	1073	1051	1033	1018	1005	993	983	975	967	960	954
Land bridge (Karlshamn)	1162	1100	1054	1018	990	966	947	930	916	904	893	883	875	867	861

Klaipeda routes

Sensitivity analysis for total average cost of one TEU for LoLo vessels for a one way voyage irrespective direction.

LoLo1					
Utilisation degree (%)	30%	35%	40%	45%	50%
Number of TEU	90	105	120	135	150
Route					
GBG-Klaipeda	259	242	230	220	212
Hamburg-Klaipeda	279	259	243	231	221
Land bridge (Karlshamn)	422	412	404	397	393
Utilisation degree (%)	60%	65%	70%	75%	80%
Number of TEU	180	195	210	225	240
Route					
GBG-Klaipeda	200	196	192	189	186
Hamburg-Klaipeda	207	201	196	192	189
Land bridge (Karlshamn)	385	382	380	378	376

LoLo2								
Utilisation degree (%)	30%	35%	40%	45%	50%	55%	60%	65%
Number of TEU	150	175	200	225	250	275	300	325
Route								
GBG - Klaipeda	237	224	214	206	200	195	191	188
Hamburg - Klaipeda	249	233	222	212	205	199	194	190
Land bridge (Karlshamn)	409	401	395	390	386	383	381	379

LoLo3												
Utilisation degree (%)	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%
Number of TEU	300	350	400	450	500	550	600	650	700	750	800	850
Route												
GBG - Klaipeda	218	209	202	196	192	188	185	182	180	178	176	175
Hamburg - Klaipeda	227	215	206	200	194	189	186	182	180	177	175	173
Land bridge (Karlshamn)	403	397	392	388	385	383	381	379	377	376	375	374

Sensitivity analysis for total average cost of one trailer for RoRo vessels for a one way voyage irrespective direction.

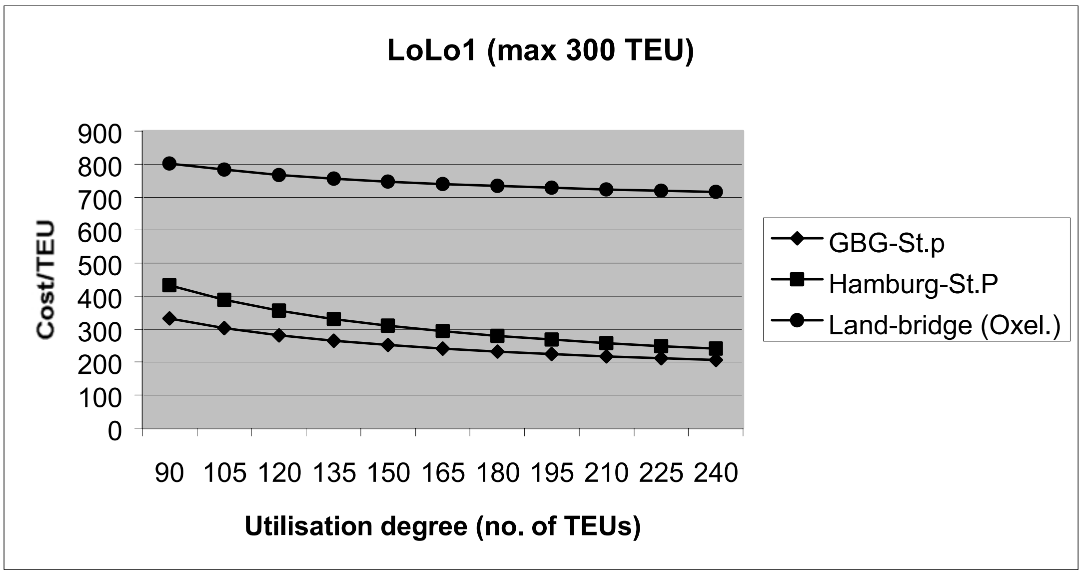
RoRo1								
Utilisation degree (%)	30%	35%	40%	45%	50%	55%	60%	
Number of trailers	21	25	28	32	36	39	43	
Route								
GBG-Klaipeda	1080	957	865	793	736	689	650	
Hamburg-Klaipeda	1268	1124	1016	932	864	809	763	
Land bridge (Karlshamn)	1263	1183	1124	1078	1041	1011	985	
Utilisation degree (%)	65%	70%	75%	80%	85%	90%	95%	100%
Number of trailers	46	50	53	57	60	64	67	71
Route								
GBG-Klaipeda	616	588	563	542	523	506	491	477
Hamburg-Klaipeda	725	691	663	637	615	595	578	562
Land bridge (Karlshamn)	964	946	930	916	904	893	883	875

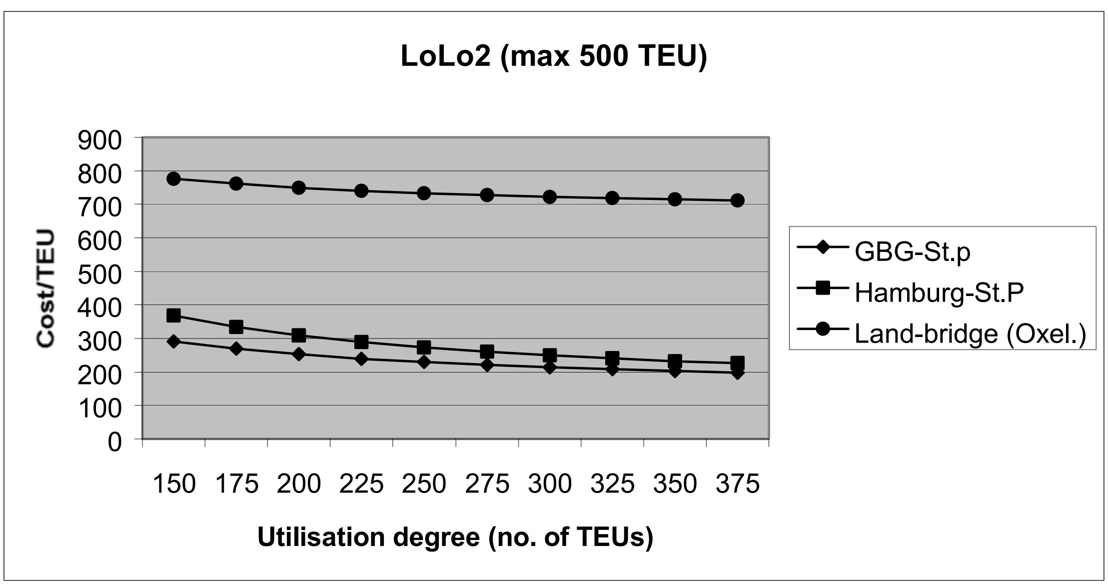
RoRo2															
Utilisation degree (%)	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
Number of trailers	35	41	47	53	59	64	70	76	82	88	94	99	105	111	117
Route															
GBG - Klaipeda	988	882	802	740	690	650	616	587	563	541	523	506	492	479	467
Hamburg - Klaipeda	1074	959	872	805	752	708	671	640	613	590	570	552	537	523	510
Land bridge (Karlshamn)	1232	1162	1110	1069	1036	1009	987	968	952	938	925	915	905	896	889

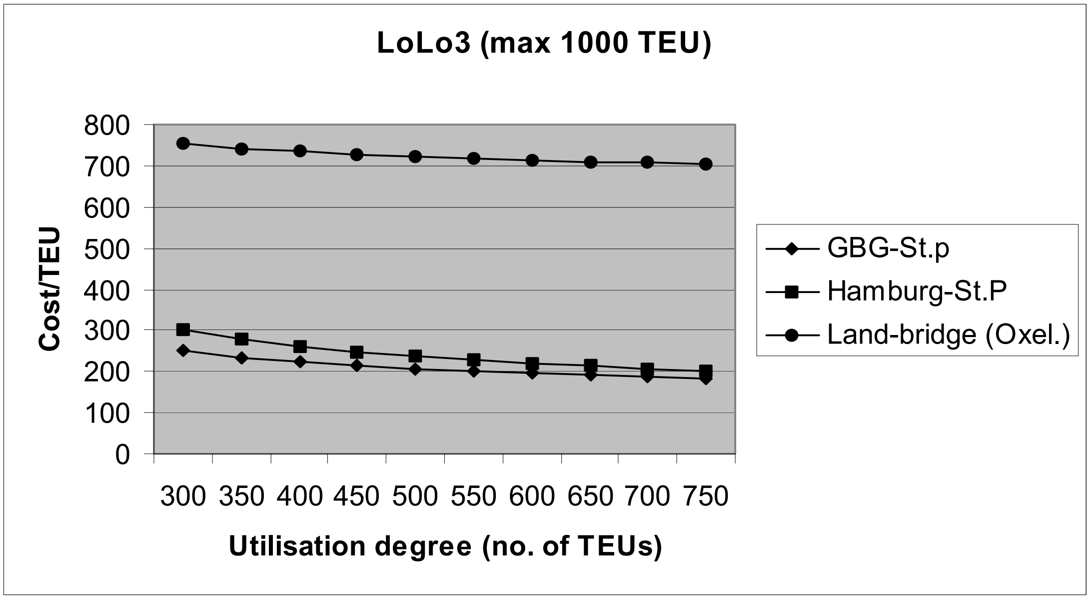
RoRo3															
Utilisation degree (%)	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
Number of trailers	51	60	68	77	86	94	103	111	120	128	137	145	154	162	171
Route															
GBG - Klaipeda	991	890	815	756	709	671	639	611	588	568	550	535	521	509	497
Hamburg - Klaipeda	1067	956	872	807	755	712	677	647	621	598	579	562	546	533	520
Land - bridge (Karlshamn)	1257	1192	1142	1104	1073	1048	1027	1010	995	981	970	960	951	943	935,5

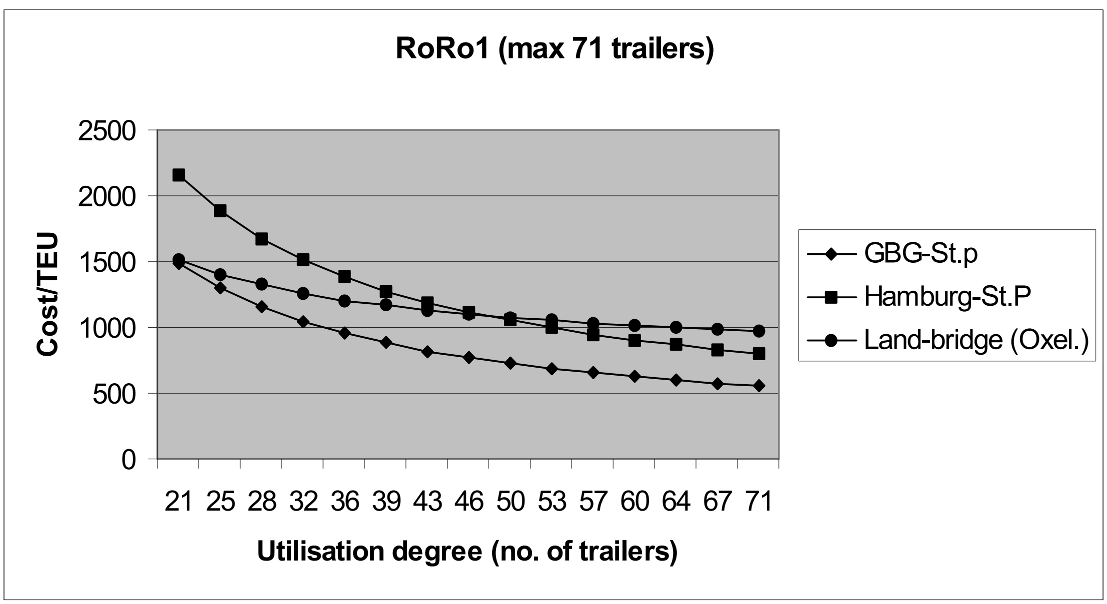
Appendix 4 – Sensitivity Analysis Results in Diagrams for St. Petersburg Routes

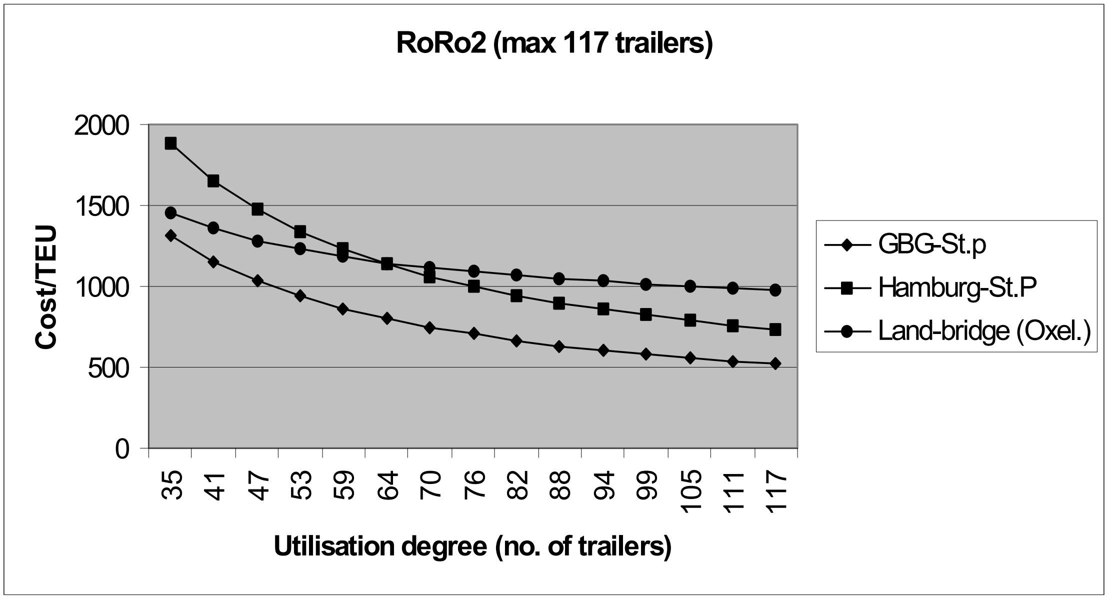
We do not present any more figures, but only the illustration of different output of different vessels can be found below.

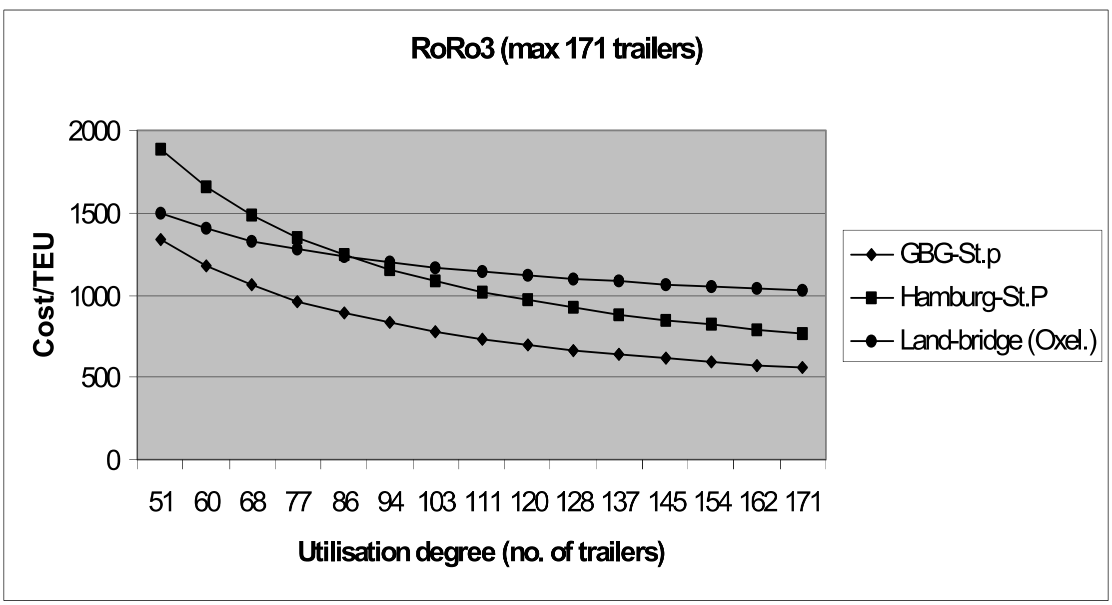





LoLo3 (max 1000 TEU)
Cost/TEU
0
100
200
300
400
500
600
700
800
300 350 400 450 500 550 600 650 700 750
Utilisation degree (no. of TEUs)
GBG-St.p
Hamburg-St.P
Land-bridge (Oxel.)


RoRo1 (max 71 trailers)
Cost/TEU
0
500
1000
1500
2000
2500
21 25 28 32 36 39 43 46 50 53 57 60 64 67 71
Utilisation degree (no. of trailers)
GBG-St.p
Hamburg-St.P
Land-bridge (Oxel.)


RoRo2 (max 117 trailers)
Cost/TEU
2000
1500
1000
500
0
35 41 47 53 59 64 70 76 82 88 94 99 105 111 117
Utilisation degree (no. of trailers)
GBG-St.p
Hamburg-St.P
Land-bridge (Oxel.)


RoRo3 (max 171 trailers)
Cost/TEU
2000
1500
1000
500
0
51 60 68 77 86 94 103 111 120 128 137 145 154 162 171
Utilisation degree (no. of trailers)
GBG-St.p
Hamburg-St.P
Land-bridge (Oxel.)