TRANSPORTATION THROUGH THE SCANDRIA CORRIDOR

A sustainable transport concept between the Adriatic Sea and Scandinavia

Erik Karlsson
John Landstedt

Master's Thesis LIU-IEI-TEK-A--10/00877--SE
Department of Management and Engineering
Logistics Management
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This project has been as interesting as it has been challenging. Interesting because of the few restrictions and the very in-time thinking that has surrounded the project. Challenging because of the size and the complexity of the project. The work has widened our knowledge in several areas and given us insight in the many difficulties that European transportation implies. We think that the project is a good completion of our education as it has given us a chance to use our knowledge and at the same time work for an interesting company.

A very big thank you would we like to send to our supervisor at Øresund Logistics, Patrik Rydén. Even due to a very tight time schedule he has always found time for us. We also like to thank our supervisor at Linkoping University, Maria Björklund, and our opponents Anna-Maria Monnest and Emma Tranarp who has helped us increasing the quality of the thesis.

The empirical part would never have been as good as it is without the help from Magnus Johansson at SIKA why we would like to thank him. We would also like to thank all the respondents in the interviews for taking some of their time to answer our questions.

At last we would like to thank each other for keeping the spirit up at all times.

Our hope is that this thesis has illustrated both the possibilities and barriers with transporting through Europe and contributed towards changing the European freight transport to be better in line with the future.

Erik Karlsson & John Landstedt
Malmö, May 2010
EXEcutiVe suMmAry

The Scandria Corridor is the shortest way between the Adriatic Sea and the Baltic Sea and stretches from the harbors in the Adriatic Sea to Scandinavia, with branches to Stockholm and Oslo. By offering the shortest route it should be an area in focus for transporting goods. But a large share of European freight traffic goes through the western parts and most main development routes are in east-west connections. Indications have however been made that higher amounts of goods will enter the European market through the harbors in the Mediterranean Sea. As Western Europe is already crowded and congestion is a problem the Scandria Corridor offers new routes with free capacity and shorter south-north connections.

An immediate problem of European freight traffic is the large use of trucks as means of transportation. As trucks causing large negative environment affects such as high emission levels, congestion on roads and deterioration of the infrastructure the European Union promotes use of other transport concepts. But the alternatives, railway and inland waterway transports, faces different kinds of barriers making them less competitive which obstructs their implementation.

The information above leads to the thesis purpose “to suggest a sustainable and innovative concept for transporting goods applicable in the Scandria Corridor.” To be sustainable the concept should be future considerate (consider changes in transport conditions), feasible (achieve competitive customer service at reasonable costs) and environmentally friendly (less negative environmental affects than the alternatives). Innovative translates as being open-minded when it comes to combining and implementing ideas, concepts and methods.

Through a mapping of the infrastructure in the corridor, conditions for the transport methods and customer values the conclusion can be drawn that railway transportation is the best option for transportation in the Scandria Corridor. There are however some barriers that obstruct the set-up of the concept and what route that should be used. A large barrier is the complexity of cross-border transport in Europe because of several different railway electrification systems. Another large barrier is different train control systems that calls for large investments in trains compatible with all systems crossed and staff educated in each system. Another barrier is the low standard of railway tracks in Eastern Europe.

A mapping of customer values informs that the price is the most important aspect followed by the delivery dependability, given that the lead time is similar to the alternatives. Flexibility is important to some but for most the aspects above are more important. Low environmental affects is important to all parties but no one wants to pay to achieve it. Through analysis of the mapping with support of the theories train needs to offer a lower price than truck alternatives offer to be competitive due to trucks flexibility and ability to reach all destinations. Furthermore train has better possibilities in profitable the longer the distance is.

Goods flows are studied for the northern Adriatic ports which give that Trieste, Venice and Koper handles the largest volumes. But the amounts of goods between the ports and northern parts of the corridor are probably too low to use one port as the south end point of the concept. Instead a strategic location like Villach (Austria) or Verona (Italy) is better suited as they can work as funnels for larger areas. The solution with a funnel seems to be the best solution for Scandinavia where
Trelleborg can be the north end point as a rail ferry from Rostock, suitable for the transport from Germany to Sweden, enters the port of Trelleborg. From Trelleborg goods can be spread to other parts of Scandinavia mainly through branches to Oslo and Stockholm.

To be sustainable a train concept needs a high fill rate in both directions. To get a high fill rate loading points can be used between the end points. Through a mapping of goods flow between Sweden and regions in the corridor suitable loading points tend to be Berlin (Germany), Munich (Germany) and Vienna (Austria). It is the demand of transport that decides how many loading points that should be used but the fewer the better since they increases the costs and lead time.

The suggested concept is a train line with green trucks as back-up to irregular demands and problems on railway tracks. Three different concept routes are presented in the thesis.

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<thead>
<tr>
<th></th>
<th>Concept 1</th>
<th>Concept 2</th>
<th>Concept 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>End point</strong></td>
<td>Trelleborg (Sweden)</td>
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<td>Trelleborg (Sweden)</td>
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</tr>
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<td>Munich (Germany)</td>
<td>Munich (Germany)</td>
<td>Prague (Czech Republic)</td>
</tr>
<tr>
<td><strong>Loading point</strong></td>
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<td><strong>End point</strong></td>
<td>Verona (Italy)</td>
<td>Villach (Austria)</td>
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</tbody>
</table>

The concepts could be arranged in order of implementation. Concept 1 probably has the best chance of getting a high fill rate but the competition is hard on the route. If concept 2 is ready for implementation depends on the demand of transport on this route. When the goods flows are large enough it would probably be a better option because of the few electrification systems and train control systems crossed. Concept 3 is more of a concept for the future, due to many barriers. By using this route bottlenecks and congestion can be avoided.
# Contents

1. Introduction ........................................................................................................................................ 2
   1.1 Background .................................................................................................................................. 2
   1.2 Problem identification .................................................................................................................... 3
   1.3 Purpose ......................................................................................................................................... 3
      1.3.1 Sustainable transports ........................................................................................................... 3
      1.3.2 Innovation ............................................................................................................................... 4
      1.3.3 Concept .................................................................................................................................. 4
   1.4 Studied system ................................................................................................................................. 4
      1.4.1 The Scandria Corridor ............................................................................................................ 5
   1.5 Focus and delimitations ................................................................................................................... 5
   1.6 Target audience ............................................................................................................................... 6
   1.7 Commissioning body ....................................................................................................................... 6
   1.8 Abbreviations .................................................................................................................................... 6

2. Theoretical framework ......................................................................................................................... 8
   2.1 Logistics - Cost and service ............................................................................................................. 8
      2.1.1 Costs in a transport concept .................................................................................................... 9
      2.1.2 Customer service .................................................................................................................... 11
   2.2 Transport logistics .......................................................................................................................... 12
      2.2.1 Choosing mode of transportation ........................................................................................... 14
      2.2.2 Transport modes .................................................................................................................... 14
      2.2.3 Intermodal transport ............................................................................................................. 17
      2.2.4 Co-modality .......................................................................................................................... 18
   2.3 Transport logistics and the environment ......................................................................................... 18

3. Problem specification ............................................................................................................................ 22
   3.1 Analysis model ............................................................................................................................... 22
      3.1.1 Mapping ................................................................................................................................. 23
      3.1.2 Analysis ................................................................................................................................. 25
      3.1.3 Concept generation and evaluation ......................................................................................... 26

4. Methodology ....................................................................................................................................... 28
   4.1 Methodological approach ............................................................................................................... 28
      4.1.1 Awareness ............................................................................................................................... 28
   4.2 Research procedure ......................................................................................................................... 29
      4.2.1 Planning ................................................................................................................................. 29
5. Mapping of the situation in the corridor ................................................................. 38
   5.1 Infrastructure .................................................................................................... 38
      5.1.1 General bottlenecks in European freight traffic ........................................ 38
      5.1.2 Trans-European Transport Network ......................................................... 38
      5.1.3 Green corridors ....................................................................................... 39
      5.1.4 Marco Polo programme .......................................................................... 39
   5.2 Railway transportation ...................................................................................... 40
      5.2.1 Problems in railway transportation ............................................................ 41
      5.2.2 ERTMS (European Railway Traffic Managing System) .......................... 42
      5.2.3 Railway electrification systems .................................................................. 44
      5.2.4 Operators .................................................................................................. 45
      5.2.5 Tracking systems ..................................................................................... 46
   5.3 Truck transportation ......................................................................................... 46
      5.3.1 Road pricing .............................................................................................. 47
   5.4 Transportation on water .................................................................................. 48
      5.4.1 SECA (SO\textsubscript{x} Emission Control Area) ...................................... 50
   5.5 Customer values ............................................................................................... 51
6. Analysis of the situation in the corridor .............................................................. 54
   6.1 Barriers in the corridor ..................................................................................... 54
      6.1.1 Railway electrification systems .................................................................. 55
      6.1.2 Train control systems .............................................................................. 56
   6.2 Concept forming ............................................................................................... 56
      6.2.1 Customer Service ..................................................................................... 56
      6.2.2 Transport costs ......................................................................................... 58
      6.2.3 Sustainable ............................................................................................... 61
7. Mapping of goods flows and logistic nodes ....................................................... 64
   7.1 South end point ............................................................................................... 64
      7.1.1 Area 1 – Venice, Chioggia ................................................................. 65
      7.1.2 Area 2 – Trieste, Monfalcone, Koper ................................................. 66
      7.1.3 Area 3 – Rijeka, Bakar, Omisalj ........................................................... 67
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1.4</td>
<td>Summary of goods flows in ports</td>
<td>68</td>
</tr>
<tr>
<td>7.1.5</td>
<td>Collaboration between northern Adriatic ports</td>
<td>68</td>
</tr>
<tr>
<td>7.2</td>
<td>North end point</td>
<td>69</td>
</tr>
<tr>
<td>7.2.1</td>
<td>Logistic nodes in Sweden</td>
<td>69</td>
</tr>
<tr>
<td>7.3</td>
<td>Goods flows between the end points</td>
<td>71</td>
</tr>
<tr>
<td>7.3.1</td>
<td>Goods flow between Slovenia and Sweden</td>
<td>72</td>
</tr>
<tr>
<td>7.3.2</td>
<td>Goods flow between Northern Italy and Sweden</td>
<td>72</td>
</tr>
<tr>
<td>7.4</td>
<td>Strategic regions in the corridor</td>
<td>73</td>
</tr>
<tr>
<td>7.4.1</td>
<td>Eastern Germany</td>
<td>74</td>
</tr>
<tr>
<td>7.4.2</td>
<td>Czech Republic</td>
<td>77</td>
</tr>
<tr>
<td>7.4.3</td>
<td>Austria</td>
<td>78</td>
</tr>
<tr>
<td>8.</td>
<td>Analysis of goods flows and logistic nodes</td>
<td>82</td>
</tr>
<tr>
<td>8.1</td>
<td>End points</td>
<td>82</td>
</tr>
<tr>
<td>8.2</td>
<td>Loading points</td>
<td>85</td>
</tr>
<tr>
<td>8.3</td>
<td>Conclusion</td>
<td>86</td>
</tr>
<tr>
<td>9.</td>
<td>Concept generation</td>
<td>88</td>
</tr>
<tr>
<td>9.1</td>
<td>Concept setup</td>
<td>88</td>
</tr>
<tr>
<td>9.2</td>
<td>Concept 1</td>
<td>90</td>
</tr>
<tr>
<td>9.3</td>
<td>Concept 2</td>
<td>91</td>
</tr>
<tr>
<td>9.4</td>
<td>Concept 3</td>
<td>92</td>
</tr>
<tr>
<td>9.5</td>
<td>Evaluation of concepts</td>
<td>93</td>
</tr>
<tr>
<td>10.</td>
<td>Conclusion</td>
<td>96</td>
</tr>
<tr>
<td>10.1</td>
<td>Implementation</td>
<td>96</td>
</tr>
<tr>
<td>10.2</td>
<td>Sensitivity analysis</td>
<td>97</td>
</tr>
<tr>
<td>10.3</td>
<td>Future research</td>
<td>98</td>
</tr>
<tr>
<td>11.</td>
<td>References</td>
<td>100</td>
</tr>
<tr>
<td>12.</td>
<td>Appendix</td>
<td>110</td>
</tr>
</tbody>
</table>
LIST OF FIGURES

Figure 1 - Map of the Scandria Corridor ................................................................. 2
Figure 2 - Costs and economical parameters are considered when designing a transport service .... 11
Figure 3 - Transport logistics divided into three levels and two markets ........................................ 13
Figure 4 - A typical setup for a combined transport concept ......................................................... 18
Figure 5 - Analysis model ........................................................................................................ 22
Figure 6 - The research procedure with a planning phase and the phases of the analysis model .......... 29
Figure 7 - A breakdown of the planning phase in the research procedure ........................................ 29
Figure 8 - Connection between induction, deduction and verification ............................................... 30
Figure 9 - A breakdown of the mapping phase in the research procedure .......................................... 32
Figure 10 - A breakdown of the analysis phase in the research procedure ......................................... 33
Figure 11 - A breakdown of the concept generation phase in the research procedure ......................... 35
Figure 12 - An estimation of European rail bottlenecks in 2010 ..................................................... 42
Figure 13 - Map of different train control systems in Europe .......................................................... 43
Figure 14 - Expected growth of the ETCS network 2007-2020 ..................................................... 44
Figure 15 - Map of different railway electrification systems in Europe ............................................ 45
Figure 16 - An estimation of European road bottlenecks in 2010 .................................................... 47
Figure 17 - Geographical locations of European main rivers .......................................................... 49
Figure 18 - Freight ferry options for train transport from Germany to Sweden ............................. 50
Figure 19 - Higher sulphur restrictions in SECA (Baltic Sea, North Sea and English Channel) ....... 50
Figure 20 - Geographic location of northern Adriatic port areas .................................................... 65
Figure 21 - Geographic locations of ports in northern Adriatic port area 1 ...................................... 65
Figure 22 - Geographic locations of ports in northern Adriatic port area 2 ..................................... 66
Figure 23 - Geographic locations of ports in northern Adriatic port area 3 ..................................... 67
Figure 24 - Goods handled in northern Adriatic ports 2008 .......................................................... 68
Figure 25 - Forecast of goods flow sizes in Sweden in 2020 ............................................................ 69
Figure 26 - Transport nodes and links in Sweden ............................................................................ 70
Figure 27 - Estimated goods volumes between Slovenia and Sweden in 2020 ............................... 72
Figure 28 - Estimated goods volumes between Northern Italy and Sweden in 2020 ....................... 73
Figure 29 - Estimated goods flows between Sweden and Eastern German regions in 2020 .......... 74
Figure 30 - Estimated goods types between Eastern Germany and Sweden in 2020 ..................... 75
Figure 31 - Estimated goods flows between Swedish regions and Bayern in 2020 ......................... 75
Figure 32 - Estimated goods flows between Swedish regions and Berlin/Brandenburg in 2020 .... 76
Figure 33 - Estimated goods flows between Swedish regions and Mecklenburg in 2020 ............... 77
Figure 34 - Estimated goods flows between Swedish regions and Czech Republic in 2020 .......... 78
Figure 35 - Estimated goods flows between Swedish regions and Eastern Austria in 2020 .......... 78
Figure 36 - Estimated goods flows between Swedish regions and Western Austria in 2020 .......... 79
Figure 37 - Goods handled in northern Adriatic ports 2008 .......................................................... 83
Figure 38 - Comparison of goods flow Northern Italy-Sweden in 2020 and railway shuttle ............ 83
Figure 39 - Comparison of goods flow Northern Italy-Swedish regions in 2020 and railway shuttle .. 84
Figure 40 - Comparison of goods flows corridor regions-Sweden in 2020 and railway shuttle ........ 85
Figure 41 - Concept 1, route: Trelleborg-Verona ........................................................................... 90
Figure 42 - Carbon dioxide emission and energy consumption of transport modes in concept 1 ....... 90
Figure 43 - Concept 2, route: Trelleborg-Villach ........................................................................... 91
Figure 44 - Carbon dioxide emission and energy consumption of transport modes in concept 2 ....... 91
Figure 45 - Concept 3, route: Trelleborg-Koper ............................................................................. 92
Figure 46 - Carbon dioxide emission and energy consumption of transport modes in concept 3 ....... 92
LIST OF TABLES

Table 1 - Modal split of European freight traffic (tonne-kilometers), 1995-2007 ........................................ 15
Table 2 - Summary of advantages and drawbacks for transport modes ...................................................... 17
Table 3 - Emission levels of CO2 for transport modes .................................................................................. 19
Table 4 - Description of different European road pricing systems ............................................................... 48
Table 5 - Size of area and population for Northern Italy and Slovenia ......................................................... 72
Table 6 - Area and population for regions in middle Europe ........................................................................ 74
Table 7 - Goods volumes required for a railway shuttle ................................................................................ 82
Table 8 - Description of concept 1 .............................................................................................................. 90
Table 9 - Description of concept 2 .............................................................................................................. 91
Table 10 - Description of concept 3 ........................................................................................................... 92
Table 11 - Summary of concept setups ....................................................................................................... 93
Table 12 - Implementation factors of the suggested concepts .................................................................... 94
INTRODUCTION

BACKGROUND

PROBLEM IDENTIFICATION

PURPOSE

STUDIED SYSTEM

FOCUS AND DELIMITATIONS

TARGET AUDIENCE

COMMISSIONING BODY

ABBREVIATIONS
1. INTRODUCTION

This chapter presents the background to the thesis from where the purpose is elaborated. The studied system will be described as orientation to the rest of the thesis. Further are the delimitations presented and the target audience is defined. At last the commissioning body and a number of used abbreviations are presented.

1.1 BACKGROUND

Indications have been made that higher amounts of goods will enter the European market through the harbors in the Mediterranean Sea. One indication is the changes in restrictions regarding the content of sulphur in marine fuel oil for sea transportation (Transportstyrelsen, 2010a), which makes other means of transportation a better option for moving goods to the northern parts of Europe. Another indication is the widening of the Suez Canal which eases sea transportation to the Mediterranean from mainly Asia (Suez Canal Authority 2010a).

The Scandria, Scandinavian Adriatic, Corridor (Figure 1, rings show the project partners) is the shortest way between the Adriatic Sea and the Baltic Sea and by that an area in focus when it comes to transporting goods. The Scandria Corridor project was initiated to promote and establish a corridor for transportation from the Adriatic Sea to the Scandinavian region. (Scandria project, 2008)

Today more than 45 % of the goods in Europe\(^1\) are transported by truck (EU energy and transport, 2009). With increasing volumes of goods some negative aspects with transportation by truck in the future has been identified. One is the undeveloped road networks in the southern parts of the corridor which needs to be improved to manage the higher volumes. Another is the rising diesel price (U.S Energy Information Administration, 2010a). A third one is that “road transport produces a wide range of negative 'external effects', including deterioration of infrastructure, congestion, noise and air pollution, as well as traffic accidents” (EurActiv, 2010a). At last the use of road pricing, a fee needs to be paid to get through a certain point or area, seems to increase in the European countries (The European Parliament, 2010a). These aspects indicate that the demand for new ways of transportation is growing.

Freight transport faces challenges of efficiency, quality and sustainability, something that must be addressed in the years ahead. At the same time freight transport is essential for the competitiveness of the European economy and the quality of life of EU citizens. This has created a need for suitable

\(^1\) EU-27, The 27 members of the European Union
concepts responding to the problems of congestion, climate change, energy supply and security. (European Union, 2010a)

1.2 PROBLEM IDENTIFICATION
The anticipated growth of goods through the Scandria Corridor implies a need for sustainable transport concepts. Road transportation is the most used transport mode in EU and were the transport mode that increased most in 2009 (intermodal transports excluded). But all goods in the future cannot be transported by truck due to the limited road capacity and the high environmental effects. EU is trying to increase the share of other transport modes by promoting and funding organizations and projects to improve the conditions for the alternatives. The alternatives to road transport in the Scandria Corridor are air, railway, inland waterways and intermodal transport. All of these are facing different kinds of problems making them less competitive which obstructs their implementation. In order to present a sustainable concept these problems needs to be mastered or avoided.

1.3 PURPOSE
In line with the changing surroundings within the Scandria Corridor and the negative aspects on current freight traffic the purpose have been formed.

The purpose of this thesis is to suggest a sustainable and innovative concept for transporting goods applicable in the Scandria Corridor.

The suggested concept will aim for an improvement compared to the present transport concepts within the route regarding customer service and environmental effects at a cost level making it attractive to potential users.

The three terms “sustainable”, “innovative” and “concept” can be translated differently why they are defined below to describe the meaning of them in this thesis.

1.3.1 SUSTAINABLE TRANSPORTS
A sustainable transport is defined by the EU Transport Council (2001) in European Cyclists’ Federation (2004) as it:

- Allows the basic access and development needs of individuals, companies and societies to be met safely and in a manner consistent with human and ecosystem health, and promotes equity within and between successive generations;
- Is affordable, operates fairly and efficiently, offers choice of transport mode, and supports a competitive economy, as well as balanced regional development;
- Limits emissions and waste within the planet’s ability to absorb them, uses renewable resources at or below their rates of generation, and, uses non-renewable resources at or below the rates of development of renewable substitutes while minimizing the impact on the use of land and the generation of noise.

2 Air has been excluded in this thesis due to the high costs
INTRODUCTION

The three parts needed to be fulfilled in order to call a transport concept sustainable have in this thesis been translated as future considerate, feasible and environmentally friendly. Future considerate means that changes in transport conditions regarding laws, regulations, goods volumes and infrastructure will be considered. Feasible handles mainly what levels in customer service and transport costs that is appropriate but also what is realistic regarding investments and technology. Environmentally friendly addresses environmental effects which contains emission levels and energy efficiency but also affects on the surroundings such as deterioration of the infrastructure and congestion.

1.3.2 INNOVATION

An innovation is the introduction of something new, like a new idea or a method (Merriam-Webster, 2010a). To be more than an invention the idea or method has to result in an improvement for the public (Real Innovation, 2010a).

The definition of innovative can be summarized as something new that results in an improvement to the public. In this thesis the idea of creating an innovative concept does not imply that the concept have to be something revolutionary but rather to be open-minded when it comes to combining and implementing ideas, concepts and methods.

1.3.3 CONCEPT

A concept can be defined as: “The reasoning behind an idea, strategy, or proposal with particular emphasis placed on the benefits brought on by that idea” (Business Dictionary, 2010a) or “An abstract or general idea inferred or derived from specific instances” (WordNet, 2010a). There are many other definitions of what a concept is but these two translates the use of “concept” in this thesis the best.

To further describe the term “transport concept” a definition has been put up by the authors for the use of it in this thesis: “A solution for transporting goods put into a package containing route, transport methods, acceptable goods and complete setup for the transport”.

1.4 STUDIED SYSTEM

The thesis includes a study and analysis of the available and future possible routes and transport modes within the Scandria Corridor. Studied transport modes are rail, road, inland waterways and multimodal transports. The different transport modes’ strengths and weaknesses are considered and compared.

The route will stretch from terminal to terminal, within the Scandria Corridor. Through analysis and mapping the most suitable route will be decided. Considered parameters are suitable harbors in matter of capacity, types of goods, connections etc., where strategic regions are placed in matter of production volumes, consumption volumes, company warehouses and distribution centers etc. and current traffic situations in matter of infrastructure, congestion etc.

An important factor for the creating of the concept is the competiveness. To make the suggested concept attractive for concerned actors, e.g. transport companies and organizations, the concept has to satisfy, and preferable outperform, customer demands. This includes keeping the costs for the concept at a point that makes it attractive to possible users.
A study of the present situation in the corridor will be done and expected future changes, in e.g. laws, infrastructure, emission levels, regarding conditions for freight transport in the corridor will be considered.

This thesis’ primary scope of time is set to five years ahead (2015) but changes further in the future will be taken in consideration. The authors have together with the supervisor at Øresund Logistics decided the scope of time with consideration to time for implementation and evaluation of the concept.

1.4.1 The Scandria Corridor
The Scandria Corridor is the shortest way between the Adriatic Sea and the Baltic Sea. The Corridor goes from the harbors in the Adriatic Sea to Scandinavia, with branches to Stockholm and Oslo. The project was launched September 2009 and its purpose is to make the transport through the corridor more environment-friendly and to improve the connections between regions in the corridor. The Scandria Corridor project group consists of many different types of actors, seen in appendix 12.1. The project’s lead partner is the Joint State Planning Department in Berlin-Brandenburg and there are 19 partners involved.

The Scandria project is divided into five different work packages. The package where this project is involved is called Innovative Logistics Solutions (appendix 12.2). Every package consists of different actions with one or many partners assigned to each action. Øresund Logistics is responsible for action Developing logistics solutions and it is the action where this project is placed (appendix 12.2). In the same work package there is also an action that is called Marketing campaign for innovative logistics solutions. The solutions Øresund Logistics create will be marketed of that group. (Scandria Project, 2010a)

1.5 Focus and Delimitations
Focus for the thesis will be on transportation through Europe which excludes both air transport and sea transport (not inland waterways). The reason for this is the differences in the methods which would require a large amount of both empirical and theoretical studies. Also pipelines are excluded since the transport conditions strongly differ from the other transport modes.

Freight transportation is put in focus and passenger transporting is excluded. Passenger transport will however be considered as a factor that contributes to congestion on road and rail networks.

The indications of the increasing amount of goods through the corridor will not be challenged. Some indications will be mentioned but will not be used as material for the analysis. The authors find the information trustworthy and an evaluation would be outside the frames for this thesis.

Areas outside the Scandria Corridor will not be focused to be able to concentrate on the specific problems and barriers in the corridor.

Due to restrictions of time the regions between the end points cannot be described as much as the south and north end points, the goods flow between Sweden and regions will be used for evaluating suitable nodes for the concept.
1.6 TARGET AUDIENCE
This thesis is mainly written to the commissioning body Øresund Logistics, with an intention to redirect it to a company or organization who in their turn, with small or no changes, should be able to use the concept presented. Other target audiences are the head of the Scandria Corridor project in Berlin-Brandenburg and companies within the transport logistics area.

1.7 COMMISSIONING BODY
Øresund Logistics is a public owned network organization located in Malmo, Lund and Copenhagen. There are 11 universities owning the company with Lund University as the main owner. The organization was originally founded 2002 with the intention to make the Øresund region one of the most important logistics hubs in Europe, with the newly built Øresund bridge between Copenhagen and Malmo that created possibilities for improved connections in the Øresund region as the biggest reason. (Patrik Rydén, Managing Director, Øresund Logistics)

For additional information about Øresund Logistics visit www.orelog.org.

1.8 ABBREVIATIONS
ATC – Automatic Train Control
ERTMS – European Railway Traffic Managing System
GPS - Global Positioning System
GSM - Global System for Mobile communication
HGV – Heavy Goods Vehicle
HSFO – High Sulphur Oil
LSFO – Low Sulphur Oil
MDO - Marine Diesel Oil
MGO - Marine Gas Oil
NOx – Nitrogen oxide gases
OBU – On Board Unit
RFID - Radio Frequency Identification
Ro-Ro, mobile self-propelled units - (Roll on – Roll of) wheeled drivable cargo
Ro-Ro, mobile non-self-propelled units - (Roll on – Roll of) wheeled non-drivable cargo
SECA - SOx Emission Control Area
SOx – Sulphur oxide gases
TENT-T – Trans European Transport Network
Tonne – The metric unit of mass equal to 1 000 kg, also known as metric tonne or metric ton
Tonne-kilometer (tkm) - Unit of measure of goods transport which represents the transport of one tonne over one kilometer.
THEORETICAL FRAMEWORK

LOGISTICS – COST AND SERVICE

TRANSPORT LOGISTICS

TRANSPORT LOGISTICS AND THE ENVIRONMENT
2. THEORETICAL FRAMEWORK

This chapter will present relevant theories in the frames of the thesis. To start out the term logistic will be defined in the section Logistics – costs and service. This section also includes cost occurring in a transport concept and customer service. Furthermore transport logistics is dealt with in the matter of transport structure followed by a presentation of the different transport modes evaluated in the thesis. A section treating logistic and the environment will finalize the theoretical framework.

2.1 LOGISTICS - COST AND SERVICE

Logistic is according to Pewe (2002) a philosophy about coordinating and controlling the resources in a company at an overall point of view. This makes logisticians the companies’ coordinators. Successful logistics coordinators need to possess knowledge and experiences in many areas. Oskarsson et al. (2006) takes it one step further and claims that logistics cover planning and performing but also controlling the result, with a focus to move and store material from being raw material to become finished products in the hands of the final customer. This often includes several companies which make different types of information necessary to achieve good results. Lumsden (2006) defines the term “logistic” based on a number of often used definitions as:

Logistics cover transfer of people and material. It exists of the activities that deal with controlling the right article or individual, in the right condition, to the right place, at the right time and to the right cost. It aims to satisfy the needs and wishes of every party with focus on the customer. Logistic consists of planning, organizing and controlling every activity in the flow of material, resources, financial assets, information and returning goods. The term contain as well operative responsibility where administration, running and procurement as constructive responsibility and build-up as well as detailing.3 (Lumsden, 2006, p. 24)

Oskarsson et al. (2006) says that the goal with logistics is to achieve a cost-effective customer service, which are low costs at a high level of customer service. Further they claim that most companies can improve their customer service and at the same time lower their costs. Lumsden (2006) refer to a dilemma called “the logistical mixing goals” which contains logistical costs, customer service and tied up capital. A change in one area often implicates a change in the other ones. The goal is to maximize the total profit from the three components.

The logistics in a company is according to Oskarsson et al. (2006) divided into three parts which are materials supply, production and distribution with stock keeping in between. These need to be coordinated to meet the demand of the market. Pewe (2002) agrees with the importance of coordination between different functions in a company and claims that a comprehensive view is the base for logistics. In order to change single activities, functions and processes you have to gain a comprehensive picture of each area. But if one base on the comprehensive view Lumsden (2006) argues that the profit and consequence of each part is difficult to see. If the view instead is based on the component Lumsden (2006) says that it is difficult to put the performance in an overall point of view. Therefore Lumsden (2006) concludes that it is essential to introduce a comprehensive view successive by starting with simple and clear components and relations.

3 Freely translated from Swedish
2.1.1 Costs in a transport concept

Particularly important in the context of logistics is according to Oskarsson et al. (2006) to consider all the costs affected by taking certain decisions. Most changes will affect different types of costs either positively or negatively. When there are a number of alternatives to choose from the total change in costs is important to identify when putting the alternatives against each other. Oskarsson et al. (2006) suggests the following cost items when calculating the total logistics cost:

- **Stock keeping** – Costs in tied up capital, obsolescence, spoilage, scrap and insurance
- **Holding cost** – Costs to run a warehouse: facilities, staff, equipment and warehouse transports
- **Transportation** – Costs in administration and performance of transports
- **Administration** – Various costs in administration of logistic activities
- **Remaining costs** – Cost items not covered above, e.g. Information, material and wrapping

Transport concepts consist mainly of transportation costs why these are explained further.

The meaning of transportation cost is different whether a transport seller or a transport buyer is asked according to Lumsden (1995). To traditional transport sellers it refers to costs connected to the actual transportation. Lumsden (2006) names these costs the “actual transport costs” which can be divided into the four groups: transfer, loading, re-loading and discharging.

By grouping the “actual transport costs” the opportunity to analyze the whole cost picture and changes in it depending on different factors is given according to Lumsden (1995). The terms type of cost, cost center and cost unit are often used in this context. The most common classification in types of cost is if it is time- or distance depending. Cost center implies what type of vehicle or transportation mode that is used and cost unit is a given transport assignment.

Lumsden (2006) says that costs can be registered as fixed or variable but these are hard to use in the same situation because they tend to overlap on each other as the time perspective differs. Some other types of cost breakdowns are described by Lumsden (2006) instead:

**Time- and distance-depending costs**: Time-depending costs grow the longer a certain vehicle is connected to a specific transportation. These costs are usually important when loading or discharging the goods because of the waiting times which can occur. Costs related to how long of a distance the goods have to be transported are distance-depending and differ from the time-depending.

**Initial, threshold and marginal costs**: To establish a flow of goods big initial costs are normally required to e.g. create relations with vehicles and terminals. These are often making up for much of the fixed costs in case of costs for interest and depreciation. Modes of transportation with a high share of initial or fixed costs will not get profitable until a sufficient amount of goods are transported in the flow. Threshold costs occur in an already created transport line or relation where the amount of goods are about to rise. To handle the higher amounts of goods investments in whole units such as vehicles have to be made which makes the costs increase in the form of steps or thresholds. The marginal cost shows how much it would cost to increase the capacity of one unit e.g. making room for one more passenger in a bus by adding one chair.

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4 Translated to English from the Swedish term “Egentliga transportkostnader”
**THEORETICAL FRAMEWORK**

*Costs for facilities and vehicles:* Costs in keeping a transport mode up and running can be divided into costs for all kinds of facilities and costs for the vehicles moving between them. Facilities involve all kinds of infrastructure like roads, railroad, terminals etcetera. Road costs are often paid in form of fees and taxes. Vehicles include all types of transporters like trucks, ships, wagons and so on.

*Terminal and during way costs:* These types split costs into terminal costs which occurs in a node or terminal and costs taking place in the link or during the way. Generally are transport modes with low terminal costs and high during way costs best suited when it comes to short transport distances and transport modes with high terminal costs and low during way costs more suited in the case of transporting long distances.

To transport buyers other costs than costs occurring for the performing of the actual transport can be equally or even more significant. In a later edition of his book Lumsden (2006) says that there can be almost an unlimited number of other costs. As examples Lumsden (1995) proposes costs for marking and identification of goods, storage functions, own administration and damaged goods among others.

Fixed and variable costs together with some economical parameters are considered in the transport system when designing a transport service (Figure 2) according to Lumsden (1995). The economic parameters proposed by Lumsden (1995) are economy of scale, scope, density, experience and presence:

*Economy of scale:* Big units with a high amount of fixed costs can in areas with large volumes take profit from the possible economies of scale e.g. bigger vehicles, better use of the infrastructure, many vehicles in use and other things.

*Economy of scope:* Occurs when the cost of producing two services in one company is lower than producing them separately. The profit comes from combination of different services.

*Economy of density:* When a market enables handling of high volumes the fixed costs can be divided among more units which make an economy of density arise. To separate it from the economy of scale the density factor address a more effective use of the resources rather than using bigger and several resources.

*Economy of experience:* By using “learning-by-doing” savings opportunities can be identified to lower the cost/unit.

*Economy of presence:* By being present in an area or transport relation opportunities in new relations and projects appear.
Theoretical framework

To make sure all transport costs will be considered when creating the concept they have been divided into four different types: terminal costs, during way costs, investment costs and goods costs. The first two are the actual costs that occur for each transport assignment. These depend on chosen route and used mode of transportation. Investment costs can be seen as fixed costs for the transport companies when investing in e.g. facilities and vehicles. The last type of costs, goods costs, will depend on the type and amount of goods transported. Who will be the cost carrier depends mainly on who owns the goods during the transport. This type will include most of the costs presented earlier as other costs which is important at first hand to the transport buyer. Examples of costs in each type are given below:

- **Terminal costs** – Costs that occurs in a node or at a terminal for loading, unloading goods, fees in harbors etc.
- **During way costs** – Costs taking place during the way between two terminals: cost for fuel, road fees, taxes, maintenance and wearing as examples.
- **Investment costs** – Initial costs that are required for the concept to run: new vehicles, systems for tracking goods etc.
- **Goods costs** – The price for transporting goods: cost for having capital tied up, insurance, spoilage, wrapping.

The five economical parameters are also interesting to consider when discussing the different transport modes and the market situation in the Scandria Corridor.

2.1.2 Customer service

In the definition of logistics it is mentioned that one part deals with satisfying the needs of the customers according to Oskarsson et al. (2006) and Lumsden (2006). Further Oskarsson et al. (2006) states that customer service is created by activities that includes interacting with customers before, while and after delivering of goods. Lumsden (2006) claims that customer service is the part in logistics that is providing income.

Both Lumsden (2006) and Oskarsson et al. (2006) uses the same elements of service, with focus on the delivery, to describe the customer service in a company. These elements are presented below, with definitions from Oskarsson et al. (2006):
THEORETICAL FRAMEWORK

- **Lead time** – The time from order placement to delivery
- **Delivery dependability** – The ability to deliver at agreed time
- **Delivery reliability** – The ability to deliver the right amount of goods at the right quality
- **Information** – What information is available to the customer
- **Flexibility/Customer adaptation** – The ability to adapt to changes made by the customer
- **Stock fill rate** – The amount of orders or lines in an order that can be delivered directly when the customer wishes it. “Service level” is another often used expression with the same meaning.

Maltz & Maltz (1998) states that customer service has two aspects. The first one is *basic customer service* which includes: order cycle time, on-time delivery and inventory availability. Common for these is that they can easily be quantified, objective and measured internally. They are also fairly highly correlated when it comes to the performance of them. The second aspect of customer service is *responsiveness* which can be explained as the ability to adapt to market changes. Speed, creativity, cooperation, and effectiveness are all examples of what can be measured in the matter of responsiveness.

In this thesis the stock fill rate will not be considered. Since this can be seen as something that is decided within the interface between supplier and customer this element is excluded. The rest of the service elements will be considered for the different routes and transport modes.

2.2 TRANSPORT LOGISTICS

Over the years international trade has been increasing which makes freight transport a growing sector (Oskarsson et al., 2006; Hesse & Rodrigue, 2004). One of the biggest reasons is the fact that companies choose to centralize their warehouses according to Oskarsson et al. (2006). By adopting this strategy the cost for transportation rises and therefore the importance of transport logistics in companies increases. The higher costs of transportation with centralized warehouses are accepted due to the number of profits in other areas. The development in better vehicles, roads and railways are along with simplified cross-border trading other indications on increased importance of transport logistics (Oskarsson et al., 2006).

Oskarsson et al. (2006) claims that companies in the transport sector tends to be bigger and the number of companies fewer due to the importance in economies of scale to lower the costs. Most manufacturing companies choose to outsource their transports to specialized transport companies with the same reason. Companies which choose not to outsource their transports often produce high volumes or require specialized vehicles. Leinbach & Capineri (2007) argues that logistic activities are highly concentrated in a few gateways and in strategic regions. Hesse & Rodrigue (2004) shares this notion and says that large-scale goods flows goes through these gateways or hubs, mainly large ports, major airports and highway intersections with access to a market area. This structure can cause bottlenecks in the chain because of congestion and delays in loading and discharging according to Leinbach & Capineri (2007).

A well known concept in transport logistics or transport geography is the space/time convergence which implies the amount of space that can be transported in a specific amount of time. Along with the expanding importance of logistic issues like synchronization of flows through nodes and network strategies needs to be considered in the concept of time/space. Flows can refer to flows of e.g.
information, goods or vehicles. Network strategies target mainly the distribution of goods which can be arranged in several ways, e.g. with distribution centers or fixed routes. (Hesse & Rodrigue, 2004)

Transport logistics can be divided into three different levels: the owner of the goods perspective/flow of material, the transporters perspective/flow in transport and the transport infrastructure according to Oskarsson et al. (2006) and Lumsden (2006) (Figure 3).

![Figure 3 - Transport logistics divided into three levels and two markets](image)

At the first level Oskarsson et al. (2006) means that the focus is on transporting products from one point to another at lowest cost and highest service level possible. Between the first level where the owners of the goods with a need for transporting is placed and the second level where the transport companies reside a transport market occur for connecting these two groups. The transporters perspective is more complex than the owner of the goods perspective because it considers goods from several companies which can be loaded at the same vehicle or in the same route. Lumsden (2006) says that the vehicles don’t disappear at one point in the system but instead creates a demand for returning goods to be able to maintain continuity in the flow. The transport industry includes a variety of actors whereupon Oskarsson et al. (2006) claims the following to be the most common:

- The transport agent, handling the contact with freight forwarders or transport companies.
- The freight forwarder, handling the contact with the firm of haulage and planning the transport.
- The firm of haulage, hiring out the vehicles
- The owner of the vehicles
- The driver

A list of important incentives to make transport companies reach the high demands of customers according to Oskarsson et al. (2006):
THEORETICAL FRAMEWORK

- Low cost is attained from a high occupancy level.
- High customer service, mainly delivery dependability, is reached by keeping regular transports at a pre-determined time-schedule.
- Short delivery lead time is achieved by having regular transports departure frequently.

The third level describes the transport infrastructure which transport companies depend on according to Oskarsson et al. (2006). Truck transportation requires roads, trains require railway, airplanes require airports etc. At this level there are companies or organizations owning the infrastructure and are thereby responsible for development and maintenance. Lumsden (2006) says that the infrastructure can be separated into internal infrastructure like company specific terminals and external infrastructure that are set up for any company to use. Between level two and three Lumsden (2006) and Oskarsson et al. (2006) says that a traffic market take place where transport companies meet the owners of the infrastructure.

2.2.1 CHOOSING MODE OF TRANSPORTATION
The main determinant of the total logistics cost when choosing a transport mode is according to Sheffi et al. (1998) the shipment size which should be decided in a trade-off between transportation cost and inventory carrying cost. The inventory carrying cost includes both the time in the transport carrier and the time until the goods are consumed, depending on the demand rate. Other parameters in the total logistics cost are according to Sheffi et al. (1998): a fixed cost per shipment, the transit time, and the capacity of the transport vehicle.

Future development in the transport sector will be based on the actions of the transport buyers according to Lumsden (2006). Another important factor is the economical development which will expand, conform and change the supply of transport modes. Lumsden (2006) points out some of the most important factors that will affect future choices of transportation:

- Fuel cost
- Environmental consideration
- Use of resources and size of vehicles
- Transport standard
- Competition and technical development
- Transport time
- Tied up capital
- Traffic to big harbors

2.2.2 TRANSPORT MODES
Table 1 show a modal split of the freight transportation for the EU. Road and sea transports have by far the largest shares while inland waterways and rail have small shares. The pipelines are used for transporting liquefied products such as oil, gas, water, hydrogen and ethanol (Australian Business, 2010a). The general strengths and weaknesses with freight transport by rail, road, sea and inland waterways will be discussed in this chapter. Sea and inland waterways will be discussed together since they are very similar but the focus will be at inland waterways.
Table 1 - Modal split of European freight traffic (tonne-kilometers), 1995-2007
(EU energy and transport, statistical pocketbook 2009)

<table>
<thead>
<tr>
<th>Year</th>
<th>Rail</th>
<th>Road</th>
<th>Inland waterways</th>
<th>Pipelines</th>
<th>Sea</th>
<th>Air</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1995</td>
<td>386</td>
<td>1289</td>
<td>122</td>
<td>115</td>
<td>1150</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>(12.6%)</td>
<td>(42.1%)</td>
<td>(4.0%)</td>
<td>(3.8%)</td>
<td>(37.5%)</td>
<td>(0.1%)</td>
</tr>
<tr>
<td>1998</td>
<td>393</td>
<td>1414</td>
<td>131</td>
<td>125</td>
<td>1243</td>
<td>2.4</td>
</tr>
<tr>
<td></td>
<td>(11.9%)</td>
<td>(42.7%)</td>
<td>(4.0%)</td>
<td>(3.8%)</td>
<td>(37.6%)</td>
<td>(0.1%)</td>
</tr>
<tr>
<td>2001</td>
<td>386</td>
<td>1556</td>
<td>133</td>
<td>132</td>
<td>1400</td>
<td>2.7</td>
</tr>
<tr>
<td></td>
<td>(10.7%)</td>
<td>(43.1%)</td>
<td>(3.7%)</td>
<td>(3.7%)</td>
<td>(38.8%)</td>
<td>(0.1%)</td>
</tr>
<tr>
<td>2004</td>
<td>416</td>
<td>1747</td>
<td>137</td>
<td>132</td>
<td>1485</td>
<td>2.8</td>
</tr>
<tr>
<td></td>
<td>(10.6%)</td>
<td>(44.6%)</td>
<td>(3.5%)</td>
<td>(3.4%)</td>
<td>(37.9%)</td>
<td>(0.1%)</td>
</tr>
<tr>
<td>2007</td>
<td>452</td>
<td>1927</td>
<td>141</td>
<td>129</td>
<td>1575</td>
<td>3.1</td>
</tr>
<tr>
<td></td>
<td>(10.7%)</td>
<td>(45.6%)</td>
<td>(3.3%)</td>
<td>(3.1%)</td>
<td>(37.3%)</td>
<td>(0.1%)</td>
</tr>
</tbody>
</table>

RAIL

Rail freight transport is able to carry a large amount of goods in the same transport. The railway companies state the average gross weight is 1000 tonnes per train, the limit for international train transport is 2000 tonnes (EcoTransIT, 2008). The train can be driven by electricity or by diesel (EcoTransIT, 2008). An electrical locomotive must have access to an electrical system and a train control system (ATC) and to operate (Patrik Rydén, 2010a).

A transport from Basel (Switzerland) to Rotterdam (The Netherlands) with a 100 tonnes cargo resulted in 0.6 tonnes CO₂ emission from rail, 2.4 tonnes from inland waterway and 4.7 tonnes with a lorry (UIC⁵ & CER⁶, 2008). The energy required to run a train is one seventh of what it takes to transport the corresponding amount of goods with truck (Nilsson, 2000). The data is based on an electrical train.

Pewe (2002) argues that rail transport is best suited for carrying high-volume and low-value products since the rail has a price system which is based on the goods-value rather than weight. Pewe (2002) also states that one of rail transports main strengths is its ability to frequently transport large volumes.

Trains can only transport goods along the rail and between terminals which restrains its flexibility. The terminal and handling fees are rather high compared with road. Another issue with train is the delivery dependability which is low (Pewe, 2002). The during way costs for rail is low (Oak value fund, 2010a) which makes it suitable for longer transports (Andersson 2007).

Lead time with train transport is long on the secondary, low-developed railway routes but comparable with road on the main routes. (Lumsden, 2006) The average speed for freight transport with railway transport across Europe was 2001 as low as 18 km/h (European Commission, 2001).

ROAD

Road transporting is the most used transport method in amount of goods and number of transports. Transporting by road is done by trucks with a trailer. A normal truck and trailer is allowed to weigh

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⁵ UIC – International Union of Railways
⁶ CER – Community of European Railway and infrastructure companies
THEORETICAL FRAMEWORK

around 40 tonnes. (Lumsden, 2006) but there are plans of implementing a new larger trailer that can carry 60 tonnes, this trailer is already in use in Finland and Sweden (European Commission, 2009 [1]).

One of the road transport main strengths is that it is very flexible (Lumsden, 2006). Pewe (2002) claims that one of the most important competitive advantages compared to other transports is the ability to easily load or unload goods during a route. The route can also be planned to maximize the fill rate.

Goods transported door to door (e.g. supplier-customer) are often shipments above 1 ton that is not shipped through terminals according to Pewe (2002). Nilsson (2000) and Pewe (2002) agree on that door to door-transport’s main advantage is less transshipment which decreases the risk of damaging and losing of goods. Pewe (2002) also sees lower cost as a benefit of less transshipment.

In World War 2 a large share of the rail network across Europe was destroyed and a development of road transports was forced to be done. Road transporting has increased heavily the last 20-25 years. That the road network is generally well developed allows the truck transporting to have short lead times. (Pewe, 2002)

The amount of vehicles travelling on roads is increasing quicker than the construction of new roads which creates queues along the existing road network (Nilsson, 2000). Examples on bottlenecks in Europe are parts of the Autobahn in Germany and roads across the Alps. (Pewe, 2002)

Road transporting is characterized by having low terminal costs but high during way costs (Pewe, 2002 and Nilsson, 2000). According to Andersson (2007) this is not suitable for long transports. Pewe (2002) agrees with this and say that road transports should not be competitive for transports longer than 300-400 km.

Road transporting has a bad reputation of being pollutant due to the using of fossil fuels, bad cleansing of the exhaust gases and therefore being seen as worse to the environment than other transport modes. The EU is working to decrease the share of road transport by implementing different restrictions and projects. (Nilsson, 2000)

INLAND WATERWAYS

Transporting at water is usually divided into two different transporting methods in the statistics, sea (open water) transport and inland waterways (canals, rivers). In this thesis inland waterways will only be handled. A common way to measure a ship’s transport capacity is by its deadweight which means the total amount of weight a ship safely can carry. Typical canal boats have a deadweight of 2150 tonnes (Pewe, 2002). According to EcoTransIT (2008) a typical vessel of Europe type has a loading capacity of 1 250 tonnes.

The main strengths of water transports are the high load capacity, the low cost between terminals (during way cost) and the free route water offers. (Pewe, 2002)

Drawbacks are expensive terminal facilities and high handling costs, partly because of the expensive equipment (cranes, large trucks etc.) and partly because of the demand for large areas for loading and discharging of goods. Another large drawback is the long lead time which increases the cost for tied up capital. (Pewe, 2002)
The EU Commission is promoting maritime transport, which is regarded as the transport mode that is most environment-friendly and energy-efficient in terms of greenhouse-gas emissions. (European Union, 2010a)

**SUMMARY OF TRANSPORT MODES**

In this subchapter a table of advantages and drawbacks with the transport modes composed from the previous chapter is presented (Table 2) to make the comparison between the transport modes easier and more obvious.

<table>
<thead>
<tr>
<th>Transport mode</th>
<th>Advantages</th>
<th>Drawbacks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rail</strong></td>
<td>• Large loading capacity&lt;br&gt;• Low during way cost&lt;br&gt;• Frequent transports&lt;br&gt;• Short load/unloading time&lt;br&gt;• Low environmental effects</td>
<td>• High terminal and handling costs&lt;br&gt;• Long transport lead time&lt;br&gt;• Low delivery dependability&lt;br&gt;• Low flexibility</td>
</tr>
<tr>
<td><strong>Road</strong></td>
<td>• Door-to-Door-transports (DD)&lt;br&gt;• High speed&lt;br&gt;• High flexibility&lt;br&gt;• Low terminal costs</td>
<td>• High during way cost&lt;br&gt;• Large environmental effects&lt;br&gt;• Bottlenecks and queues</td>
</tr>
<tr>
<td><strong>Inland waterways</strong></td>
<td>• Low during way cost&lt;br&gt;• Free route&lt;br&gt;• Large loading capacity&lt;br&gt;• Low environmental effects</td>
<td>• Expensive terminal facilities&lt;br&gt;• High handling costs&lt;br&gt;• Long transport lead time</td>
</tr>
</tbody>
</table>

2.2.3 INTERMODAL TRANSPORT

There are several definitions involved within the area of using more than one transport mode for transporting goods. Three words are often used and needs to be defined as their meanings differ: Multimodal, intermodal and combined transport. The term Multimodal defines as: when goods are transported with more than one transport mode (Lumsden, 2006; UNECE - The United Nations economic commission for Europe, 2010a). The definition of Intermodal differs, it is used as a synonym to multimodal or as the movement of goods between one transport mode and another. Woxenius (1998) and Beuthe (2007) describes intermodal as a subset to multimodal where intermodal transports are characterized as shipments in a loading unit, e.g. container, that switch transport mode at least once, multimodal accept if the goods are loaded piece by piece (e.g. timber). The European Commission transport glossary (2010a) defines combined transport as “…complete transport operation involving various modes of transport”. Lumsden (2006) describes combined transport as the combination of different transport modes when creating a transport chain.

The most common combined transports usually consists of road transport the first and last part of the route and rail and/or boat transport the main part of the route (Figure 4). (Lumsden, 2006)
Lumsden (2006) means that the main point when creating efficient multimodal systems is that the goods are transported at a loading unit and that it is at the same loading unit along the route. Examples on loading units used are containers, swap bodies and trailers. The loading units’ structure is similar – a big box capable of carrying goods that fits both train and trucks. Since there is more than one transport mode involved it is important that loading and discharging of the goods is quick and that there is a demand of having combo-terminals (terminals which can receive/load goods from different modes of transports).

Leinbach & Capinieri (2007) claim that intermodal transportation is regarded as an important cure to land transport congestion but has contributed to the problem in some areas. Rather than the development of individual transport modes a big share of the recent reduction in transport costs is due to measures reducing the existing barriers between road, rail, sea and air.

2.2.4 Co-modality

Co-modality is another term used in transport logistics, it differs from multimodality and intermodality. While those transport concepts consist of at least two transport modes co-modality doesn’t have that requisite. European Commission (2006 [1]) describes co-modality as optimizing transports not just for the whole chain but also efficient use of the specific transport modes on their own.

Inger Gustafsson (2008) describes the main difference between intermodality and co-modality as “...the new focus on the total efficiency of the transport sector instead of the transfer of goods from road to rail and maritime transport”.

2.3 Transport logistics and the environment

There is a trend that the amount of goods transported in the EU is steadily increasing. Between 1996 and 2006 the total volume of transported goods in tonne-kilometers (including EU member states except Malta and Cyprus) increased by 35 %. Transported air volume increased by 43 %, road volumes with 45 %, boat 33 % and rail grew with 11 % (EEA – European Environment Agency, 2008). This made air and road transports take larger shares of transported goods, maritime keeping its share and rail’s share decreases.
Air and road transports are more CO$_2$-pollutant than boat and rail (Table 3). With the market share of air and road increasing it is possible to draw the conclusion that transports across the Europe are becoming more CO$_2$-pollutant. The transport sector made up for 27% of the total CO$_2$-emissions in EU-27 by 2005. (UIC & CER, 2008)

Table 3 - Emission levels of CO2 for transport modes

<table>
<thead>
<tr>
<th>Emission levels of CO$_2$ for transport modes (g/tkm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
</tr>
<tr>
<td>Road</td>
</tr>
<tr>
<td>Water</td>
</tr>
<tr>
<td>Rail</td>
</tr>
</tbody>
</table>

CO$_2$ is one of the so called greenhouse gases, which the majority of the world’s leading climate experts connect to the global warming (European Commission, 2009 [2]). Other greenhouse gases emitted during fossil fuel combustion are N$_2$O as well as the indirect greenhouse gases NO$_x$ and CO (Berntsen, 2004; UNFCCC – United Nations Framework Convention on Climate Change 2010a). Berntsen (2004) argues that road traffic is a main contributor to the global warming partly because of its large emission of CO$_2$. Road transports constituted 94% of the total transport greenhouse gas emissions in the EU 2007, international air and maritime transports excluded (Eurostat, 2009). To face the climate change EU has made three energy and climate targets to be met by 2020:

- A reduction in EU greenhouse gas emissions of at least 20% below 1990 levels
- 20% of EU energy consumption to come from renewable resources
- A 20% reduction in primary energy use compared with projected levels, to be achieved by improving energy efficiency. (European Commission, 2010a)

In 1999 the EU Parliament introduced the Eurovignette directive. The directive which was revised 2006 mean that EU-member states may charge heavy vehicles (vehicles weighing between 3,5 and 12 tonnes) travelling on road in line with the level of damage they are causing and to what emission category the vehicle belongs to. The directive laid the foundation for road pricing which will be discussed later in this thesis. (European Union, 2010b)

Except for the emission of greenhouse gases transports also affects the environment through noise, air pollution, fragmentation of habitats and accidents (Eurostat, 2009). In a transport package created by the EU called Greening Transport one of the three main points was to reduce noise from rail freight. The goal with the package was to improve the sustainability with transports (both passenger and freight). (European Union, 2010c)
PROBLEM SPECIFICATION

ANALYSIS MODEL
3. PROBLEM SPECIFICATION

How the work of achieving the purpose is disposed make up for the content of this chapter. An analysis model specifies the research procedure through the rest parts of the thesis. A number of questions are presented for each part of the analysis model. The questions will pin down the content of the research to the most relevant areas.

3.1 ANALYSIS MODEL

The important part of solving a problem may not be what exact model that is chosen but to find a way of working that is both well-reasoned and structured (Oskarsson et al., 2006). With this in mind an analysis model have been created based on discussions between the authors and the supervisor at the commissioning body. The analysis model describes the way of the research from a mapping to the concept generation.

The way of achieving the purpose has been divided in three parts. The first part is a mapping of the current situation in the Scandria Corridor and a compilation of customer values. The content of the mapping is based on the content of the theoretical framework and includes relevant information about the corridor needed to create a concept that fulfills the purpose of the thesis. Customer values will be compiled to secure the feasibility and competitiveness of the concept. The second part is the analysis where the information in the first part will be compared to and analyzed in line with the theories presented in the theoretical framework. The third and last part is the actual concept generation where the most important parameters will be considered in the planning of the transport route and the set-up of the concept. The described steps make up for the content in the created analysis model shown in Figure 5.

![Figure 5 - Analysis model](image-url)
To create a better structure for the reader, the mapping and the analysis parts have been divided into two steps. The first step discusses surrounding factors such as customer values, infrastructure and transport modes. The second step maps and analyzes the goods flows to identify fitting end- and loading points for the concept.

3.1.1 Mapping
The foundation to successful changes is to know the current status (Oskarsson et al., 2006). The mapping of the current situation will be made in four areas: infrastructure, transport modes, customer values and flow of goods. *Infrastructure* will present the current situation to identify the problems. *Transport modes* map views from the business world on rail, road and inland waterway. To make the concept feasible the *customer values* will also be compiled. *Flow of goods* handles types and volumes of transported goods.

**Infrastructure**
To be able to evaluate and come up with new concepts it is a prerequisite to know what the infrastructure (rail-, road- and sea networks) in the corridor look like in the current situation, since the transport modes are restricted to their infrastructure (Oskarsson et al., 2006). Leinbach & Capineri (2007) argues that logistic activities often are concentrated in few gateways and strategic regions which can result in congestion. An important aspect is therefore to know if there are any general barriers in the corridor not only congestion related but also other barriers. Bottlenecks connected to a specific transport mode will be discussed in respective transport mode’s chapter below. To know how the infrastructure is developing ongoing and future projects needs to be mapped.

- What does the infrastructure in the corridor look like?
- Are there any infrastructure problems along the corridor? Where are they located?
- What are the barriers in the corridor and where are they located?
- What projects are initiated for developing the infrastructure?

**Transport modes**
This section is divided into railway transportation, truck transportation and transportation on water. To see which transport mode that is most suitable for this thesis’ concept a review of the different transport modes’ strengths and weaknesses will be done to get a general idea of each mode. In addition to this specific questions concerning each transport mode is also presented. There is hardly any transport mode that is cheaper or more expensive than other transport modes in all situations (Lumsden, 2006). Two types of costs are connected to the type of transport mode, during way costs and terminal costs. They will therefore be studied.

- What are the transport modes’ during way and terminal costs?
- What is each transport mode’s strength and weakness?

**Railway transportation**
To drive a train electrically an ATC-system and an electrical system are required (Patrik Rydén, 2010a) and when crossing borders it is important to know what systems different countries operate. It is also important to see if there are any bottlenecks in the corridor. To see the future development on railways, projects and cooperation’s between transport companies are of interest. A freight train
transport around 1000 tonnes per train (EcoTransit, 2008), what methods are there to keep a high level of information to the customers even when the goods volumes are high?

- What different ATC-systems are there in the Scandria Corridor?
- What different electrical systems are there in the Scandria Corridor?
- Are there any barriers or bottlenecks in the corridor?
- What projects and cooperation’s between companies are there?
- How can the information to the customers concerning transported goods be kept high?

**TRUCK TRANSPORTATION**
A big problem with road transports is the bottlenecks and queues according to Pewe (2002) and Nilsson (2000). It is important to locate these problems since they affect both the lead time and the delivery dependability. Nilsson (2000) implies that EU is introducing restrictions for road transport, to make the concept future considerate those needs to be mapped.

- Where are the bottlenecks on road in the corridor located?
- What restrictions for road transports are there now and what restrictions are planned?

**TRANSPORTATION ON WATER**
When travelling between the north and south end points the Baltic Sea has to be taken in consideration. What routes are possible? What is the future for water transports in the corridor?

- What are the options for crossing the Baltic Sea?
- What changes concerning sea transports are planned, affecting the corridor?

**CUSTOMER VALUES**
When generating the concept it is important to know what aspects the intended customers hold as important. Short lead time, the ability to transport high volumes or low environmental effects is examples of handled factors. This will be the basis of the decision factors used when creating possible concepts.

- What aspects do potential customers value?

**FLOW OF GOODS**
Leinbach & Capineri (2007) argues that logistic activities often are highly concentrated. If there are large goods flows to some points in the corridor the point can be used to get higher economy of scale, which means higher profit and better use of infrastructure and vehicles (Lumsden, 2006). Therefore goods flows needs to me mapped. General goods flows through both end points will be studied as well as more specific flows within the corridors. If there are cooperation’s between regions these can be used to create economy of scale as well. To be able to decide which regions to go through, interesting points and regions in relation to the end points will be mapped as well.

Since different transport modes might be suitable for transporting different types of goods, as an example Pewe (2002) suggest rail as suitable for transporting high-volume low-value products. It is important to find out what different types of goods that are transported through the corridor.

Intermodal transports are a combination of transport modes where the goods are shipped in a loading unit (Woxenius, 1998 and Beuthe, 2007). For the intermodal transports there is a need for
Problem Specification

combo-terminals, a terminal that can handle two transport modes (Lumsden, 2006). A mapping of where those are located is therefore needed.

- What goods flows are there within and to the corridor?
- What types of goods are transported?
- Where are the combo-terminals located in the studied areas?
- Is there any cooperation between regions in the corridor?
- What points and regions are suitable as end points?

3.1.2 Analysis

The analysis consists of the three chapters: Barriers in the corridor, Concept forming and End- and loading points. End- and loading points will discuss the information from the mapping of goods flows while concept forming and barriers in the corridor use the other mapping as main source of information.

Barriers in the corridor

The most important barriers in the corridor needs be identified. These barriers needs to be discussed and options how to handle the barriers needs to be examined. To keep the concept future considerate it is necessary to know where the development in the corridor concerning the barriers is heading.

- Which are largest important barriers?
- How will the largest barriers be handled?
- What kind of development concerns the barriers?

Concept forming

The mapping of customer values concerning customer service will be analyzed to see how relevant service elements vary between transport modes. There is also a need to rank service elements to know which ones that should be preferred when creating the concept. How customer service elements can be improved is also an important object to discuss. Transport costs will be discussed and analyzed to make sure that the concept is feasible. A concept that is friendly to the environment, e.g. using renewable resources, has low emission levels and is energy efficient will be prioritized. Lumsden (2006) argues that the environmental consideration is one of the most important factors that will affect future choices of transportation. In order to make the concept feasible an important object to discuss is how to handle the different problems that the concept will face during the early phase.

- How do the service elements vary between different transport modes and routes?
- Which service elements should be preferred?
- How can discussed customer service elements be improved?
- How is transport costs affecting the concept generation?
- How can an environmentally friendly concept be designed?
- What problems can the concept encounter during the startup phase?
- How can the start up problems be faced?
**Problem Specification**

**End- and Loading Points**
To be able to decide which points to use in the concept generation, points and regions needs to be compared and discussed. An aspect needed to be taken in consideration is what types of goods that are transported.

- What end points are suitable for the transport concept?
- What loading points are suitable for the transport concept?

**3.1.3 Concept Generation and Evaluation**
From the two areas route and transport setup a few concepts will be generated and then evaluated to recommend one concept. The concepts need to be evaluated to see which one that fulfills the purpose: innovativeness, feasibility, environmentally friendly and future considerate in the best way.

- Which concept should be recommended based on the thesis’ purpose?

**Transport Set-up**
What transport modes will be used and how to change between them is questions needed to be answered when generating the concept. Fundamental for the concept is not only to specify which transport modes that will be used but also to specify the setup of the transport. Aspects used when doing this is e.g. number and times of departures and use of tracking system.

- Which transport modes will be used?
- How many departures per week will the concept have?
- What time-table is suitable for the concept?

**Route**
One of the concept’s prerequisites is to have a route through the Scandria Corridor which means a decision of what end- and loading points that should be used and how many loading points the concept shall have.

- Where will the routes end points be located?
- How many loading points will be used?
- Which loading points will be used?
METHODOLOGY

METHODOLOGICAL APPROACH

RESEARCH PROCEDURE

QUALITY OF METHODS
4. METHODOLOGY

This chapter presents the methodology of the research procedure. The approach and orientation chosen for the thesis are also presented and motivated. With the analysis model presenting the research procedure the methods used in the process is handled. The last part is a discussion of the quality in chosen methods and the trustworthiness of the information.

4.1 METHODOLOGICAL APPROACH

Methodology can be explained as in which way a project should be performed to in the best possible way achieve the purpose according to Björklund & Paulsson (2003). Arbnor & Bjerke (1994) says that the applied methodology should harmonize with the chosen viewpoint, methods and scope of survey to avoid scientific vague results.

The fundamental view in knowledge varies between persons and can be used to describe the goals of a person’s research according to Björklund & Paulsson (2003). Three different viewpoints exist in this area: analytical, systematical and social. Researchers with an analytic viewpoint tend to keep the truth as objective and complete as possible. They aim at finding source-effect-relations with no consideration to the subject opinion and where the knowledge is independent to the observer.

Reality is divided into parts where the sum of these makes up for the totality. Objectivity is also the matter in the systematical viewpoint but here the totality is separated from the sum of the parts. Relations between different parts are put in focus when the researcher wants to find synergy effects and incentives. In the social viewpoint the reality is explained as a social construction affected by and affecting persons. Connections between different person’s constructions are put in focus where the description of reality depends on experience and actions on the person describing it. (Arbnor & Bjerke, 1994; Björklund & Paulsson, 2003)

In this thesis the systematical viewpoint is chosen because the Scandria Corridor can be explained as a system of transporters competing on an existing infrastructure. Relations and synergy effects can be found in e.g. type of goods and mode of transport or current infrastructure and planning of routes. The totality in this type of system is abstract and therefore hardly explained with the sum of the parts.

4.1.1 AWARENESS

There is an importance in showing awareness in existing methods regarding the positive and negative effects when motivating the methods chosen for the research according to Björklund & Paulsson (2003). Awareness shall be showed in the three levels methodology, method and practical procedure. Methodology can be expressed as the research design which explains the methods and relations between them. Method refers to in what ways data is collected and processed. How the methods are used in reality is the means of practical procedure.

In the research procedure, presented below, the methodology is made known by showing how the parts of the thesis are connected and by explaining the purpose of each phase. Methods used in each phase and how they are executed in the practical procedure is also presented in the research procedure together with discussions of how they can affect the result.
4.2 RESEARCH PROCEDURE

The research procedure has been divided into a planning phase and the three phases in the analysis model, presented in the problem specification, shown in Figure 6.

![Figure 6 - The research procedure with a planning phase and the phases of the analysis model](image)

4.2.1 PLANNING

The planning is the first phase of the research procedure including development of the purpose and describing relevant background to the problem, building a comprehensive theoretical framework and specifying the problem by bringing out central questions and put together an analysis model. How the parts of the planning phase are connected is presented in Figure 7. The work done in this part is presented in a planning report.

![Figure 7 - A breakdown of the planning phase in the research procedure](image)

DEVELOPMENT AND FORMULATION OF THE PURPOSE

The purpose needs to be clear and head-on to make both the authors and the readers able to evaluate the fulfillment of it (Björklund & Paulsson, 2003). In order to formulate the purpose in this way several discussions have been made throughout the planning stage as more knowledge in the frames of the thesis has been achieved. Both the supervisor at the commissioning body and the
supervisor at the university have been consulted to get opinions about it in different angles. The background information was the base of forming the problem and to the development of the purpose.

**PROBLEM SPECIFICATION**
In this section the orientation of the thesis and the study approach is described.

**RESEARCH ORIENTATION**
The existing amount of knowledge in the field of research can affect what type of study that is used. When the amount of knowledge is low there is a need to find basic understanding which proposes an *exploratory study*. In cases with existing basic knowledge and understanding a *descriptive study* can be used which aims at describing but not explaining relations. If the aim is to both describe and explain an *explanatory study* can be used to seek deeper knowledge and understanding in an area. *Normative studies* are used when there is certain knowledge and understanding in the field of research and the purpose is to propose measures. (Björklund & Paulsson, 2003)

This thesis uses a normative approach where the focus is to present a concept for transportation and measures to implement the concept in the Scandria Corridor. Knowledge and understanding in the field of research is presented in the theoretical framework and the empiric. This is the base for what measures that is suitable for the concept.

The way of working with a thesis can be described as cyclic where the procedure starts in the empirical world, moves into theory and then ends back into empiric (Figure 8). The empirical world points at given facts. The first step, *induction*, is to move from observations made into relevant theory. This is a way to insert a certain case into the general theories, suiting the facts of the case. Next step, *deduction*, is to question the general theory in the matter of implementing it in the actual case by making predictions about the empirical studies. The last step, *verification*, is to move back into facts to prove the predictions right or wrong. (Arbnor & Bjerke, 1994)

![Figure 8 - Connection between induction, deduction and verification](Arbnor & Bjerke, 1994, p. 107)

The first two steps, induction and deduction, are used throughout this thesis. The mapping of the current situation in the corridor is compared to the theories of the theoretical framework. Then the empirical studies are related to be able to analyze and predict the best set-up of a concept which is presented. The verification part will be a matter of the future to evaluate the concept.


**STUDY APPROACH**

A study where the information is given in numbers can be described as quantitative and all other forms of studies are generally seen as qualitative. The biggest advantage of quantitative studies is that the information is equal and comparable. Qualitative studies are often best suited for complex problems where the meaning and significance of the information is important. (Eriksson & Wiedersheim-Paul, 2008)

Input to this research is compiled from both quantitative and qualitative studies. In the mapping of goods flows quantitative data in form of statistics have been used to be able to compare different nodes in the matter of import and export. The rest of the information is based on qualitative data in form of mainly interviews. By using interviews questions can be formed to get answers in desired areas.

**BUILDING THE THEORETICAL FRAMEWORK**

Relevant theories in the theoretical framework depend on the purpose of the thesis and partly the chosen method (Björklund & Paulsson, 2003). To choose relevant areas of theory the substance of the purpose have been discussed. Areas needed in order to achieve the purpose in all aspects were therefore studied and presented. The content of the theoretical framework when the actual project starts are possessed knowledge of the authors (Eriksson & Wiedersheim-Paul, 2008). In line with the rest of the research knowledge in the studied areas added quality in collected data.

As ground to the content of the theoretical framework fundamental books of logistics and transport logistics have been used. On top of this, articles have been used as they tend to keep a more specified starting point. Reports, brochures and Internet sources have been used in order to keep the information up-to-date.

Different databases, like Business Source Premier and ScienceDirect, have been used in the search of relevant articles. The search words have been specified until a proper amount of search results were obtained. Reviews of many articles have been done to find the ones including substantial information about the areas in the frames of the thesis. Internet sources used is mainly pages for trustworthy organizations like the European commission. Vague information on one Internet page was proven by using another page.

**ANALYSIS MODEL**

An analysis model directs the future collection and analysis of data (Björklund & Paulsson, 2003). A structured way of working is therefore presented in our analysis model. It bases in the current situation in the Scandria corridor and discussions with the commissioning body. To fulfill the purpose of the thesis the analysis model will therefore be the basis of the mapping, analysis and concept generation.

**4.2.2 MAPPING**

Mapping is the first step in the analysis model and includes collecting relevant data in appropriate ways. The main areas of the mapping chapters and connections to the planning phase are presented in Figure 9.
DATA COLLECTION

Eriksson & Wiedersheim-Paul (2008) says that collection of data and data analysis probably is the most central parts in a scientific point of view. They point out the importance to keep it systematic and to clearly present the process. Björklund & Paulsson (2003) mention a number of different methods for collecting data: interviews, presentations, surveys, study of literature and experiments. A major difference between literature studies and interviews are the type of information they result in. Literature studies are secondary information and interviews are first hand information.

There are different types of communicating with another person. Interview in person involves other aspects, such as reading body language (Björklund & Paulsson, 2003) making them preferable. A disadvantage with interviews in person is the large amount of time required in comparison with for example an E-mail interview.

Interviews in person have been the primary method in the data collection. When interviewing in person follow-up questions can be used to get the desired information. E-mail and telephone have also been used for some interviews. In addition to interviews a seminary called “Climate for a transport change” with presentations of companies like DHL and Volvo and their transports with the climate in focus is the base for some information.

Interviews in person have been used for information from Björn Boklund (Business development manager, UBQ), Jan Olofsson (Marketing director, DHL Rail), Mareike Donath (Advisor at Ministry of Transport, Building and Regional Development in Mecklenburg-Vorpommern) and Wilfried Laboor (Ministry of transport and agriculture in Berlin/Brandenburg). The prepared questions for these interviews are presented in appendix 12.3. Furthermore Patrik Rydén (Managing director, Øresund Logistics) has been consulted several times throughout the process. All the respondents at these interviews hold a broad knowledge of the transport market and a deep knowledge in the specific line of work. This makes information gathered in interviews trustworthy and up to date.

For all interviews questions were prepared beforehand. In this way all areas of interest could be addressed. Lekvall & Wahlbin (2001) says that only questions that the respondent is expected to have knowledge about should be asked. As most interviews in this thesis sought information in a broad span there were some questions that the respondent could not answer. The reason for this
was in most that the questions handled specific areas and the respondent lacked knowledge in these areas. When questions were not answered the authors have tried to seek answers in other interviews or by searching the Internet.

Statistics on goods flows through the north Adriatic ports comes from Eurostat which is a part of the European Commission. Statistics on goods flows to and from Swedish regions comes from Magnus Johansson at SIKA (A Swedish government administrative authority for transport and communication) and is an estimation of how the situation will look like in 2020, based on earlier volumes. The fact that the statistics were estimations could mean that the information might be a source of error in the end but since the concept should be future considerate the authors believes that estimations is better to use than earlier values.

To get additional information in specific areas Internet pages and various publications have been used. As Internet contain a large span of information from all kinds of sources focus have been on using trustworthy pages.

Another part of the mapping was to initially gather information of as many areas as possible in the Scandria corridor for the authors to get a basic knowledge. In this way the data collection of specific information could be more effective and secure that the information was relevant to the areas of the thesis. But as freight traffic in the Scandria Corridor addresses many and large areas of information not all can be mapped in a research of this range. The authors have tried to gather basic information in most areas and specific information in areas of special interest. There is however a need for deeper mapping in some areas.

4.2.3 ANALYSIS
The information gathered in the mapping together with relevant theories presented in the theoretical framework is the object of the analysis. The parts of the analysis phase and how they are related to the planning and the mapping phases are presented in Figure 10.
The analysis will in a large extent be based on the thoughts of the authors why the content must be described and motivated in a detailed way (Björklund & Paulsson, 2003). Discussions of how the situation in the corridor described in the mapping affects a transport concept have been done to raise different views. Input from the authors has also been used to make conclusions of the situation in the Corridor regarding what the theory says. The main areas of the mapping chapters and connections to the planning phase are presented in.

The infrastructure in the corridor is mainly analyzed in the matter of where problems and bottlenecks are located and how they can be avoided. It is not a part of this thesis to suggest solutions to these problems but an important part is to map them to know the effect of transporting through certain areas. Furthermore the infrastructure together with the alternative transport modes and customer values are analyzed in the matter of customer service, transport costs and sustainability to draw conclusions of how the concept should be formed. Specific levels of customer service and exact size of transport costs are not handled as this is a complex matter that would demand a lot of time and specific information, which can be hard to find. The comparability of options would be strengthened if this could be done why it is suggested to be done before a transport concept becomes reality.

Goods flows to and from different regions have been compared in the analysis to see what points that can be used as nodes in the concept. The amount of goods between Sweden and regions in the corridor has been evaluated based on what volumes that is required for a train shuttle departing one, three or five times per week. By using volumes needed for a train shuttle a hint is given to the feasibility of using a specific node. A difficult part is to see how large share of the goods transporting between two regions that is able to attract by the proposed concept. This call for a deeper market analysis before taking decisions about what nodes that should be used. Another note is that the concept probably will use more than two end nodes why the flow between two regions do not need to reach the whole volumes demanded by a shuttle.

The fact that only goods flows between different regions are presented with Sweden as base lower the quality of comparing them to see the what points that is most suitable. However the flows to and from the end points are the most important as they cover longer distances. A mapping of the complete goods flows between all points in the corridor would of course give the best result. But doing a mapping of that extent would demand a lot of time and some flows are probably not even documented why they cannot be mapped.

4.2.4 Concept generation
How the concept should be formed is presented in the concept generation. This phase means to sum up the thesis and present a concept fulfilling the purpose and is firmly established in the mapping and the analysis phases. How the parts of the earlier phases leads to the concept generation are presented in Figure 11.
The first part of the concept generation is an extension of the analysis that describes what the setup of the concept should be like. The most suitable north and south end points and how many loading points that should be used are also presented. This sums up the earlier analysis into conclusions to give the reader clarity of the results.

A few different concept routes are presented as alternatives for the final concept. The alternatives are evaluated in the matter of important parameters and the concept with the most substance being sustainable, keeping costs at an acceptable level and offering a good customer service will be chosen. No concept can be the best as different parties value decision factors different why probably not all readers agree with the authors.

If several solutions are given they should be presented in similar ways to simplify the comparison for the reader (Björklund & Paulsson, 2003). All three presented concept routes in this thesis follow the same style and they are discussed in the matter of the same factors to achieve that comparability.

To measure and compare the emission levels for different transport modes at the same route the webpage named Ecotransit.org has been used. EcoTransIT is an instrument for calculating environmental impacts of any freight transport initiated by five railway companies. By using this instrument an indication is given to if the concept is more environmentally friendly than the alternatives using the same route. The fact that the instrument was initiated by railway companies can make train transportation advantageous but the indication it gives should still be valid.
4.3 Quality of Methods

Triangulation is a way of increasing the authenticity of a study. It is described as using more than one method to study the same phenomenon to get different perspectives. Triangulation can also be used for other means than methods e.g. different sources is used when collecting data, several persons evaluates the same material or different theories is used at the same data. (Björklund & Paulsson, 2003)

Different means of triangulation is used throughout the thesis to keep the information trustworthy. In the theoretical framework different sources where used in areas where the authors find it necessary to assure the content. Interviews building the empirical studies have been with several persons to get different views and opinions.

The trustworthiness of a study can be measured by the reliability, validity and objectivity. Reliability shows the extent of getting the same value when repeating a study. Validity measures if the measured object actually is the intended. Objectivity shows in what extent values affects the study. (Björklund & Paulsson, 2003)

A high reliability is achieved by questioning more than one person in an area. This has been done and interviewed persons have been asked similar questions. As mentioned above triangulation is used which also contributes to a high reliability.

In order to keep a high validity interviews have been done with persons holding a great knowledge in the attended area. To make sure the questions are relevant the authors have been studying the attended area beforehand. In doing this relevant follow-up questions could be formed in the scope of the interview. At most interviews both authors where present which increases the validity since there is a bigger chance that the most relevant follow-up questions were asked.

The validity has also been assured by consulting the supervisor at the commissioning body, the supervisor at the University and the objectors in most areas of the thesis. Moreover has frequent meetings with the supervisor at the commissioning body been hold to keep the validity high throughout the whole process.

The information is achieved from acknowledged sources and knowledge is attained in several areas to strengthen the objectivity. By being more than one author collected data is less likely to be misunderstood. To prevent that personal values affect the set-up and the route of the concept advantages and disadvantages in different choices have been compared. The process with a planning report presented for the supervisor and objectors is also a measure to get a high objectivity in the thesis.
Mapping of the situation in the corridor

Infrastructure
Railway transportation
Truck transportation
Transportation on water
Customer values
5. MAPPING OF THE SITUATION IN THE CORRIDOR

As the infrastructure is the base of all transports it is handled to know of barriers and future development. The situation of alternative transport modes is presented where barriers are in focus but also what kind of setup that is appropriate is brought up. At last a compilation of what aspects customers value the most is showed.

5.1 INFRASTRUCTURE

The infrastructure is presented in the matter of barriers in freight traffic and future development.

5.1.1 GENERAL BARRIERS IN EUROPEAN FREIGHT TRAFFIC

As freight traffic in Europe has evolved some bottlenecks have occurred. A large bottleneck, or at least crowded area, is Western Germany where large goods flows are transported. Even if it can lead to improvements in transporting more goods in Eastern Germany it has historically been more freight traffic in Western Germany which have sort of set a standard for how it should be which is hard to change. (Mareike Donath, Advisor at Ministry of Transport, Building and Regional Development in Mecklenburg-Vorpommern)

How to get through the Alps is a matter that concerns all traffic. This fact has been a barrier to transports between places south of the Alps to places north of them for a long time. (Mareike Donath)

A large part of the goods with an origin in other continents than Europe and Africa with a destination in Central Europe comes by boat to ports in northwestern Germany, Belgium and the Netherlands. This reality has made these parts of Europe very crowded by all the freight traffic. The strategic location of this region has also made it popular for large distribution centers and central storage facilities which result in even more transports leaving and entering the region. (Patrik Rydén, Managing director, Øresund Logistics & Jacob Wajsman, Statistical expert, Banverket)

Eastern Europe offer new opportunities in freight traffic but at the same time the infrastructure in this area is undeveloped compared to Western Europe which can be seen as a barrier. Another problem with Eastern Europe is the difficulty to get information about the situation as well as statistics on passenger and freight traffic. (Wilfried Laboor, Ministry of transport and agriculture in Berlin/Brandenburg)

5.1.2 TRANS-EUROPEAN TRANSPORT NETWORK

The Trans-European Transport Network, from now on only mentioned as TEN-T, is a network working for more efficient and more environmentally friendly transports across Europe. TEN-T initiates and funds projects within the whole field of logistics in EU, including road, rail, boats, inland waterways, air and intermodal transports.

Their goals with the projects are to:

- Establish and develop the key links and interconnections needed to eliminate existing bottlenecks to mobility
- Fill in missing sections and complete the main routes - especially their cross-border sections
- Cross natural barriers
- Improve interoperability on major routes (TEN-T, 2010a)

TEN-T has a lot of projects both planned and completed in, around and outside of the Scandria Corridor. 30 projects are included in a priority package because of their importance and all projects are supposed to be finished at latest by 2020. Main part of the 30 projects is concerning railway (18 projects, 3 are intermodal with road and rail included). One third of the projects are concerning the Scandria Corridor and they are presented in Appendix 12.4 together with a table showing the amount of money invested in the projects.

5.1.3 GREEN CORRIDORS

The transportation of goods through Europe are constantly increasing, the European Commission has estimated that the volumes of transported goods will increase with 50% between 2000 and 2020. Green Corridors is a concept created by the Swedish government in cooperation with concerned companies, such as DB Schenker Transport Company and the Volvo Group. (Privata affärer, 2010a)

A green transport corridor is characterized as (Swedish Government, 2010a):
- Sustainable logistic solutions
- Integrated logistic concepts with utilization of co-modality
- A harmonized system of rules
- National/international goods traffic on long transport stretches
- Effective and strategically placed transshipment points and infrastructure
- A platform for development and demonstration of innovative logistics solutions

The purpose of Green Corridors’ is to make transporting through the corridor more environmentally friendly (greener) by raising the level of communication between countries. Doing so creates possibilities for using co-modal transports and removing bottlenecks. An objective is to create a geographic corridor between Finland-Sweden-Denmark-Northern Germany-Holland-Belgium (Swedish Government, 2010a). The green corridor concept is a step in line with the European Commission’s goal to create a greener and more sustainable transport structure. (European Union, 2010d)

5.1.4 MARCO POLO PROGRAMME

Marco Polo is a funding programme of the European Union with the strategy to: “shift as much freight traffic as possible from roads to other modes of transport”. It is instituted to tackle the problem with traffic congestion and pollution coming from road transport which is often the preferred transport mode. The large volumes of freight transportation European roads have to carry everyday have made them overused and crowded. The project aims at promoting other means of transportation as rail, sea and inland waterways which often have spare capacity and pollute less. It is also mentioned that not all traffic have to be shifted of the road. To be able to offer an important door-to-door service feeder traffic and final distribution can be handled by truck. For the rest of the distance inter-modal projects, combining road, rail and waterborne transport, are eligible. (European Commission, 2009 [3])

Projects and services helping to fulfill the purpose of the programme are supported in the start-up. EU funding helps to subsidise the initial operations until customers support the services. One of the
fundamental barriers to setting up new transport services is that customers want to see them running regularly before committing to them. Projects don’t have to propose a new transport service to be funded. Projects aiming to spread a “common learning” or know-how amongst companies and organizations to overcome structural market barriers are also promoted. (European Commission, 2006 [3])

The programme started in 2003, with an annual budget of €25 million, and the first phase, Marco Polo I, ended in 2006 (European Commission, 2006 [2]). Since 2007 a new phase, Marco Polo II, replaced the first one and will run until 2013, with an annual budget of €60 million. The goal is to free roads of an annual volume of 20 billion tonne-kilometers of freight. (European Commission, 2009 [2])

Scandinavian Shuttle

One of the projects funded by the Marco Polo programme is called “Scandinavian shuttle”. By using the Öresund fixed link a rail freight corridor between the Ruhr area in Germany and central parts of Sweden is created. Scandinavian shuttle offer deliveries of goods in both directions on a daily rail service with fixed journey times and are open to any train operator wishing to use it. The aim is to replace the mix of truck and ferry services used in the corridor earlier. To be able to trace the goods each container or trailer has a GPS card reporting its position. (European Commission, 2009 [2])

5.2 Railway Transportation

The information below is mainly based on an interview with Björn Boklund, Business development manager, UBQ. Where other information is used the source is noted.

Goods suitable for railway transportation are at first hand unit loads or almost anything that is placed in containers during the transport. Above this the distance is the critical factor for what types of goods that can be transported by railway. Almost every type of goods should be able to be transported by railway and still get the economy together if the distance is long enough. To keep in mind is that to get a profitable solution with railway transportation it is commonly said that the distance needs to be above 500-600 kilometers. This is the case for most situations but there are cases where a profitable solution can be found at shorter distances. Generally said is that the longer the distance the better the chance to put together a competitive solution with railway transports.

The main factor when it comes to making a certain railway transport profitable is the fill rate (Björn Boklund & Jan Olofsson, Marketing director, DHL Rail). A rule that usually applies is 80-20 which means that 80 % of the train wagons should be filled with goods. In Scandinavian Shuttle the train consists of 36-38 wagons, which usually is the case for trains in Europe, where 28-30 of them needs to be filled to keep the transport profitable. Another important factor is to fill the train with goods in both directions, returning goods flow. If there only is a demand for transport in one direction the train wagons will be standing at one end point because no one wants to pay to bring the wagons back empty. A way of getting similar goods flows in both directions is to set a lower price for the direction where the demand is lower to attract more customers. Swedish import and export can be used as an example of this where exporting goods generally is more expensive to transport than importing goods because of the different demands. For a train shuttle a good idea is to secure a base of goods by linking some companies with large volumes of goods that needs to be transported to the shuttle.
To attract customers to a railway solution it needs to be competitive to other transport methods, primary truck transportation. A dilemma occurs when designing the timetable for a train shuttle. Customers want as frequent departures as possible but the most economic solution is to depart first when the train is fully loaded with goods. How the optimal solution is formed is therefore important. The availability on the railway tracks is furthermore limited during the day, and primarily during rush hour traffic around 7-9 in the morning and 16-18 in the afternoon (Björn Boklund & Mattias Persson, DHL). Freight trains are in addition to this at the lowest level of prioritization in the railway networks. In Sweden the order of prioritization is that X2000 (fast regional passenger trains) comes first, other regional passenger trains comes second, local passenger trains comes third and last are the freight trains. In excess of this some freight trains cannot meet a fast passenger train because the covers on the freight train wagons will be ripped off by the wind. It is hard to find times when there are none or just a few passenger trains on the tracks which is a problem. The most attractive time is at night where just a few passenger trains are active. Designing a well-reasoned timetable is possibly the most important matter to be able to offer a competitive lead time and delivery service.

One example of a railway shuttle concept is the Scandinavian Shuttle. Scandinavian shuttle run between Herne in Germany and Norrköping in Sweden through Denmark five days a week. The transported volume run up to an average of 50 000 000 tkm/month. It has been a successful concept when it comes to environmental effects such as reducing emissions and removing trucks from the roads. It is also making way for a new concept where goods from Turkey are transported to Sweden. This concept includes three train shuttles. The first one starts in Istanbul (Turkey) and goes to Sopron (Hungary) where the goods are loaded on another shuttle to Herne where it is loaded to Scandinavian Shuttle. This concept has three departures a week and it takes 9 days for the goods to arrive in Norrköping. If the goods were transported by truck at this route it would arrive in around 7 days. This number can be changed due to the schedule for the driver who needs to sleep at predetermined times and perhaps have the weekend off.

Appendix 12.5 shows the railway network in and close to the Scandria Corridor.

5.2.1 PROBLEMS IN RAILWAY TRANSPORTATION
There are a lot of problems or barriers in European railway networks. Some of them are being dealt with but the possible solutions will not take effect in the closest years. Many problems base on countries wanting to establish national optimum which creates negative effects when it comes to border-crossing. National solutions were in the beginning defensive actions to make sure other countries could not enter the national railway network. (Patrik Rydén)

Some problems with railway are the earlier public monopoly on railways that still affects the supply of private actors in the railway industry. The traceability of goods does not function properly in many railway solutions and needs to be improved. The sensitivity to hard weather conditions, mainly snow and cold which affect Northern Europe in a larger extent than the rest of Europe. The railway networks in Southern and Eastern Europe are not extended and developed as much as in rest of Europe. There is a difficulty in convincing potential customers that a new railway solution is profitable for them when there is no existing concept to demonstrate. (Björn Boklund)

One big problem for trans-national railway transports in Europe is that trains in many countries are bound to the driver and not intermodal adapted. This means that the train cannot leave the country where it belongs. Around 90 % of all trains are not intermodal adapted. With this prerequisite when
forming a cross-national railway connection investments in new trains are in most cases required which are costly. (Jan Olofsson)

A topic that interests a large audience is the implementation of high speed train lines for passenger transport. This obstructs the situation for freight trains because the tracks get crowded and calls for development of several branch lines to enable meeting of trains. One connection that is especially appointed is from Dresden (Germany) through Prague (Czech Rep.) to Vienna (Austria) where freight traffic is low prioritized. (Wilfried Laboor)

Figure 12 shows an estimation of bottlenecks in the European network of railway transports by 2010 in a study made by the European commission in 2001. The thicker lines the more used railway tracks. Crowded areas are mainly Western Europe, Austria and main lines in Sweden and Italy.

![Figure 12 - An estimation of European rail bottlenecks in 2010](image)

(Unity, solidarity, diversity for Europe, its people and its territory (2001) European Commission)

5.2.2 ERTMS (EUROPEAN RAILWAY TRAFFIC MANAGING SYSTEM)

A railway network needs to be controlled by a security system. The security systems main objective is to prevent accidents by controlling that there are no obstacles on the planned route and if the track is occupied by another train. It also controls switches and reports speed limits to the driver or the
engine computer. Another objective is to make the railway network more efficient by e.g. allowing more than one train travelling at the same track (IDG – International Data Group, 2010a). Today many countries have their own signal system; there are more than 20 different systems across the European Union (Unife, 2009), the different systems are showed in Figure 13.

![Map of different train control systems in Europe](image)

**Figure 13 - Map of different train control systems in Europe**
(Migration of the European train control system (ETCS) and the impacts on the international transport market (2006) Obrenovic et al.)

To run safely at a route through Europe each train has to be equipped with one device for each train control system crossed. Engines compatible with different systems is therefore needed which is costly and increases the complexity. Train drivers and maintenance staff have to be trained to be able to operate each installed system. This makes a change of train driver and/or engine necessary when entering some countries. (ERTMS, 2010a)

To solve the problem with the many signal systems an industrial project was initiated by a group of companies and public actors supported by the EU in 2000. It is called *European Railway Traffic Management System* (ERTMS) and aims at replacing the different national train control systems and creating a standardized rail control system. (ERTMS, 2010a)
Advantages with ERTMS is cost savings in form of lower maintenance costs, shorter lead times, higher punctuality and up to 40% higher capacity compared with the current railway structure (due to reducing the distance between trains). (ERTMS, 2010b)

The ERTMS consists of two components, ETCS and GSM-R. ETCS stands for European Train Control System and aims to replace the regional train control systems. GSM-R is a radio system for voice and data communication (ERTMS, 2010a). ERTMS can be implemented in three different levels where level 1 is similar to today’s train control systems and level 2 and 3 are based on radio signals. (Banverket, 2010a)

As Figure 14 shows, ETCS and ERTMS are planned to grow extensively in the near future. In January 2010 Austrian Railways ÖBB agreed to sign a contract to equip 449 vehicles (locomotives and cars) with ERTMS. The project will start 2010 and has a finalizing date 2014. Austria is a key to the ERTMS’ future due to the large part of European transit traffic passing through Austria. (Alstom, ERTMS supplier, 2010a)

![Expected growth of the ETCS network 2007-2020](image)

(UIC - International union of railways, 2007)

In 2007 ERTMS was completed or planned through the major part of the path between Italy and Scandinavia (UIC, 2007). Appendix 12.6 shows the current state of ERTMS in Europe and the future development plan.

5.2.3 RAILWAY ELECTRIFICATION SYSTEMS

Trains are powered by either electricity or other fuel types. Diesel is used at first hand where the railway is not electrified. Electrified railways are prepared with a railway electrification system which powers the trains with electrical energy. Most major railways in Europe are electrified but the electrification systems are different throughout the world. For a train to run with a specific electrification system the locomotive needs to be equipped with an engine compatible with that system. A locomotive can be equipped to operate on more than one system but it is an expensive option. In the Scandria Corridor three different systems can be found, shown in Figure 15. (Patrik Rydén)
5.2.4 Operators
The European market of railway operators mainly includes national operators. Cooperation has been more common lately though. (Jan Olofsson)

Xrail – An alliance made up of European railway companies
With UIC (International union of railways) as project initiator an initiative in making European railway wagonload more efficient and customer friendly have been done in forming the alliance Xrail including seven big European railway companies. The main goal of the alliance is to increase the competitiveness of European wagonload traffic by strengthening the position against road traffic. Partners of the alliance and their main areas can be found in appendix 12.7.

In the first phase the main economic areas in Austria, Belgium, Czech Republic, Germany, Luxembourg, Sweden and Switzerland will be connected but the long-term goal is to cover the entire European wagonload network. The Xrail network will operate on existing infrastructure with a large use of the TEN-T corridors.

Wagonload makes up for around 50 % of European railway freight traffic used for transporting e.g. paper or chemicals. The term wagonload traffic can be explained by a train consisting of wagons provided by different customers picked up and delivered at predetermined points along the railway network. (Xrail - The European wagonload alliance, 2010)
5.2.5 Tracking systems
When trucks are used as means of transport a tracking system is in most cases not necessary because the driver can answer for where he/she is at the moment. The use of tracking systems in railway transportation is not particularly widespread in Europe. (Jan Olofsson) Of the ones that uses tracking systems a small amount, e.g. Scandinavian Shuttle, have trackers on each trailer to be able to trace specific goods while other ones one tracks the locomotives. The latter is not as dependable because a train can sometimes change the locomotive or some trailers may be left behind or transported on another train. (Björn Boklund)

Possible tracking systems are GSM, GPS and RFID. RFID are small tags placed on each trailer containing information of the goods. The tags are read by readers placed along the railway tracks. GPS uses satellite information to position the goods. GPS and RFID often need to be used simultaneously to get the desired information. (Björn Boklund) GSM trackers are smaller types of GPS trackers which do not need large radio antennas to communicate with satellites and cost less than other trackers (Tracking the world, 2010a).

5.3 Truck transportation
Trucks will always be needed as a means of transportation as they offer a flexible choice and can transport to any location, as long as there are roads connected. In short distances trucks are superior to the alternatives as they are much less time consuming than e.g. trains in loading and discharging of goods. (Jan Olofsson)

In a marketing point of view trucks are more often seen by the public as they use the same roads as everyone else. Large companies, e.g. ICA and Arla, are often using this as a commercial opportunity where their names and products can be exposed at a low cost. When using trains this opportunity is reduced as train wagons in a large extent are owned by the train operators and railways are placed where less people are located. (Björn Boklund)

Trucks offer the most flexible choice in transportation but have other disadvantages compared to the alternatives. Intermodal transports have less environmental effects and can be formed in a more cost-effective way but the risk is higher because intermodal alternatives are more sensitive to distractions and changing conditions. This is probably the reason why truck transportation still is used in such a large extent in European freight traffic. (Mattias Persson)

Volvo is showing interest in making trucks more environmentally friendly by making them more fuel-effective and building trucks driven by different kinds of fuel. They are also developing a Duo-trailer truck which is based on the EU 25.25 m module concept. (Volvo Group, 2010a) The idea with the concept is to make the European transport system more multi-modal by building trucks compatible with shipping containers and trains. The trailer is also capable of carrying more goods which eventually can reduce the number of trucks needed in Europe. (Cecilia Gunnarsson, Environmental Manager at Volvo 3P)

Figure 16 shows an estimation of bottlenecks in the European network of truck transports by 2010 in a study made by the European commission in 2001. The thicker lines the more used roads. Crowded areas are mainly Western Europe, Northern Italy and some parts of Austria.
5.3.1 ROAD PRICING

Road pricing is more of reality than theory why it is defined below, before the European situation is presented.

“Road pricing is a potentially effective instrument for curbing transport and transport-related problems” is a statement which most transport analysts would agree on according to Verhoef et al. (2008, p.1). Further he claims that many policy documents identifies road pricing as a cornerstone in transport policies.

Eliasson & Lundberg (2003) says that there may be two main purposes for road pricing which are financing and managing traffic. If the fee has a managing purpose it can in turn also have the purpose to improve the environment or accessibility. Verhoef et al. (2008) addresses three developments which kept road pricing current. The first one is the growth in transport volumes, causing congestion and pollution. Next there is the ongoing improvement in technologies for automated vehicle identification and charging. At last budget demands motivate the request for alternative funding of road infrastructure construction and maintenance.
The options for road pricing measures are wide in range according to Verhoef et al. (2008) with the examples toll roads, express lanes, toll cordons, area charging and kilometer charges. They also indicates that charge levels and toll differentiation varies due to local conditions.

**EUROPEAN ROAD PRICING**

The European region consists of different road pricing systems, often national systems. They differ in charge level, payment method and what type of vehicle that is charged. Appendix 12.8 shows the different European road pricing systems in a map which are explained in Table 4. Beyond the systems described there are several specific road tolls established mainly to cover the cost of building that part of the infrastructure e.g. the Öresund Bridge. Road pricing will probably be used in a larger extent in the future and some countries where road pricing is not yet adapted already have plans to introduce a road pricing system. (Øresund Logistics, 2009)

Table 4 - Description of different European road pricing systems
(Øresund Logistics, 2009)

<table>
<thead>
<tr>
<th>European road pricing systems</th>
<th>Pricing system</th>
<th>Vehicles charged</th>
<th>Payment system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweden, Norway</td>
<td>Cordon tolls around city centre in Stockholm, Oslo, other Norwegian cities</td>
<td>All</td>
<td>Direct short range communications</td>
</tr>
<tr>
<td>Germany</td>
<td>Distance, weight and emission based charge</td>
<td>HGVs, Heavy Goods Vehicle, above 3.5 tonnes</td>
<td>GPS satellite system with OBU, On Board Unit</td>
</tr>
<tr>
<td>Italy, France, Spain, Portugal</td>
<td>Distance based motorway tolls</td>
<td>All</td>
<td>Toll booths</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Distance and weight based charge</td>
<td>HGVs above 3.5 tonnes</td>
<td>OBU, can be used in Austria, and automatic license plate reading</td>
</tr>
<tr>
<td>Austria</td>
<td>Distance and weight based charge</td>
<td>All</td>
<td>OBU and automatic license plate reading</td>
</tr>
<tr>
<td>Hungary, Czech Republic</td>
<td>Distance based motorway tolls</td>
<td>All</td>
<td>Vignette system, stickers attached to windscren</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>Distance related charge varying by road and vehicle type, toll cordons in some cities</td>
<td>HGVs above 3.5 tonnes for all UK roads, all vehicles for toll cordons</td>
<td>GPS satellite system with receiver, specific systems for toll cordons</td>
</tr>
</tbody>
</table>

5.4 **TRANSPORTATION ON WATER**

The main rivers in Europe are shown in Figure 17 which can be used for inland waterway transportation. Barges are used frequently on some rivers and offer a competitive alternative to other means of transportation. (Björn Boklund)
The natural way for goods to Sweden through the Scandria Corridor is by crossing the German region of Mecklenburg-Vorpommern and go by ferry to Sweden. Of the ports in this region Rostock is most suited for transports to Sweden by the port of Trelleborg and furthermore the one of the ports that is improving the most. One alternative is the port of Sassnitz which mainly is used for transports to the east. The distance between Stralsund and the port of Sassnitz has been a bottleneck historically but improvements have been done lately which have increased the accessibility. (Mareike Donath)

Scandlines operates ferries formed in a way that makes it able to put whole trains on them. This possibility is given for three ferry lines from Northern Germany to Scandinavia, see Figure 18. The first goes between Puttgarten (Germany) and Rødby (Denmark) and is a short trip. The second goes between Rostock (Germany) and Trelleborg (Sweden) which takes 5,5 hours and departs 3 times/day in both directions. The third goes between Sassnitz and Trelleborg which takes 3,5 hours and departs 5 times/day in both directions. The last two ferries offer a possibility for the drivers to get a sleeping break. (Scandlines, 2010a)
Large shipping companies of the world are today using ports in northwestern Germany and the Netherlands like Rotterdam and Hamburg in a large extent when goods are imported to Europe. The number of ships from e.g. Asian territory that stops in the northern Adriatic ports is limited. (Björn Boklund)

5.4.1 SECA (SO\textsubscript{X} EMISSION CONTROL AREA)

The Baltic Sea, the North Sea and the English Channel are the areas included in SECA, SO\textsubscript{X} emission control area, (Figure 19) which have been set up to control the amount of sulphur in marine fuel oil, bunker oil like MGO (Marine Gas Oil), MDO (Marine Diesel Oil) and heavy fuel oil. The change regulated in MARPOL Annex VI regulation 14.4 to 1,5 % as the maximum amount of sulphur in bunker oil has made the restriction in SECA harder than for other European waters e.g. the Mediterranean Sea with a maximum level of 4,5 %. In Swedish territorial waters\textsuperscript{7} the maximum limit of sulphur content is set to 0,1 %. (Transportstyrelsen, 2010a)

The change of the limit to 1,5 % in the Baltic Sea and the North Sea SECAs led to a reduction in

\textsuperscript{7} The water up to 12 nautical miles outside of the base line
sulphur dioxide (SO$_2$) from shipping in these areas by 42 % in the year of 2008. (Einemo, 2009)

Outside of SECAs almost all ships will operate on HSFO (High Sulphur Oil) mainly because of the high price and low availability of low sulphur bunkers in many ports. For these ships to enter a SECA there will be a need to switch to LSFO (Low Sulphur Oil). A regulation forces ships that are switching from HSFO to LSFO to wait sufficient time to make sure that all fuel exceeding 1,5 % is fully flushed out of the system before entering a SECA. Ship operators will need to know the required changeover time for the current ship to plan the voyage. (DNV - Det Norske Veritas, 2010a)

Changes have been made to MARPOL Annex VI regarding future reductions in SO$_x$ emissions from ships. The current limit of 1,5 % in SECAs will be reduced to 1 %, taking effect in 1 July 2010. From the start of 2015 the limit is set to be further reduced to 0,1 % in these areas. The global sulphur cap of 4,5 % will be reduced initially to 3,5 % in 1 January 2012 and then progressively to 0,5 % in the planned date of 1 January 2020. A review of the eligibility of this date is set to 2018 where a date shall be affirmed. (IMO - the International Maritime Organization, 2010a)

5.5 CUSTOMER VALUES

The information below is a compilation of information gathered in interviews with Björn Boklund, Jan Olofsson, Mareike Donath, Wilfried Laboor and Patrik Rydén. The view these people have of how important different aspects are matched up well.

The price is the aspect that by far is most important when it comes to customers deciding how to transport their goods. To attract customers using trucks as means of transportation to use railway transportation the price needs to be 10-15 % lower according to Jan Olofsson.

When it comes to lead time it depends on the market for the goods types how important the aspect is. It is more important to be able to stick to the schedule and deliver the goods at the agreed time, delivery dependability. When setting up a railway transport between two points it should usually offer the same lead time as if a truck should do the transport.

Flexibility is often used as the big advantage of truck transport which in fact is better than the alternatives, air transport excluded. This higher level of flexibility that trucks can offer compared to trains is only important to a small part of all companies in need of transports, e.g. the process industry, if the train has decent frequency in departures. Train transportation can offer flexibility in capacity at a larger extent than truck which is valued high by companies with large transport volumes.

Environmental effects, mainly emissions, make for an aspect that both customers and transport companies wants to reduce but no one wants to pay for it to be done. It is an important aspect that, in a public point of view, is often put aside.
ANALYSIS OF THE SITUATION IN THE CORRIDOR

BARRIERS IN THE CORRIDOR

CONCEPT FORMING
6. Analysis of the Situation in the Corridor

Essential factors of the infrastructure are discussed to find out how they affect the choice of transport modes and route designing. How to avoid the barriers is crucial for the transport concept why it is analyzed. How to perform well in customer service, how to keep transport costs low and how to be sustainable are discussed in the last part.

All of the transport methods taken in consideration for the concept of this thesis have pros and cons. To be said firstly is that rail and sea transportation are preferred compared to truck transportation from EU’s point of view since boats and trains are friendly to the environment and do not interfere with passenger traffic in the same extent as trucks. Trucks are however the only of these transport modes that can reach all destinations within the Scandria Corridor as boats need water and trains need railway tracks.

The geographical positions of the rivers in Europe does not offer any long distance north-south connections in the Scandria Corridor which makes inland waterway transports non applicable for a transport concept from the Adriatic Sea to Scandinavia. Branch lines to and from loading points could be arranged with inland waterway transports on the locations where rivers run through, but this opportunity will not be handled further as it is not covered in this thesis. Sea transporters are not applicable in the corridor except for the small part of the Baltic between Northern Germany and Sweden, if the route does not go through Denmark. For this short distance it would probably not be suitable to load the goods on a large freight ship in Germany and unload it when it reaches Sweden. The option to load trains or trucks on a ferry is probably less costly and time-consuming and by that a better solution.

Trains can be used as long as there are railway tracks which there are in most places. Using railways are complex because some tracks are built with double lines and some with single lines, the capacity differs depending on tracks and routes, electrification and control systems varies throughout Europe and the prioritization of freight traffic is low. Above this most origins and final destinations are not directly connected to a railway network which calls for truck transports to and from train terminals. Since the route will be arranged terminal to terminal these trips will not be included in the concept but as they are needed in most cases the concept needs to be formed with intermodality in mind.

Truck transports are flexible and easy arranged but are not innovative solutions and above all not sustainable options for the future. Because of this the usage of trucks should be as low as possible and railway transportation should be preferred as the option for transports on land.

6.1 Barriers in the Corridor

That Eastern Europe offer a chance of improved freight traffic due to the capacity and shorter routes is something most people agree on. But the need for improvements and matching to European standard is large and it will take several years to achieve a situation where transports can be planned through this area without problems. When looking at railway infrastructure and improvements a large focus is on east-west connections. This leaves a call for better north-south connections to be able to establish successful transport concepts from the Baltic to Scandinavia. A large share of the
goods from southern and eastern parts of Europe to Scandinavia is first transported to Western Europe to be re-loaded and later transported to Scandinavia. Why the situation looks like this is probably because transportation through Eastern Europe cannot be formed in a way that matches the solution of going via Western Europe. Improvements and focus corridors, see TEN-T projects, appendix 12.4, are improving connections to Western Europe and therefore Eastern Europe is getting further behind.

A critical path in the Scandria Corridor is the Alps where nature prevents development of a comprehensive rail and road network. From the Adriatic Sea to the north there are, as in the current situation, three options how to get past the Alps: the first is to go to the west to Verona and then north to Innsbruck, the second is to go north to Salzburg through Villach and the third is to go northeast to Vienna. The first two options are crossing the Alps while the third goes to the east of the mountains.

TENT-T priority project 1, a railway axis from Palermo (Italy) to Berlin (Germany), make up for a possible route for freight transport from the northern Adriatic Sea to Berlin as it passes Verona (Italy) which is also connected to Venice and Trieste through TEN-T priority project 6, a railway axis from Lyon (France) to Kiev (Ukraine). It would include a small detour to the west to Verona before going north but the prioritization of these railway corridors may make up for the detour.

How to get from Germany to Sweden, and vice versa, is an important part of the Scandria Corridor. There is one possible way to transport on land all the way to Sweden which is by going through Denmark. This route is a detour but the advantage is that the transport will be unbroken. A closer way is to use a ferry from Northern Germany to either Denmark, and transport the last way on land, or to Sweden and the port of Trelleborg. The ferry between Rödby and Puttgarten is the shortest ferry trip which is an advantage to the other ferry options. Disadvantages with this line are that the route has to be drawn through Denmark which increases the complexity, due to more borders and systems crossed, and that Puttgarten is not located in a natural way for the Scandria Corridor. The ferry options to Trelleborg depart from either Rostock or Sassnitz. In advantage of Sassnitz is that the trips are two hours faster than the ones from Rostock. However do drivers appreciate the 5,5 hours long trip the Rostock ferry takes as they can get a sleeping break of 5 hours. In disadvantage of Sassnitz is the lower availability to the port as a result of its location. Furthermore Mareike Donath said that Rostock is a larger port and that it is developing the most of the ports in Mecklenburg-Vorpommern. The Fehmarnbelt fixed link, see appendix 12.4, that is planned to be ready in 2018 will offer a closer connection to Sweden through the Scandria Corridor in the future. It is possible that this will be the best option in the future but it is hard to tell at the moment. If the fixed link is finished in 2018 it will probably take some years before freight traffic will run there without problems.

6.1.1 RAILWAY ELECTRIFICATION SYSTEMS
The fact that the railway electrification systems differs throughout Europe makes up for the biggest problem when designing the route for a transport concept. An option is to use diesel trains but since they are less environmentally friendly it is not an option for the concept in this thesis. The less systems trains need to operate in the better since locomotives needs to be equipped to handle all systems crossed. The best solution would be to just transport in one system but the dispersion of European electrification systems, see Figure 15, reject this option for transports all the way from the
Adriatic Sea to Scandinavia. Since there are three different electrification systems within the Scandria Corridor a locomotive equipped to handle all three can travel on railway tracks in the whole corridor, as long as they are electrified. This would make the designing of the route easier but the investment costs would be very high. If the number of electrification systems to operate in is limited to two a route from the Adriatic Sea to Scandinavia is possible but some areas need to be avoided. Czech Republic has two different systems, one for the Southern part and one for the Northern part, which is a big problem if the concept only should be compatible with two systems. This would exclude Austria, Germany and Sweden and is by that presumable not an option for the concept. If the route should be drawn through Denmark then Italy, Slovenia and Northern Czech Republic needs to be avoided which means that the route must start in Croatia, or further south, and go west to Germany through Southern Czech Republic or Austria, with an end node at the Adriatic Sea. This route is presumably not a good option either. The conclusion can therefore be drawn that if the concept should only be compatible with two railway electrification systems it would be 15 kV AC, enables Sweden, Germany and Austria, and 3 kV DC, enables Italy Slovenia and Northern Czech Republic. With only one system a route the whole way is not possible but it can be drawn as far south as to Austria and still go all the way to Sweden.

6.1.2 Train Control Systems

Europe looks like a puzzle in Figure 13 because of all the different train control systems. As the map can tell, a railway concept from the Adriatic Sea to Scandinavia needs to be compatible with at least three different train control systems. For every system to operate in a device is needed to make the train compatible to the system. The cost for investment in devices for all systems to operate in is probably a smaller problem than the need to educate the drivers and staff for every system. The situation is the same as with the electrification systems that the less train control systems that are needed the better. The need to limit the number of train control systems is however not as critical as the need to limit the number of electrification systems. A future solution to this problem is the implementation of ERTMS which will make cross-national railway transports easier. This is a needed solution but it will not take effect in several years since firstly by 2020 all the main railway lines should be implemented with ERTMS. Before ERTMS is the standard in European railway networks the problem remains and has to be taken in consideration when a transport route is designed.

6.2 Concept Forming

There are many aspects to consider when forming a concept. Within customer service, transport costs and sustainable transports some of the most important factors are discussed.

6.2.1 Customer Service

How well a concept perform in the matter of customer service is hard to say when it can be expressed in different elements of service. These elements are valued differently among customers but commonly are that delivery dependability and lead time are ranked high. In alternatives with similar lead times the delivery dependability seems to play a big part. Flexibility can be expressed in foremost flexibility in departure and flexibility in capacity and are ranked high by some companies but for a large share it is not as important as price and times. Information to the customers seems important when something out of the ordinary happens and the agreed times and terms are changed. A high level in delivery reliability is something that is expected and a transport concept with poor performance in delivery reliability is not even an option for companies.
A short *lead time* is crucial for e.g. high valued goods and goods needed to be kept cold or with short lasting quality, e.g. foodstuffs. The longer the lead time is the longer goods will be stored in a transport which means tied up capital. This is why high valued goods are in need of short lead times. For a transport concept from the Adriatic Sea to Scandinavia the origin of the goods probably plays a part. Goods imported to the ports have already been transported a distance at sea which means that the lead time already is long and the lead time for the last part are less important than the cost and the ability to transport all goods to the same destination at the same time. When comparing the options in transport methods trucks can offer the shortest lead time in short distances. Inland waterway transport is the slowest method in most cases. Railway transportation is the fastest option in long distances, with proper circumstances. The situation and infrastructure of the European railway networks are barriers to the lead time that train transports should be able to offer. In the current situation with a low average speed of European cross-national freight trains a railway concept are hard to form in a way that the lead time is shorter than with truck transports. When comparing the lead time for a railway solution and a truck solution there is something that easily is put aside. As an example we study a made up situation with goods that needs transportation from point A to point B. The problem in this example is that A and B is not directly connected to train terminals and needs extra transport if a train solution is chosen. The lead time for a truck shows the time from origin to destination but the lead time for a train show the time from terminal to terminal. The lead time for the train solution in this case do not express the actual time from A to B as it needs to be complemented with the time of two loadings and two short truck transports. If the extra transports are not included in the lead time for the train solution it could show a false reality. The best possibilities of achieving short lead times in railway transport is by using times where there are a lot of available space on the tracks and use routes where the railway tracks are not as heavy-loaded as other routes. Night time is the best possible time of achieving short lead times. However a freight train from the south to the north, or vice versa, of the Scandria Corridor cannot travel the whole distance in one night, especially if one or more loading points are used. Therefore the distance travelled at night should be where the tracks are most crowded during day time. Heavy-loaded railway tracks are foremost found in Western Europe which makes Eastern Europe, or more specific the Scandria Corridor a better option. One part of the corridor that offers capacity and free times are Berlin to Rostock which promotes the use of a ferry from Rostock to Trelleborg.

The *delivery dependability* depends on the ability of the transport method to run without unexpected interruptions. Ships are not concerned of stops on the route caused by others because they run on water. On the other hand hard weather is a concern for sea transports. Trucks are concerned by the traffic situation in forms of congestion, accidents, road construction and sometimes the weather situation. Trains have similar concerns as trucks with the addition of problems with the railway tracks. Another matter that concerns railway transports is the availability to attend the track by road. If a problem occurs at the track or with a train it is in many cases impossible for a service vehicle to assist the train because there are no roads leading to the track at the place the train is stuck. By this fact it is in most cases hard to tell when the train is going to work properly again. Trucks have an advantage in this matter because it is easier to attend a truck that has come up against an unexpected problem that caused it to stop. The low standard of road and rail networks in Eastern Europe causes a higher risk to run into problems delaying the transport than in Western Europe. An important challenge when forming a railway transport concept is the designing of a time-table that is
attractive to the customers. An even more important challenge is to hold the times presented in the
time-table maintaining a high level of delivery dependability.

*Flexibility* is a wide expression. Trucks are said to have the best flexibility but this refers mainly to the
flexibility in departure as a truck do not run on fixed times. Trains and ships on the other hand are
often stuck to time-tables with fixed departures. The frequency of departures for these two transport
methods is what expresses their flexibility in departure. If the means of transports are compared in
the matter of flexibility in capacity instead, trains and ships can handle much larger volumes than
trucks on the same transport. When a railway transport concept is designed a high flexibility is not
the primary factor to achieve as it is important only to a small part of all companies. Moreover the
flexibility in departure a truck transport offer, in almost every case, cannot be achieved by a train
transport. The companies in need of high flexibility in departure will thereby use trucks, or airplanes,
as a means of transport. For railway transport concepts the focus should only be on getting an
acceptable level of flexibility and then focus on other factors.

*Information* is a safety for customers as they want to keep control of their goods. Information can be
given before a transport on e.g. times, prices, terms and so on but also during the transport in form
of status of the transport, where the goods are located at the moment and if there will be any delays.
The information during the transport is easy to get with truck transport as the truck drivers are
contactable by phone and can give the information needed. To be able to give customers close
information during railway transports some kind of tracking system can be used. Whether a tracking
system is needed or not are there separate opinions about as railway solutions often have preset
time-tables that tells when goods should arrive at specific points. When problems occur on railways
the ability to track the goods would not matter in many cases because no one knows how long delay
a problem of this kind will cause.

The *Delivery reliability* can be negatively affected on each loading point as the number of possible
human mistakes increases. Therefore an unbroken transport from origin to destination would be the
best solution if the highest possible level of delivery reliability is prioritized. Tracking systems can be
a help to maintain the delivery reliability as they tells if any goods are forgotten at any point.

6.2.2 **TRANSPORT COSTS**

Since the price is by far the most important factor in what customer’s value it should be in interest of
keeping the costs low in a transport concept. When using trucks it is hard to form the transport in
different ways since the most effective way should be to drive directly from the origin to the
destination. The alternatives, by ship or train, needs access to ports or terminals and the routes are
limited to water for ships and railways for trains. The origin and the destination of goods are rarely in
direct connection to both ports and railway terminals why these transport alternatives, in most
cases, require an intermodal solution. Thereby the conclusion that sea and railway transporters
needs to offer a lower price than trucks can be drawn since trucks offer direct connection and flexible
departure times. Jan Olofsson argued that railway transports needs to offer a price that is 10-15 %
lower than what is offered for truck transports.

Depending on the setup for the concept the costs will vary and be allocated in different cost types. A
review of the cost types presented in the theoretical framework on how different setups and routes
affect the size of them is presented below.
**Terminal costs** will depend mainly on which transport modes that are used and how many stops there are between the end points. All loading stops will increase the terminal costs as terminal access is needed and the cost for the actual loading work. If the concept should have an intermodal setup the change between transport modes will also increase the terminal costs. The theory is clear that truck transports have a low amount of terminal costs but rail and sea transports have a high amount which should apply in reality as well.

**During way costs** depends on the distance for the cost for fuel and indirect for the cost of maintenance since longer distances increase the wear. The amount of during way costs is the highest for truck transports mainly because of the lower capacity than the alternatives. Lower volumes of goods transported in each vehicle implies that each product or article has to carry a larger share of the during way costs. The usage of fuel and what fuel type vehicles run on is a topic that is up-to-date as emissions say to conduce to a worse climate. As oil is not a renewable resource the price has run up in the last years and the price will probably rise further in the future which increases the cost for fuel and by that the during way costs for trucks will be even higher than in the current situation. Another matter that contribute to the during way costs for trucks is road pricing which are used in many European countries and future plans tells of even more countries that are going to use it. A truck transport between the Adriatic Sea and Scandinavia runs through a number of road pricing systems that calls for different devices and stickers to function in all systems. Most countries in the Scandria Corridor use distance based charges and since the distance from the north to the south of the corridor is long the total road pricing cost will be large. In railway transports the transported volume in each train is large and there are a lot of goods to spread the during way costs among making the cost small for each product or article. The same apply for ships where the capacity usually is even higher than for trains. How to get from Germany to Sweden can be managed in three ways as mentioned above which will affect the during way costs in different ways. If the transport should be arranged without usage of a ferry the distance should be longer and fuel costs higher. Whenever a ferry is used for transporting trucks or trains on water covered paths the cost will be a charge for the use of the ferry service.

**Investment costs** occur in steps and foremost in the startup of a new concept. Vehicles, facilities and other equipment need to be purchased to be able to fully operate the transport concept. Investments will be particularly large in railway transports because of all problems in European railway networks. To be compatible with different systems costs will be high for locomotives and education of staff. Trucks are standardized and will not need anything extra to run in the Scandria Corridor.

**Goods costs** are depending on many other factors than the setup for the concept why it is hard to see how large they will be. What types of goods that is transported affects this cost type and since almost all types of goods are accepted it will be different for each time.

In today’s transport market the five economic parameters Lumsden (1995) proposes when designing a transport service matters in different extent. An important part is to know of them and what opportunities a company can get by forming a service with consideration of the parameters. It is hard to achieve a high level in all of them but single handed they all offer advantages compared to competitors.
**Economy of scale** matters greatly when it comes to transport companies and operators. This conclusion is made from the situation in Europe where a small amount of large companies are performing most of the transports. As a transport operator you need to obtain a number of expensive vehicles to be able to offer what the customers want. Access to terminals for train operators and ports for shipping companies is another matter included in this parameter. To achieve a high level in economy of scale large investments and a broad customer basis is needed which makes it hard for new companies to enter the market. Economy of scale is most important for shipping companies as the ships used for transport are far more expensive than e.g. trucks. For train operators investments in locomotives and trailers are needed which is costly. The European railway situation calls for more expensive investments than e.g. trains operating in only one country. This comes from the non-unified European railway infrastructure with different electrification systems, train control systems and non-intermodal adapted trains.

**Economy of scope** can be the advantage of cooperation between companies or organizations. All actors have different strengths and by cooperation actors can take a use of strengths they would not have as a single player. An example of this is Xrail where seven train operators have started a cooperation to offer better trans-national railway solutions.

**Economy of density** addresses one of the most important factors in profitable transport solutions, the fill rate. The more of the capacity that is used the costs will be spread among more goods which enables lower prices or higher profit. The economy of density is more crucial the bigger the vehicles are because a shortage can lead to great losses. In railway transportation Björn Boklund said that 80 % of the capacity needs to be filled. Because of the shifting demands in transportation a railway solutions probably should have a fill rate at above 80 % to get through periods of lower demands. A train shuttle often have different demands in the directions which implicate that the fill rate in the direction with the highest demand needs to be high enough to cover for the other direction, if the fill rate in that direction is too low. A railway solution cannot be profitable unless the average fill rate exceeds the critical limit.

**Economy of experience** can be an advantage when it comes to changing concepts as problems and possibilities occur as well as identifying better solutions. It is hard to simulate transport concepts before they exist as the circumstances are complex and markets change. This is a problem especially with planned railway concepts as the routes are fixed to the railway network and investments often are specific to a certain concept. Adapting to the best solution after implementation can therefore be hard to realize.

**Economy of presence** is a great advantage when it comes to attract customers. It is said that without an existing railway concept it is hard to convince customers that using the concept is profitable for them. The fixed costs in the startup of a new railway transportation concept are large which makes companies want to connect customers to the concept before startup to ensure some income on a frequent basis. This creates a dilemma for the transport company when the startup of a new concept can include a big risk to not get enough income to cover the costs. Economy of presence can also be a marketing factor as the name of the company is seen at places where it operates. Trucks spread the word to a large audience as they travel long distances on roads. Trains are not as good marketers as trucks but it helps to be present in places where many potential customers are located.
6.2.3 Sustainable

Since the fill rate is an important factor in railway transports, which require sufficient goods flows in both directions, one prerequisite to start a new concept is to link some customers to the concept. But even with customers linked to the concept a large risk stands to not get a fill rate high enough to cover the costs. As with most new businesses this is an unavoidable risk and the important part is to keep it as low as possible. In the initial phase of a concept or a pilot for a concept it is harder to get good results because it is not an established concept where potential customers can see how it performs. In this phase the concept is also heavy-loaded with large fixed costs. The frequency of departures depends on how high the demand for transport is between the nodes of the concept. In the startup phase the volumes transported by the concept is probably low and by that the number of departures a week is low. This makes the alternative to transport with truck more attractive due to the flexibility in departure time. The startup phase includes some difficulties but if the concept succeeds to evolve and keep the fill rate at a high level it will probably be successful in the long run. There is a great importance in this phase to learn about how to form the concept and get to know what customers value the most. The route does not have to be the same all the time but instead be adjusted to go through the nodes where the demand for transports is the highest.

To get as low emissions as possible truck transportation is not a good option. Development in truck transportation is being done to reduce fuel use and to use other fuel types but it is not likely that it will make truck transport comparable to sea and railway transportation in the upcoming years. EU wants to get the freight of the roads by funding projects that increases or strengthen the use of railway and sea transportation. It is clear that using trucks in long distance freight transportation is not a sustainable solution.
MAPPING OF GOODS FLOWS AND LOGISTIC NODES

SOUTH END POINT
NORTH END POINT

GOODS FLOWS BETWEEN THE END POINTS

STRATEGIC REGIONS IN THE CORRIDOR
In this chapter, a research of which nodes is suitable to use for the transport concept is presented. The nodes or points are divided into end points and loading points. Areas around the Adriatic Sea are named south end point candidates and areas within Sweden are named north end point candidates to keep the end points apart. The evaluated nodes are described as candidates for this thesis’ transport concept and their attributes. The candidates to the south end point are harbors, the size of the different harbors will therefore be considered. For the north end point (Sweden) it is important to see the general goods flow.

Goods flows between areas where the northern Adriatic ports are located and Sweden are described to give an idea of the market for the transport concept. To locate the strategic points within the corridor a mapping for the relations between Sweden and different points in middle Europe is presented.

The statistics involving Sweden comes from the Swedish traffic department “Trafikverket” and is an estimation of how the goods flows will look like in 2020. All data is not published why the presented statistics is a compilation of information given in “Draft national plan for transport from 2010 till 2021” and data from Magnus Johansson at SIKA-Institute. The data is more viable for this thesis than current data since the project scope of time is set to 2015. When statistic between Sweden and another country or region is presented, import means that Sweden has imported the goods and export means that Sweden has exported goods.

7.1 South End Point
As the name Scandria shows the corridor stretches from the Adriatic Sea to Scandinavia. South end point for the concept will be somewhere on the coast surrounding the Adriatic Sea which mainly includes the countries Italy, Slovenia and Croatia. To get the shortest possible distance to Scandinavia the northern part of the Adriatic Sea will be evaluated, shown in Figure 20. This part of the sea has been divided into three identified areas for a possible south end point. These are the areas around 1- Venice, 2-Trieste and 3-Rijeka. A table of driving distances between all ports is presented in appendix 12.9.
The rest of this chapter contains a mapping of these three areas including goods volumes, goods types and geographic location. Complete tables of the port statistics are presented in appendix 12.10.

7.1.1 AREA 1 – VENICE, CHIOGGIA
Area 1 consists of the two Italian ports of Venice and Chioggia, Figure 21 shows their geographic position.
VENICE – ITALY
Venice has a strategic position for the northern parts of Italy but also by being a part of Corridor 5 and located close to the railway corridor Palermo-Berlin. The port of Venice handles many different types of goods and most of them in significant volumes. (Port of Venice, 2010a)

CHIOGGIA – ITALY
Chioggia lies 25 km south of Venice by boat or 50 km by road. The port of Chioggia is historically an important fishing port but the handled goods volumes have increased later on to a total of around 3000 tonnes. (Port of Chioggia, 2010a)

7.1.2 AREA 2 – TRIESTE, MONFALCONE, KOPER
Area 2 consists of the Italian ports of Trieste and Monfalcone and the Slovenian port of Koper, Figure 22 shows their geographic position.

TRIESTE – ITALY
The port of Trieste is by the location an international hub for both sea and land transports as there are good connections by land to in first hand east and west directions along Corridor 5 which stretches from Lyon to Kiev. Except for the sea transported inwards and outwards goods high volumes of goods enter the terminals in the port area by land every day and leaves by land not long after, these goods are not included in the port statistics presented. More than 100 trains leave Trieste every week serving mainly Northeastern Italy, Southern Germany, Austria, Hungary, Czech Republic and Slovakia. Crude oil is by far the largest product handled in the port but the general cargo also reaches high volumes. The port can handle most products transported by sea even though the volumes in some products still are low. Trieste has a policy to grow and develop the port by grasping the increasing possibilities of cargo traffic from both sea and land transports. (Port of Trieste, 2010a)

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*A railway connection between Lyon and Kiev*
MONFALCONE – ITALY
The port of Monfalcone is the port closest to the central parts of Europe by being the most northern Adriatic port. Monfalcone is specialized in general cargo and dry bulk and can handle all types of products within these groups. Coal together with iron and steel products make up a large share of the goods handled in the port. Close to the port is a railway connection to at first hand Trieste and Venice. (Port of Monfalcone, 2010a)

KOPER – SLOVENIA
The port of Koper is a multi-purpose port which makes it able to handle all types of goods. There are a number of terminals in the port area specialized to handle and warehouse the different types of goods entering and leaving the port. Dry bulk makes up for the largest part of goods handled in the port which mainly consists of coal and minerals. The liquid bulk cargo terminal handles at first hand chemicals, minerals and vegetable oils but also taxable products such as mineral oils and alcohol. The car terminal is one of the largest in the Mediterranean where cars from mainly Japan, South Korea and Turkey are imported and European cars exported.

All of the terminals are connected to suitable railway infrastructure which is used frequently since approximately 70% of the goods in and out of the terminals are transported by train. The port serves Slovenia, Austria, Czech Republic, Southeastern Germany, Slovakia, Hungary, Serbia, Croatia and Romania with railway containerized goods. (Port of Koper, 2010a)

7.1.3 AREA 3 – RIJEKA, BAKAR, OMIJALJ
Area 3 consists of the three Croatian ports of Rijeka, Bakar and Omisalj, Figure 23 shows their geographic position

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RIJEKA, BAKAR, OMIJALJ – CROATIA
The free zone⁹ of the port of Rijeka includes the three port areas of Rijeka, Bakar and Rasa, the oil/pipeline-terminal of Omisalj and a warehousing complex. The port area of Rijeka handles

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⁹ An area within a port where goods may be temporarily stored without paying duty
transshipment and warehousing of general goods which in most cases comes in containers. It also has specialized units for the transshipment of paper, timber, metallurgical products, dangerous cargo, heavy cargo, frozen and conditioned food, and units for the final processing of cargoes. A bulk cargo terminal is placed in the port area of Bakar where incoming goods is mainly made up by dry bulk with coal as the largest part. Outgoing goods consists of coal but also refined oil products. The port area of Rasa includes a terminal for general cargo and a terminal for livestock (animals and cattle in farming). (Port of Rijeka, 2010a)

The port of Omisalj handles large amounts of crude oil and some oil products. It is sheltered from strong wind and wave impact and all sizes of tankers can enter the port. (JANAF, 2010a)

7.1.4 SUMMARY OF GOODS FLOWS IN PORTS
The amounts of goods in the different ports and areas put against each other in Figure 24. The figure shows that the port of Trieste has the largest amounts of goods followed by the port of Venice and the port of Koper. To keep in mind is that Trieste has a large share of crude oil, 76 %. For the areas the figure shows that area 2 handles the highest amounts of goods followed by area 1 and that the amounts in area 3 is the lowest. For all ports apply that the amounts of inwards goods are much higher than the amounts of outwards goods.

7.1.5 COLLABORATION BETWEEN NORTHERN ADRIATIC PORTS
The northern Adriatic ports have identified benefits of collaboration between the ports instead of full competition mainly due to the increasing goods volumes in recent years and indications on further growth in goods through Adriatic ports. An example of this is the recent forming of the North Adriatic Port Association (NAPA) between the ports of Venice, Ravenna, Trieste and Koper. Koper operating company Luka Koper said that NAPA aims at strengthen infrastructural facilities and make the ports
more competitive. The president of Trieste claims that this was a fundamental step and that it gives the opportunity to fully exploit the reference markets of each port. (Fairplay, 2010a)

Trupac & Kolenc (2002) has earlier pointed out benefits in a joint approach to the market of the ports of Trieste, Koper and Rijeka. By the fact that these three ports are all universal ports with specialized terminals a joint approach will strengthen their position on the market.

7.2 NORTH END POINT
For the north end point regions in Sweden will be described. The location and the boundaries for the different regions are explained in appendix 12.11.

The overall goods flows in Sweden can be seen in Figure 25. It is clear that a large amount of goods is going to/from Gothenburg through the harbor. The flow from Southern Sweden to Eastern middle Sweden is significant as well as the flow along the west coast.

1 mm = 4 million tonnes
Red = Increasing
Green = Decreasing

Figure 25 - Forecast of goods flow sizes in Sweden in 2020
(Estimation of freight in 2020, 2005)

7.2.1 LOGISTIC NODES IN SWEDEN
As seen in Figure 26 the largest node in Western Sweden is Gothenburg. Nodes in Eastern middle Sweden are Norrköping/Linköping and Örebro/Hallsberg. Jönköping is another node with rather large amount of goods passing through. In Southern Sweden there are three harbors: Helsingborg, Malmö and Trelleborg that will be considered as one region. The northern part of the country (middle and upper Norrland) will not be considered since it is much lower amounts of goods transported to those areas compared to the rest of the country. The five areas, greater-Gothenburg, Linköping/Norrköping, Jönköping, Örebro/Hallsberg and Malmö/Helsingborg/Trelleborg are the
candidates for being the concept’s north end point. Björn Boklund mentioned that using the north end point as a funnel can be a method to collect as much goods as possible when the amount of goods is too low in a particular location to create profitability.

The main part of the following information about the nodes is from the Swedish logistic journal, Intelligent Logistik (Intelligent logistik, 2010a). The nodes described are all placed in top 10 when the journal ranked logistic nodes. The criteria for the ranking can be seen in appendix 12.12. In sections with information found elsewhere the source is noted.

**GREATER-GOTHENBURG (WESTERN SWEDEN)**

Gothenburg has the biggest Nordic harbor with several direct ocean lines as well as the largest container harbor and extended feeder traffic. There are approximately 25 railway shuttles that reach entire Sweden and also south Eastern Norway. The region has strong economic growth as well as good transport infrastructure with several combined terminals. In the area cooperation exists between different transport departments and the city council as well as strong and extended regional cooperation. There are large goods flows to and from Gothenburg but a large share goes through the harbor which can be deceiving since such transports is not easily replaced with other means of transport (Jacob Wajsman).
Norrköping/Linköping (Eastern middle Sweden)
Norrköping/Linköping is well located near Sweden’s geographical centre, between Norrköping and Örebro. The region has a good transport infrastructure with extended container harbor with growing Baltic Sea transports and a railway shuttle to Western Germany, Scandinavian Shuttle. Several combined terminals are located in the area as well. A new regional cooperation, Logistikia, exists and there is also a cooperation concerning land areas around Norrköping/Linköping. There are a lot of paper pulp companies in the area that transport large amount of paper pulp to the whole Europe (Patrik Rydén). Björn Boklund describes the region as an area with neither great inflow nor outflow.

Örebro/Hallsberg (Eastern middle Sweden)
The region is closest to Sweden’s geographical centre of the regions. Örebro/Hallsberg has a large and growing population within the logistical coverage area. Good infrastructure with a large combined terminal in Hallsberg and also one of Sweden’s largest freight airports. There is a strong cooperation within the region, called Logistikregionen. Hallsberg is a big railway hub (Lars Sjöberg).

Jönköping (Småland and the islands)
The area has a good transport infrastructure within the logistic area of coverage. The region offer good service for companies and good access to land areas for establishment. There are three combined terminals located in the area. In the region there are several active logistic- and company networks.

Malmö/Helsingborg/Trelleborg (Southern Sweden)
The second largest container harbor in Sweden is located in Helsingborg. The region benefits from being geographically close to the continent. It is the largest area inhabitant-wise, including greater-Copenhagen, with approximately 3,5 million residents. The area has good transport infrastructure with a combined terminal in Helsingborg and a large vehicle transport terminal in Malmö. Here is also an active network for establishment. Björn Boklund thinks that this area can be used as a funnel to gather goods from Sweden that will be transported to places within the corridor as well as distribute goods coming from the corridor to different places in Sweden.

7.3 Goods flows between the end points
As mentioned in the introduction to this chapter it is important to present the goods not just to and from the different points, the goods flows between the regions must also be considered. Since the statistic is hard to come by for specific locations, such as Trieste and Koper, the goods flows will instead be to the regions where these are located. In Trieste’s case it means the region Northern Italy which means a geographically large region. As mentioned in the description for the Trieste harbor there are a good connections to west from Trieste so the goods in Northern Italy can be seen as a possible market. It has to be taken in consideration that it is not possible to see the whole amount as a possible market though. For Koper the region is the whole Slovenia. The country Slovenia is small though, which means that the whole region can be seen as a possible market as well.

What is interesting to see is if there is a large amount of goods transported between two end point candidates, for example Eastern middle Sweden and Slovenia. To find a relation like that would make those points suitable as end points. It is important that the flow is big in both ways, both import and export.
Table 5 - Size of area and population for Northern Italy and Slovenia

<table>
<thead>
<tr>
<th></th>
<th>Area (km²)</th>
<th>Population (2008)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Italy</td>
<td>119 921</td>
<td>27 390 496</td>
</tr>
<tr>
<td>Slovenia</td>
<td>20 273</td>
<td>2 028 630</td>
</tr>
</tbody>
</table>

### 7.3.1 GOODS FLOW BETWEEN SLOVENIA AND SWEDEN

The goods flow is low, only 15 000 tonnes import and export to the largest area, Eastern middle Sweden. Western Sweden imports over 10 000 tonnes but do not export any large amounts. Northern middle Sweden export some amount but the import is very low. The goods flows are presented in Figure 27.

![Estimated imported and exported goods Slovenia-Sweden in 2020 (tonnes)](image)

**Figure 27 - Estimated goods volumes between Slovenia and Sweden in 2020 (SIKA)**

### 7.3.2 GOODS FLOW BETWEEN NORTHERN ITALY AND SWEDEN

Sweden imports and exports very large amounts of goods to Northern Italy. Eastern middle Sweden is expected to import and export 300 000 tonnes 2020. Northern middle Sweden export more than 400 000 tonnes but the import is very low. Småland and the islands, Southern and Western Sweden import and export substantial amounts as well (between 100 000-200 000 tonnes). The goods flows are presented in Figure 28.
Paper and pulp and petroleum products are the two main products exported. Eastern middle and Northern middle Sweden is the largest exporters with Småland and the islands export some amounts of petroleum products as well. Earth, stone and building material and manufactured industrial products from Eastern middle Sweden, Småland and the islands and Western Sweden are the biggest importers. Eastern middle Sweden imports a large amount of foodstuffs as well. Complete statistics is presented in appendix 12.14.

7.4 STRATEGIC REGIONS IN THE CORRIDOR

According to Jan Olofsson the fewer nodes the better since every stop during the route increases the cost (handling and terminal costs) and the lead time. For the route between the Baltic and the Adriatic Sea the recommendation was to have as few points as possible. Wilfried Laboor argues that the demand of goods controls the number of loading points. The loading points should also be points with good connections to other areas with large good flows.

The regions located within the Scandria Corridor and between the end points are interesting to study. The goods flow to and from Eastern Germany, Austria and the Czech Republic will therefore be presented. Different types of goods will be discussed for each region, based on statistic presented in appendix 12.15. Since Sweden consists of many regions only the most interesting relations will be presented. Western Sweden, where Gothenburg is located, Southern Sweden with Malmö/Helsingborg/Trelleborg, Eastern middle Sweden with Örebro and Norrköping/Linköping will always be presented. The other regions will be included if the flows are large enough to affect the choice of points within the corridor. Western, Southern and Eastern middle Sweden will be referred at as the main regions.
Table 6 - Area and population for regions in middle Europe

<table>
<thead>
<tr>
<th>Regions and countries</th>
<th>Area (km²)</th>
<th>Population (December 2008)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bayern</td>
<td>70 552</td>
<td>10 749 506</td>
</tr>
<tr>
<td>Berlin/Brandenburg</td>
<td>30 373</td>
<td>5 954 168</td>
</tr>
<tr>
<td>Mecklenburg-Vorpommern</td>
<td>23 186</td>
<td>1 664 356</td>
</tr>
<tr>
<td>Austria</td>
<td>83 870</td>
<td>8 205 533</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>78 866</td>
<td>10 220 911</td>
</tr>
</tbody>
</table>

7.4.1 EASTERN GERMANY

Since Germany is Sweden’s by far largest trading partner, as is shown in appendix 12.16, it is of importance to see the relations between Germany and Sweden in a closer perspective. Our focus is the eastern part of Germany.

As seen in Figure 29 Bayern, Berlin/Brandenburg and Mecklenburg-Vorpommern are the three largest regions in Eastern Germany when it comes to goods volumes to and from Sweden. The other regions (Sachsen, Sachsen-Anhalt and Thüringen) are very small volume-wise and will not be considered. The geographic locations of the regions are presented in appendix 12.17. Sweden imports the largest amount of goods from Bayern and Brandenburg while Mecklenburg-Vorpommern, Bayern and Berlin are the largest export regions in Eastern Germany.

Figure 29 - Estimated goods flows between Sweden and Eastern German regions in 2020 (SIKA)

The types of goods mainly imported from Eastern Germany are manufactured industrial products, almost 400 000 tonnes and unprocessed lumber, more than 200 000 tonnes. Earth, stone and building material along with paper and pulp is the two main types of goods exported to Eastern Germany. The transport volumes of different goods types are presented in Figure 30.
Bayern are the largest region import-wise to Sweden. Far more goods are imported from Bayern than exported to the region which can be seen in Figure 29. Eastern middle Sweden, Western Sweden and Småland and the islands are the areas with the largest goods flows. The import from Bayern is big, 150 000 - 200 000 tonnes to Western and Eastern middle Sweden. The export is just around 50 000 tonnes to all the regions. The type of goods that is imported the most is manufactured industrial products and also some amounts of metal products to a lesser extent to Western Sweden. See appendix 12.15. To Bayern a lot of paper and pulp are exported as well as some earth stone and building material from Småland and the islands. Wilfried Laboor thinks that Munich is a suitable node for this thesis’ concept. Munich has many freight villages located around the city and large amount of goods are handled in the city. Goods flows between Bayern and Swedish regions are presented in Figure 31.
BERLIN/BRANDENBURG

Berlin/Brandenburg has the best connections with Eastern middle Sweden, Northern middle Sweden and Småland and the islands. The import is largest to Eastern middle of Sweden, 70 000 tonnes and Northern middle Sweden is the largest exporter with 100 000 tonnes exported. Southern and Western Sweden has small goods flows both import- and export-wise.

Sweden imports mainly unprocessed lumber to Northern middle Sweden, Middle Norrland and Småland and the island. To Eastern middle Sweden there is also some chemicals imported.

To the region Berlin/Brandenburg Sweden exports almost exclusively paper and pulp in large amounts. Northern- and Eastern middle Sweden along with Småland and the islands are the largest exporters. Although there are few exported product groups where the total amount is quite large since the amount of exported paper and pulp is very big. According to Wilfried Laboor the transport ministry of Berlin/Brandenburg are studying the possibilities for having a paper train from Sweden. That train would mainly focus on paper if there are enough volumes.

Around Berlin/Brandenburg there are a number of freight villages, Wilfried Laboor argues that Wustermark, a newly built freight village, would suit this concept. Wustermark has rail, truck and a port. There are good connections with Hamburg which handle big amounts of goods.

Goods flows between Berlin/Brandenburg and Swedish regions are presented in Figure 32.

![Estimated imported and exported goods Berlin/Brandenburg-Sweden in 2020 (tonnes)](image)

Figure 32 - Estimated goods flows between Swedish regions and Berlin/Brandenburg in 2020 (SIKA)

MECKLENBURG-VORPOMMERN

Mecklenburg-Vorpommern have a very unbalanced goods flow, they have almost as high export flow as Bayern but at the same time a very low import flow. More than 150 000 tonnes are exported from Småland and the islands, while Eastern middle and Southern Sweden exports 50 000 tonnes. The import is very small to all regions. Mecklenburg-Vorpommern exports small amounts of goods to Sweden. Of the goods that are exported, Western Sweden is the largest importer, manufactured industrial products and agricultural products are imported to that region.
As appendix 12.15 shows the northeastern German region is object for earth, stone and building material exported from especially Småland and the islands but Southern Sweden, Eastern middle Sweden and Western Sweden also exports substantial amounts. Earth, stone and building materials is by far the largest product group, there are also small amounts of paper and pulp exported from Eastern middle Sweden and Northern middle Sweden. From Småland and the islands a large share (127 000 tonnes) are exported from Gotland. Goods flows between Mecklenburg-Vorpommern and Swedish regions are presented in Figure 33.

![Estimated imported and exported goods](image)

**Figure 33 - Estimated goods flows between Swedish regions and Mecklenburg in 2020 (SIKA)**

7.4.2 **Czech Republic**
Czech Republic imports more goods than it exports but the trade balance is fairly even. All main regions as well as Northern middle Sweden exports substantial amounts of goods to Czech Republic. Eastern middle and Northern middle Sweden are the largest exporters with 80 000 tonnes exported. The other main regions export around 50 000 tonnes.

Few regions import noticeable amounts of goods from Czech Republic but Eastern middle and Western Sweden and Middle Norrland are the biggest importers. Paper and pulp and metal products are the most exported products. Eastern middle and Northern middle Sweden are the largest exporters of those products. Western Sweden export some amounts, 20 000 tonnes, of Chemicals and Småland and the islands and Southern Sweden export some earth stone and building material, also around 20 000 tonnes each.

Middle Norrland import over 50 000 tonnes chemicals while Western and Eastern middle Sweden along with Småland and the islands import manufactured industrial products. Goods flows between Czech Republic and Swedish regions are presented in Figure 34.
7.4.3 AUSTRIA

Sweden trade moderate amounts of goods with Austria. The statistic from Austria is divided into one eastern and one western part. Eastern Austria is a slightly larger trading partner than the western part but it is not a big difference.

EASTERN AUSTRIA

Eastern middle Sweden is the biggest importer with 80 000 tonnes. Småland and the islands and Western Sweden import half of that amount each. All main regions as well as Northern middle Sweden export substantial amounts, 40 000-80 000 tonnes, with Eastern middle and Northern middle Sweden as the biggest export regions. From Eastern Austria metal products and manufactured industrial products are the two main goods imported. Eastern middle, Småland and the islands and Western Sweden import similar amounts, 15 000 tonnes of both metal products and manufactured industrial products, an exception is Eastern middle Sweden that import twice as much metal products. Paper and pulp along with petroleum products are the largest exported types of goods, mostly from Eastern middle and Northern middle Sweden but also some paper and pulp from Småland and the islands. Goods flows between Eastern Austria and Swedish regions are presented in Figure 35.
Western Austria

There are more goods exported to than imported from Western Austria. Eastern middle Sweden has the largest goods flow to Western Austria with Western and Southern Sweden having smaller goods flows in comparison. Northern middle Sweden and Småland and the islands have substantial export flow but low import flow.

Western Austria export large amounts of foodstuffs mostly to Eastern middle Sweden but also minor amounts to Southern and Western Sweden. To Western Sweden there are some manufactured industrial products and earth, stone and building material transported as well. Similar with Eastern Austria, paper and pulp along with petroleum products are the largest types of goods exported. Eastern middle and Northern middle Sweden are the largest exporters of paper and pulp. Petroleum products are more evenly distributed with Eastern middle Sweden being the largest region, Småland and the islands, Northern middle Sweden and Southern Sweden export small amounts. Goods flows between Western Austria and Swedish regions are presented in Figure 36.

![Estimated imported and exported goods Western Austria-Sweden in 2020 (tonnes)](image)

*Figure 36 - Estimated goods flows between Swedish regions and Western Austria in 2020 (SIKA)*
ANALYSIS OF GOODS FLOWS AND LOGISTIC NODES

END POINTS
LOADING POINTS
CONCLUSION
8. ANALYSIS OF GOODS FLOWS AND LOGISTIC NODES

Goods amounts and types of goods in goods flows are the main aspects in choosing what nodes that are suitable for the concept. Goods flows are compared to the volumes of a railway shuttle with different frequency in departures to see where the demand for transport is high enough. The chapter is summarized by conclusions of the suitability of different nodes.

Björn Boklund and Jan Olofsson mentioned that one of the most important factors of a transport concept is to have enough goods flow in both directions to get profitability. Full wagons one way and empty wagons another way makes not enough money. This chapter will discuss the goods flows between chosen regions in the Scandria Corridor.

To put the goods flows, presented in the empirical chapter, in relation, estimated required amounts of goods for a railway shuttle will be used. In Table 7 the data is presented for having a shuttle leaving 5-days a week which is what Scandinavian shuttle operates today, 3-day and 1-day is also included to show the range of goods depending on how many departures/week. The figures are based on what amount of goods Scandinavian Shuttle transports, see appendix 12.18 for further explanation.

Table 7 - Goods volumes required for a railway shuttle

<table>
<thead>
<tr>
<th>Number of departures/week/direction</th>
<th>Goods/train (tonnes)</th>
<th>Total amount of goods/year (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1 000</td>
<td>240 000</td>
</tr>
<tr>
<td>3</td>
<td>1 000</td>
<td>144 000</td>
</tr>
<tr>
<td>1</td>
<td>1 000</td>
<td>48 000</td>
</tr>
</tbody>
</table>

The analysis will focus on how to get enough goods in both directions. The statistics presented, except for the harbors, is based on estimations of how the situation will be in 2020. The amount of goods handled through the Adriatic ports is expected to rise but it is very hard to estimate how much because it depends on which harbor the shipping companies decide to turn to. The strong possibility that there will be more goods through the harbors should be taken in consideration.

8.1 END POINTS

Both Björn Boklund and Jan Olofsson recommend having a funnel rather than having a specific region as end point. This has especially been discussed for Sweden but also for the south end point to avoid tying the transport concept to a specific harbor and rather be an Adriatic shuttle than for example a Trieste shuttle. This creates opportunities for gathering goods from many Adriatic harbors rather than just one.

To evaluate the option of having a funnel versus transport to a specific region, goods transported from the area around the Adriatic Sea to Sweden is presented regional-wise in relation to 5-day and 3-day shuttle.
The statistics from the harbor tell the general size of it. It is hard to tell where the goods are transported from or where they are going. Figure 37 shows that the Venice, Trieste and the Koper harbors are much bigger than Rijeka and that there are more goods inwards than outwards generally. A large part of the Trieste inward goods is crude oil though which may not be suitable for this transport concept since there are other transport modes such as pipelines that are more suitable. Without knowing the exact destination or origin of the goods handled in the harbors it can only be assumed that there are higher possibilities to get goods transported from the harbors rather than to them. It will be hard to have a shuttle based solely on one harbor. Trieste which is the biggest harbor would demand 5% of all goods transported outwards to come from Sweden which is very unlikely. Overall the harbor’s goods flows are very unbalanced especially the harbors in area 1 (Venice and Chioggia) and area 2 (Trieste, Monfalcone and Koper) where the import is much higher than the export.

![Goods handled in northern Adriatic ports 2008](image)

**Figure 37 - Goods handled in northern Adriatic ports 2008**

![Estimated imported and exported goods Northern Italy-Sweden in 2020 compared with shuttle (tonnes)](image)

**Figure 38 - Comparison of goods flow Northern Italy-Sweden in 2020 and railway shuttle**
As Figure 38 shows, Northern Italy is a big exporter and importer to Sweden and the shuttle would have to take 25% of the import and 16% of the export to have sufficient goods to serve a 5-day shuttle in both directions. The goods flow indicates that the shuttle cannot rely solely on goods traded between Sweden and Slovenia, that amount is far too low even if all goods traded between Sweden and Slovenia is taken in consideration. Northern Italy on the other hand has enough amounts to on its own support almost five 5-day shuttles for import and six for export. It should be taken in consideration that Northern Italy is six times as large as Slovenia though. Still, Northern Italy has much higher density of traded goods.

![Estimated imported and exported goods Northern Italy-Sweden in 2020 compared with shuttle, regional split (tonnes)](image)

Figure 39 - Comparison of goods flow Northern Italy-Swedish regions in 2020 and railway shuttle

The statistic broken down to a regional level, Figure 39, show that only two regions, Northern and Eastern middle Sweden has enough export-goods to supply a 5-day shuttle and only Western and Eastern middle Sweden has enough import. This means that the only region that has enough amounts of goods for a 5-day shuttle both ways is Eastern middle Sweden and that is barely. A 3-day shuttle going both directions can be managed by Western Sweden, Småland and the islands and almost Southern Sweden, along with Eastern middle Sweden. This point towards having a funnel in Sweden to get more goods rather than using a specific region.

The total goods flow from Italy is enough to provide a 5-day shuttle both ways but it is unlikely to take all goods transported between Northern Italy and Sweden since Northern Italy is a large region and this concept cannot focus on the whole area. Sweden exports a lot more goods than it imports, the Adriatic harbors should be used to raise the amount of goods imported since most of the harbors have more inwards goods than outwards, especially area 1 (Venice and Chioggia) and area 2 (Trieste, Monfalcone and Koper) which also are the harbors with most goods handled.
8.2 Loading Points

Both Jan Olofsson and Wilfried Laboor says that the lesser loading points the better but it might be required to have a number of loading points for this concept to give the shuttle enough fill rate. Figure 40 show that Bayern, Berlin/Brandenburg and almost Eastern Austria have enough amounts of goods both directions to serve a 5-day shuttle. All regions except Mecklenburg-Vorpommern can fill a 3-day shuttle though which means that most of the regions would be worth to discuss whether they should be a loading point or not.

Figure 40 - Comparison of goods flows corridor regions-Sweden in 2020 and railway shuttle

Berlin/Brandenburg import almost exclusively paper and pulp from Sweden and the fact that there are thoughts of creating a paper train to Sweden is a sign there are goods connections to Sweden and also that paper and pulp is suitable for transporting on train.

Bayern is the region with the strongest relations to Sweden considering the amount tonnes traded. There are more goods imported than exported which would fit in combination with Northern Italy. Manufactured industrial goods are the type of goods most imported from Bayern and it is suitable to transport on trains mainly because of its heavy weight.

Mecklenburg-Vorpommern is the region that does not have enough goods to support a 3-day shuttle even if all goods for the whole region was exported and imported. The import from Sweden is among the highest of all the discussed regions but the export to Sweden is far too low. Given that it is a much smaller region than Bayern for example but if the choice is between Mecklenburg-Vorpommern and Berlin/Brandenburg not much speaks in favor of Mecklenburg-Vorpommern. Those two regions are of similar size and located close to each other but since the import flow between the end points is low to start with it is better to choose Berlin/Brandenburg, no other circumstances than goods flow taken in consideration.
Between Eastern and Western Austria there are not much of a difference in goods amounts but Eastern Austria is slightly larger in both import and export. Both import mostly paper and pulp and petroleum products but Eastern Austria exports more foodstuffs while Western Austria exports metal products. Foodstuffs can be more difficult to transport due to their limited sustainability which can make Western Austria slightly more suitable as a loading point.

Czech Republic is similar to Western and Eastern Austria respectively in goods amounts but Czech Republic is more than twice as large as Eastern and Western Austria respectively. There are therefore more than twice as much goods per area unit even if the goods flows are similar. That favors using Austria as a loading point rather than Czech Republic.

8.3 CONCLUSION

The primary goods flow for the transport concept will be those through the Adriatic ports and the goods flow between the end points. The flow between Northern Italy and Sweden is large and Sweden export more than import which would be a good combination with the large Adriatic ports which have much larger goods handled inwards than outwards.

As loading points, Bayern, Berlin/Brandenburg and Western Austria seems to be the most suitable regions considered their amounts of goods and also their types of goods which are suitable for intermodal transport concepts.

For Sweden it is recommended to have a funnel that can gather goods and then ship it downwards to Europe. There are generally not enough amounts of goods to have a specific region at least for the primary goods flow between Sweden and Northern Italy. If a specific region would be chosen then Eastern middle Sweden has the largest amount of goods and would be the most suitable. There are a couple of good connections between certain regions and loading points, such as Berlin/Brandenburg-Eastern and Northern middle Sweden, Western and Eastern Austria-Eastern middle Sweden but generally the goods are divided quite even over the different regions.
CONCEPT GENERATION

CONCEPT SETUP

CONCEPT 1

CONCEPT 2

CONCEPT 3

EVALUATION OF CONCEPTS
9. CONCEPT GENERATION

The information given in the mapping and the discussions of the analysis will be used to form the sketch of a concept. How the concept should be formed is complex due to all circumstances in the Scandria Corridor. An initial discussion will handle general questions such as the selection of transport modes, use of nodes and possible routes. Three alternative concepts will then be presented where strengths and weaknesses will be brought up. The last part is an evaluation of the concepts including a conclusion of what concept that is the most suitable in the current situation.

9.1 CONCEPT SETUP

As the analysis pointed out truck transport is not a sustainable option which leaves railway transport as the best solution for transportation on land. The concept will therefore be formed as a train line between two points and include points along the route where loading will be possible. As the concept is formed between two terminals it will not handle the transports from origin or to destination but it is important to have an intermodal design to enable use of other transport methods. For the concept to be competitive to other solutions, mainly truck transportation, in the startup phase the flexibility in departure needs to be increased. As mentioned in the analysis the number of departures will be low in the startup why customers sometimes have to wait a couple of days before their goods can be transported. A way to increase this flexibility is to use green trucks as a back-up if a train gets full. In this way all customers can be promised that their goods will be transported at the specified departure time. Trucks can also be used as back-up when circumstances, e.g. weather conditions, cause frequent stops on the railways. In this way the delivery dependability can be kept at a high level. A well-reasoned time-table is one of the most important matters when it comes to customer service. The departures should be at times that are attractive to potential customers to get the highest possible fill rate. Times in the time-table should still be realistic so the delivery dependability is high. Night time should be used in a large extent and especially for areas with heavy-loaded railway tracks to achieve short lead times. The time-table should also be official for customers to have a high level of information. To also have a high level of information during the transport a tracking system is the best solution. GPS trackers on each trailer give specific information of the location of all goods.

Since the concept is not formed as a result of a specific demand for one type of goods or one company the end nodes do not have to be in one specific point with high demand. The end nodes do not even have to be fixed as they can be changed if other places tend to be better alternatives. As mentioned earlier a good solution is to have the end nodes working as funnels for bigger areas. This solution is probably the best to start with for a concept of this kind where almost all kinds of goods are accepted and the transport concept should supply a large area.

For the northern part of the corridor, Scandinavia, a place in Southern Sweden would be suitable. In this way railway transports to and from the end node can be arranged along the two main lines railway routes in Sweden; one through Gothenburg which also could transport goods from Oslo and Norway and the other through Stockholm which also could transport goods from the northern parts.
of Sweden. A point in Southern Sweden furthermore needs to be crossed for most goods that are transported to and from Europe on trucks. Suitable locations for this end node are either Trelleborg or Malmö. Trelleborg is the best option when a ferry from Germany is used as it enters the port of Trelleborg. If the route instead should be drawn through Denmark then Malmö would be a better option as the Öresund Bridge enables railway transport all the way to Sweden.

In the southern part of the corridor, the Adriatic, a place with both high demands and good connections should be chosen. A location of the end node in or close to a port would be a good solution given that large amount of goods to other parts of the corridor, mainly Scandinavia, is transported through the port. One port with good connections, large volumes and short distances to adjacent ports is Trieste why it would make a good choice of south end point if the amount of goods named above is large enough. The amounts are probably not that high in these days, but there are indications that they will be higher in the future, why another location could make up for a better solution, with the same arguments as for the Scandinavian part to use it as a funnel for a bigger area.

Another matter if the end node is located in a port is that the competition between ports could make other ports refuse to transport their goods to the port where the end node is located. If the case would turn out like this is hard to tell but hopefully closer cooperation between ports would neutralize this kind of competition. Where the best location for a funnel for these parts is located depends on what area that makes up for the largest share of the goods transported on the concept. Verona (Italy) is one option for a funnel as it has a strategic location for goods from Italy. Another option is Villach (Austria) which is located almost on the way down north for the northern Adriatic ports.

The use of loading points should be kept as low as possible which calls for sufficient amounts of goods between the end points. If the indications are correct and the northern ports of the Adriatic Sea will be used in a larger extent in the future a direct railway shuttle between the north and the south of the Scandria Corridor could be possible in some years ahead. In the current situation the number of loading points is decided by the demand for transports between points in the corridor. As too many loading points affects aspects like cost, lead time and delivery reliability negatively the number should be around 1-3 loading points. Where the loading points should be located do not have to be fixed, as with the end nodes, as they can be changed if other points show higher demands or includes better solutions for the concept. Points in the corridor that however shows good connections and has sufficient goods flows and by that seems suitable as loading points are Berlin (Berlin/Brandenburg), Munich (Bayern) and Vienna (Eastern Austria).

When it comes to what route the concept should have between the end nodes the different railway electrification systems makes up for the biggest barrier. As discussed earlier the train needs to be compatible with three different electrification systems to enable all routes in the corridor. In order for the concept to be feasible, mainly due to large specific investment costs, a limitation to draw the route through only two electrification systems will be necessary, with a notation that the use of only one system would be the best solution.

For the passage from Germany to Sweden the ferry between Rostock and Trelleborg seems like the best solution. Having the route through Denmark interferes with already crowded routes and is a detour for transports in the Scandria Corridor. Rostock seems like a better option than Sassnitz because of the port development and availability to the ports despite of the two hours longer trip. If
the planned Fehmarnbelt fixed link will be a better option is leaved for the future to tell as it will not be an option for many years.

9.2 CONCEPT 1

This concept poses a safe alternative with funnels in both ends. The south end point is located in the middle of Northern Italy and will act as a general funnel for Northern Italy and further south. After a while it might be a good idea to move the south end point closer to the Adriatic ports to make this concept more specific on demands between the end points.

Table 8 - Description of concept 1

<table>
<thead>
<tr>
<th>Concept 1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>End point</td>
<td>Trelleborg (Sweden)</td>
</tr>
<tr>
<td>Loading point</td>
<td>Wustermark (Germany)</td>
</tr>
<tr>
<td>Loading point</td>
<td>Munich (Germany)</td>
</tr>
<tr>
<td>End point</td>
<td>Verona (Italy)</td>
</tr>
<tr>
<td>Countries passed</td>
<td>4</td>
</tr>
<tr>
<td>Distance</td>
<td>1 491 kilometers</td>
</tr>
<tr>
<td>Equivalent route with truck</td>
<td>1 547 kilometers</td>
</tr>
<tr>
<td>Number of ATC systems</td>
<td>3</td>
</tr>
<tr>
<td>Number of electrical systems</td>
<td>2</td>
</tr>
</tbody>
</table>

In Figure 42 a comparison between concept 1 and truck transport along the decided route concerning environmental effects is presented. The data is based with a load of 1000 tonnes.

Figure 42 - Carbon dioxide emission and energy consumption of transport modes in concept 1
9.3 Concept 2

While the south end point for concept 1 is located in the middle of Northern Italy, concept 2’s south end point is located closer to the Adriatic ports to focus on gathering goods from them. It can still act as a funnel for parts of Northern Italy but now also for some parts of Austria. This concept will therefore be well-suited for the expected rise of goods through the Adriatic ports. What makes this concept viable is that the electrical - and ATC systems passed are very few.

Table 9 - Description of concept 2

<table>
<thead>
<tr>
<th></th>
<th>Concept 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>End point</td>
<td>Trelleborg (Sweden)</td>
</tr>
<tr>
<td>Loading point</td>
<td>Wustermark (Germany)</td>
</tr>
<tr>
<td>Loading point</td>
<td>Munich (Germany)</td>
</tr>
<tr>
<td>End point</td>
<td>Villach (Austria)</td>
</tr>
<tr>
<td>Countries passed</td>
<td>3</td>
</tr>
<tr>
<td>Distance</td>
<td>1 394 kilometers</td>
</tr>
<tr>
<td>Equivalent route with truck</td>
<td>1 462 kilometers</td>
</tr>
<tr>
<td>Number of ATC systems</td>
<td>2</td>
</tr>
<tr>
<td>Number of electrical systems</td>
<td>1</td>
</tr>
</tbody>
</table>

In Figure 44 a comparison between concept 2 and truck transport along the decided route concerning environmental effects is presented. The data is based with a load of 1000 tonnes.

Figure 44 - Carbon dioxide emission and energy consumption of transport modes in concept 2 (Ecotransit, http://www.ecotransit.org/, 2010-05-13)
9.4 **Concept 3**

The last concept is also the boldest, the south end point is located in an Adriatic port (Koper) which is located between two other big Adriatic ports, Rijeka and Trieste. The meaning is to really focus on gathering as much goods as possible from all the northern Adriatic ports. This puts the concept’s scope further into the future than the other concepts. The number of ATC – and electrical systems that the train has to handle is too many today and therefore the alternatives are either waiting for Slovenia, Czech Republic (in particular), Austria and Germany to get similar systems or use diesel trains. Diesel trains will make this concept much less environmentally friendly though. This concept is perhaps the one with most potential and the most innovative concept since it really uses the infrastructure capacity of Eastern Europe.

**Table 10 - Description of concept 3**

<table>
<thead>
<tr>
<th>Concept 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>End point</strong></td>
</tr>
<tr>
<td>Trelleborg (Sweden)</td>
</tr>
<tr>
<td><strong>Loading point</strong></td>
</tr>
<tr>
<td>Wustermark (Germany)</td>
</tr>
<tr>
<td><strong>Loading point</strong></td>
</tr>
<tr>
<td>Prague (Czech Republic)</td>
</tr>
<tr>
<td><strong>Loading point</strong></td>
</tr>
<tr>
<td>Vienna (Austria)</td>
</tr>
<tr>
<td><strong>End point</strong></td>
</tr>
<tr>
<td>Koper (Slovenia)</td>
</tr>
<tr>
<td><strong>Countries passed</strong></td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td><strong>Distance</strong></td>
</tr>
<tr>
<td>1 780 kilometers</td>
</tr>
<tr>
<td><strong>Equivalent route with truck</strong></td>
</tr>
<tr>
<td>1 683 kilometers</td>
</tr>
<tr>
<td><strong>Number of ATC systems</strong></td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td><strong>Number of electrical systems</strong></td>
</tr>
<tr>
<td>3</td>
</tr>
</tbody>
</table>

In Figure 46 a comparison between concept 2 and truck transport along the decided route concerning environmental effects is presented. The data is based with a load of 1000 tonnes.

**Figure 45 - Concept 3, route: Trelleborg-Koper (Google Earth)**

In Figure 46 a comparison between concept 2 and truck transport along the decided route concerning environmental effects is presented. The data is based with a load of 1000 tonnes.

**Figure 46 - Carbon dioxide emission and energy consumption of transport modes in concept 3 (Ecotransit, http://www.ecotransit.org/, 2010-05-13)**
9.5 Evaluation of concepts

When the concepts are compared some aspects promotes one concept while other aspects promotes another. For that reason no concept can be said to be the best. A comparison between the concepts in different aspects is presented below which will fall into a proposal of which concept that is most suited for the current situation and which concept that is most suited if some circumstances changes.

<table>
<thead>
<tr>
<th>Table 11 - Summary of concept setups</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Concept 1</strong></td>
</tr>
<tr>
<td><strong>End point</strong></td>
</tr>
<tr>
<td><strong>Loading point</strong></td>
</tr>
<tr>
<td><strong>Loading point</strong></td>
</tr>
<tr>
<td><strong>Loading point</strong></td>
</tr>
<tr>
<td><strong>End point</strong></td>
</tr>
<tr>
<td><strong>Countries passed</strong></td>
</tr>
<tr>
<td><strong>ATC systems</strong></td>
</tr>
<tr>
<td><strong>Electrical systems</strong></td>
</tr>
</tbody>
</table>

If the infrastructure along the three routes are compared the first concept uses one of the TEN-T priority projects, the railway axis Palermo-Berlin, which calls for few problem on the railway tracks. A risk is thou that by being a “main route” it can get crowded and times on the tracks are hard to get. By crossing two different railway electrification systems and three train control systems it makes up for a barrier but it is still feasible. The second project uses the same railway axis from Munich to Berlin but from Villach to Munich the railway is probably not as prioritized. Nevertheless is Austria a country with a highly developed railway network. The biggest advantage of concept 2 is that it only needs to be compatible with one railway electrical system and two train control systems. The third concept passes more countries and goes through Eastern Europe which calls for a larger infrastructural barrier. The infrastructure along this route will be improved but with the current low standard it will probably take several years. The fact that it crosses three railway electrification systems and five train control systems is probably a too large barrier for the concept to be feasible.

Since all concepts have similar setups the difference in innovativeness depends on how new of a route a concept has. All concepts use the same route between Sweden and Berlin which is not that new but it is not used in a large extent. The route way down south differs for the concepts and is not particularly innovative for concept 1 as it is already tested and used for substantial volumes. Concept 2 has a bit more innovative route while concept 3 has a route that is less tested and therefore more innovative.

The during way and terminal costs are similar for the concepts but what is worth discussing is how it compares to truck. The distance from Rostock to the south end point is around 1 300 kilometers. The distance where train becomes profitable is said to be around 500 kilometers which mean that the presented concepts would be fine concerning the during way and terminal costs.

The vehicle investments will be highest for concept 3 because of the many ATC - and electrical systems but to have as many as five and three systems is not possible, it would be too expensive. Therefore it should be considered that concept 3 is a concept for the future when the systems are
Concept generation

more similar. One of concept 2’s strengths is the homogeneity of ATC- and electrical systems this lead to cheaper trains and cheaper education of the drivers.

The goods transported can be divided into goods coming from the regions around the nodes and goods handled through the harbors. The amounts of goods through the harbors are more insecure but have great potential since there are such large amounts involved. The expected increase is also hard to estimate but again, the potential is very large since there are such large amounts of goods involved. This make concept 3 being more insecure than the other concepts since it depends on the goods handled through the ports. The south end point of concept 1 may be located more favorable (centre of Northern Italy which has a large flow of goods to Sweden) at first sight but a large part of the goods traded may prove difficult to transfer to this concept. The competition from other shuttles is a threat as well as geographical reasons, goods from northwestern Italy might rather go through Western Germany. Concept 2 is therefore perhaps the most balanced concept with less competitors and a good chance of getting goods both from the Adriatic ports as well as from Austria which have strong goods flows to and from Sweden.

As long as the train is electrical and not driven by diesel all concepts are very environmentally friendly. The concepts show similar results, that a truck concept would use three times as much energy and emit three times as much greenhouse-gas. It is hard to estimate how much the green trucks would affect the result but since the trucks will be used as a compliment they will transport much lesser amount of goods than the train and their environmental effects will be small.

Table 12 - Implementation factors of the suggested concepts

<table>
<thead>
<tr>
<th></th>
<th>Concept 1</th>
<th>Concept 2</th>
<th>Concept 3</th>
</tr>
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<tbody>
<tr>
<td>Feasibility</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Future considerate</td>
<td>Short</td>
<td>Average</td>
<td>Long</td>
</tr>
<tr>
<td>Environmental effects</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Innovativeness</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Barriers</td>
<td>Some</td>
<td>Few</td>
<td>Many</td>
</tr>
</tbody>
</table>

As a conclusion the concepts could be arranged in order of implementation. Concept 1 probably has the best chance of getting a high fill rate since the goods flows in the route are large and it is by that the concept that fits the best in the current situation. But the questions if there are room for another transport concept along this route still stands. If concept 2 is ready for implementation depends on the demand of transport on this route. The amounts of goods through the northern Adriatic ports plays a big part as Villach is supposed to work as a funnel for goods through these. When the goods flows are large enough to get a proper fill rate on this concept it would probably be a better option than concept 1 because of the few electrification systems and train control systems crossed. For both concept 1 and concept 2 the future plan is to move the south end points closer to the Adriatic ports if the goods flows through them calls for it. Concept 3 is more of a concept for the future. By using this route bottlenecks and congestion can be avoided. If the number of electrification systems is lowered, ERTMS is implemented and railway infrastructure is improved this concept would be the best solution as it uses the available capacity of the Scandria Corridor and presents a route that is not used in a large extent.
CONCLUSION

IMPLEMENTATION

SENSITIVITY ANALYSIS

FUTURE RESEARCH
10. CONCLUSION

This chapter will sum up the thesis by expressing how the purpose is fulfilled and how the concept responds to the information in the background. When the concept can be implemented and what is needed before implementation is also handled. A sensitivity analysis handles insecurities in information and choices that can affect the outcome of the thesis. At last some recommendations are given concerning future research.

According to the purpose the suggested concept should be sustainable, innovative and applicable in the Scandria Corridor. Table 12 shows how the evaluated concepts match up to these factors, with applicable expressed as number of barriers and sustainable divided into feasibility, future considerate and environmental effects. As the table shows no concept performs at the highest level in all factors which makes no concept being the best in all situations. When reviewing each concept separately the third concept is future considerate, innovative and has low environmental effects. But the many barriers and low feasibility prevents it from being implemented in the current situation and by that it is not fulfilling the purpose completely. For the second concept the number of barriers is the lowest and it is partly innovative and future considerate. If the goods flows in this route are high enough it should have achieve a high feasible which should make it fulfill the purpose. The first concept has a high feasibility, some barriers and low environmental effects but it is not as future considerate or innovative as the other concepts. It still reaches acceptable levels in these to make the concept fulfill the purpose.

All of the concepts are responding to the information in the background as they all have a route stretching between the south and the north part of the corridor and uses trains as means of transportation. The locations of the south end points make them able to respond to the indication of higher amounts of goods through the harbors in the Mediterranean Sea. The route alternatives uses free capacity of the Scandria Corridor in different extent but since there are large barriers to mainly railway transportation in the east parts of Europe all capacity of the Scandria Corridor is hard to use in the current situation. The concept also meets the directives of EU to promote sustainable transport solutions that reduce the use of trucks in Europe.

The indications brought up in the background are making some Swedish companies review their transports. As an example a company in the wood-processing industry has realized that SECA-regulations will increase the costs of their current sea transports why they are looking at railway alternatives. Another example is a company transporting goods to and from Czech Republic by trucks that will get higher transport costs because of higher road pricing costs and higher ferry prices due to SECA-regulations why they also are looking at railway solutions.

10.1 IMPLEMENTATION

Before the implementation of one of the concepts the goods flows within the route needs to be further studied. The most important matter is to assure that companies in need of transportation in the Scandria Corridor will consider using the concept. Since it is hard to get a proper fill rate on a new concept some companies should be linked to the concept before implementation to make sure that a base of goods is transported.
Another issue that needs to be investigated is when there are free times on the railway tracks in the route. Free times together with what speed that can be held on certain tracks are prerequisites to the forming of the time-table. Another matter is how much time that should be reserved for the stopping on the loading points. The time should be short enough to keep a competitive lead time but long enough to make sure that there will be no delays since the delivery dependability in most cases are valued higher than the lead time.

Since investing in vehicles and equipment is required before a concept becomes reality a company has to be responsible for the operation of the concept. For part of the funding an application should be sent to the Marco Polo programme. Drivers and other staff need to be employed and educated in all railway systems crossed which also is a kind of investment.

When the concept should be implemented depends on if the goal is to establish a sustainable transport concept were goods currently are being transported on trucks or if the goal is to establish a sustainable transport concept using the free capacity of the Scandria Corridor to transport the expected higher amounts of goods in the future. For the first goal concept 1 or concept 2 could be implemented as soon as the prerequisites have been straightened out and goods flows are large enough. For the other goal concept 3 is best suited but the implementation cannot take place until the goods flows on the route is higher and some of the barriers have been removed.

Our strong belief is that truck transports will not be easily replaced but in 5-10 years, train is likely to be used in a much larger extent than today. Train shuttles that exist today have proved that it is possible to be successful. The keyword to success is cooperation between countries to get one unified electrical system and one ATC system in Europe and between transport companies to achieve competitiveness.

In the end customers just wants the goods to be transported from one point to another and care less of what kind of transport that is used. If road, rail and waterway transport companies could cooperate and create a transport concept together the potential for transportation would be very high. All transport modes have strengths and weaknesses and by using all modes they could complement each other and use the infrastructure more effective than it is used today. This is far away from the situation today though, but recently (early 2010) several big train companies across Europe started the cooperative venture Xrail. This indicates that the development is heading in the right direction.

10.2 Sensitivity analysis

Since the thesis covers a wide area all areas could not be studied as deep as we wanted. This implies a risk since the mapping may not take all important factors in consideration as close as it should. The mapping of the goods flows leaves out the connections between the loading points and possible south end points. This could affect the choice of loading points and south end point why it should be taken in consideration before implementation.

The statistics on goods flows estimated for 2020 is a prognosis and not definite numbers and could prove to be incorrect. Still, the prognosis is based on the situation today and the result would not be that far away to affect the result of this thesis, given that nothing exceptional happens that would change the situation completely.
CONCLUSION

An important indication for this thesis is that the goods flows through the Adriatic ports will increase but even if the goods would not go through the Adriatic ports this thesis should still be of use to transport actors across Europe. If the expected increase will take place somewhere else, for example through the port of Marseille, the concept’s south end point can be moved and the loading points can be adjusted to fit that route. Other aspects are the environmental effects and the need for transportation of goods in other routes and modes than through Western Europe with truck. This thesis also points out the difficulties with transporting across borders with train and especially through Eastern Europe why this information is useful for European transport companies.

The use of a normative approach in such a wide area as this thesis covers makes it hard to propose specific measures. The measures are instead described as how to form the transport concept regarding different factors. Some factors are discussed in an overall level and do not run into precise descriptions of measures.

10.3 FUTURE RESEARCH

Some of the areas presented in this thesis could be studied even deeper to increase the quality of the presented information. Customer values is a chapter that could be studied more thorough to really see which service elements that is more important to the customer and adjust the concept in line with that.

The mapping chapter of the goods flow in the thesis is extensive but there is a need for further research. The goods flows between the loading points and the south end point needs to be studied and also the goods flows to and from the ports.

A delimitation of the thesis is that the indications given in the background will not be challenged. But for further research the effects of the widening the Suez Canal, tougher regulations in SECA and the pressure from EU to use alternative transport modes should be studied. How much the goods flows will increase and what routes will be used is also essential to research.
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BOOKS

ARTICLES

BROCHURES, REPORTS AND OTHER MATERIAL

INTERNET

PERSONAL CONTACTS

PICTURE REFERENCES
11. REFERENCES

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(Figure 18) Freight ferry operations Baltic Sea, Scandlines (2010-05-06)
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(Figure 41, 43 and 45) Route of concept 1, 2 and 3, created in the program Google Earth
(Figure 42, 44 and 46) Emissions and energy consumptions, calculated with help of EcoTransIT (2010-05-13) http://www.ecotransit.org/

(Table 5) Regional stats of Italy and Slovenia (2010-05-07)

(Table 6) Regional stats of Austria, Czech Republic and Germany (2010-05-06)
APPENDIX

MEMBERS OF THE SCANDRIA PROJECT

SCANDRIA PROJECT WORK PACKAGES

INTERVIEW QUESTIONS

TEN-T PROJECTS

EUROPEAN RAILWAY NETWORK

ERTMS IN EUROPE

XRAIL PARTNERS

MAP OF EUROPEAN ROAD PRICING SYSTEMS

DRIVING DISTANCES BETWEEN NORTHERN ADRIATIC PORTS

COMPLETE STATISTICS OF GOODS HANDLED IN PORTS

REGIONS IN SWEDEN

CRITERIA FOR THE RANKING OF THE LOGISTIC LOCATIONS IN SWEDEN

IMPORT AND EXPORT BETWEEN SWEDEN AND SLOVENIA

IMPORT AND EXPORT BETWEEN NORTHERN ITALY AND SWEDEN

GOODS FLOWS BETWEEN SWEDEN AND REGIONS IN THE CORRIDOR

SWEDEN’S IMPORT AND EXPORT 2009

REGIONS IN GERMANY

AMOUNT OF GOODS TRADE PER DEPARTURE OF SCANDINAVIAN SHUTTLE
12. APPENDIX

12.1 APPENDIX - MEMBERS OF THE SCANDRIA PROJECT

Table 13 - Members of the Scandria Project

<table>
<thead>
<tr>
<th>National / Regional public authorities and organizations</th>
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<tr>
<td>Swedish Road Administration</td>
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<tr>
<td>Berlin-Brandenburg</td>
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<td>Mecklenburg-Vorpommern</td>
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<td>German Association</td>
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<table>
<thead>
<tr>
<th>Business / R&amp;D institutions</th>
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<td>Royal Institute of Technology Stockholm</td>
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<td>Halmstad port</td>
<td></td>
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<tr>
<td>Rostock port</td>
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<td>Öresund Logistics / Öresund University</td>
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<td>University of Applied Sciences Wildau</td>
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<td>Jyväskylä Regional Development Company</td>
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<td>City of Neuruppin</td>
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</table>
12.2 **Appendix - Scandria Project Work Packages**

**Figure 47 - This project’s role in the Scandria Project**
(http://www.scandriaproject.eu, 2010-01-25)

**Figure 48 - Øresund Logistics part in the Scandria Project**
(http://www.scandriaproject.eu, 2010-01-25)
12.3 Appendix - Interview Questions

12.3.1 Questions to Björn Boklund (Business Development Manager, UBQ)

Scandinavian Shuttle
Where are any problems/barriers in the startup of Scandinavian Shuttle?

How does Scandinavian Shuttle perform today?

What types of goods are most suitable for Scandinavian Shuttle or general train transport?

What makes Scandinavian Shuttle a better option than the alternatives?

Does Scandinavian Shuttle have a high goods flow in both directions?

What types of goods are imported/exported to/from Sweden?

How important is the flow of returning goods on train transports?

What are the most important aspects when it comes to achieving profitability in a railway transport concept?

How can a competitive lead time and customer service be achieved in train transport?

Train Shuttle from Turkey
Where are the biggest barriers to railway transport through Europe located?

Are there any countries with specific large barriers? Should these countries be avoided?

Our Concept
What do you think of Trisete as the south end point?

What do you think of Norrköping as the north end point?

What points in the Scandria Corridor do you find suitable as loading points?

What are the options when transporting from Germany to Sweden?

Other
What kinds of tracking systems are available and how do they perform?
12.3.2 Questions to DHL – Jan Olofsson (Marketing Manager, DHL Rail)

What are the most important aspects when it comes to achieving profitability in a railway transport concept?

How can a competitive lead time and customer service be achieved in train transport?

What aspects, e.g. lead time, price, flexibility, environmental affects etc., do customers value high?

Is DHL using any tracking system?

Train shuttle Verona-TRAVEMÜNDE

Are there any barriers/problems with the shuttle?

What types of goods are transported, in both directions?

Are there any loading points between the two end points?

How long is the lead time?

How long does it take for a truck to transport between the end points?

Our Concept

What do you think of Trisete as the south end point?

What do you think of Norrköping as the north end point?

What points in the Scandria Corridor do you find suitable as loading points?

How many loading points do you find appropriate for this set-up?

Do you know of any freight traffic bottlenecks in or close to the Scandria Corridor?

Where are the biggest barriers to railway transport through Europe located?
12.3.3 Questions to Mareike Donath (Advisor at the Ministry of Transport, Building and Regional Development in Mecklenburg-Vorpommern)

Where are the major goods flows located within the corridor and its surroundings?

What areas have a high/low railway-capacity?

How much of this capacity is filled today?

Are there any bottlenecks in the corridor?

Are there any difficulties in railway transport through certain countries/areas in the corridor?

Our project

What do you think about our thoughts so far?

Within the corridor, what kinds of goods, and in what volumes, are transported to and from your region, to and from what places?

What points do you find suitable as loading-points between Trieste and Sweden?

Do you see Rostock/Sassnitz as a feasible loading point?

The shortest way geographically to Scandinavia is through eastern Germany but a problem with this route is the low volumes compared to e.g. western Germany, do you think the goods volumes are large enough to transport through eastern Germany?

Another problem is how to travel between Germany and Sweden, what do you think about the solution of travelling by boat between Rostock/Sassnitz and Trelleborg?
12.3.4 Questions to Wilfried Laboor (Ministry of Transport and Agriculture in Berlin/Brandenburg)

Tell us about your part in the Scandria Project.
What was the initiative to the project?

What kinds of goods are mainly imported through the ports in the northern Adriatic Sea?
Where are the major goods flows located in the corridor and its surroundings?
How will future European freight traffic look like in the corridor?

What areas have a high/low railway-capacity?
How much of this capacity is filled today?
Are there any bottlenecks in the corridor?
Are there any difficulties in railway transports through certain countries/areas in the corridor?

Our Project
What do you think about our thoughts so far?
Do you find it feasible?
   - If not, what would be required in order to make it feasible?

What do you think about Trieste as a south end point for our concept?
Are there large goods flows to certain points within the corridor, from the Adriatic ports?
Within the corridor, what kinds of goods, and in what volumes, are transported to and from Berlin, to and from what places?
How many loading-points do you find appropriate?
What points do you find suitable as loading-points between Trieste and Sweden?
Do you see Berlin as a feasible loading point?

The shortest way geographically to Scandinavia is through eastern Germany but a problem with this route is the low volumes compared to e.g. western Germany, do you think the goods volumes are large enough to transport through eastern Germany?

Another problem is how to travel between Germany and Sweden, what do you think about the solution of travelling with boat between Rostock and Trelleborg?

What kind of transport set-up do you find appropriate for this route?

We heard that you’ve been trying to establish “Paper Trains” between Berlin and Sweden, what can you tell us about that?
12.4 APPENDIX - TEN-T PROJECTS
In this appendix the TEN-T projects concerning the Scandria Corridor are presented. The summaries are found on the TEN-T webpage. First a list of all the projects is showed where projects concerning the Scandria Corridor are marked. After the list budgets for each of the projects concerning the Scandria Corridor are presented in Table 14. At last the summaries are presented.

1. Railway axis Berlin-Verona/Milano-Bologna-Napoli-Messina-Palermo
3. High-speed railway axis of south-west Europe
4. High-speed railway axis east
5. Betuwe line: COMPLETED
6. Railway axis Lyon-Trieste-Divaca/Koper-Divaca-Ljubljana-Budapest-Ukranian border
7. Motorway axis Igoumenitsa/Patra-Athina-Sofia-Budapest
8. Multimodal axis Portugal/Spain-rest of Europe
10. Malpensa airport: COMPLETED 2001
11. The Øresund bridge: COMPLETED 2000
12. Nordic Triangle railway/road axis
13. Road axis United Kingdom/Ireland/Benelux
14. West coast main line
15. Galileo
16. Freight railway axis Sines/Algeciras-Madrid-Paris
17. Railway axis Paris-Strasbourg-Stuttgart-Wien-Bratislava
18. Waterway axis Rhine/Meuse-Main-Danube
19. High-speed rail interoperability in the Iberian Peninsula
20. Railway axis Fehmarn belt
21. Motorways of the Sea
23. Railway axis Gdansk-Warszawa-Brno/Bratislava-Wien
24. Railway axis Lyon/Genova-Basel-Duisburg-Rotterdam/Antwerpen
25. Motorway axis Gdansk-Brno/Bratislava-Vienna
26. Railway/road axis Ireland/United Kingdom/continental Europe
27. "Rail Baltica" axis: Warsaw-Kaunas-Riga-Tallinn-Helsinki
28. "Eurocaprail" on the Brussels-Luxembourg-Strasbourg railway axis
29. Railway axis of the Ionian/Adriatic intermodal corridor
30. Inland Waterway Seine-Scheldt
APPENDIX

Table 14 - Budget for the TEN-T priority projects concerning Scandria Corridor

<table>
<thead>
<tr>
<th>Project</th>
<th>Total project cost:</th>
<th>EU contribution:</th>
<th>Funding (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>€5,078,280,000</td>
<td>€964,050,000</td>
<td>19 %</td>
</tr>
<tr>
<td>6</td>
<td>€2,441,092,000</td>
<td>€767,640,000</td>
<td>31 %</td>
</tr>
<tr>
<td>10</td>
<td>Completed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Completed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>€2,328,260,000</td>
<td>€180,760,000</td>
<td>8 %</td>
</tr>
<tr>
<td>17</td>
<td>€4,757,513,838</td>
<td>€659,363,272</td>
<td>14 %</td>
</tr>
<tr>
<td>18</td>
<td>€417,300,000</td>
<td>€85,980,000</td>
<td>21 %</td>
</tr>
<tr>
<td>20</td>
<td>€1,325,959,874</td>
<td>€376,190,000</td>
<td>28 %</td>
</tr>
<tr>
<td>21</td>
<td>€102,929,000</td>
<td>€20,748,000</td>
<td>20 %</td>
</tr>
<tr>
<td>22</td>
<td>€13,000,000</td>
<td>€6,500,000</td>
<td>50 %</td>
</tr>
</tbody>
</table>

12.4.1 RAILWAY AXIS BERLIN-VERONA/MILANO-BOLOGNA-NAPOLI-MESSINA-PALERMO
The railway axis ‘Berlin-Verona/Milano-Bologna-Napoli-Messina-Palermo’ is a key north-south axis crossing the Alps along the Brenner Corridor. It touches upon three Member States: Germany, Austria and Italy, and will link up important urban areas in Germany and in Italy.

A significant increase in capacity will result and the project will bring about modal shift in the sensitive mountainous regions it is crossing.

Regular reporting on the progress of this project has been made available thanks to the annual activity reports of the European Coordinator, Mr. Karel Van Miert. (http://tentea.ec.europa.eu/en/ten-t_projects/30_priority_projects/priority_project_1/priority_project_1.htm, 2010-02-26)

![Figure 49- Railway axis Palermo-Berlin](http://tentea.ec.europa.eu/en/ten-t_projects/30_priority_projects/priority_project_1/priority_project_1.htm, 2010-01-27)

12.4.2 RAILWAY AXIS LYON-TRIESTE-LJUBLJANA-BUDAPEST-UkrAINIAN BORDER
The railway axis Lyon-Trieste-Divaca-Koper-Divaca-Ljubljana-Budapest-Ukrainian border is an important east-west link crossing the Alps between Lyon and Turin and between Italy and Slovenia. Four Member States are involved in the project: Hungary, Slovenia, Italy and France. It is a
fundamental link in the European transport network that will be able to absorb part of the continuing growth of traffic flows between the southeast, central and southwest regions of Europe.

An important increase in rail freight capacity will be achieved and will help to realize a modal shift in the sensitive mountainous regions.

Regular reporting on the progress of this project has been made through the annual activity reports of the European Coordinator, Mrs. Loyola de Palacio, and her successor, Mr Laurens Jan Brinkhorst. (http://tentea.ec.europa.eu/en/ten-t_projects/30_priority_projects/priority_project_6/priority_project_6.htm, 2010-02-26)

12.4.3 MALPENSA (COMPLETED 2001)
The existing Malpensa international airport in Milan has been developed into a modern hub, with increased runway capacity, a new passenger terminal (Terminal 1), control tower, aircraft parking areas (aprons), and a cargo centre. Major investment has brought substantially increased capacity to meet rapid traffic growth relief, developing a much more efficient international hub. (http://tentea.ec.europa.eu/en/ten-t_projects/30_priority_projects/priority_project_10/priority_project_10.htm 2010-01-27)

12.4.4 ÖRESUND FIXED LINK (COMPLETED 2000)
The Öresund Bridge created a direct road and rail link across the straits between Copenhagen in Denmark and Malmö in Sweden, with a four-lane motorway running above a doubletrack railway. The fixed link consists of a 4 km tunnel under the sea, a 4 km long artificial island, and a 7.5 km bridge – the world’s longest cable-stayed bridge for road and heavy rail – plus new access routes. (http://tentea.ec.europa.eu/en/ten-t_projects/30_priority_projects/priority_project_11/priority_project_11.htm 2010-01-27)
12.4.5 **RAILWAY/ROAD NORDIC TRIANGLE RAILWAY/ROAD AXIS**

The Nordic Triangle transport corridor links the Nordic countries of Sweden and Finland and their respective capitals to each other and improves passenger and freight transport from the region to Central Europe, the Baltic countries and Russia.

This multimodal scheme involves upgrading road, rail and maritime infrastructures in Sweden and Finland in order to improve transport links between the Öresund fixed link, (Priority project No 11), Stockholm, Oslo, Turku, Helsinki and the Finnish–Russian border.


![Figure 51 - Nordic Triangle rail/road axis](http://tentea.ec.europa.eu/en/ten-t_projects/30_priority_projects/priority_project_12/priority_project_12.htm, 2010-01-27)

12.4.6 **RAILWAY AXIS PARIS-STUTTGART-WIEN-BRATISLAVA**

The railway axis Paris-Strasbourg-Stuttgart-Wien-Bratislava is an east-west oriented axis crossing very densely populated areas in the centre of Europe. It touches upon four Member States: France, Germany, Austria and Slovakia.

Regular reporting on the progress of this project has been made available through the annual activity reports of the European Coordinator, Mr. Péter Balázs. (http://tentea.ec.europa.eu/en/ten-t_projects/30_priority_projects/priority_project_17/priority_project_17.htm 2010-01-27)

![Figure 52 - Railway axis Paris-Strasbourg-Stuttgart-Wien-Bratislava](http://tentea.ec.europa.eu/en/ten-t_projects/30_priority_projects/priority_project_17/priority_project_17.htm, 2010-01-27)
12.4.7 **INLAND WATERWAY AXIS RHINE/MEUSE-MAIN-DANUBE**

This corridor, one of the longest ones in the Trans-European Transport Network, crosses Europe transversally from the North Sea at Rotterdam to the Black Sea in Romania. The Meuse and the Rhine rivers are the entrance gates for the Belgian and the Dutch inland waterways to this Priority Project corridor. The Main canal connects the river Rhine to the Danube, which then flows into the Black Sea.

Along with Priority Project 30, Canal Seine-Scheldt, and in recognition of its complexity and multifaceted aspects, the European Commission has appointed Mrs. Karla Peijs as European Coordinator for Inland Waterways.

![Figure 53 - Waterway axis Rhine/Meuse-Main-Danube](http://tentea.ec.europa.eu/en/ten-t_projects/30_priority_projects/priority_project_18/priority_project_18.htm, 2010-01-27)

12.4.8 **RAILWAY FEHMARN BELT RAILWAY AXIS**

This axis is an extension of the Öresund crossing (Priority Project 11) and the Nordic triangle road and rail links (Priority Project 12) and is a key component in the main north–south route connecting Central Europe and the Nordic countries. It will involve the construction of a bridge or a tunnel in order to form a fixed road and rail link, spanning the 19 km wide Fehmarn Strait between Germany and Denmark, as well as improvements to related rail links in Denmark and Germany.

The project will provide an alternative for the ferry link between Rødby, Denmark and Puttgarden, Germany. It is expected to stimulate economic development in the Baltic Sea regions of Denmark and Germany, especially in the cross-border areas close to the link. Once completed, it aims to attract passenger and freight traffic estimated at 3.3 million vehicles and 30-35 thousand trains a year, helping to relieve congestion on the Great Belt route across Denmark, in particular on the rail network.

![Figure 53 - Waterway axis Rhine/Meuse-Main-Danube](http://tentea.ec.europa.eu/en/ten-t_projects/30_priority_projects/priority_project_18/priority_project_18.htm, 2010-01-27)
12.4.9 Motorway of the Sea

Four motorways of the sea corridors have been identified for support across the EU. On these corridors, projects will help to concentrate flows of freight on sea routes, with the aim of reducing road congestion and/or improving access to peripheral and island regions and Member States. The network will include facilities and infrastructure concerning at least two ports in two different Member States, primarily of use for freight transport, although motorways of the sea should not exclude combined transport of persons and goods.

The projects may also include activities with wider benefits not linked to specific ports, such as ice breaking, dredging, information systems. However, such projects have to demonstrate that they relate to the network and fulfill the general objectives of motorways of the sea: modal shift and/or cohesion.

12.4.10 RAILWAY AXIS ATHINA–SOFIA–BUDAPEST–WIEN–PRAHA–NÜRNBERG/DRESDEN

The project links eastern Member States through a major railway axis. Completing the axis will improve connectivity between all the networks on the basis of common standards. This axis is the only connection from southeastern Europe (and Greece) to the heart of the EU.

Some sections have been already completed - in Germany, Czech Republic, Hungary and Greece - and works on the remaining ones will start only after 2013. (http://tentea.ec.europa.eu/en/ten-t_projects/30_priority_projects/priority_project_22/priority_project_22.htm, 2010-01-27)
12.5 **APPENDIX - EUROPEAN RAILWAY NETWORK**

Red lines marks main double track railways, orange lines marks main single track lines, purple lines marks secondary lines and blue lines marks ferries.

*Figure 57 - European railway network*

12.6  APPENDIX - ERTMS IN EUROPE

Figure 58 - ERTMS in Europe, overview
(UIC, 2007)
Figure 59 shows the deployment plan for ERTMS in Europe where red lines marks railways where ERTMS should be implemented at the latest by 2020. Purple lines marks railways where voluntary national deployment is an option.

Figure 59 - ERTMS Deployment plan for Europe, red lines show railways where ERTMS should be implemented at the latest by 2020
12.7 APPENDIX - XRAIL PARTNERS

- CD Cargo (Czech Republic)
- CFL cargo (Luxembourg)
- DB Schenker Rail (Germany, Netherlands, Denmark)
- Green Cargo (Sweden, Norway)
- Rail Cargo Austria (Austria, Hungary)
- SBB Cargo (Switzerland)
- SNCB Logistics (Belgium)
Figure 60 - Map of European road pricing systems
(Øresund Logistics)
### 12.9 APPENDIX – DRIVING DISTANCES BETWEEN NORTHERN ADRIATIC PORTS

#### Table 15 - Driving distances between northern Adriatic ports

*Google maps, http://maps.google.com/, 2010-03-23*

<table>
<thead>
<tr>
<th>Driving distances (km)</th>
<th>Venezia</th>
<th>Chioggia</th>
<th>Trieste</th>
<th>Monfalcone</th>
<th>Koper</th>
<th>Rijeka</th>
<th>Bakar</th>
<th>Omisalj</th>
</tr>
</thead>
<tbody>
<tr>
<td>Venezia</td>
<td>0</td>
<td>57</td>
<td>165</td>
<td>136</td>
<td>193</td>
<td>235</td>
<td>248</td>
<td>263</td>
</tr>
<tr>
<td>Chioggia</td>
<td>57</td>
<td>0</td>
<td>194</td>
<td>164</td>
<td>239</td>
<td>264</td>
<td>277</td>
<td>292</td>
</tr>
<tr>
<td>Trieste</td>
<td>165</td>
<td>194</td>
<td>0</td>
<td>28</td>
<td>28</td>
<td>85</td>
<td>98</td>
<td>113</td>
</tr>
<tr>
<td>Monfalcone</td>
<td>136</td>
<td>164</td>
<td>28</td>
<td>0</td>
<td>59</td>
<td>101</td>
<td>115</td>
<td>129</td>
</tr>
<tr>
<td>Koper</td>
<td>193</td>
<td>239</td>
<td>28</td>
<td>59</td>
<td>0</td>
<td>76</td>
<td>89</td>
<td>104</td>
</tr>
<tr>
<td>Rijeka</td>
<td>235</td>
<td>264</td>
<td>85</td>
<td>101</td>
<td>76</td>
<td>0</td>
<td>13</td>
<td>30</td>
</tr>
<tr>
<td>Bakar</td>
<td>248</td>
<td>277</td>
<td>98</td>
<td>115</td>
<td>89</td>
<td>13</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td>Omisalj</td>
<td>263</td>
<td>292</td>
<td>113</td>
<td>129</td>
<td>104</td>
<td>30</td>
<td>17</td>
<td>0</td>
</tr>
</tbody>
</table>
### 12.10 APPENDIX – COMPLETE STATISTICS OF GOODS HANDLED IN PORTS

**Table 16 - Goods handled in the port of Venice 2008, complete statistics**

(Eurostat, [http://ec.europa.eu/eurostat](http://ec.europa.eu/eurostat), 2010-03-22)

<table>
<thead>
<tr>
<th>Goods handled in Venice 2008 (ttons)</th>
<th>Inwards</th>
<th>Outwards</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Large freight containers</strong></td>
<td>1 589</td>
<td>1 762</td>
<td>3 351</td>
</tr>
<tr>
<td>-- 20-ft freight units</td>
<td>875</td>
<td>878</td>
<td>1 753</td>
</tr>
<tr>
<td>-- 40-ft freight units</td>
<td>713</td>
<td>883</td>
<td>1 596</td>
</tr>
<tr>
<td><strong>Dry bulk goods</strong></td>
<td>9 705</td>
<td>391</td>
<td>10 096</td>
</tr>
<tr>
<td>-- Agricultural products</td>
<td>1 603</td>
<td>86</td>
<td>1 689</td>
</tr>
<tr>
<td>-- Coal</td>
<td>2 743</td>
<td>7</td>
<td>2 750</td>
</tr>
<tr>
<td>-- Ores</td>
<td>170</td>
<td>7</td>
<td>177</td>
</tr>
<tr>
<td>-- Other dry bulk goods</td>
<td>5 189</td>
<td>290</td>
<td>5 479</td>
</tr>
<tr>
<td><strong>Liquid bulk goods</strong></td>
<td>11 453</td>
<td>1 310</td>
<td>12 763</td>
</tr>
<tr>
<td>-- Crude oil</td>
<td>5 270</td>
<td>169</td>
<td>5 439</td>
</tr>
<tr>
<td>-- Liquified gas</td>
<td>88</td>
<td>33</td>
<td>121</td>
</tr>
<tr>
<td>-- Other liquid bulk goods</td>
<td>1 435</td>
<td>293</td>
<td>1 728</td>
</tr>
<tr>
<td>-- Refined oil products</td>
<td>4 660</td>
<td>816</td>
<td>5 476</td>
</tr>
<tr>
<td><strong>Ro-Ro, mobile self-propelled units</strong></td>
<td>314</td>
<td>306</td>
<td>620</td>
</tr>
<tr>
<td>-- Road goods vehicles and accompanying trailers</td>
<td>314</td>
<td>306</td>
<td>620</td>
</tr>
<tr>
<td><strong>Ro-Ro, mobile non-self-propelled units</strong></td>
<td>219</td>
<td>606</td>
<td>825</td>
</tr>
<tr>
<td>-- Rail wagons, shipborne trailers, shipborne barges</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>-- Unaccompanied road goods trailers and semi-trailers</td>
<td>218</td>
<td>606</td>
<td>824</td>
</tr>
<tr>
<td><strong>Other cargo not elsewhere specified</strong></td>
<td>1 928</td>
<td>336</td>
<td>2 264</td>
</tr>
<tr>
<td>-- Iron and steel products</td>
<td>1 607</td>
<td>213</td>
<td>1 820</td>
</tr>
<tr>
<td>-- Other general cargo</td>
<td>321</td>
<td>125</td>
<td>446</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>25 208</td>
<td>4 712</td>
<td>29 920</td>
</tr>
</tbody>
</table>

**Table 17 - Goods handled in the port of Chioggia 2008, complete statistics**

(Eurostat, [http://ec.europa.eu/eurostat](http://ec.europa.eu/eurostat), 2010-03-22)

<table>
<thead>
<tr>
<th>Goods handled in Chioggia 2008 (ttons)</th>
<th>Inwards</th>
<th>Outwards</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Large freight containers</strong></td>
<td>10</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>-- 40-ft freight units</td>
<td>10</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td><strong>Dry bulk goods</strong></td>
<td>1 720</td>
<td>192</td>
<td>1 912</td>
</tr>
<tr>
<td>-- Agricultural products</td>
<td>411</td>
<td>37</td>
<td>448</td>
</tr>
<tr>
<td>-- Coal</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>-- Ores</td>
<td>6</td>
<td>19</td>
<td>25</td>
</tr>
<tr>
<td>-- Other dry bulk goods</td>
<td>1 301</td>
<td>138</td>
<td>1 439</td>
</tr>
<tr>
<td><strong>Liquid bulk goods</strong></td>
<td>4</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>-- Liquified gas</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>-- Other liquid bulk goods</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td><strong>Ro-Ro, mobile self-propelled units</strong></td>
<td>116</td>
<td>73</td>
<td>189</td>
</tr>
<tr>
<td>-- Road goods vehicles and accompanying trailers</td>
<td>116</td>
<td>72</td>
<td>188</td>
</tr>
<tr>
<td>-- Trade vehicles (incl. import/export motor vehicles)</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Ro-Ro, mobile non-self-propelled units</strong></td>
<td>161</td>
<td>26</td>
<td>187</td>
</tr>
<tr>
<td>-- Rail wagons, shipborne trailers, shipborne barges</td>
<td>0</td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>
### Table 18 - Goods handled in the port of Trieste 2008, complete statistics

<table>
<thead>
<tr>
<th>Goods handled in Trieste 2008 (ttons)</th>
<th>Inwards</th>
<th>Outwards</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Large freight containers</strong></td>
<td>995</td>
<td>928</td>
<td>1 923</td>
</tr>
<tr>
<td>-- 20-ft freight units</td>
<td>563</td>
<td>381</td>
<td>944</td>
</tr>
<tr>
<td>-- 40-ft freight units</td>
<td>431</td>
<td>547</td>
<td>978</td>
</tr>
<tr>
<td><strong>Dry bulk goods</strong></td>
<td>584</td>
<td>533</td>
<td>1 117</td>
</tr>
<tr>
<td>-- Agricultural products</td>
<td>121</td>
<td>63</td>
<td>184</td>
</tr>
<tr>
<td>-- Coal</td>
<td>38</td>
<td>132</td>
<td>170</td>
</tr>
<tr>
<td>-- Ores</td>
<td>228</td>
<td>9</td>
<td>237</td>
</tr>
<tr>
<td>-- Other dry bulk goods</td>
<td>200</td>
<td>328</td>
<td>528</td>
</tr>
<tr>
<td><strong>Liquid bulk goods</strong></td>
<td>29 345</td>
<td>158</td>
<td>29 503</td>
</tr>
<tr>
<td>-- Crude oil</td>
<td>28 409</td>
<td>6</td>
<td>28 415</td>
</tr>
<tr>
<td>-- Liquified gas</td>
<td>142</td>
<td>0</td>
<td>142</td>
</tr>
<tr>
<td>-- Other liquid bulk goods</td>
<td>159</td>
<td>15</td>
<td>174</td>
</tr>
<tr>
<td>-- Refined oil products</td>
<td>635</td>
<td>137</td>
<td>772</td>
</tr>
<tr>
<td><strong>Ro-Ro, mobile self-propelled units</strong></td>
<td>520</td>
<td>638</td>
<td>1 158</td>
</tr>
<tr>
<td>-- Other mobile self-propelled units</td>
<td>0</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>-- Road goods vehicles and accompanying trailers</td>
<td>462</td>
<td>547</td>
<td>1 009</td>
</tr>
<tr>
<td>-- Trade vehicles (incl. import/export motor vehicles)</td>
<td>56</td>
<td>74</td>
<td>130</td>
</tr>
<tr>
<td><strong>Ro-Ro, mobile non-self-propelled units</strong></td>
<td>946</td>
<td>1 069</td>
<td>2 015</td>
</tr>
<tr>
<td>-- Rail wagons, shipborne trailers, shipborne barges</td>
<td>1</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>-- Unaccompanied road goods trailers and semi-trailers</td>
<td>943</td>
<td>1 064</td>
<td>2 007</td>
</tr>
<tr>
<td><strong>Other cargo not elsewhere specified</strong></td>
<td>340</td>
<td>1 143</td>
<td>1 483</td>
</tr>
<tr>
<td>-- Forestry products</td>
<td>43</td>
<td>23</td>
<td>66</td>
</tr>
<tr>
<td>-- Iron and steel products</td>
<td>135</td>
<td>1 050</td>
<td>1 185</td>
</tr>
<tr>
<td>-- Other general cargo</td>
<td>163</td>
<td>70</td>
<td>233</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>32 727</td>
<td>4 468</td>
<td>37 195</td>
</tr>
</tbody>
</table>

### Table 19 - Goods handled in the port of Monfalcone 2008, complete statistics

<table>
<thead>
<tr>
<th>Goods handled in Monfalcone 2008 (ttons)</th>
<th>Inwards</th>
<th>Outwards</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Large freight containers</strong></td>
<td>21</td>
<td>5</td>
<td>26</td>
</tr>
<tr>
<td>-- 40-ft freight units</td>
<td>20</td>
<td>3</td>
<td>23</td>
</tr>
<tr>
<td><strong>Dry bulk goods</strong></td>
<td>2 035</td>
<td>89</td>
<td>2 124</td>
</tr>
<tr>
<td>-- Agricultural products</td>
<td>4</td>
<td>37</td>
<td>41</td>
</tr>
</tbody>
</table>
## Table 20 - Goods handled in the port of Koper 2008, complete statistics

<table>
<thead>
<tr>
<th>Goods handled in Koper 2008 (tttons)</th>
<th>Inwards</th>
<th>Outwards</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Large freight containers</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-- 20-ft freight units</td>
<td>683</td>
<td>490</td>
<td>1 173</td>
</tr>
<tr>
<td>-- 40-ft freight units</td>
<td>875</td>
<td>686</td>
<td>1 561</td>
</tr>
<tr>
<td>-- Freights &gt; 20-ft and &lt; 40-ft</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Dry bulk goods</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-- Agricultural products</td>
<td>607</td>
<td>145</td>
<td>752</td>
</tr>
<tr>
<td>-- Coal</td>
<td>3 388</td>
<td>2 259</td>
<td>5 647</td>
</tr>
<tr>
<td>-- Ores</td>
<td>2 109</td>
<td>39</td>
<td>2 148</td>
</tr>
<tr>
<td>-- Other dry bulk goods</td>
<td>1 059</td>
<td>15</td>
<td>1 074</td>
</tr>
<tr>
<td><strong>Liquid bulk goods</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-- Crude oil</td>
<td>29</td>
<td>5</td>
<td>34</td>
</tr>
<tr>
<td>-- Liquified gas</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>-- Other liquid bulk goods</td>
<td>32</td>
<td>0</td>
<td>32</td>
</tr>
<tr>
<td>-- Refined oil products</td>
<td>2 629</td>
<td>44</td>
<td>2 673</td>
</tr>
<tr>
<td><strong>Ro-Ro, mobile self-propelled units</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-- Live animals on the hoof</td>
<td>0</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>-- Other mobile self-propelled units</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>-- Road goods vehicles and accompanying trailers</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td><strong>Ro-Ro, mobile non-self-propelled units</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-- Rail wagons, shipborne trailers, shipborne barges</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>-- Unaccompanied road goods trailers and semi-trailers</td>
<td>2</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td><strong>Other cargo not elsewhere specified</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-- Forestry products</td>
<td>71</td>
<td>135</td>
<td>206</td>
</tr>
<tr>
<td>-- Iron and steel products</td>
<td>268</td>
<td>158</td>
<td>426</td>
</tr>
<tr>
<td>-- Other general cargo</td>
<td>5</td>
<td>739</td>
<td>744</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>11 761</td>
<td>4 739</td>
<td>16 500</td>
</tr>
</tbody>
</table>
### Table 21 - Goods handled in the port of Rijeka 2008, complete statistics

<table>
<thead>
<tr>
<th>Goods handled in Rijeka 2008 (ttons)</th>
<th>Inwards</th>
<th>Outwards</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Large freight containers</strong></td>
<td>884</td>
<td>246</td>
<td>1130</td>
</tr>
<tr>
<td>- 20-ft freight units</td>
<td>431</td>
<td>104</td>
<td>535</td>
</tr>
<tr>
<td>- 40-ft freight units</td>
<td>453</td>
<td>142</td>
<td>595</td>
</tr>
<tr>
<td><strong>Dry bulk goods</strong></td>
<td>282</td>
<td>135</td>
<td>417</td>
</tr>
<tr>
<td>-- Agricultural products</td>
<td>164</td>
<td>108</td>
<td>272</td>
</tr>
<tr>
<td>-- Ores</td>
<td>14</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>-- Other dry bulk goods</td>
<td>104</td>
<td>27</td>
<td>131</td>
</tr>
<tr>
<td><strong>Liquid bulk goods</strong></td>
<td>196</td>
<td>78</td>
<td>274</td>
</tr>
<tr>
<td>-- Crude oil</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>-- Refined oil products</td>
<td>196</td>
<td>76</td>
<td>272</td>
</tr>
<tr>
<td><strong>Other cargo not elsewhere specified</strong></td>
<td>74</td>
<td>876</td>
<td>950</td>
</tr>
<tr>
<td>-- Forestry products</td>
<td>11</td>
<td>188</td>
<td>199</td>
</tr>
<tr>
<td>-- Iron and steel products</td>
<td>16</td>
<td>600</td>
<td>616</td>
</tr>
<tr>
<td>-- Other general cargo</td>
<td>47</td>
<td>87</td>
<td>134</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>1437</td>
<td>1336</td>
<td>2773</td>
</tr>
</tbody>
</table>

### Table 22 - Goods handled in the port of Bakar 2008, complete statistics

<table>
<thead>
<tr>
<th>Goods handled in Bakar 2008 (ttons)</th>
<th>Inwards</th>
<th>Outwards</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dry bulk goods</strong></td>
<td>1605</td>
<td>831</td>
<td>2436</td>
</tr>
<tr>
<td>-- Coal</td>
<td>1198</td>
<td>831</td>
<td>2029</td>
</tr>
<tr>
<td>-- Ores</td>
<td>350</td>
<td>0</td>
<td>350</td>
</tr>
<tr>
<td>-- Other dry bulk goods</td>
<td>56</td>
<td>0</td>
<td>56</td>
</tr>
<tr>
<td><strong>Liquid bulk goods</strong></td>
<td>368</td>
<td>1189</td>
<td>1557</td>
</tr>
<tr>
<td>-- Crude oil</td>
<td>0</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>-- Liquified gas</td>
<td>0</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>-- Refined oil products</td>
<td>368</td>
<td>1164</td>
<td>1532</td>
</tr>
<tr>
<td><strong>Other cargo not elsewhere specified</strong></td>
<td>37</td>
<td>5</td>
<td>42</td>
</tr>
<tr>
<td>-- Iron and steel products</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>-- Other general cargo</td>
<td>37</td>
<td>4</td>
<td>41</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>2011</td>
<td>2025</td>
<td>4036</td>
</tr>
</tbody>
</table>

### Table 23 - Goods handled in the port of Omisalj 2008, complete statistics

<table>
<thead>
<tr>
<th>Goods handled in Omisalj 2008 (ttons)</th>
<th>Inwards</th>
<th>Outwards</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Liquid bulk goods</strong></td>
<td>6594</td>
<td>0</td>
<td>6594</td>
</tr>
<tr>
<td>-- Crude oil</td>
<td>6260</td>
<td>0</td>
<td>6260</td>
</tr>
<tr>
<td>-- Refined oil products</td>
<td>334</td>
<td>0</td>
<td>334</td>
</tr>
<tr>
<td><strong>Other cargo not elsewhere specified</strong></td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>-- Other general cargo</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>6595</td>
<td>0</td>
<td>6595</td>
</tr>
</tbody>
</table>
12.11 APPENDIX – REGIONS IN SWEDEN

Table 24 - Geographic location of Swedish regions

The region named Stockholm has been included in Eastern middle Sweden in the thesis.
12.12 APPENDIX – CRITERIA FOR THE RANKING THE LOGISTIC LOCATIONS IN SWEDEN

The logistics journal “Intelligent Logistik” ranks the best logistic locations in Sweden. They base their rank on six criteria:

1. Geographic location, neighborhood to Sweden’s demographic concentration point.
2. The total volume of existing and additional logistic areas the coming five years.
3. Versatility and accessibility in logistics infrastructure in form of roads, rails, harbors, air ports and combined terminals.
4. Total supply of logistics services, relevant academic education and access to labor.
5. Climate of cooperation and networks within the region.
6. The price for and access of land for new establishments.
12.13 APPENDIX - IMPORT AND EXPORT BETWEEN SWEDEN AND SLOVENIA

Figure 61 - Estimated export Sweden-Slovenia in 2020 (SIKA)

Figure 62 - Estimated import Slovenia-Sweden in 2020 (SIKA)
**APPENDIX**

**12.14 APPENDIX – IMPORT AND EXPORT BETWEEN NORTHERN ITALY AND SWEDEN**

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**Figure 63 - Estimated export Sweden-Northern Italy in 2020**
(SIKA)

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**Figure 64 - Estimated import Northern Italy-Sweden in 2020**
(SIKA)
APPENDIX

12.15 Appendix – Goods flows between Sweden and regions in the corridor

12.15.1 Import and export Czech Republic-Sweden

Figure 65 - Estimated export Sweden-Czech Republic in 2020 (SIKA)

Figure 66 - Estimated import Czech Republic-Sweden in 2020 (SIKA)
12.15.2 Import and Export Bayern-Sweden

**Estimated export Sweden-Bayern in 2020 (tonnes)**

- Sum of Agricultural products
- Sum of Chemicals
- Sum of Earth, stone and building material
- Sum of Manufactured industrial products
- Sum of Metal products
- Sum of Paper and pulp

**Figure 67 - Estimated export Sweden-Bayern in 2020**
(SIKA)

**Estimated import Bayern-Sweden in 2020 (tonnes)**

- Sum of Agricultural products
- Sum of Unprocessed lumber
- Sum of Chemicals
- Sum of Crude petroleum
- Sum of Foodstuffs
- Sum of Iron ore and metal waste
- Sum of Manufactured industrial products
- Sum of Processed wood products
- Sum of Earth, stone and building material

**Figure 68 - Estimated import Bayern-Sweden in 2020**
(SIKA)
12.15.3 Import and Export Berlin/Brandenburg-Sweden

**Figure 69 - Estimated export Sweden-Berlin/Brandenburg in 2020**
(SIKA)

**Figure 70 - Estimated import Berlin/Brandenburg-Sweden in 2020**
(SIKA)
12.15.4 Import and Export Mecklenburg-Vorpommern-Sweden

Figure 71 - Estimated export Sweden-Mecklenburg-Vorpommern in 2020 (SIKA)

Figure 72 - Estimated import Mecklenburg-Vorpommern-Sweden in 2020 (SIKA)
### APPENDIX

#### 12.15.5 IMPORT AND EXPORT WESTERN AUSTRIA-SWEDEN

**Estimated import Western Austria-Sweden in 2020 (tonnes)**

- Sum of Agricultural products
- Sum of Metal products
- Sum of Chemicals
- Sum of Manufactured industrial products
- Sum of Foodstuffs
- Sum of Earth, stone and building material

**Figure 73 - Estimated import Western Austria-Sweden in 2020**
(SIKA)

**Estimated export Sweden-Western Austria in 2020 (tonnes)**

- Sum of Chemicals
- Sum of Earth, stone and building material
- Sum of Metal products
- Sum of Paper and pulp
- Sum of Petroleum products

**Figure 74 - Estimated export Sweden-Western Austria in 2020**
(SIKA)
12.15.6 Import and Export Eastern Austria-Sweden

Figure 75 - Estimated import Eastern Austria-Sweden in 2020 (SIKA)

Figure 76 - Estimated export Eastern Austria-Sweden in 2020 (SIKA)
12.16 Appendix – Sweden’s Import and Export 2009

Figure 77 - Sweden’s import and export in 2009
(SCB, 2010)
Figure 78 - Geographic location of German regions
(http://www.slimschool.ik.org/img/Website_Main_Pictures/regions_germany2.gif, 2010-05-20)
12.18 Appendix – Amount of Goods Traded per Departure of Scandinavian Shuttle

To show how much goods that is needed for a transport concept, Scandinavian Shuttle can be used as an example. The shuttle transports 50 000 000 tonne-kilometer per month on an 1160 km long route. This equals approximately 43 000 tonnes per month and 500 000 tonnes per year. The shuttle operates 5 times a week in both directions and the load is approximately 1000 tonnes per train. The amount of goods that is needed approximately is around 1000 tonnes per train sent. 240 000 tonnes in each direction per year is approximately needed for having a shuttle departing five times a week in both directions.