Project part-financed
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Trans Baltic task 5.5

The market for intermodal transport in the Trans Baltic Port-Hinterland Corridor to the ferry link Gdynia – Karlskrona

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PREFACE

During the spring 2012 Vectura has accomplished the study ”Trans Baltic task 5.5 The market for intermodal transport in the Trans Baltic Port-Hinterland Corridor to the ferry link Gdynia – Karlskrona”. The study has been accomplished in close co-operation with the client Region Blekinge and the shipping line Stena Line. This report is the final reporting of the project and includes description and analysis of the market conditions as a basis the establishment of an intermodal hinterland connection to/from the Port of Karlskrona

The work has been accomplished by the following researchers;

- Lina Wells, Vectura Consulting (Project Leader until March 1st, 2012)
- Fredrik Bärthel, Vectura Consulting (Project Leader from March 1st, 2012)
- Edith Sorkina, Vectura Consulting
- Michael Malmquist, Vectura Consulting
- Marcin Wolek, Protrans (subconsultant)

This report has been written by Fredrik Bärthel and Edith Sorkina, Vectura Consulting, who also are responsible for the content of the report. A steering group has been appointed to work in close co-operation with the researchers.

Vectura want to address a thank you to the study's funders, the person listed above as well as others who favorably, for example, to be interviewed, contributed to this study could be conducted in a positive spirit, and that interesting results and valuable information emerged.

Göteborg in June 2012

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Title: Trans Baltic task 5.5 The market for intermodal transport in the Trans Baltic Port-Hinterland Corridor to the ferry link Gdynia – Karlskrona

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Summary

Freight transport between the Nordic Countries (Sweden and Norway) and Eastern Europe as well as the Baltic States, though originating from an invisible level, have erupted since the fall of the Iron Curtain in 1989. Despite the tremendous and continuous growth, the freight flows are not visible in the National statistics used when prioritizing infrastructure investments or as argued by Bengt Birgersson in the Port Strategy Investigation in 2008: “The structure of the Swedish transport flows has been stable for the last 20 years and hence will be for the next 20 years”.

The frequent ferry connection service between the Scandinavia Peninsula and Eastern Europe is a natural consequence of the lack of land bridges between the peninsula and the continent. To conclude, the ferry is part of the Trans-European infrastructure and is a prerequisite for the trade between Eastern Europe and Scandinavia. For the focal port, Port of Karlskrona, the transport volume has seen a 19 % annual increase since 1999, and the market share has increased to 22 %.

Currently, the upgrading of the Coast to Coast Line, Emmaboda - Karlskrona, and the upgrading and electrification of the railway to the Port of Karlskrona. In the Port an intermodal terminal, able to handle 600 m long trains, are being built. All these investments are made in the context of MoS project "Baltic-Link Motorways of the Sea, Gdynia - Karlskrona", funded by the EU and Karlskrona.

BYT BILD

The aim of this project “Trans Baltic task 5.5” is to discuss and analyze if an intermodal hinterland transport service connected to the ferry link Gdynia – Karlskrona could increase the attractiveness and competitiveness of the ferry link. In accordance with Van Klink and van den Berg (1998), we argue that the port authorities or shipping lines should change attention from the organization of the seaside to the land side. The new role would be to support and coordinate initiatives for development and implementation of intermodal hinterland corridors and in co-operation identify markets and customer segments that could be reached and/or attracted by intermodal transport systems. Subsequently, in the second step, organize sufficient capacity. However, if such a service should be able to enter the highly competitive and fragmented transport market, the intermodal transport solution should be designed based on following principles:

- Offer a significant, sustainable competitive advantage (SSCA)
- To be integrable with the dominating transport systems
- Be implemented based on a well-developed marketing orientation (spatial and commodity) in order to secure a base volume.

The competitiveness of intermodal systems reaches its optimum when large frequent transport volumes are transported over medium or long distances, i.e. where an intermodal service provider (ISP) can benefit from system’s inherent economies of scale while maintaining sufficient frequency. At the port and hinterland terminal nodes the diverging characteristics of the transport modes are bridged to allow time and spatial consolidation of shipments. Between the nodes high capacity links are needed to supply the producing industry with cost and time efficient transport systems. The identification and evaluation of these links and nodes is vital for the ISP to be able to offer a more cost efficient transport service than the present and a service it is able to market towards its potential users in one or

several potential spatial markets. Hence, the aim of the study is to analyze the opportunities to design and implement a competitive hinterland service adapted to the needs and requirement of the corridor via Karlskrona – Gdynia.

The project has been based on a structured analytical approach, shown below, starting with activity 1 (Market), and followed by activity 2 (Standards and regulations) and activity 3 (Transport resources). Based on activity 1-3 a transport system analysis was made in activity 4, including the sub processes: spatial focusing, transport plan, need for infrastructure investments or regulatory exemptions and finally business economical/socio-economical evaluation of the proposed transport services. Activity 4 would in the subsequent steps lead to proposal for implementation and/or pilot actions.

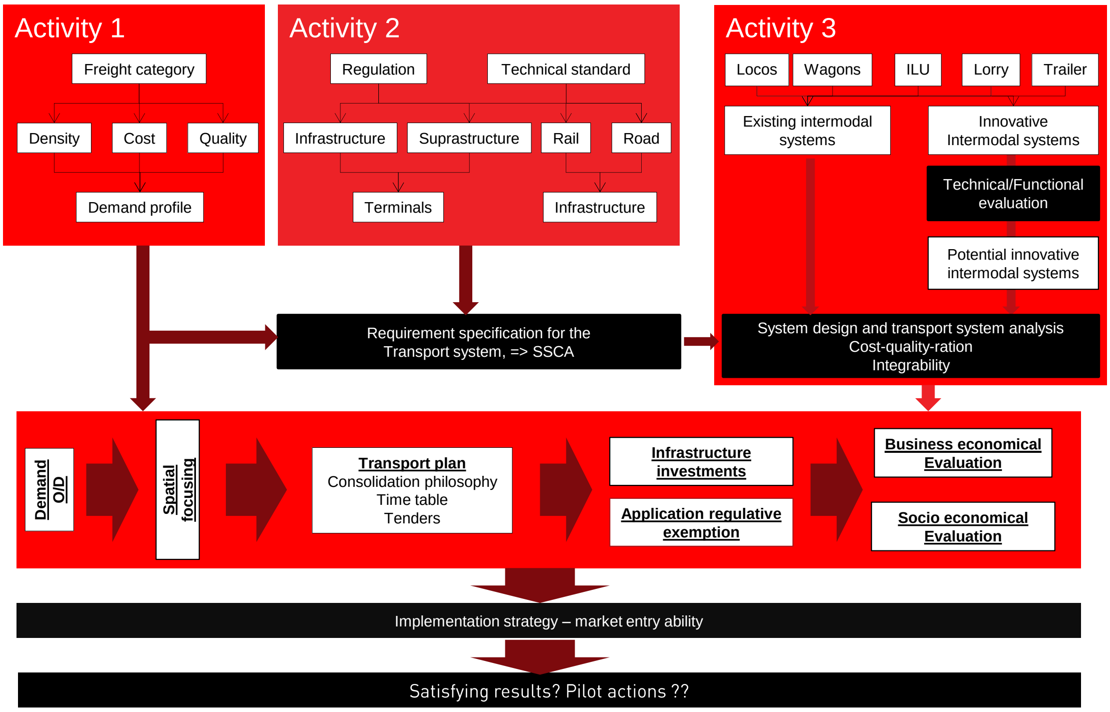


Figure 1 **Schematic sketch of the structured analytical approach used in the project.**

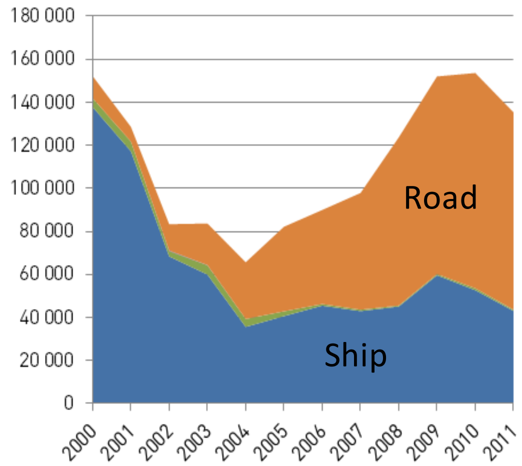
Activity 1: in accordance with the project steering group we decided to initially focus solely on fresh fish (including back haul) as base volume for the transport service. A base volume is defined as the initial volume guaranteeing the profitability of the transport service during the critical implementation phase. When the base volume is secured and the quality is stable, the ISP could start to stepwise expand the service based on the well-developed implementation plan.

Fish accounts for 6.6 % of the Norwegian export (2010) and is one of the major export articles to Poland. Today a clear majority of the Norwegian fresh fish export, except for volumes to e.g. France, is transported by truck, however there are several business trends indicating an increased potential for the intermodal transport:

- Future growth of export will primarily come from fresh fish segment. Salmon represented 61% of exports in 2010 and out of this 74% was exported fresh. Nearly half of the total volume of salmon and trout is produced in the four northern most counties: Nordland, Nord-Trondelag, Troms, Finnmark.

- There is a shift in trade relations from Western towards Eastern Europe.
- Strong international competition will force the aquaculture industry towards continued restructuring, streamlining, leading towards growing cooperation in the industry. Already today we can see emerging joint sales organizations, cooperation in harvesting and packaging. Moreover, number of factories, exporters, licensed farmers has been reduced, while volumes have grown. Today, 25% of companies having salmon export licenses control 90 % of the exports.
- Location of the industry creates favorable conditions for intermodal rail in terms of long distances to the consumer market, combined with long distance repositioning of road vehicles (only 1 out of 4 road vehicles is unloaded in the fishing regions);
- Signs of new technology that would increase the shelf life of the products, which indicates opportunities for increased lead time, as receivers of cargo are not interested in increased inventories.
- Strong interest from the local communities and severe problems with foreign road hauliers, particularly during winter conditions.

Poland is the third largest market for Norwegian fish after France and Russia. It is a large processing country and 60% of volumes are re-exported (mostly to Germany). These processing industries are located on the Baltic coast line and buy the fresh fish largely on ex-works terms. Hence the decision whether to use intermodal transport or pure road transport lies at the Polish Processing Industry side. The lead time requirement is 48-72 hours from Norway and requires dedicated temperature regulated trailers.

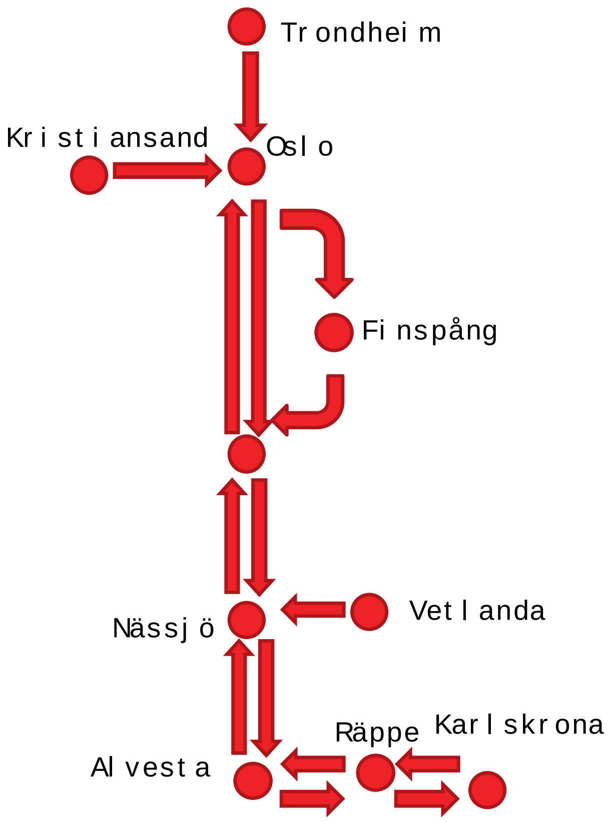


The Norwegian fish industry and its agents are according to the study satisfied with the present service and do not expect any large changes in cost/quality ratio of this service and hence the incentives to change both marketing and logistics channels is small or nonexistent. Costs only represent 6-8 % of the product price and hence there is mainly a strong focus on the quality. However, there are quality problems due to seasonal variations and winter conditions. During high season there is lack of truck capacity and during winter time accidents and delays on the snowy/icy road are highly common (only in February-March 2012 200 foreign trucks were off the road in Nordland County).

Existing set-ups	road – cheap despite problems with road transport, cargo owners too large extent satisfied road - flexible for re-routing (fewer long term contracts) partly triangular traffic possible adjustments in internal processes to synchronize with rail transport low concentration in the industry food imports (potential return cargo) in Sweden concentrated in Malmö/Helsinborg region Transport buying too large extent ad hoc vs. 2-3 year contracts with Norwegian operators
Organizational	many actors transport buyers - too large extent not the senders who should the leading role? (channel manager/leader)
Infrastructural	industry located far from rail terminals increased rail track charges in Sweden lack of road tolls
Operational, logistical and service related	need for door-to-door services- who should take the responsibility fresh fish time sensitive delays affect stronger consolidated shipments
Regulative	lack of regulations on winter tires
Technical	2-10% of trailers equipped for intermodal handling
Attitude	cargo owners skeptical to rail haulers not interested

Barriers towards intermodal transport

To conclude, fresh fish is not the cargo commodity suitable for forming the base volume in an intermodal transport system. As pointed out there are several reasons for this, however there are complementing cargo commodities that might serve as base volume. For instance, in the southbound direction - paper and pulp, aluminium, while northbound - colonial foods, perishables and recycled paper. In the report these flows are presented and discussed extensively based on the knowledge gathered about flows of aluminium bars to sub-suppliers for the automotive and furniture manufacturers from Mo i Rana, Farsand (South coast) and Sundalsöyra (West coast), based on recycled paper (northbound), tissues (Northbound) and paper products (south bound). Together these commodities form a base flow with a hub in Vetlanda and Alvesta/Räppe as shown in the schematic figure.



In the report two different set ups are presented and discussed. The first is based on the national intermodal operator Cargo Net and the second on a present set up operated by the Swedish Rail operator TÅGAB. Due to the complex structure and the service supply Vectura has favored the latter solutions for a potential pilot between the countries.

Content

1 Introduction

Freight transport between the Nordic Countries, Sweden and Norway, and Eastern Europe and the Baltic Countries, have erupted since the fall of the Iron Curtain in 1989, however originating from an invisible level. Even though a tremendous and continuous growth, the freight flows is still not visible in the statistics presented by the Swedish Transport Administration when prioritizing infrastructure investments or as argued by Bengt Birgersson in the Port Strategy Investigation in 2008; "The structure of the Swedish transport flows have been stable for the last 20 years and hence they will be for the next 20 years".

The transports in the mentioned transport corridor is totally dominated by accompanied trailers shipments with a market sharing of over 95 % and the sole remaining volumes is represented by unaccompanied dry and tank bulk flows. For the focal port, Port of Karlskrona, the transport volume has seen a 19 % annual increase since 1999, and the market share has increased to 22 %. Though the competing Ports, particularly Trelleborg and Ystad, handle higher volumes on the Polish market.

The container volumes, oversea freight flows, is completely concentrated to the ports Göteborg and Helsingborg. The planned Port in Stockholm, Norvik, will, according to the expertise, not affect the container port structure, the container flows and the port calls, however the complementing Port terminal in Gdansk, Poland, will according to the same expertise help the Port of Göteborg to attract the valuable direct calls and hence act as an incentive to even increase the concentration of oversea service.

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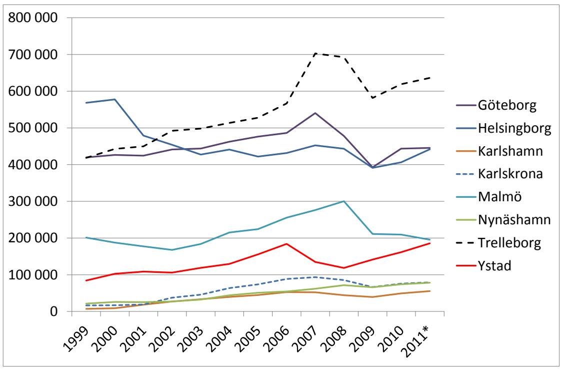


Figure 1 Increase of trailer transport to and from the Ports of Southern Sweden 1999 - 2011.

The extensive daily ferry connection service, see figure 2, from Sweden to the European Continent is a natural consequence of the lack of land bridges between the Scandinavian Peninsula and the European Continent. Hence, the ferry is a part of the Trans-European infrastructure, which in combination with the extremely high degree of accompanied transport (>95 %) indicate that the transports not should be denoted as intermodal rather unimodal. The transport link is a pure prerequisite and not a complementing transport solution.

The ferry service is quite similar; however the diverging ferry lines have forelands and hinterlands partially separate and partially overlapping. There are two opportunities for a shipping line to attract new volumes; (1) market the service to the transport users within the existing Forelands/Hinterlands and (2) to market the transport service to transport users outside the existing Forelands/Hinterlands and hence to expand the Inland market area. Intermodal transport systems are a strong tool to enlarge a port's foreland or hinterland.

The spatial dimension of a hinterland could be defined based on the generalized logistical cost, i.e. related to transport time, risk of delay, security, and safety. Thus the generalized costs cover all relevant costs for bridging the transport distance between a consignor and consignee. Hence, a ports hinterland is dynamic. It might change due to fundamental developments in technology, economy and society, which all have an impact on the demand of transport users for port services as well as the generalized costs. Further, if the port has a representative in the inland region this might reduce the psychological distance between the region and the port. Then, the generalized cost will be lower. Thus the development of intermodal transport systems might result in easier access to locations at a long distance from the port than places nearby, implying a clear opportunity and threat in the port competition.

The researchers, Van Kling and van den Berg (1998), argue that the port authorities and shipping lines should change attention from the organization of the seaside to the land side. In this new role to coordinate initiatives of the development and implementation of inland corridors the new role strongly change significantly towards identification of markets to be reached by intermodal transport systems and to organize sufficient capacity.

The competitiveness of intermodal systems reaches its optimum when large frequent transport volumes are transported over medium or long distances, i.e. where an intermodal service provider (ISP) can benefit from system's inherent economies of scale while maintaining sufficient frequency. At the port and hinterland terminal nodes the diverging characteristics of the transport modes are bridged to allow time and spatial consolidation of shipments. Between the nodes high capacity links are needed to supply the producing industry with cost and time efficient transport systems. The identification and evaluation of these links and nodes is vital for the ISP to be able to offer a more cost efficient transport service than the present and a service it is able to market towards its potential users in one or several potential spatial markets.

1.1 Aim and Hypothesis

The aim of the study is to analyze the opportunities to design and implement a competitive hinterland service adapted to the needs and requirement of the corridor via Karlskrona – Gdynia. However, if such a service should be able to enter the highly competitive and fragmented transport market, the intermodal transport solution should be designed according to five hypotheses:

Hypothesis 1: The intermodal service provider needs to design and implement a logistics service, which offers its potential users the following cornerstones; (1) a significant, sustainable competitive advantage (SSCA), (2) is integrable with the dominating transport systems and (3) is implemented based on a well-developed marketing orientation (spatial and commodity) in order to secure a base volume.

Hypothesis 2: Hence, of vital importance is the identification process where one or several complementing commodity groups, alone or in combination could provide a base volume for the transport service and hence, ensure the profitability during the implementation phases.

Hypothesis 3: Restructuring of the marketing-, logistics- and transport channels is vital to allow adaptation to an intermodal set up.

Hypothesis 4: According to Storhagen *et al (*2008) the barriers towards adaptation of an intermodal strategy (for time and temperature sensitive shipments) could be categorized according to; (1) market, (2) organization, (3) production and operation, (4) Planning, administration and ICT, (5) Technology, (6) Infrastructure, (7) Regulation and (8) Societal barriers. Hence, to understand both incentives and barriers towards such change a well structures analysis and segmentation of these obstacles is needed in order to identify measures to strengthen or bridge the obstacles.

Hypothesis 5: In according with van Zuylen and Weber (2002) there is need to stimulate efforts in the industry to change logistics system with trans-/national measures or regulations top-down. Our hypothesis; there is need for national or transnational support or subsidies for the industry to overcome the inertia of change. Today, there are only transnational programs (Marco Polo) to stimulate such change, however these require very large volumes over long distances and is according to Woxenius and Bärthel (2008) not suited for countries, as Norway and Sweden, where a majority of freight flows is small and dispersed.

1.2 Scope and delimitations

From a spatial point of view the project is focused on the transport corridor origination in Northern Norway through Sweden via Port of Karlskrona to the Port of Gdynia, including its hinterland.

From a commodity point of view the project team was advised by the steering committee to focus on the market aspects, and particularly on farmed fresh fish, including backhaul, due to the common perception that farmed fish will be the base volume for the new service. A base volume is defined as the initial volume guaranteeing the profitability of the transport service during the critical implementation phase. When the base volume is ensured and the quality is stable, the ISP could start to stepwise expand the service based on the well-developed implementation plan.

The main reasons for choosing fish farming as focal object of study are;

- It the biggest export article from Norway to Poland (36% in 2009);
- It is a growing industry and an important export industry for Norway;
- The location of the industry creates favorable conditions in terms of distance (important requirement for economic viability of intermodal transport)
- There is an on-going discussion in the seafood industry on how to shift more cargo to rail and strong interest from local communities.

1.3 Definitions

Throughout the report there are some frequent technical terms that need to be explained for the normal reader. These words mainly refers to the rail, road and intermodal transport system and is explained in alphabetic order

Accompanied transport: Movement/Transport of road vehicles, parts of vehicles or intermodal load units (ILU) on another transport mode (rail or sea) accompanied by the road vehicle driver.

Block train: Train consisting of two or more wagon blocks which runs between a two nodes without intermediate marshalling or shunting of wagons and without transshipment of loading units. The wagons are sorted into wagon blocks, i.e. by destination, on the node of train composition.

Container: Generic term for box to carry freight, strengthened for repeatable use, usually stackable and fitted with devices for horizontal transfer or vertical transfer between modes.

Corner fitting: Standard fixing point for the ILU (ITU) on the carrying vessel, vehicle or wagon.

DryPort: An inland terminal directly connected to seaport(s) with high capacity transport mean(s), where customers can leave/pick-up up their standardized units as if directly to a seaport.

Foreland: land beyond maritime area to which the port ships its export and from which it derives its import.

Hinterland: Areas behind the port to which the port sends import and from which it draws export. A ports hinterland is dynamic. It might change due to fundamental developments in technology, economy and society, which all have an impact on the demand of shippers for port services as well as the generalized costs. For the port authority the demand might be regarded as an exogenous variable and as augmented by van Klink and van den Berg (1998) this might also be true for the generalized costs.

Intermodal load unit: Term for different types of load carriers used for intermodal freight transport as well as transportation in general. Included in the definition are swap bodies, semi-trailers and containers, but an extended definitions also include RoRo cassettes, paper rolls, standard sawn wood units as well as specially designed freight containers of corresponding size and standard.

In this report we denotes a container or a swap body a intermodal loading unit (ILU) in order to stress the shipment, consignments or goods to be transported (Woxenius and Bärthel, 2008). ECMT uses the denotation intermodal transport unit (ITU:s). Woxenius and Bärthel (2008) uses the denotation intermodal transport unit as a "collecting" name for transport units as wagons, trucks and vessels. Thus the ILU:s are loaded onto, in or coupled to an ITU.

Table 1 Intermodal loading units – categories and standard dimensions.

Category	Type	Lenght	Width	Height	Gross weight	Pay load	Volume
		(m [foot]]	m (EU[Se])	m (normal)	ton	ton	m3
Container	A	12,12 (40')	2,438	2,591	30,5	26,4	64
	B	9,09 (30')	2,438	2,591	25,4	24,4	51
	C	6,06 (20')	2,438	2,591	24,0	21,5	33
	D	3,02 (10')	2,438	2,438	10,2	8,8	16
Swap body	A 1212	12,12	2,55-2,60	2,67	34	23,5/26,5	74
	A 1250	12,50	2,55-2,60	2,67	34	23,2/26,2	76
	A 1360	13,60	2,55-2,60	2,67	34	22,8/25,8	80
	C 715	7,15	2,55-2,60	2,67	16	11,4/13,4	43
	C 745	7,45	2,55-2,60	2,67	16	11,4/13,4	45
	C 782 (High cube)	7,82	2,55-2,60	2,90	16	11,4/13,4	50
Swap body	EU standard	13,6	2,55	2,67	32,5	25	90
	EU Maxi/Jumbo	13,6	2,55	2,67	32,5	24,7	100
	Sweden - Finland	18,0	2,60	3,50	41,5	33	140

Intermodal transport

From a conceptual point this definition view intermodal transport as a coordinated transport where at least two different transport modes are used to fulfill a physical movement of a shipment loaded into an intermodal loading unit (ILU). This ILU is transported without consolidation or deconsolidation from consignor to consignee and is at least once transshipped between the coordinated traffic modes. Thus, to be denoted as an intermodal transport a transport needs to satisfy the following demands.

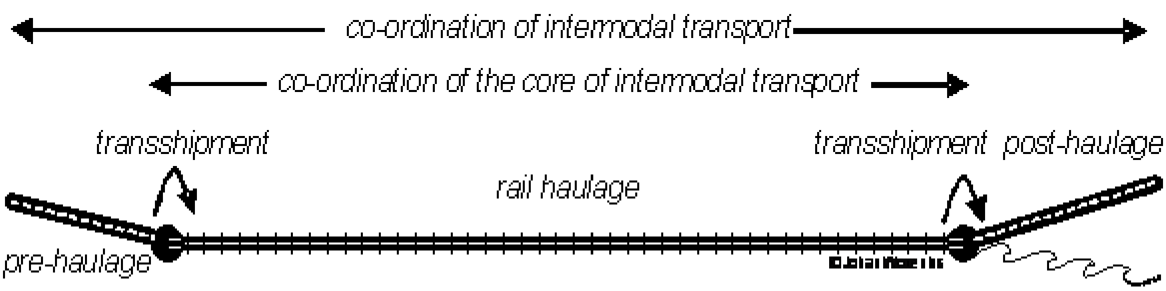
The shipment shall be transported in unbroken intermodal loading units from sending to receiving point.

ISO-containers, swap bodies, semi-trailers and specially designed freight containers of corresponding size are regarded as ILU:s.

The ILU must change between transportation modes at least once between sending to receiving point.

In this study the transport modes are road and rail, primarily, which normally is denoted intermodal transport. In this project the definition assume a transport where the shipment is loaded into the ILU at the sending point. The ILU is transported by road to an intermodal terminal, where the ILU is transshipped onto a wagon and subsequently transported to the receiving terminal by block or shuttle train. On the receiving terminal the ILU is transshipped, occasionally stored, and transported by truck to the consignee (receiving point). The intermodal load unit is not deconsolidated until the ILU arrives at the consignee.

The concepts of multimodal and intermodal transportation are often mixed up. The major difference distinguishing these two concepts the utilization of ILU:s in an intermodal transport chain from a consignor to a consignee where the ILU is transshipped at least once between sending to receiving point according to the above mentioned definition. A multimodal transport chain consists of at least two different traffic modes, but the shipment is not necessarily loaded in an ILU. Thus, the concept of intermodal transport might be considered as a subset of multimodal freight transport. An example of multimodal transport is round timber transported by truck from the wood to a round timber terminal. At the terminal each timber is transshipped to a wagon occasionally through an intermediate storage area. Finally loaded onto a freight wagon the timber is transported to the Pulp Mill for production of pulp. All handling of the timber is done by the piece.



Figur 2 **Begreppsförklaring till avgränsningarna i beskrivningen av det intermodala transportsystemet i rapporten (Källa: Woxenius och Bärthel, 2008).**

Land container: Standardized container according to UIC norms, for an optimal use mainly in road-rail combined transport.

Lift pockets: Standard lifting devices mounted on swap bodies and semi-trailers to allow vertical transshipment on intermodal terminals.

Maritime container: A container conforming standards that enable it to be used in cellular ships. Most maritime containers conform to ISO standards.

A high cube container adds extra length and width – 9’6” (2,9 m) instead of 8” (2,44 m).

A super high cube container adds extra length, width and height related to the standard ISO container. These dimensions may fluctuate, reaching length of 45´, 48´or 53 ´.

Megatrailer

The load unit Megatrailer is a newer design based on an internal height of 3 000 mm. In order to cope with the EU regulation, i.e. maximum vehicle height 4 000 mm, the loading surface is lower 330 mm in relation to the standard trailer. The lower loading height entails lower lifting devices and hence in order to be transshipped in intermodal transport a dedicated wagon, class T5/T3000, has to be used.

Standard dimensions for Megatrailers is; length 13600 mm, inner width 2480 mm and inner height 3000 mm. Max payload 33 Euro pallets and loading volume 100 m^3.

Pocket wagon:

A rail wagon with recessed pockets to accommodate the wheels of the road semi-trailers, and sometimes a swap body, so as it remains within the loading gauge (DE: Taschenwagen).

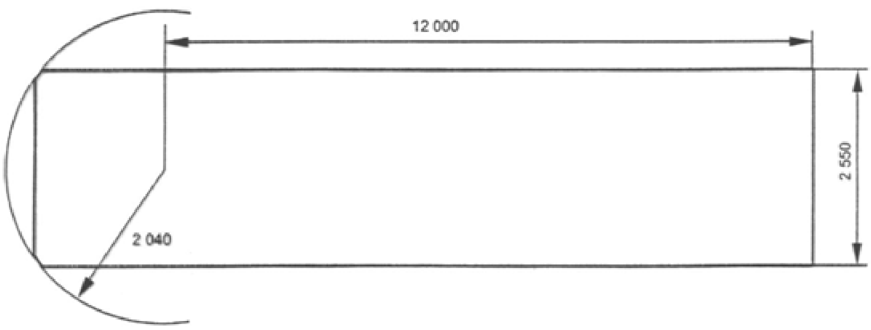
RoRo:

RoRo is a generic term for "Roll-on-Roll-off". As the term (denotation) reveals the loading units are driven on or off a ship, or as in the case of Semi-trailer: Any vehicle intended to be coupled to a motor vehicle in such way that part of it rests on the motor vehicle and substantial part of its weight and of the weight of its load is borne by the motor vehicle. These may have to be specially adapted to be used in intermodal transport.

Semitrailer:

A semitrailer is a trailer without a front axle and thereby connected to a road tractor via a King-pin. Via the coupling device a significant part of the vehicle's weight is transferred to the road tractor.

The EU regulation stipulates a maximum length of 13 600 mm, i.e. a maximum length of 16,5 meters for a road train. The maximum gross weight of a 2-axle tractor with 3-axle semi-trailers is 40 tons and 44 tons for a 3-axle tractor with 3-axle semi-trailer or chassis loaded with intermodal transport units, such as an ISO container with 30 tons gross weight. This combination allows under Swedish regulation a maximum gross weight of 50 tons. A standard semi-trailer has a tare weight of 5 tonnes and an average of 8 tons and a load capacity of 33 Euro Pallets.



Figur 3 Dimension of a semi-trailer (top view) (source: standard CEN TS 14993)

According to UIC 596-5 semitrailers have to equipped with lift pockets and if the width exceeds 2500 mm with air suspension (basically the standard for semi-trailers). A semi-trailer that is equipped for intermodality has 200 - 2000 kg higher tare weight.

A high proportion of semi-trailers transported by intermodal transport is called curtain trailers (tarpaulin). This design is designed to withstand wind forces arising when two trains meet each other in a tunnel, at speeds up to 120 km / h (SS-operation).

Swap body: A swap body is a standardized container which can be detached from the vehicle. The swap body is normally equipped with four support legs (drop-down), one in each corner. A swap body vehicle is normally equipped with a special lifting device or with air suspension which enables the suspension to be lifted or lowered. Standard sizes for swap bodies are presented in table 1.

Twist lock: Standard fixing devices for securing ITU’s to the carrying vehicle, vessel and wagon.

Unaccompanied transport: Movement/Transport of road vehicles, parts of vehicles or intermodal load units (ILU) on another transport mode (rail or sea) not accompanied by the truck driver.

Unit load: Load consisting of items or packages held together by one or more means and shaped or fitted for handling, transport, stacking and storing as a unit.

1.4 Working process

The model used in the project was originally developed by Jensen (2008) and has been as base for researchers and consultants during the last years. However, due to the aim and scope of the project this model has been adapted to the conditions in the project. The model used is presented below starting with activity 1 (Market), and followed by activity 2 (Standards and regulations) and activity 3 (Transport resources). Based on activity 1-3 a transport system analysis was made in activity 4, including the sub processes: spatial focusing, transport plan, need for infrastructure investments or regulatory exemptions and finally business economical/socio-economical evaluation of the proposed transport services. Activity 4 would in the subsequent steps lead to proposal for implementation and/or pilot actions.

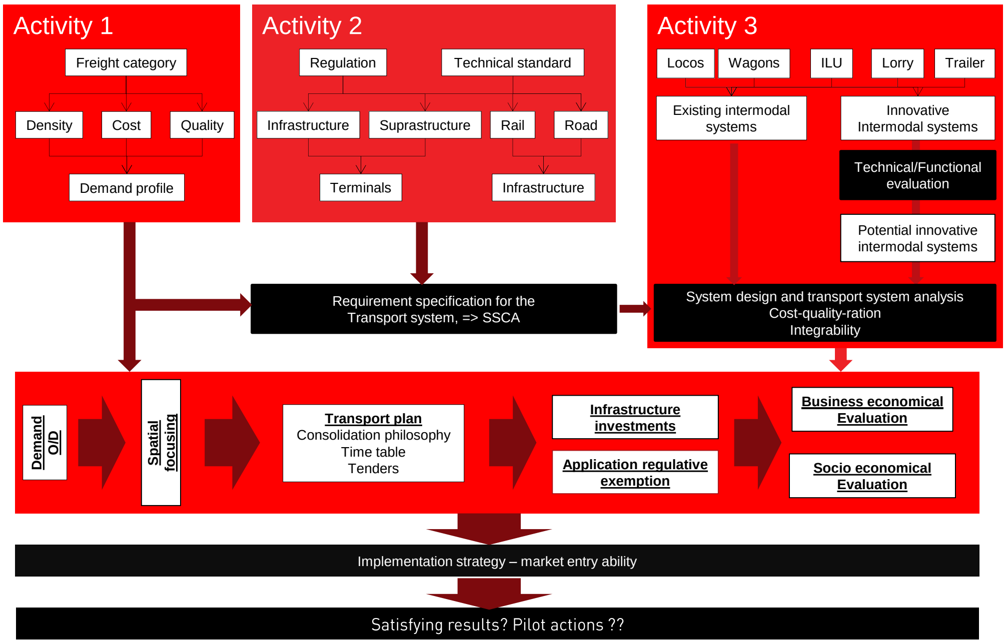


Figure 2 Schematic sketch of the structured analytical approach used in the project.

1.5 Methods used during the project

Along the project we have used (1) literature studies, (2) Interviews, (3) Analytical tools and (4) external presentations in order to collect, structure, process and analyze data and information in order to be able to draw our final conclusions.

1.5.1 Literature Review

Literature studies were included in the traditional way to identify previous research, reports of development projects and other public reports to build a frame of reference and to take advantage of previously documented results. Literature study's primary mission was to identify and find as much documentation as possible about ongoing and completed projects that have been made with intermodal corridor services. The identification is based on a combination of personal experiences and interviews of others. This part of the method the device is important both to identify and learn from the experience gained in previous attempts, and partly to analyze any differences in conditions in a comparison between when the projects, pilots or implementations attempts were carried out and under what situations. Both are for the project highly relevant issues..

1.5.2 Interwiews

The other primary source of information has been interviews. Selecting people to interview has taken place in the dialogue between the authors and the clients based on the knowledge of ongoing and completed development projects, identified in the literature. The goal was to get a full penetration of the forwarding industry and a good spread of people interviewed in order to capture as many aspects as possible within the study area. A total of 15 interviews conducted under the project. It should be noted that the dialogue with forwarding industry is influenced by the willingness of respondents to conduct factual interviews and discussions. In most cases the authors were assessing the respondents' answers were factual and reasonable, but in a few cases we have instead been based on secondary literature in those cases assessed as more objective than the response. The authors have chosen this model in order not to conflict with the respondents.

1.5.3 Categorization and analysis of barriers

There is a wide variety of studies and reports indicating the opportunities and barriers to establish or utilise intermodal freight transport. Most studies only point out the obvious organisational, technical and regulative issues, without making attempts to structure, prioritize and combine the barriers into packages of measures to stimulate shippers towards a radical shift from a unimodal road strategy towards an intermodal strategy. However to avoid the dominating thin analysis, we have based the analysis on the structured frame of references published by Storhagen et al (2008) and PROMIT (2009).

There are many factors that affect the potential of intermodal transport- they can either facilitate or hinder development of new solutions and increased use of intermodal transport by shippers. One potential categorization of these aspects is the following:

- Market aspects
- Organizational aspects
- IT, administrational and planning aspects
- Infrastructural aspects
- Operational aspects
- Regulative aspects
- Technical aspects
- Societal aspects

Intermodal initiatives can in principle be divided into 4 different groups, depending on the combination of current services/new services and current users/new users.

	Current services	New services
New users	Alignment of service offers with shippers' supply chain	Development of new concepts and a convincing approach
Current users	Performance improvement based on indicators leading to Adjustments	Enlargement of services based on proven success

Figure 3 ***Categories of initiatives (PROMIT 2009)***

The port will focus on Concept Development, whereas the potential of a new intermodal solution is evaluated for the case of new services for new users.

> *"Concept development initiative focuses on the development of new intermodal services for short- and medium distances based on the needs and requirements of shippers and logistics service providers. These projects are very complex and require a minimum level of volume to become economically viable and a minimum contract period to reduce risks for those actors that have interest to invest heavily in equipment and infrastructure. Therefore they involve many different actors, including a new network/service design, development of a new planning and control system, and specification of a business model. Convincing actors of the benefits of joining a new initiative is an intensive critical step in the approach*." (PROMIT 2009)

1.5.4 External presentations

During the project, the project results have been presented and discussed with representatives of authorities, carriers, shippers and manufacturers. These presentations and related discussions have been very important for the project focused implementation, analysis and results. It has given us the opportunity to dialogue, some reconciliations and a lot of interesting discussions. All sessions are regularly documented and retrospectively analyzed.

1.6 Time plan

The project was conducted during the period from January – June, 2012.

2 Freight flows

In the subsequent chapter the logistics and transport market, i.e. the trade between Norway/Sweden and Poland is presented and discussed. The chapter is opened by a general discussion about exports and imports between the regions and the general part is followed by a deeper analysis of the trade of farmed fish between Norway and Poland, including potential back haul. The chapter is, due to lack of base volumes from the fish farming industry ended by a discussion about potential freight flows in the Swedish-Norwegian part of the axis. These freight flows might be a base volume to introduce a service, however not linked to the Polish market this would be the base to overcome the initial inertia of change and hence in a second step the service could be extended the commodity group farmed fish.

2.1 Trade between Norway/Sweden and Poland

Poland´s foreign trade flows are mainly stretching in the East-West direction, constituting 65 % of the whole turnover, the use of the passenger-freight ferry connections.

The trade relations between Poland, Sweden and Norway are reported in the table by the share of import and export. Sweden is Poland's 12th trade partner in the world and in recent years Poland's merchandise turnover with Sweden has been dynamically increasing. Since 1998 it has doubled. Poland's share in Sweden's turnover was also significant. In 2009, Poland ranked 13th among the recipients of Swedish goods and 12th among countries which export goods to the Swedish market.

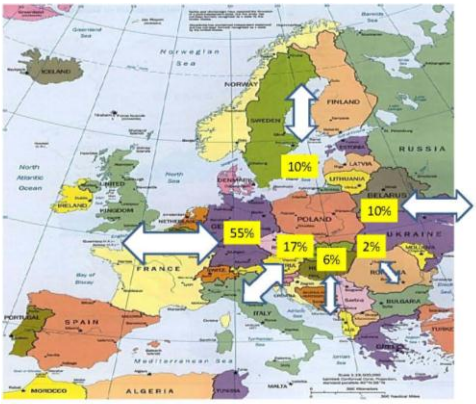


Figure 4 *Trade lines of Poland 2010 (TransBaltic 2010*

Table 2 *Respective share of import and export in Norway, Sweden and Poland's foreign trade accounts (2009)*

	Export	Import
Sweden – Poland	2,7 %	1,83 %
Poland – Sweden	2,5 %	3 %
Norway – Poland	1,91 %	1,29 %
Poland – Norway	2,5 %	1,6 %

In the trade relationship between Poland and Sweden, electromechanical industry products play the key role (export – approx. 52%, import – approx. 48% in 2009). Main products from the group exported to this market are: (1) vehicles, (2) spare parts and accessories, (3) TV reception equipment and its parts, (4) insulated wire, (5) parts for lifting, (6) relocating, loading and unloading devices and (7) rolling bearings.

Other important commodities are metallurgical products, chemical products, wood-and-paper industry products and mineral products. Also furniture and wood products are an important group of goods exported to Sweden. Together they currently comprise approx. 16% of exports.

Trade between Poland and Norway also covers a wide spectrum of commodities. The largest import shares to Norway fall upon manufacturers of metals; other transport equipment; road vehicles; electrical machinery, apparatus and appliances; furniture etc. While the main exported commodities from Norway are: fish; petroleum and petroleum products; non-ferrous metals; iron and steel etc.

Table 3 Commodity structure Norway-Poland trade (Transbaltic 2010).

NO imports from Poland 2009			NO exports to Poland 2009		
Commodity group	MNOK	Share	Commodity group	MNOK	Share
Total imports	11 743,2	100 %	Total exports	8 644,2	100 %
Manufactures of metals	1 635,9	13,9 %	Fish	3 116,7	36,1 %
Other transport equipment	1 181,5	10,1 %	Petroleum & products	1 597,3	18,5 %
Road vehicles	1 066,9	9,1 %	Non-ferrous metals	723,3	8,4 %
Electrical machinery, apparatus	890,7	7,6 %	Iron & steel	313,6	3,6 %
Miscellaneous manufactures articles	877,7	7,5 %	Paper & paper produce	241,5	2,8 %
Furniture and parts	830,3	7,1 %	Manufactures of metals	153,1	1,8 %
Telecommunication etc.	642,2	5,5 %	Crude fertilizers and crude minerals	131,5	1,5 %
General industrial equipment	608,7	5,2 %			
Office machines and data processing machines	578,5	4,9 %			

As can be seen from the figures above, industrial cargo is important part of the import flows from Poland, while fish produce makes up around 1/3 of export flows to Poland. Graph below illustrates the development in value and volumes in trade between Norway and Poland. In terms of volume, exports to Poland exceed imports. Whereas import volumes have been rather stable over the last 7 years, export volumes were affected stronger by financial crises and have since 2009 been recovering and growing. Value of Norway's export to Poland has increased faster than volumes after 2009, but overall both have increased. Before the start of crises import value from Poland exceeded export value, while after the crises the trade balance with Poland has been positive.

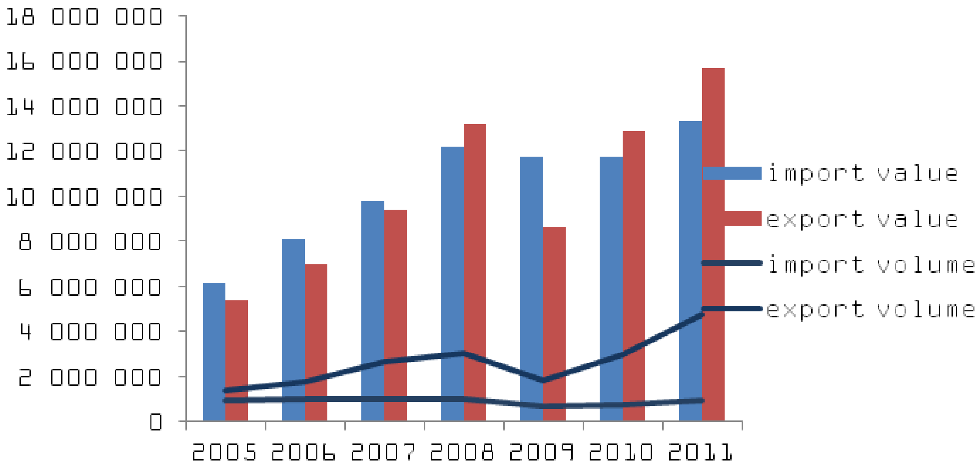


Figure 5 *Norway's trade with Poland, units: value in thousand NOK, volume in tons (based on Statistics Norway 2012)*

2.2 Transport between Poland and Sweden/Norway

A major share of trade volumes between Norway and Poland are bulk or semi-bulk products, consequently the share of volumes that are transported between Norway and Poland by ship is high: import 66,5%, export: 94,6% (2011). Table below illustrates the share of different modes of transport used in trade between Norway and Poland.

Import from Poland 2011		
	ship	66,5%
	lorry	30,5%
	railway	2,5%
	other	0,5%
Export to Poland 2011		
	ships	94,6%
	lorry	5,4%
	railway	<0,1%
	other	<0,1%

Figure 6 ***Norway's trade with Poland, by mode of transport, unit: percentage, as share of transport used in the volumes (based on Statistics Norway 2012)***

As can be seen, the second major share in trade volumes is by truck, similarly as with sea transport, the difference between import and export flows is quite large: 29,3% of imports from Poland and 5,3% of exports to Poland are carried by road. The share of rail is low in both directions, whereas more is used on import from Poland. Such misbalances in trade volumes transported by road, obviously pose a challenge for trucking companies in keeping the utilization of vehicles high. For more detailed view on volumes transported by intermodal transport in trade between Norway and Poland see the figure below.

Table 4 *Norway's trade with Poland, by mode of transport, unit export and import volumes in tons (statistics from Norwegian Statistics Bureau 2012)*

		2005	2006	2007	2008	2009	2010	2011
Import from Poland	Intermodal	14	13	76	79	46	101	84
	Road transport	1632	3581	2626	1831	1482	2898	2336
Export to Poland	Intermodal	114	39	96	49	18	:	60
	Road transport	698	1270	2112	1372	799	1000	1307

Volumes transported by ro-ro ferries in both directions have seen a significant drop in 2008-2009, but since then have had a positive trend. Intermodal rail-road transport for transport between Norway and Poland covers a rather insignificant share of trade volumes.

Ferry transport plays an important role in the trade between Scandinavia and Poland. There are several ro-ro ferry connections from the main Polish ports and Sweden. The competing ferry connections are; Ystad – Świnoujście (44 %), Trelleborg – Świnoujście (27 %), Nynäshamn - Gdynia (7 %) and Karlskrona – Gdynia (22 %).

Table 5 **Number of trailers on the Polish market.**

	Units	%
Ystad	153000	44%
Nynäshamn	25000	7%
Karlskrona	76000	22%
Trelleborg	96000	27%
	350000	

The graph below illustrates the development in intermodal volumes in ports with direct connection to Poland. There are two categories of flows, Intra-continental flows, i.e. within EU, based on semitrailers and an intercontinental flow based on ISO-containers. The intercontinental flows are totally dominated by the Ports of Göteborg, with the Port of Helsingborg as an alienated second, and the port of Gdansk as an interesting newcomer. However, in the Region Skåne-Blekinge-Småland the Port of Helsingborg handles 77 % of the ship-port volumes[1].

In the segment road based trailer transport the market shares for the Port of Karlskrona has increased dramatically during the last 15 years. Since 1999 the number of handled units has increased by 19 % per year and the market share on the Polish market has increased to some 22 % and this market share will according to Långtidsutredningen (2008) increase significantly due to the ever growing trade between Scandinavia and the Countries in Eastern Europe and the CIS countries. However, if we compare the total handled volumes to and from the European continent the Ports of Skåne still handles some 87 % and hence the Swedish transport policy is completely focused on these ports when prioritizing infrastructure investments or as argued by Bengt Birgersson in the Port Strategy Investigation in 2008: “The structure of the Swedish transport flows has been stable for the last 20 years and hence will be for the next 20 years”.

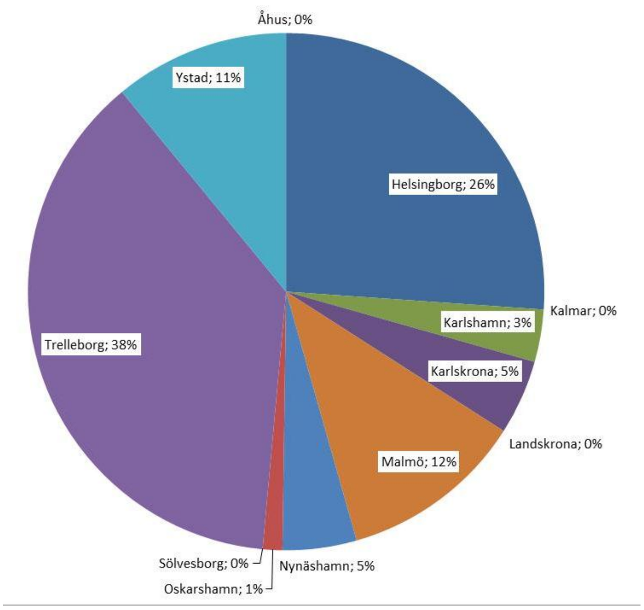


Figure 7 ***Market share for the ports in the Region Skåne-Blekinge-Småland for containerized shipments***

2.3 Case study: Farmed fish

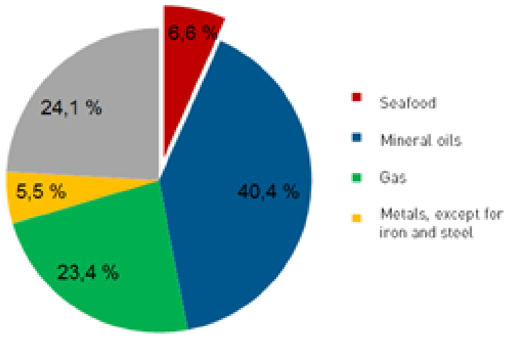
In the subsequent chapter the Norwegian fish farming industry is presented and the potential for intermodal transport in the axis Norway – Poland via Port of Karlskrona is discussed.

2.3.1 Seafood industry and export in Norway - General overview

Norway is the 11th largest seafood nation in terms of harvesting and farming (based on 2008 volumes), but in terms of export value, Norway is the second largest exporter of seafood in the world after China (Sjomatstatistikk 2010). In 2005, Norway accounted for a quarter of Europe’s seafood production (Tveten 2005). The fish industry is an important contributor to the country’s exports - in 2010 the fish industry accounted for 6.6 % of Norway's total export

[1] Observe: there is large volumes to and from the region transported via the Port of Göteborg (not included).

revenues (Sjomatstatistikk 2010). As can be seen from the figure below the value of exported fish and fish products from Norway has been generally increasing during the past 20 years, except for the small dip in the beginning of 2000s.



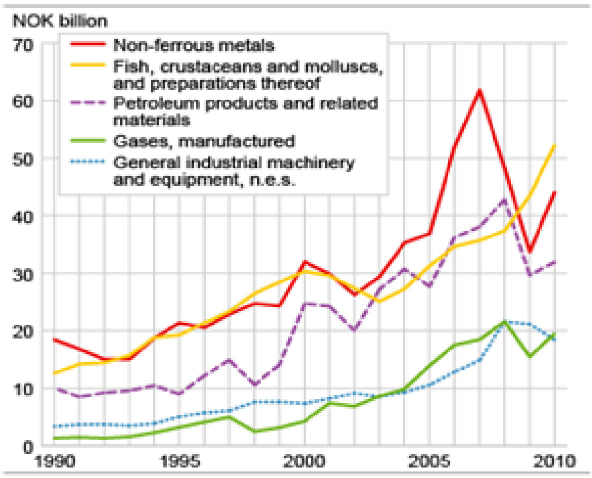


Figure 8 ***Seafood share in Norwegian exports(Left) and Export of goods.by Five largest, by SITC goods division, 1990-2010, unit: NOK billion (right)***

Following table gives a basic overview of the Norwegian fishing industry, for comparison figures from 2006 and 2010 are presented. As can be seen, major changes have taken place during the 4 year period. The main trend is consolidation in the industry, both the number of factories, exporters and licensed farmers has been reduce, while the value for exported fish has significantly increased. Today's fish farming industry has a differentiated structure which is both smaller companies with active ownership and large global corporations. Few larger companies export most of the seafood (NMC 2005).

Table 6 ***Norwegian fishing industry (based on NSEC 2006 & Sjomatstatistikk 2010)***

	2006 (** figures from 2004)	2010 (* figures from 2009)
The fleet	7313 vessels	6309 vessels
	11042 fisherman main occupation	9924 fisherman main occupation
	2891 fisherman secondary occupation	2356 fisherman secondary occupation
Fishing industry	693** factories	479* factories
	13 500** employees	10 100* employees
Aquaculture	2 636 licenses	1 313 licenses
	3 489 employees	5 070* employees
Export	520 exporters	464 exporters
	135 counties	142 counties
Export value	35,6 billion NOK	53,7 billion NOK

Interest for seafood from Norway has been high around the world (Vectura 2012). Norwegian seafood exports in 2010 were 53.7 billion (+9 billion compared to 2009) corresponding to a volume of 2.67 million tons (+ 90 thousand tons compared to 2009) (Sjomatstatistikk 2010). The fish industry in Norway is diverse: consisting both of wild catch and farmed fish. Farmed fish sales accounted for 33,3 billion NOK in 2010 and include sale of salmon and trout, while wild catch, accounting for 20,4 billion NOK in 2010 is mainly composed of herring, mackerel, cod and Pollack (Sjomatstatistikk 2010). As can be seen from graph below, the value of exported farmed fish has increased rapidly after the turn of the century and surpassed value of wild catch. In terms of quantity, volumes of wild catch are still significantly higher than from fish farming.

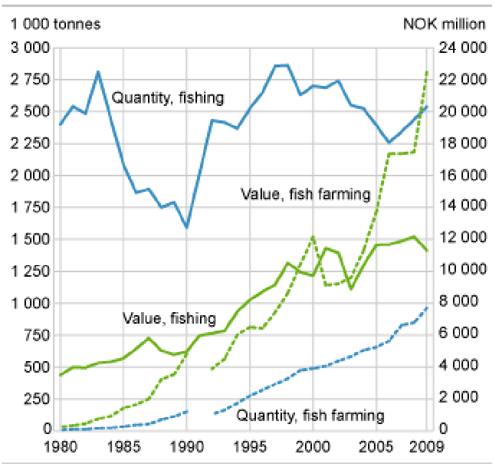


Figure 9 ***Fishing and farming in Norway: value & volume.***

Biggest market of Norwegian seafood is European Union accounting for 58 % of export with a corresponding value of 30.9 billion NOK in 2010. European Union is followed by Asia - Eastern Europe accounting for 15 and 14 % respectively. In terms of countries, France is the single biggest market, followed by Russia, Poland and Denmark. During the past 3 years all four biggest markets have experienced growth in terms of value of export.

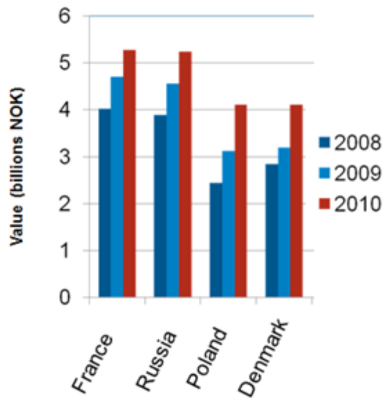


Figure 10 ***Most important markets for Norwegian seafood 2008-2010 (Sjomatstatistik 2010)***

In terms of export composition, salmon is the largest item- accounting for around 60 % of the total export value. Production of salmon has been steadily increasing.

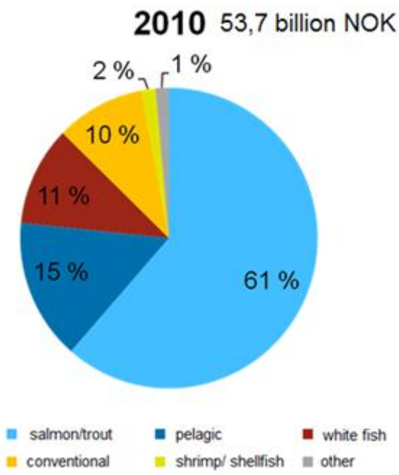


Figure 19: Division of export in value, 2010 (Sjomatstatistikk 2010)

Norway is the biggest producer of salmon in the world, with the market share of approx. 60 % in 2009. The biggest market for the Norwegian salmon similarly to the whole industry is EU (72 % of Norwegian salmon exports), followed by France (4.6 billion NOK), Poland (3.5 billion NOK) and Denmark (2,4 billion NOK. To a large extent Poland and Denmark are processing salmon for further distribution in EU (Sjomatstatistikk 2010). A major shift in the dominant markets for fresh seafood has been from Western to Eastern Europe, with Poland and Russia (3.9 billion NOK) as the main destinations of these exports (Nordland County Council 2009). Salmon exports to Russia have increased almost 66 %, accounting for 82 % of 2010 exports to Eastern Europe (Jensen 2012).

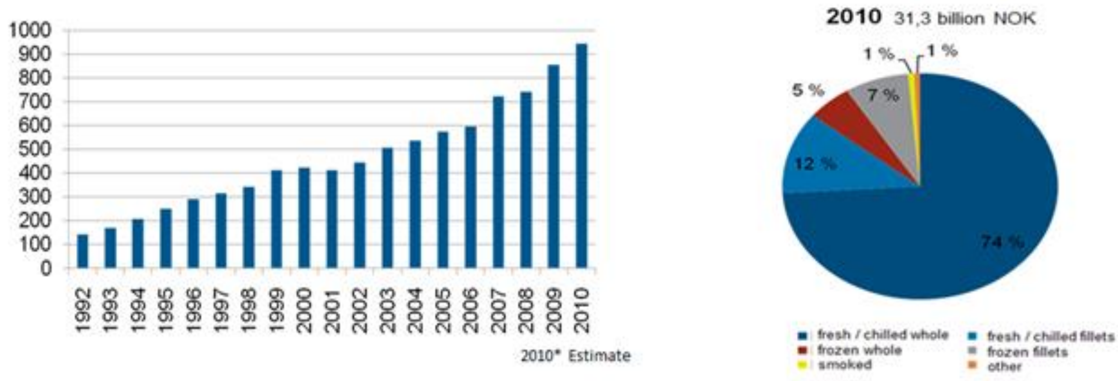


Figure 11 ***Norwegian production of salmon (Left) Norwegian exports of salmon (Right) (Sjomatstatistikk 2010)***

Distribution and sales are taken care of by a limited number of exporting companies in Norway. According to the Norwegian Export Council there are some 380 companies with cense to export salmon, white fish and shellfish. However, less than 25 companies control 90% of volumes. (NMC 2005)

2.3.2 Localization of the industry

Following map illustrates the geography of the Norwegian seafood industry- both wild catch and aquaculture. As can be seen farming is more equally distributed along the coast line, while fishing is more concentrated in mid and northern part of the coast line.

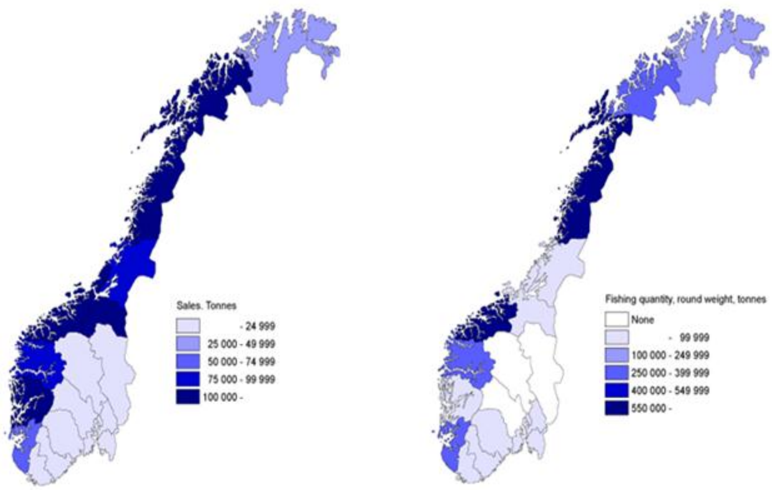


Figure 12 ***Industry localization: on the left – sales of farmed fish; on the right- fishing quantity***

Nearly half of the total volume of salmon and trout is produced in the four northernmost counties-Nordland, Nord-Trondelag, Troms and Finnmark.

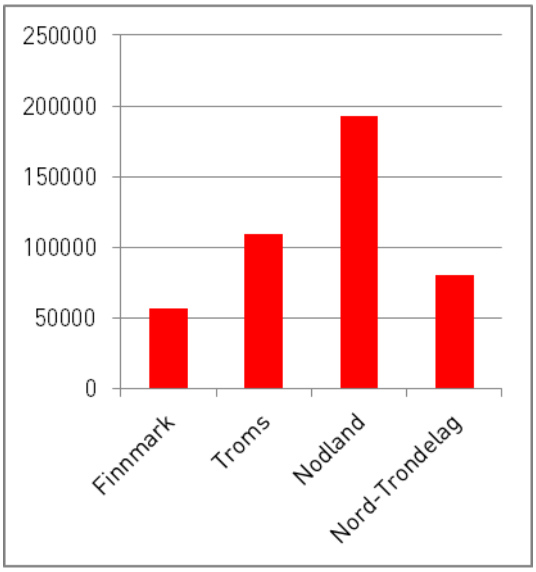


Figure 13 ***Volumes of farmed fish (in tons) 2010 (armed salmon, trout, and other species such as cod and halibut).***

2.3.3 Polish fish industry

The Polish fish processing industry consists of over 250 processing plants, which have the right to sell their products in the European Union, and more than 370 firms entitled to make direct sales (in regional markets, i.e., small processing plants adjacent to fish farms). Most plants, especially small and medium, are private enterprises or family businesses. Only some medium and large enterprises are capital firms listed on stock exchanges and owned by international concerns or funds.

Most fish industry plants were started after 1990 under free market conditions. The intense involvement of the owners made the fish processing sector develop very dynamically, not only satisfying the growing expectations of Polish consumers but also opening export markets.

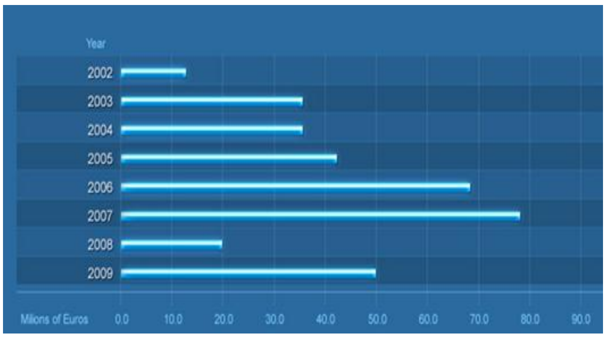


Figure 14 ***Investments in Polish fish processing industry in MEuro***

Before accession to the European Union in 2004, hygienic-veterinary requirements were raised. The Polish fish industry had to introduce intense modernization, while plants which failed to meet the highest veterinary standards were closed. Most plants managed to adjust to the EU regulations thanks to major financial and organizational efforts.

Today the Polish fish processing industry produces 360 000-380 000 tonnes annually, resulting in 1.5 billion Euros of income. Over 59% of production is exported to Germany, Great Britain, France, and Denmark, among other European and non-European countries.

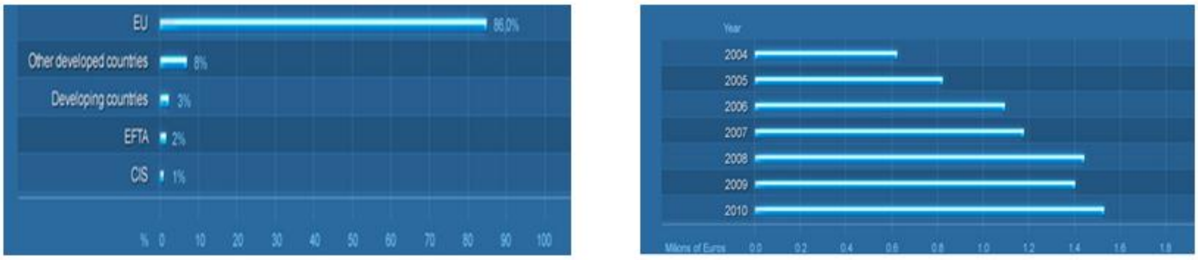


Figure 15 ***Markets of Polish fish export 2010 (share of volume) and right the dynamic development of Polish fish***

The map below shows the location of major fish processing companies in Poland. To conclude; there is a center of location around Kolobrzeg (Kolberg), Slupsk (Stolp) and Gdynia. In between Slupsk and Kolobrzeg a breakeven point can be found where the transport distance to/from the Norwegian market is shorter (in both time and distance) if the shipments are routed by Trelleborg/Ystad or Karlskrona. For example the transport distance from Oslo to Kolobrzeg is 1091 km via Trelleborg and 1196 via Karlskrona and for Slupsk 1079 via Karlskrona and 1203 via Trelleborg. For both directions the transport needs to be routed on the main road network.

Company	Location
ESPERSEN,	Koszalin
ABRAMCZYK	Bydgoszcz
SOLMAR	Darłowo
SUPERFISH	Kukinia
MORFISH	Gdynia
WILBO	Gdynia
MIESZKO	Sławno
FROSTA	Bydgoszcz
RYBHAND	Jarocin
STANPOL	Słupsk
KORAB	Ustka
SAL	Kołobrzeg

Figure 16 **Main locations of the Polish fish processing industries (left) and the main companies (including location (right)).**

2.3.4 Poland's fish imports

Due to its limited access to fisheries, Poland is an attractive market for raw fish material suppliers. Currently, the most important suppliers of raw fish material for Polish fish processing plants are producers from the following countries: Norway, Iceland, Great Britain, and Spain. Polish fish processing plants import significant amounts of pelagic fish (herring fillets and mackerel – usually frozen) which are used for smoking and production of marinated fish, salads and cans. Another important raw material is imported salmon (fresh and gutted, to be filleted and smoked in Poland, mainly for re-export). (Poland Fish 2012)

Polish fish imports of fish and fish products have been steadily growing during the past 20 years. Calculations show that average growth per year from 1991 until 2006 has been 23 % (NHH 2009).

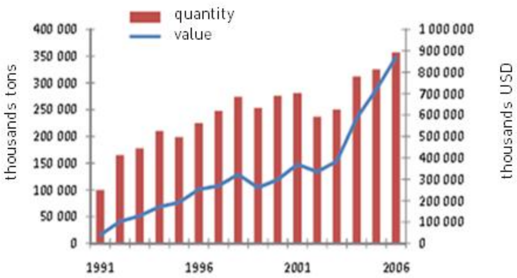


Figure 17 ***Polish fish imports (Source: NHH 2009, based on FAO statistic).***

Value of the imports has been growing more rapidly than the quantity due to a transition to more expensive produce. It has been a clear shift in consumption patterns towards more expensive products. It appears that the steady increase in imports has become even clearer after 2004, since Poland's EU membership has led to increased trade in fish (NHH 2009). 86% of Polish fish exports in 2010 were destined for other EU countries (Poland Fish 2012), mostly to Germany.

For several years, Norway has been the leading supplier of fish and fish products to the Polish market and import of these goods constitutes a significant share of total trade between these two countries (International Baltic WP4). For instance, Poland is the second largest market for Norwegian salmon in 2010 (Sjomatstatistikk 2010). Since Poland entered the EU in 2004 it has become was a strategic location for processing fish, and is the main location for processing of Norwegian salmon. The Norwegian share of the Polish fish imports has declined in recent years as more and more Poland imports fish from other countries. (NHH 2009).

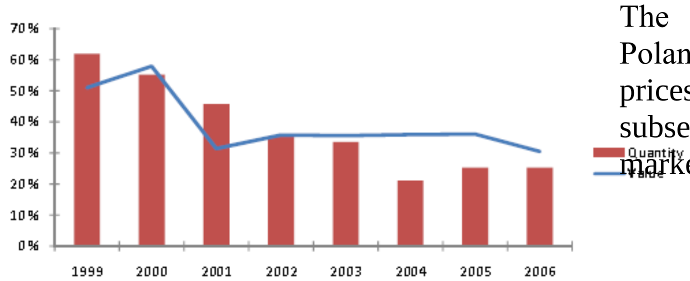


Figure 18 ***Norwegian share in the Polish fish imports (Source: NHH 2009)***

The decrease in Norway’s share of Poland’s fish imports is mainly due to prices on the Norwegian market and subsequent exploration of other origin markets (TransBaltic WP 4).

The graph below shows the development of Norwegian exports to Norway in terms of both value and quantity.

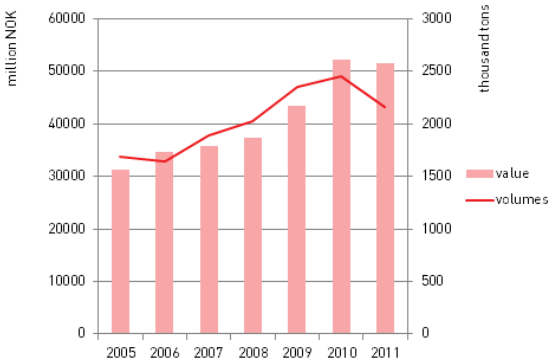
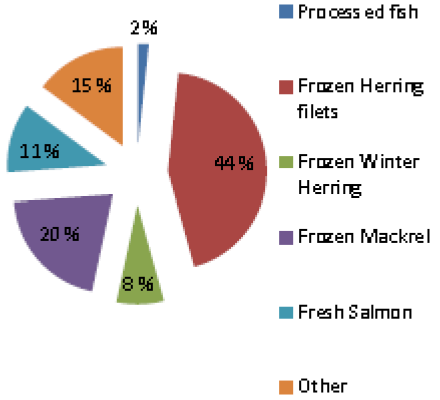


Figure 19 *Export of fish and fish produce from Norway to Poland: left scale value in million NOK; scale on the right: volume in thousand tons (Source: Statistisk sentralbyrå, www.ssb.no)*

As mentioned, the product composition of Norwegian fish exports to Poland has changed dramatically in recent years. In 2001, the main products frozen herring fillets and frozen mackerel. In 2008 was however frozen herring fillets of only 6 % of total exports, down from 44 % of total exports in 2001. Fresh farmed salmon had the opposite trend, from 11 per cent of total exports in 2001 to 71 % in 2008. Mackerel's share has decreased from 20 % to 2 % of total exports during that period. The share of processed fish has declined from 2 % of total exports in 2001 to just 0,38 % in 2008. Important to bear in mind is that the chart shows the comparison for the value, not volume. (NHH 2009)



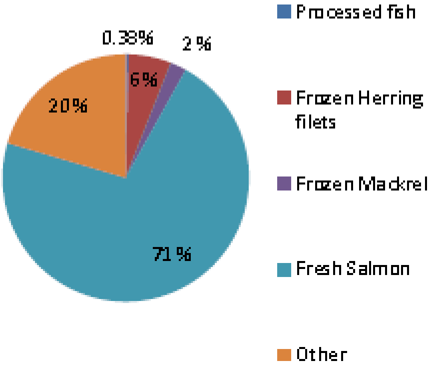


Figure 20 *Norway's fish export to Poland. On the right: 2008, on the left: 2001 (Source: NHH 2009, based on Norwegian statistics Bureau)*

Investigation into fish and seafood transports in the Norway-Poland corridor within TransBaltic WP4, revealed that the Polish coastal regions are the largest recipient area for Norwegian products. This area holds the clear majority of import enterprises and about 60% of manufacturing plants authorised for EU trade.

Table 7 *Major importers of Norwegian seafood in Poland (InterBaltic WP4 final report)*

Company name	Location	Production
MORPOL Sp. Z o.o.	Ustka (North coast)	30.000 tons of salmon
Suempol	Bialystok, Podlaski region – central	10.000 tons of salmon
Almar	Kartuzy (North coast, near Gdynia)	3.000 tons of salmon
Sona	Koziegowski (southern part of Poland)	1.000 tons

2.3.5 Industry and trade trends

Following list summarizes the major trends in the seafood industry and trade between Norway and Poland that are seen to have important influence on the development of transport of the exported produce:

- Fewer more effective production plants and slaughter houses (Tveten 2005 & Jensen 2012), but "centralization" of activities is characterized by enhanced activities at less central locations. Thus the concentration of the plants is not taking place in locations suitable for building intermodal transportation hubs for large volumes.

- The future growth of export will primarily come from the fresh fish segment. In the trade between Norway and Poland major shift taken place towards more expensive produce (including fresh fish).

- Strong international competition will lead to demands for continued restructuring and streamlining of the aquaculture industry.

- Growing cooperation in the industry: joint sales organizations, cooperation in harvesting and packing.

- 86% of Polish fish exports in 2010 were destined for other EU countries, mostly to Germany.

- Polish coastal regions are the largest recipient area for Norwegian products, which means domestic transport within Poland from port to plant does not require long-distance transport.

- A major shift in the dominant markets for fresh seafood has been from Western to Eastern Europe, with Poland and Russia as the main destinations for these exports.

- There are signs that new technology will make it possible to increase the shelf life of fresh fish and to freeze the fish in a way that has less impact on the quality. There is reason to believe that increased shelf life will allow for increased lead times as willingness to pay for extended storage time in the stores is limited.

2.3.6 Seafood transport

Harvesting, slaughtering, processing are commonly located in different locations, thus there is a need for transport in different parts of the fish supply chain. Efficient and effective transport solutions are of vital importance to the competitiveness of the industry. Transporting of fish and fish produce is complex both due to the nature of the cargo and industry. Following factors have an important impact on the transport of seafood:

- *Temperature sensitivity* (requirements vary)

Table 8 ***Temperature requirements for fish transport (Maersk Line 2012)***

Commodity	Recommended temperature (C)

Fish (chilled)	**-1 to 0**
Fish (deep frozen)	**-20 or colder**
Fish products (lightly preserved)	**1**
Fish products (semi preserved)	**2**
Shellfish (deep frozen)	**-20 or colder**

- *Lead time* (varies): type of cargo determines time sensitivity. For the export of fresh seafood from Norway the transport time is essential, since that has a direct impact on shelf life and consequently price of product. For instance, fresh salmon has a shelf life of 14 days in the controlled cooling. It is essential that shipments of salmon are completed quickly and with good quality to increase the proportion of time that salmon may be in store. Most of the fresh salmon exported goes in the truck (Vectura 2012). When trucking fresh salmon and white fish to customers at the continent, 2 and 3 drivers operate the trailer, in order to keep the schedule (NMC 2005). Transport costs represent a very small percentage of product prices, and given a short shelf life of fish, lead time and time used for transport is essential. On the other hand, frozen and prepared seafood do not have critical demands on transport time to the market (InterBalric WP4). Consequently, frozen salmon is mostly transported by boat.
- *Seasonal variations*: the export volume of fresh seafood varies over the year, and thus the need for transportation (Jensen 2012). Summer for instance is a low season.
- *Mode choice*: choice of transport largely based on price criterion, followed by punctuality and time.
- *Long distance to the market* makes efficient and effective logistics highly important for the competitiveness of the industry.
- *Transport buyers*: too large extent transport buying is a responsibility of importers/ receivers of cargo. Goods are sold on ex-works terms, which means that neither the producer not the exporter have any control over how the cargo is transported to the customer. At the same time more and more sales are taken place not within long-term contracts, which means both the purchase of fish and consequently transport is becoming more ad hoc.
- *Industry location*: fish factories that are situated on the coast are connected to the local road network. In in many cases, these are county roads or municipal roads that are not designed for truck size and axle loads as are most rational for the industry to use (NTP 2003).

Norway is exporting seafood to more than 170 countries. As majority of processing plants are located along the Norwegian cost, sea transport plays a major role. In 2011, export volumes of fish and fish products transported by rail and intermodal rail constituted just 0,12 % of total export volumes of fish and fish products. Following table presents a comparison of how exported fish and fish products are transported from Norway to Poland and in general (all markets).

Table 9 *Modal split 2011: export of fish and fish products from Norway: comparison of modal split to Poland vs. total export of fish and fish products*

	to Poland	total export
Ship	**31,80%**	**53,10%**
Railway	0%	0,10%
Intermodal	<0,1%	<0,1%
Road	**68,20%**	**72,70%**
Aircraft	0%	3,20%

Much of the pelagic production is seaborne cargo, with main shipping ports such as Tromso, Svolvaer, Alesund, Måløy and Bergen (NMC 2005). The big challenge is related to the transport of fresh fish and other high-value fish products. Shelf life and the importance of flexibility is the main cause of the high proportion of road transport to Europe. For instance, from the three counties (Nordland, Sor-Trondelag and Hordaland) that produce the largest share of total exports of fresh salmon and trout, road (including ships) and air represent respectively 71% and 29% of the number of shipments. As air is characterized by high frequency and low weight, the net weight of the market share of vehicles and aircraft are 92% and 8%, respectively. (SIB AS 2009) Oslo remains the major hub for the export of fresh seafood as well as for the import of vegetables, flowers and fruit from the continent (NMC 2005).

In Norway, the transport sector consists of several small operators as well as a few larger logistic companies. However, in the fresh seafood segment, the larger companies are dominating and have nearly 90 % of the market:

- Nor Cargo Thermo, Oslo/Trondheim
- Linjegods, Oslo
- Tollpost, Oslo/Bodø
- DHL, Oslo
- Johs. Lunde, Sola/Oslo
- Thermo Transit, Midelfart (Denmark), Oslo/Bø i Vesterålen

The share of fish and fish products transported to Poland by road is significantly higher compared to the aggregated figures for all markets - 67,8 % of fish produce is transported to Poland by truck . The graph below illustrated how the modal split in fish produce transports from Norway to Poland has changed since year 2000. Clearly, road transport of fish produce has significantly increased.

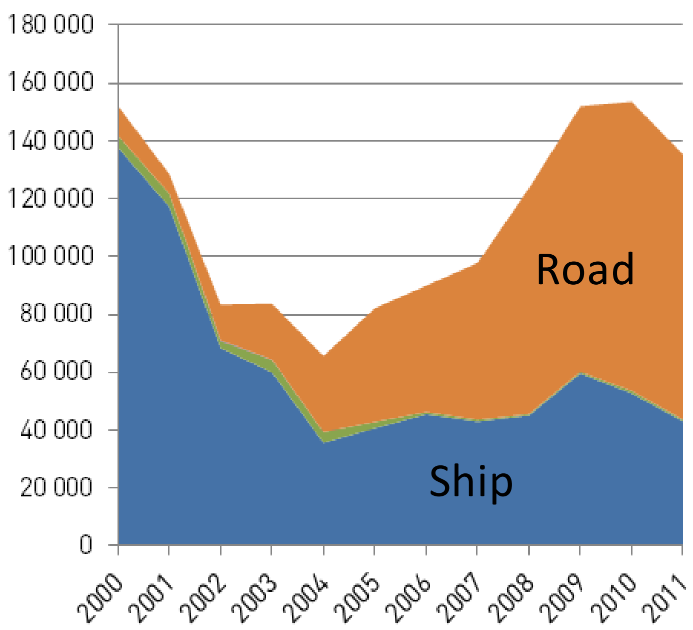


Figure 21 *Modal split 2000-2011: transport of fish & fish products from Norway to Poland, share of volumes*

Average truck carries around 19 tons of fish. The price of transporting a truck to Poland from Northern Norway is around 25 000 NOK, whereas per kilo transport only accounts for 6-7 % of the product price.

2.3.7 Challenges in road transport

The large share of road transport in Norwegian seafood export is problematic and unsustainable in long-term. As mentioned previously, due to the flexibility and the relatively low cost, road transport is often the preferred mode for transport of fish produce to continental Europe, especially for more time sensitive cargo. Following list is a summary of problematic issues associated with the current road-dominated transport solutions for fish produce export:

- Serious and fatal traffic accidents. For instance, in Nordland County during February-March 200 trucks were off the road;
- Congestion on roads, especially in central-eastern part of Norway (NTP 2003);
- Emissions;
- Low utilization of resources: empty runs on return transport (Nordland County Council 2009);
- High share of foreign drivers: impacts cost structure and thus the competitiveness of road transport compared to other modes.

Table 10 *Carriage of fish by lorry across national border by nationality of lorry (2011)*

	All nationalities	Norwegian	Swedish	Danish	Finnish	Other
Volume	930 363	674 520	8 462	11 256	32 398	203 727
Share	100%	73%	1%	1%	3%	22%

For example, for fresh fish exported to Poland from Nordland County, the share of polish drivers is up to 90 %. Large share of foreign drivers is also as problematic as the drivers are often not used to road conditions, especially during the winter period.

- Long distances to market: challenges in terms of driving and rest time regulations (Jensen 2012);
- During periods of major demand for fresh fish there is great pressure on the truck capacity. This leads to significant delays, longer transit time and, not least in relation to the unpredictability of when shipments arrive at their destination. This is especially problematic as fresh seafood products have limited shelf life (Jensen 2012);
- Low standard of roads between fish plant and trunk road and on parts of the trunk road links north - south along the coast line (NTP 2003). Poor road standards results in longer transport time, time scarcity in relation to ferry routes, trains, airplanes etc. (Jensen 2012). Bad quality of roads can also cause damages to the fish boxes (Jensen 2012).

2.3.8 Challenges in rail transport

Role of rail /intermodal rail for the fish industry in Norway has been very insignificant – less than 0,1 % for the export of fish and fish products. Fish is not a traditional rail cargo; there are service quality problems in the rail cargo sectors; transport buyers have little experience and biases towards rail; rail market is in a transition phase; the rail network does have a good match with the industry geography; rail transport requires consolidation of large volumes etc. Despite that, the interest toward rail and especially intermodal rail that combines the benefits of flexible road transport with economies of scale from rail transport has been increasing. Industry is facing problems regarding existing road-based solutions and to make the practices more sustainable, not only concerning the products. Dependence on road transport can be reduced by developing new innovation rail-road intermodal solutions or establishing new Ro-Ro routes. Currently the Norwegian seafood industry is investigating different opportunities both exploring the potential of road-rail and road-sea combinations. The following discussion will focus on how rail is used today and what is the issues.The graph below illustrates volumes of Norwegian export of fish produce transported by intermodal rail. The statistics however do not account for export volumes that are transported partially by rail – nationally or from Northern Norway through Sweden to Oslo. A great increase can be indicated in 2010 which most likely corresponds to the newly discontinued connection Oslo – Rotterdam, which was operated by the freight forwarder Bring. There are several reasons for this discontinuation, but some are; (1) operational non-prioritised transport through Denmark and (2) temporary withdrawal of the environmental supplement in Denmark in combination (3) with lack of economical endurance within the forwarding company.

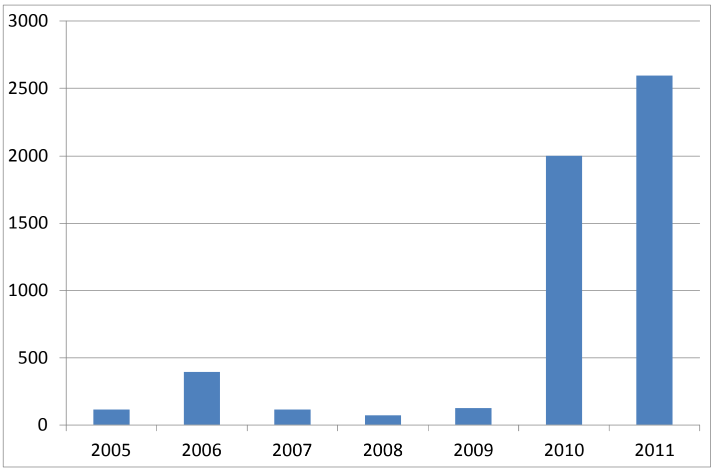


Figure 22 *Use of railway and intermodal rail for Norway's export of fish and fish products, unit: tons*

There are two main railway routes that carry fish from Northern Norway to Oslo today: one originating in Bodo/Fauske and one originating in Narvik. The latter involves transit through the Swedish railway network as Narvik is not connected to the rest of Norwegian railway network. For instance, 49% of the fish from Troms region went on a train through Narvik - around 36 thousand tons (Transportutveckling 2012).

Rail has a negative perception among cargo owners, based on a study of cargo owners working with fresh seafood (NMC 2005). Based on a study of 11 major fish exporting companies in North Norway, the few companies that were using rail had mostly positive experiences, though some complained about flexibility and punctuality of the service.

As mentioned, transport time is a major factor in case of fresh fish transport. The table below shows transports time from terminals in the northern part to terminal in Oslo.

Table 11 *Transport time by rail to Alnabru terminal in Oslo (Transportutvikling 2003)*

From terminal	Transport time
Bodø	20:50
Fauske	19:49
Mo i Rana	16:09
Mosjøen	14:50
Trondheim	07:51

2.4 Potential volumes for backhaul

The transports of farmed fish to Poland are today balanced by transports of colonial products, vegetables and general cargo from Poland. These shipments are sent to the large grocery firms, mainly in the Skåne Region, however also sent to Mälardalen. According to the respondents; for Northbound transports the link from Świnoujście – Trelleborg is preferable if the shipments are designated for Helsingborg. Some respondents also claim transport actors performing illegal cabotage transport and illegal third country transports violating the Scandinavian transport regulation within Sweden and between Sweden and Norway. Even though, only 25 % of these trucks arrive to the Fish farming counties with cargo.

Trucks with fruits, vegetables and general cargo from Poland and other origins in central Europe to Scandinavia are according to statistics returning more or less empty back to the south. (Norrland County Council 2009), which is opposed by the respondents. However, in terms hygiene, fish today is loaded on pallets in special cargo carriers and with today's disinfection processes there is no concern over risk of odor and other health factors for other cargo to be loaded in the same transport unit

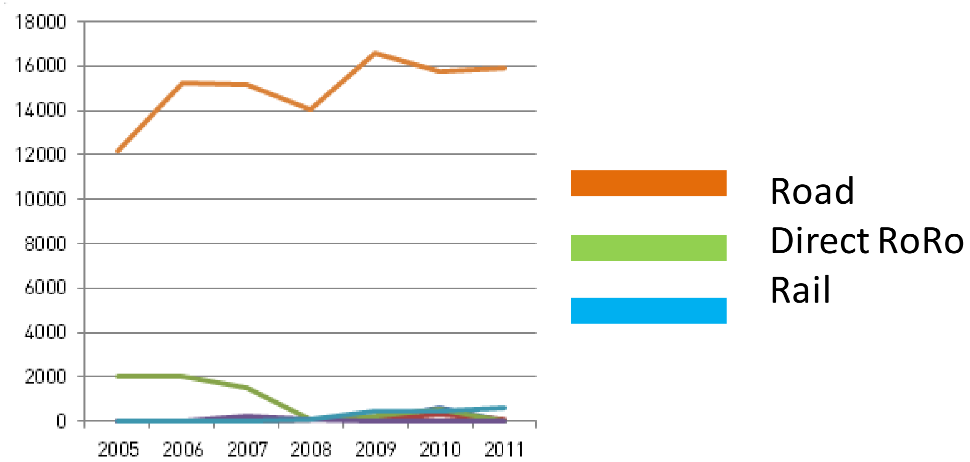


Figure: Import of fruits from Poland to Norway by mode of tarnsport, unit: tonnes (Source: Statistisk sentralbyrå, www.ssb.no)

2.5 Complementing transport flows

In the previous subchapter we have presented the main case study of this project. We can already assume that these volumes cannot fill a complete intermodal train from Norway to Port of Karlskrona and hence they need to be consolidated with other consignment categories in order to establish a base volume for the transport service. These complementing shipments have to be found in both transport directions and will briefly be described and discussed in the following chapter.

A large volume transported from Norway to Sweden and Poland is Aluminum and paper products. However, the Norwegian paper and pulp industry is undergoing a structural change and at least one industrial group has made bankruptcy. Hence, the following discussion contains some question marks related to the future changes within the latter group.

For the Commodity group Aluminum there are three major manufacturers delivering large volumes to the Swedish industry. These factories are located in Mo i Rana, Sundalsöyra and Farsand, and over 100 000 tons of aluminum is transported from these three factories to the manufacturing (automotive and furniture) in Småland and Östergötland, Sweden.

Transports of Aluminum casting are either made on conventional rail wagons or semi-trailers. On a rail wagon 65 tons might be loaded and on a semitrailer up to 28-34 tons, however, one barrier is the absence of conventional rail transport from Norway to Sweden and also the absence of terminals in Sweden. In the study "VETLANDA" Bärthel and Arvidsson (2001) proposes a terminal in Vetlanda and in the study Vectura (2012) a terminal in either Hultsfred or Södra VI is proposed to serve the local market in Småland. In combination with the newly developed terminal in Räppe, owned and operated by Alwex, a network of terminals could be established and between the manufacturers in Norway and these terminals a frequent transport service could be established.

Figure 23 The Aluminum terminal in Vetlanda need to bed extended in order to handle increased freight volumes (Photo: Fredrik Bärthel, Vectura).

The respondents indicate a frequent service of at least on connection peer week, i.e. the frequency and the time reliability is the decisive parameters together with the transport price.

In the northbound direction there is a need for transport of Tissue Paper to the Norwegian groceries as well of Waste paper to the Paper Mill in Levanger (Norske Skog). The Tissue Paper is produced by Metsä-Tissue (Pauliström) and Swedish Tissue and is transported to the distribution Centres for the Norwegian Market. Some of these volumes are already transported by rail, however the shipper is not satisfied with neither the service nor the ability to find balanced freight flows (affecting the transport costs). Other shippers indicating a need for transport services in the axis investigated is saw mills and chemical industries. All these shippers have small and dispersed freight volumes, i.e. not enough volumes for initiating a transport service on their own. However together a service connecting Oslo and Småland/Blekinge via Hallsberg – Nässjö could be established with sufficient frequency and freight balances for profitability.

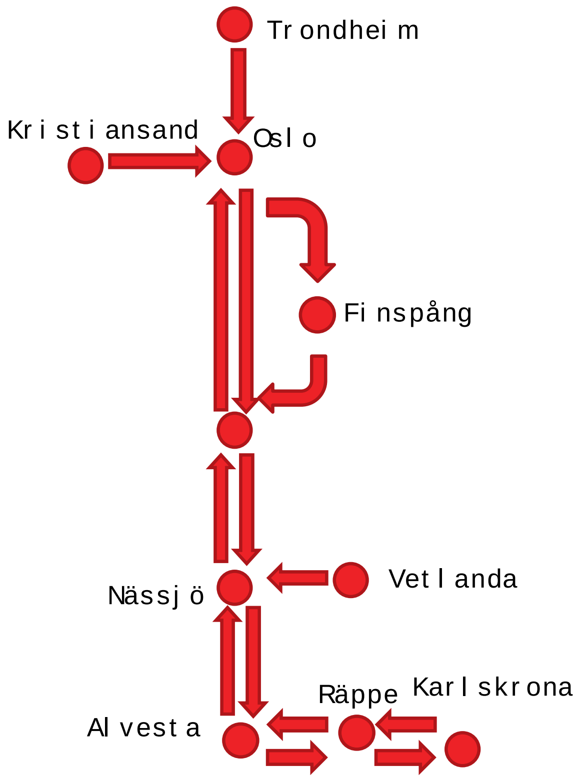


Figure 24 Proposed network in the facal corridor

The consumer driven market require frequent transports (five days a week) and acceptable time reliability. When several transport service providers can offer frequency and time reliability, the next and final step will be to choose the TSP who offers the best price in order to get an optimal cost-quality-ratio. Hence, a fundamental factor in intermodal transport have difficulty competing with truckloads and clean road transport are: first, that intermodal cargo carrier has a load capacity that is 15–20 % lower than the load unit adapted for road transport. Secondly, it reduces the load capacity by 5-8% if an intermodal transport unit used (loaded on an L-wagon) or 15-20% of the number of EURO-pallets are counted. If both the consignor and the consignee have private sidings the transport is competitive to unimodal road, however an intermodal transportation is also burdened by the lifting and pre- and end haulage costs, resulting in a railway carriage that had a cost advantage (relative to the truck), 10-30% will be 15-60% more expensive than road. The figure below shows exemplified the phenomenon where the x-axis represents distance and the Y axis relative cost compared to full load cost (industrial track - industrial track). In order to create economy of these shipments require balanced flows (line ToR-Interm). The line ToR-VLT indicate the effects of balanced flows where the cart repositioned at the endpoints.

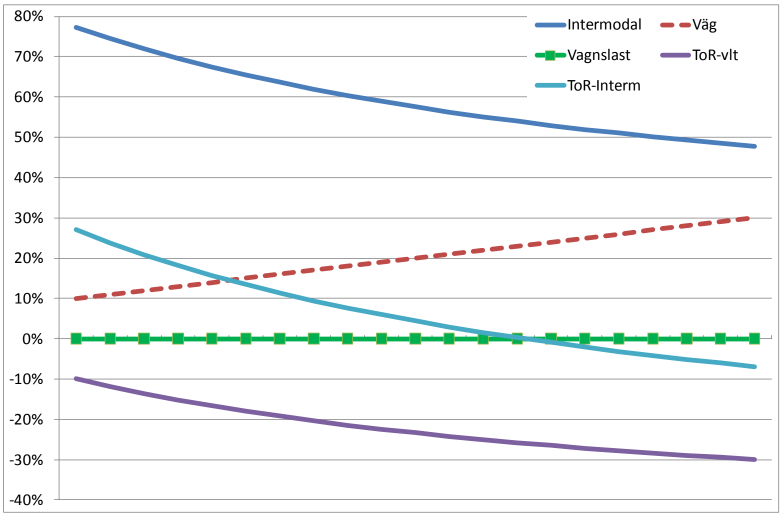


Figure 25 Cost Impacts if the road transport is transfered to an intermodal or rail transport. The effects of balanced transportation specified in the ToR-VLT and ToR-Interm.

The lead time affects not only business opportunities in the provision market, but also affects the cost of transport by the lead time affect resource utilization. Today there are shunting at Feralco and SAPA only a few days a week, which in combination with longer lead times between sender and receiver have a negative impact on resource utilization. Rental for wagons, are paid seven days a week. Loop time for these tank wagons is in the current situation an average of two loops per three weeks (rent index 100). If the number of shunting operations were increased to five days a week, combined with more free shunting times in both mornings and afternoons a reduced lead times (with 24 hours between Nässjö - Gothenburg) could be reached. For the shipper the rental cost per loop would be reduced from index 100 to index 30. At present, transport costs are equivalent between road and rail, however a change would give the railways a considerable cost advantage of approximately 30%.

The lead time from customer order to delivery is essential for shippers to compete in the provision market. The lead time of the utilization of road is shorter domestic as well as between Sweden and continental Europe, although the industrial track is available in each endpoint. Missing industrial track, the company must employ a transshipment terminal or free loading area. It extends the transport times by up to 24 hours per occasion. This means in many cases that the rail option is disqualified even though the price is considerably lower. All handling, including shunting and transfer, increases the risk of cargo damage. A large number of the companies interviewed state that cargo in combination with the handling at terminals is essential for the railroad shall be required for a transport assignment. This requires the free loading area or truck cargo terminal at the shipping or receiving point where the cargo load on the road and rail. From the interviews show that it requires a good knowledge of various types of goods and the transshipment affect opportunities to transfer freight from road to rail from a freight perspective, period. Fragile goods basically mean that industrial tracks in both endpoints are a condition that the goods are transported by rail. While traditional railway steel products are sensitive for strain and tension and place high demands on the operation. The organization of intermodal transport is more complicated than for truckloads or trucking. Missing private sidings must transport chain initiation and / or ends with a road transport and the goods need to be loaded on the truck loading terminal or free loading area from road to rail. This requires planning and coordination of transportation, storage, loading equipment and other resources in the transport chain as well as on cooperation between the transport chain actors. The organization of intermodal transport is a barrier and is already the goods in a truck, it often makes the journey between sender and receiver is the only highway unless the transport distances are very long.

One aspect that is clear from the interviews is that rail cars are at the sender's and recipient's disposal for 8-12 hours for loading and / or unloading. The time horizon enables the company to even out the coat of loading personnel during the hours of the day and thereby create better working conditions for loading personnel and truck drivers. The interviews also show a drawback of using free loading areas in relation to private sidings at the factory site. The multimodal transport solutions disappearing advantage of the coating by loading personnel in relation to the wagons are loaded at the industry and simultaneously to the requirement of handling equipment at free loading area or wagon load terminal. For larger volumes the pre or end haulage need to be performed over a longer period. This extends the lead time in combination with the planning requirements increase.

Studies Östlund et al (2006) show that companies that traditionally did not use rail discovered the advantage of rail transport through marketing efforts from a regional rail operator or niche operator (Woxenius and Barthel, 2008). With local operators raised questions around the capillary infrastructure back up on the table and traffic is allowed to develop gradually.

3 Transport, technical and infrastructural regulations

European countries and regions are gradually moving towards a network economy, where important nodes of economic, cultural and technological progress are linked together by a well-connected infrastructure network. Notions as interoperability, intermodality and interconnectivity have gained popularity among European politicians and decision makers and are might be regarded as "EU jargon" (Priemus et al, 1998). These notions refer to different potentials among the different actors involved in the transport system as they are related to potentials for various actors and operators to realize value added and economic benefits as a result of the integration of different modes and nods in the European transport network.

Related to the development and implementation the European Union has committed itself to strive towards interconnectivity and interoperability in and between the different national transport networks. Missing links are a natural consequence of country by country provision without looking to the wide uses of a European network (Nijkamp et al, 1994). The EU policy is directed towards intermodality, interconnectivity and interoperability, i.e. thinking in terms of systems rather than individual modes.

There are different dimensions of interoperability; (1) technical, (2) organizational, (3) juridical and (4) cultural interoperability. The frequently limited discussion around technical dimension is inadequate. The reason, explained below, is that the different national transport systems are operated by different organizations, using different technologies in accordance with legislation. Any of these dimensions may cause impediments to interoperability.

<u>Technical interoperability</u>

Technical interoperability is achieved when different transport systems are linked in way which effectively and efficiently extends the network of services. Technical interoperability requires the various systems' physical infrastructure to interface effectively and efficiently. A unimodal example of technical interoperability is the linking of national rail systems across the national boundaries to facilitate international rail transport.

<u>Organizational interoperability</u>

Organizational interoperability (corporate interoperability) occurs when different organizations are willing and able to co-operate to provide the transport service. Organizations which need to co-operate may be from different sectors, in different countries and with different functions of the transport system.

<u>Juridical interoperability</u>

Juridical interoperability is mainly related to different national and European legislation, which may cause impediments in the transport chain. One example may be that co-operation between different organizations in the transport sector is limited by European and anti-trust laws. This causes impediments in the development of intermodal transport chains. Another example is that different countries apply and implement directives from the European Commission differently and this may cause barrier between the different countries in the development of an interoperable network. For example the different implementation of a deregulate railway has caused a restriction for international competition.

Cultural interoperability:

For example different languages between different countries may act as impediments to transport and this can also be due to cultural identity (i.e. working conditions).

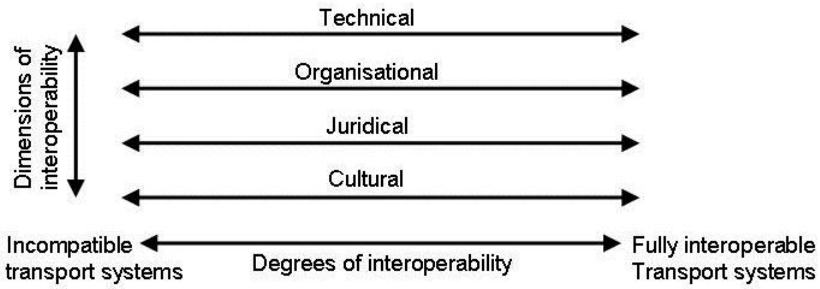


Figure 26 **The dimensions of interoperability**

Full interoperability is achieved when the different transport systems deemed to have technical, organizational, juridical and cultural interoperability. This would enable a user to purchase a specific transport service for a pre-defined purpose O/D-relation from a single source; with complete and certain knowledge of any appropriate alternative timetables, prices, interchanges and transport modes. However, in the chapter we have focused on the technical and partially juridical level of interoperability and will in the subsequent chapters (denoted market) also highlight organisational and cultural interoperability.

3.1 Road transport

The regulation regarding road vehicle dimensions differ between the countries in the transport corridor. Hence in this chapter the regulations in the Nordic countries are compared to the dimensions in Poland and the former Eastern Europe. The latter countries have the general regulations of the European Union (18.75 meters and 40 tons). In Sweden longer and heavier trucks are allowed (25.25 meters and 60 tons) and in Norway heavier (18.75 meters and 50 tons). In Sweden pilot actions for 32 meters and 80 tons are tested in pilot actions for short haul container transport port-hinterland for Volvo Logistics and for wood transport for the forest industry.

The vehicle dimensions in the European Union are in general limited by a gross weight of 40 tons and a maximum length of 18.75 meters. The length load carrying unit is restricted to 16.4 meters resulting in an effective loading length of 15.65 meters since 2.35 m is dedicated for the cabin and 0.75 m for the clutch. The aim of the regulation is to avoid mobility problems in urban areas. The maximum weight is restricted to 40 tones if the road train consists of a 2-axle tractor with a 3-axle semitrailer. According to EU rules a gross weight of 44 tons for a 3-axle tractor unit with 3-axle semi-trailer carrying intermodal freight carriers is allowed. Hence, this allows a sea container with 30 tons gross weight to be transported. The same combination of vehicles with Swedish regulations might weight 50 tons.

In Sweden and Finland longer and heavier trucks or road trains have been allowed for decades. In Finland the maximum length was 22 meters and in Sweden 24 meters until 1997. When Sweden entered the EU in 1997 the differing dimensions of road vehicles raised a discussion within the EU. Based on a proposal from the Swedish government dated August 1, 1997, a new modular system, Class Transport System (TCS - now the European Modular System) was introduced in Sweden and Finland. This gave foreign hauliers the ability to adapt their vehicles to the Swedish standard by combining standard dimensions on vehicles.

The TCS/EMS concept refers to road vehicle combinations with a maximum length of 25.25 meters based on combinations of road vehicles and load units complying with Directive 96/53/EC. This directive stipulates a maximum loading length of a road vehicle, except a trailer or semitrailer, of 7.82 meters. If the EMS road train is longer than 24 meters it needs to be maneuverable in concentric circles with an outer radius of 12.5 meters and an inner circle of 2 meters. Further, an EMS combination is not allowed to be higher than 4.0 meters (EU's height limit)[2] and finally the directive stipulates that the combinations should be equipped with ABS brakes and with clutches in accordance with Directive (94/20/EC). One advantage, often mentioned, is the interoperability between the EMS concept and intermodal transport, since both are based on intermodal loading unit dimensions. Further, compared to a 24 meters road train an EMS road train increases the loading length with 7-8 %, but have higher energy consumption and higher maintenance costs than the traditional road trains of 24 meters.

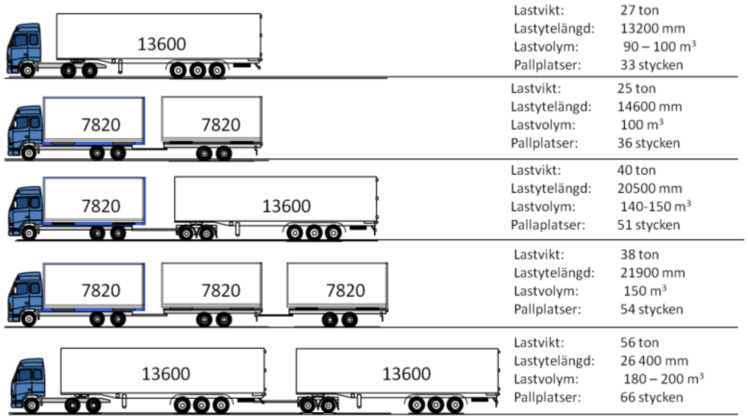


Figure 27. Existing and proposed intermodal road transport concepts on the European market. The upper two are allowed in all Europe and the third EMS-concept is allowed in Sweden and Finland (length: 25,25 m). Abbreviations: lastvikt = pay load, lastytelängd = loading length, lastvolym = loading volume, and pallplatser = capacity (number of Euro pallets).

Sweden allows longer and heavier vehicles than most European countries and the changes in the Swedish regulation have significantly increased the competitiveness of road transport. Changes in the regulation in 1989 and 1993 increased the payload by 27 % and in 2008 the average road transport cost was 1.3 Euro per km, including loading and unloading (VTI, 2007). An analysis of the difference between EU-vehicles and EMS vehicles show a cost difference of 17-20 % per tonkm (Backman and Nordstrom, 2002, Nelldal et al, 2000, VTI, 2007) in favor for EMS.

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[2] The height restriction in Sweden is 4.5 meters (infrastructural restriction) for other road trains.

3.2 Railway transport

There are great similarities between Norway and Sweden when it comes to legislation and regulatory framework within rail transports. As an EU-member Sweden has adopted the different EU-package concerning rail transports. In this summary of the differences we will highlight for intermodal transport important differences.

3.2.1 Loading gauge for intermodal transport

The permitted loading gauge in Sweden is larger than allowed in most other countries in Europe and is greater than loading gauge provided in the new common European technical standards (TSD).

It is in most cases, the standards for road traffic, which determines the gauge on the transport of unit loads in intermodal transport chains, but there are limitations of the rail system. In an intermodal transport system is (1) infrastructure (links), (2) infrastructure in yards (nodes) and (3) terminals handling equipment that limits the gauge. The standards for intermodal rail are like for conventional rail transport, set by the UIC. In the regulations the loading gauge for swap bodies are set by the letter C and semitrailers by P. The letter is followed by either a two-digit or a three digit number.

The two-digit denotation indicates permissible level above a 0-line of 3630 mm above the rail for a 2 500/2 550 mm wide load unit. This means that in the loading gauge P70 indicates that semi-trailers with 4 meter corner height might carried on condition that the wheels are positioned 330 mm above the rails.

The three-digit denotation refers to the height of a 2600 mm wide swap body placed on a standard wagon. Within the loading gauge of P400, a semi-trailer with 4000 mm corner height and 2600 mm width can be loaded onto a wagon with a wheel floor 330 mm over the rails.

The most common gauge in Europe [Poland] is P400/C400 and in Scandinavia P410/P407/C405. P400 allows the transport of semi-trailers with width 2600 mm and corner height 4000 mm (4330 mm above the rails) and the infrastructure with gauge C400 allows transport of swap bodies with width 2600 mm and corner height 3150 mm. This means that the railway operators in Sweden can transport load units with conventional wagons, for which there is need for dedicated wagons in Europe.

The technical interoperability in the corridor is sufficient; however each transport corridor needs to be examined separately. The limitations that previously existed in both Norway and Sweden have gradually been removed, however there are still problems to transport the trailers with corner height 4 500 mm used by the grocery industry. The height of the load units is mostly limited by the gripping arms of the handling equipment, since these dimensioned for positioning of lift pockets on the load unit.

Finally it must be noted that the load profile differs between road and rail. The railway has a generous profile width and road a generous height. In Sweden limited the height profile of road trains is limited by the practical bridge passing height of 4.5 meters. Hence, the road train in Sweden often consists of a combination of a Swap body of 3150 mm inner height on the truck and afterwards a dolly and a trailer with 3500 meters of interior height. The general regulation stipulates P410/P407/C405 in Sweden, meaning transport of a swap body with an external height of 3 200 mm and width 2 600 mm, however in combination with the introduction of gauge C, the last restrictions on volume load unites disappeared. A number of respondents indicate the importance to extend the loading gauge to gauge C. The current bureaucratic management with dispensations is both too complicated and time consuming to be acceptable as an administrative solution.

3.3 Maximum train length

Train length is the distance between the front of the locomotive and the rear of the last wagon. The maximum technical train length is determined by the braking capabilities. The safety requirements contained in BVF 900.3 indicates that the maximum train length for braking mode P/R of 730 meters and for mode G 880 meters. However, the infrastructure does not allow these train length, hence the permitted train length is needed to be examined during the time slot allocation process.

In Sweden the infrastructure normally allow train length of 630 meters. It is possible to make longer trains on the double track routes, but if the sidings are not appropriate for the longer trains this will reduce the infrastructural capacity. In times of capacity constraints the train length have to be limited to 630 meters, while in the future these constraints will be extended to allow the 750 meters. The restrictions apply primarily to single-track railway lines where the oncoming train is forced into the siding and the longer the train must be made by special permission.

Skoglund and Bark (2007) examined the length of the meeting and bypass sidings at three distances. A summary of the results reported in the table below and the result is that the length of the train is 630 meters in length which must be accepted short-sighted not to increase the capacity restraints of the infrastructure. The study also included a review of the marshalling and direction of the tracks on Hallsberg's sidings, but the results are not relevant in the study because the trains are assumed to be driven between the departure terminal and receiving terminal, including any intermediate terminals, without shunting hump.

Table 12 Double track Single track (partially double) Single track Average

	Double track	Single (partial double)	Single tr	Average
Sidings less than 650 m	100%	100%	100%	100%
Sidings over 650 m	39%	68%	56%	51%
Sidings over 750 m	20%	13%	19%	17%

Length constraint is negative for heavy trains over long distances and especially for international transport; i.e. for intermodal trains the length is the limiting factor. Development of rail-borne freight is dependent on the extension of the meeting and bypass tracks and the addition of trunk lines to the major freight routes, as Hallsberg - Mjölby - Malmo - Continent and Hallsberg's sidings.

3.4 Information and Communication systems

The Rail authorities were early users of information systems, but mainly to control their own production resources and administration. EDI connections with customers are of recent date and there is a need for further development. Efficient ICT is vital for the forwarders controlling large numbers of small consignments (part loads and general cargo) from a large number of shippers, but less crucial to hauliers, rail and intermodal operators which can move a single container or some 80 boxes in a shuttle train for a limited number of customers.

3.4.1 Information and Communication systems - Norway

The Norwegian National Transportation plan 2010-2019 stress that the Port of Oslo and the Alnabru terminal will play essential roles for intermodality in Norway in the coming years (NTP, 2009). The research project PROFIT (Project Future Intermodal Terminals) aims to address this call for attention from the government.

PROFIT is sponsored by The Research Council of Norway through SMARTRANS – a research program for industry transport and intelligent transport systems. By changing the terminal layout and control systems at both the Port of Oslo and the Alnabru terminal the project aims to generate new administrative and control system for the entire supply chain (PROFIT, 2010). The project includes major actors in the Norwegian transport industry: CargoNet (freight train operator and terminal operator), Jernbaneverket (the Norwegian National Rail Administration and rail infrastructure owner), DB Schenker (international freight forwarder), Bring Logistics (international freight forwarder), LTL (Norwegian forwarding association), Ergo Group (IT provider) and the Port of Oslo. In accordance with The National Transport Plan (NTP, 2009) PROFIT aims to develop efficient intermodal terminals and network through improved collaboration between ports, carriers, terminals and forwarders.

Today, Jernbaneverket is the responsible organization for communicating delay warnings and deviations from train schedule. This is today a process of email communication, causing frustration among the train operator companies and freight forwarders. In general, the communication in the value chain is based on phone, fax and email. There is limited sharing of information and common IT solutions, and no superior directing principles to guide the actors in the value chain. The chain has thus a low degree of flexibility, and the transition between modes is far from seamless.

3.4.2 Information and Communication systems - Sweden

The Swedish Rail authorities were early users of information systems, but mainly to control their own production resources and administration. As pointed out by Sjöstedt (in Woxenius and Sjöstedt, 2003) there is a need for development and implementation of more sophisticated ICT systems for intermodal transport systems. A large number of EU project with Swedish partners have been and are carried out (i.e. FreightWise).

3.5 General freight policy

3.5.1 Norwegian Freight Policy and Regulations

In Norway, the conditions for intermodal transport are different from the conditions in Sweden in the sense that the topography of the Norwegian fjords and mountains make transportation difficult.

The Norwegian road and rail network has greater gradients than in Sweden and does not allow as heavy trains/vehicles. Moreover, the length of vehicles in Norway is considerably shorter than in Sweden. In Sweden and Finland a road vehicle of 25.25 m is allowed, compared with 18.75 m in Norway. Furthermore, the road vehicles are allowed to be 2550 mm wide compared to Sweden's 2600 mm. This affects the utilization of different load units or load units combinations used. Swap bodies class C are more profitable in Norway where two swap bodies are loaded onto the same truck, compared to a truck with a semitrailer, in order to use the maximum vehicle regulations.

The railway infrastructure in Norway did not allow transportation of semi-trailers until 2003/04 when the infrastructure loading gauge was expanded to P407. Now, this market segment is growing fast and 20% of the load units transported in Norway is semi-trailers, Swap bodies is still, by far, the dominating load unit. The growth of Norway (estimated to 300 000 units) is in the semi-trailers segment.

3.5.2 Swedish Freight Policy and Regulations

Regulatory changes, which occurred in the Swedish railway network in 1988 have, above all, favored road transportation. Three major changes have been decided upon:

- Trucks' gross weight has increased in two steps from 51.6 ton to 56.0 ton in 1989 and from 56.0 ton to 60.0 ton in 1993. This has enabled a 22% increasing in net weight and a general price reduction in the transport market.

- In 1972, Sweden adopted 24 meters length for trucks, which was a demand from the forestry industry. Sweden allows trucks up to 25,25m length since 1997 if they follow the standards according to the European Modular System concept. For palletized gods it means that additional pallets can be loaded compared with a truck 24 m long.

- Kilometer taxes were revoked due to competition reasons in 1993.

Sweden's generous rules for trucks have influenced, in a negative way, the possibilities for development and establishment of an intermodal transport system. Modifications occurred in the competition between rail, intermodal transport solutions and long trucks have diminished intermodal transport's potential (Banverket, 2007/b). This is shown by Cardebring and Lundin (2007) that demonstrate a decrease of 13% in road traffic if road taxes were reinstalled. The result is supported by the experience of other countries that have implemented road taxes to heavy trucks (Gustafsson et al., 2007).

3.5.3 Heavy Road Fee

There are several countries in Europe, among all Austria, Germany, Switzerland and lately Poland, who have introduced Heavy Vehicle Fees. Two main conclusions might be drwn from the monitoring of this change; (1) the loading degree and resource utilization of trucks have increased and (2) there has been a shift from pure road transport to rail and intermodal transportation. The degree of shift is 6 % more transports on rail in Germany and during 2011 HVF was introduced in Poland when the previous Euro vignette is abolished. The system is applied at highways and major roads and is applicable for all road vehicles of gross weight over 3 500 kg. All vehicles need to be equipped with an electronic box, viaTOLL, which automatically monitor when the vehicle is passing a toll road. In the subsequent table the tolls for the different Euro classes in Poland are presented.

Table 13 Road tolls Poland

Euro 0	0,53	Zloty per km	2,37	Zloty/km	1,2561	SEK/km
Euro 1	0,53	Zloty per km	2,37	Zloty/km	1,2561	SEK/km
Euro 2	0,53	Zloty per km	2,37	Zloty/km	1,2561	SEK/km
Euro 3	0,46	Zloty per km	2,37	Zloty/km	1,0902	SEK/km
Euro 4	0,37	Zloty per km	2,37	Zloty/km	0,8769	SEK/km
Euro 5	0,27	Zloty per km	2,37	Zloty/km	0,6399	SEK/km

In Norway and Sweden there are no road tolls, however in Norway the rail rack charges is almost zero. In Sweden the adapted rail infrastructure charges are doubled or tripled until 2015, and hence this regulation indicates a political strive, compared to the European White Book, in the opposite direction.

3.5.4 Regulative framework for Cargo securing

The forces and stresses on the shipment/cargo differ between the transport modes and thus, the regulation regarding cargo securing is different not only between the transport modes but also between different nations. This indifference has been highlighted by the Swedish firm MariTerm, who based on empirical evidence argue for a harmonization of the regulations for cargo securing/lashing on road/rail. A non-harmonized framework is a clear obstacle towards interoperability between the network (transport modes and nations) and particularly obstacle increased share of intermodal transport in the corridor.

In technical terms the acceleration 0.5 g for road transport and the corresponding acceleration is 1.0 g according to the UIC Loading Guidelines and the CEN method for rail transport. This discrepancy makes a large different for the dimensioning of cargo securing arrangements in the intermodal loading unit. E.g. top-over lashings (indirect fastening) are considered much less efficient during railway than road transport.

The responsibility for Cargo Securing (depend on transport agreement) is the operator.

4 Infrastructure

The infrastructure in the focal corridor consists of the transport networks (nodes and links) in both Norway and Sweden. The presentation starts with a general overview of the terminal networks in the countries, including a dedicated presentation of the node Karlskrona. In the second part the infrastructure connecting the nodes are presented and discussed.

4.1 The intermodal Terminal Network in Scandinavia

During the 60’s and 70’s some 30 conventional terminals were established in Sweden. These terminals were used until the big structure re-organization and market adaptation of RailCombi/SJ Cargo that was done around 1990 (Bärthel and Woxenius, 2002). The number of terminals was constant until 1998. In the process of market adaptation and structural rationalization of the national railways that occurred in the early 1990s the number of terminals was reduced to 16, which basically corresponds to the network operated by the intermodal operator Cargo Nets. The aim with a few large terminals connected by a block/shuttle trains without frequent shunting or marshalling became the single strategy for intermodal transport companies, infrastructure authorities and shippers, as stated in the report, combined transport - report on problems and potentials (Swedish Freight Association, 1997).

The development, aided by the increasing containerization, the expansion of the Gothenburg Port and the liberalization of the railway sector, shows a strategy with flaws. New supplementing terminals in combination with new rail and intermodal operators were needed to impel volume growth. Hence, a large number of terminals have been opened since 1998 with the initiative and support from the transport buyers, transporters, and from municipalities (Bergqvist, 2007, Storhagen et al, 2008) and a large number of projects is planned or in progress. There are several important explanatory factors for the development. The first is linked to the deregulation of the Swedish railway industry. The second is the strategic cooperation between the Port of Gothenburg, local fleet operators, railway operators and small regional hauliers and their joint contribution to an extensive intermodal port hinterland network that has proved competitive, relatively road transport at distances down to 150-200 km. Currently, there are about 25 shuttles to/from the port.

In the following table, there 36 terminals for transshipment between road and rail are presented. The compilation is missing the major ports as Trelleborg, Gothenburg Port, Port of Helsingborg, and Norrköping, and a number of terminals, called free loading areas, but include a major share of the intermodal freight in Sweden but might serve as a good overview of the historical development in Sweden with two development phases and a consolidation phase in between.

Table 14 Intermodal terminals in Sweden – development from 1965 to 2010. In the table the development and consolidation phases are clearly visible. Ports handling load units intermodal rail-port or rail-road are not included in the summary.

Year	Opening intermodal terminals in Sweden						Opened	Accumulated number	Closed	Closing of intermodal terminals in Sweden				
1965	Solna	Göteborg					2	2						
1970	Malmö	Örebro	Sundsvall				3	5						
1971	Göteborg-Skandiahamnen	Norrköping					2	7						
1972	Luleå	Gävle	Jönköping	Karlstad			4	11						
1973	Stockholm-Årsta	Nässjö (Jönköping)					2	13						
1974	Västerås	Helsingborg					2	15						
1980	Borlänge	Kalmar	Skellefteå	Umeå			4	19						
1981	Trelleborg						1	20						
1985/86	Stadsgårdshamnen	Värtahamnen					2	22						
1987	Halmstad						1	23						
1990	Älmhult						1	24						
1991								22	2	Karlstad	Skellefteå			
1992								19	3	Halmstad	Kalmar	Västerås		
1993								19						
1994								19						
1995								18	1	Stadsgårdshamnen				
1996								18						
1997								18						
1998	Karlstad	Linköping	Nässjö	Finja	Halmstad	Mölndal	6	24						
1999	Åmål	Åhus					2	26						
2000								26						
2001								21	5	Linköping	Nässjö	Finja	Halmstad	Mölndal
2002	Insjön						1	22						
2003	Eskilstuna	Hallsberg	Grycksbo				2	23	1	Örebro				
2004	Nässjö	Falkenberg					2	25						
2005	Örebro	Västerås					2	27						
2006	Sandarne	Falköping	Motala	Haparanda			4	31						
2007	Tomteboda						1	32						
2008	Vaggeryd	Vännäs	Stockaryd				3	35						
2009	Katrineholm	Alvesta					2	36	1	Grycksbo				

The development of the intermodal transport system in combination with the deregulation of the intermodal network means that there are now four parallel networks at the Swedish Intermodal market. First, a large amount of intermodal units are transported in the wagon load network operated by Green Cargo. Secondly, the domestic intermodal network operated by Cargo Net where block trains is operated between a defined numbers of terminals. The domestic volumes have almost stagnated due to the established channels to market and strong competition from road transport (Bärthel and Cardebring, 2007). Thirdly, there is a network of shuttles to/from the Ports of Gothenburg and Helsingborg to inland terminals. Finally, intermodal shuttles for semi established between South/Middle Sweden region and the European continent. The border crossing networks is in most cases linked through the gateways in Gothenburg, Helsingborg, Malmö and Trelleborg.

The Swedish network has changed significantly over the past five years. The number of relationships that served has decreased dramatically from 1095 in 1995 to 180 in 2004. The change goes hand in hand with the company switched to producing intermodal transport based on solid trains of 25-30 cars in each train set. The terminals connect with each other with a full train in order to create good quality but the transport cost and time-consuming shunting and marshalling. The fixed train sets used in both Norway and Sweden allow for quick turns through slots at four hours and thus a high resource utilization in the system. Transport times and time accuracy has improved considerably through the establishment of direct trains. The figure on the next page shows the average speed for Green Cargo and mail trains for Cargo Net network. There is established a direct train 75-85 km/h on average, but when the trains are exchanged together decreases the average speed. For example, Jönköping - Stockholm, average speed 49 km/h, compared with 86 km/h on the route Göteborg - Stockholm, Sweden. Less than 10% of shipments are delayed by 30 minutes more between Gothenburg and Stockholm. The company has relationships for the railway supply high precision in transportation between terminals.

As stated the number of intermodal terminals has not decreased since the mid-1990s, but the number of OD-relations served has decreased radically, since the operational philosophy of the network has changed. The networks are nowadays composed of a number of terminals connected by shuttles in which the various relations have few or no connections in between. This limits the potential for intermodal in high value products, as the existing networks do not meet customer demands for geographical accessibility, frequency and time flexibility. A dense terminal network without heavy investment in heavy handling equipment, easy entry/exit to terminals without change of engine and a flexible organization in and around terminals is needed. This means that the traditional roles i.e. how the railway companies operate terminals and trains as well as road hauliers organize collection and distribution around the terminals, need to be changed.

The number of terminals in Scandinavia exceeds 65 terminals including free loading areas, private sidings, regional terminals port terminals and conventional terminals. There are therefore several types of terminals, where we can identify (1) Port Terminals, (2) Conventional intermodal terminals, (3) Hub and spoke terminals (4) Gateway terminals, (5) Line Terminals (6) Free loading areas and (7) industrial sidings. A further distinction can be made based on the following subcategories: (1) national and regional terminals, depending on the services provided, (2) if the terminals are only inter-modal or multi-purpose, and (3) of the terminals can be defined as one or double side access terminals. The distinction between these categories is fluctuating.

Table 15 Intermodal terminals in Sweden.

Conventional	Ports	Multipurpose	Lightcombi	Free loading	Industrial sidings	Under development
Gävle	Falkenberg	Borlänge	Borlänge	Gällivare	Avesta-Krylbo	Bastuträsk
Göteborg Gullbergsvass	Gävle Hamn	Eskilstuna	Halmstad	Haparanda	Bro	Hässleholm
Hallsberg	Göteborg Centralharpan	Falköping	Hässleholm	Pieå	Bålsta	Jönköping/Torsvik
Helsingborg	Halmstad	Insjön	Linköping	Skellefteå	Hällefors	Stockholm-Rosersberg
Jönköping - Ljungarum	Helsingborgs Hamn	Motala	Mölndal	Skövde		
Luلå	Karlshamn	Nässjö	Nässjö	Ånge		
Stockholm-Tomteboda	Karlstad	Sandarna		Örnsköldsvik		
Stockholm-Årsta	Köping	Vaggeryd				
Sundsvall	Lysekil	Vännäs				
Umeå	Norrköping	Åmål				
Västerås	Oskarshamn					
Älmhult	Oxelösund					
Örebro	Södertälje					
	Trelleborg					
	Uddevalla					
	Varberg					
	Västerås					

Investment costs for a conventional terminal varies but for an intermodal terminal it is between 50–500 mkr (5–50 M€). The cost variations are depending on among others the size of the terminal and the necessary additional investments in the connecting infrastructure. The handling costs at the terminals intermodal with the hauling costs are two factors that explain why intermodal transports are not competitive at shorter distances. Terminal- and hauling costs constitutes up to 70% of the total transport costs on short and medium length transport relations (Bärthel and Woxenius, 2003) and for domestic transports the limit for profitability is 400-500 km. Still in some cases intermodal solutions have proven to be profitable in the last few years (Bärthel and Cardebring, 2007, Flodén, 2007).

In conventional terminals loading/unloading cannot be done under the overhead contact wire. Switching to and from the terminals takes a long time and is normally needed during inconvenient hours (at 03-04.00) - long before the regular shunting operations starts. The early shunting is either dimensioning shunting resources, or affecting the delivery of time sensitive shipments as general cargo and other time-critical shipments. Posten Logistics and DB Schenker also point out the need for short handling times at the intermodal terminals if intermodal transport should be an alternative to road transport. The time consumption of the nodes must not exceed the time savings made link between terminals.

The organization of the terminals is an important parameter, and here we find the first difference in the cost structure of port-hinterland relations and the conventional terminals. Port hinterland shuttles have a flexible organizational structure where local/regional transport operators takes care of pre and end haulage and terminal handling during normal working hours. This means increasing opportunities to smooth the flows during the day, and to reduce staff requirements and avoid over staffing shifts. It shall be related to the conventional terminals, where most of the handling at terminals is done between 3:00 to 08:00 and from 16:00 to 10:00 p.m. and where staff cannot be used during daytime.

In Sweden, the land has traditionally been owned by Jernhusen, infrastructure by BV and the terminal has been driven by the Cargo Net (Conventional terminals). New regional terminals, which are partly forced because the traditional operators are not let in new entrants in the terminals, created through cooperation between hauliers, local authorities and smaller rail companies have shown to structurally and operationally efficient than the conventional.

Larger terminals and ports are administrated as open terminals with full time employed personnel and are supplied with many tracks, portal cranes, trucks, warehouses for containers, etc. The number of terminals supplied with portal cranes has decreased considerably and today only the terminals in Gothenburg and Malmö have this equipment. Smaller terminals are administrated by hauliers either as a strategic operation together with hauling operations or as a stand-alone side operation

The terminal is the interface between the various modes of transport, but it is not clear whether the terminal will be operated by a local/regional haulier, a terminal company, or railway operator. Terminals have traditionally belonged to the railway companies, but the deregulation has really challenged the traditional division.

4.1.1 Accessibility to intermodal transport

A closely related factor to the transport mode/solution choice is the accessibility to rail transport services. The physical accessibility to rail is an important factor and the Swedish Rail administration (1997) shows that primarily shippers with private sidings used rail freight transport According to Jacob Wajsman (Nelldal et al 2007) 55 % of the transported volumes are transported between a consignor and consignee, both with private sidings, 15 % was intermodal freight transport, 15 % was transferred on a multimodal terminal at the last 15 % was transported to/from a port.

There is a genuine interest to increase the market shares for intermodal transport (Jensen et al, 2008), i.e. within the food and everyday commodity industry (Storhagen et al, 2008). A severe barrier towards increased intermodal freight transport is the slow-moving rail operators. "It takes months to an offer, if at all, and to get one you need considerable volumes. There is also a perceived lack of interest in discussing strategic and tactical development issues, often a requirement for designing competitive intermodal solutions. Thus there is still a wide gap between the expectations a real practice, but the gap is gradually diminishing.

4.2 Intermodal Terminal Network in Norway

The Norwegian Railway Freight Company made a change in strategy on January 1, 2003. The company abandoned the conventional wagon load traffic and concentrated their service supply on intermodal transport. There were two basic reasons for the change strategy: (1) opportunity to avoid the costly and time-consuming marshalling and (2) to change the market role towards the shippers. The change transformed the company into a supplier intermodal transport to freight forwarders, hauliers and other transport service providers. Today, Cargo Net offers terminal service and rail operation between terminals, while the transport service provider supply pre- and - end haulage.

The conventional wagon load transport system was closed except from some services in Mo i Rana, some car transport and dedicated transport systems for timber and wood chips. These transports represent around 10 % of the company's turnover.

Intermodality has more or less been on top of the Ministry of Transport's political agenda since the mid-1980s, without great success in regard to a transportation shift towards rail and sea (Halseth, 2004). The National Transportation Plan 2010-2019 (NTP, 2009) underlines the national importance of Alnabru and Oslo port, and the political support for increased intermodality with Alnabru as hub seems unambiguous.

Rail transport in Norway has shown a rising trend, but the main portion is still transported on road. The figures show that the amount of freight transported in Norway on road, rail and sea has more than doubled since 1965, while transport measured in ton kilometers has increased by more than three times (Statistics Norway, 2010).

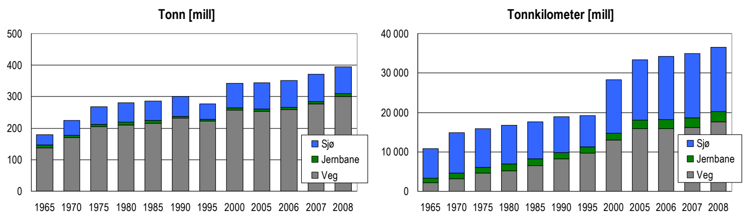


Figure 28 **Million tons transported by road, rail and sea in Norway from 1965 to 2008 (left) and million tonkms by road, rail and sea from 1965 to 2008.**

Despite the lack of complete success, the intermodal transport strategy from 2002 has almost been a story of success. The volumes transported has increased by some 10-20 % per year and in 2008 950 000 TEO (10 million tons) were transported. As a result, intermodal freight has a market share in the major O/D-relations in Southern Norway of 30-50% and towards Northern Norway of 80 %.

The largest terminal, Alnabru, has grown from some 100 000 TEUs years 1997 to 537 000 TEUs in 2008. Hence, the terminal is the second largest in Europe. Around 90 % of all intermodal freight transport in Norway is handled on this terminal and a prognosis indicates 1

000 000 TEU to be handled in 2020. Other major terminals is Bergen (112 000 TEU in 2008), Trondheim (100 000), Stavanger (85 000), Narvik (45 000), Drammen (43 000), Bodø (38 000) and Kristiansand (25 000). The terminal network is presented in the subsequent figure.

The frequency of the Norwegian domestic links is 3-7 rounds and the rail operator indicates a economic break even distance of 300-400 km if collection and distribution distances are less than 20-30 km at the terminals.

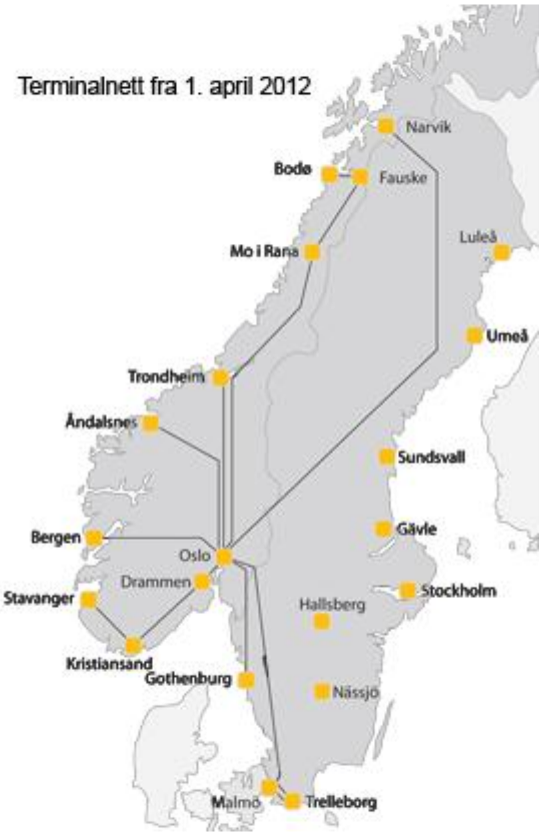


Figure 29 Terminal network operated by Cargo Net. Intermodal freight transport in Sweden

The freight transport market has increased considerably since 1990 and the growth is expected to continue due to economic development, structural transformation of the economy and increasing affairs with the Eastern Asia and other developing countries. The development is affected by increasing energy prices, but this change affect road and rail transport more than maritime transport.

Rail transportation has for the last 50 years lost market shares to road transportation, but since a break point in the early 2000 the freight volumes as well as market shares have increased. In 2007 the market shares for: sea 37 % (only small fraction inland waterways), rail 20%, intermodal road-rail transport 4% and road 39% (Swedish Rail Administration, 2008).

4.2.1 Intermodal freight demand in Sweden

In Sweden the Swedish Rail Administration began to implement an intermodal terminal network in the 1960s. The intermodal system did not become an early success, despite hopes. The market for intermodal became stagnant at 2 % market share in the early 1990s (Swedish

Freight Association, 1997). The intermodal operators focused their business on the market for large volumes over long distances and thus the number of terminals was reduced. 500 kms was regarded as the break even distance for the intermodal transport in competition with road transport. The intermodal transport over medium distances and for small and dispersed flows over medium and long distances were left to hauliers and road forwarders.

Factors that explain the stagnating market is found, not only in the market process, but also in market organization and in the tacit knowledge of the transport industry. The development of the intermodal system was not a priority at the market characterized by competition between the modes rather than being a complementary to the dominating unimodal transport design (Nelldal et al, 2000). Within the truck industry intermodality was perceived as a something "the cat dragged in" and the railway administration considered intermodality as a product that drained volumes from the conventional wagon load system (Woxenius and Bärthel, 2008).

Thus, at the strategic level the Swedish Rail operator SJ Gods, as well as a number of railway administrations in Europe, realized the opportunity to invest in development and implementation of new and competitive intermodal transport system. The results of the ambitions were a number of national trials during the 1990s where the most renowned example is SJ Light-combi that was established as a pilot customer in 1998. But there was no concentrated effort on a European or national level to market and implement an innovative system in large scale (Woxenius, 1998 and Bärthel and Woxenius, 2003) except from Austria and Switzerland (Rudel, 2002).

Consequently Demker (2000) found that the intermodal transport in Sweden reached a peak level of around 4.5 to 5.0 million tons and 2.5 billion tonkm in the middle of the 1990s and concluded that the goal of 10 million tones presented in 1990 was an illusion (ibid.). During the 1990s however, three important regulative changes occurred. Primarily, the Port of Gothenburg launched a strategy of a new intermodal shuttles network between the port and its hinterland as a complement to road transport. Second the rail freight market became entirely deregulated. Thirdly, the infrastructure fees (track access charges) were reduced by 65 MEuro per year in 1997. Together, these changes contributed to the strong stepwise development of intermodal transport in the Nordic countries. Primarily an extensive port hinterland shuttle network was established to/from the Port of Göteborg and later to/from the Port of Helsingborg. Secondly, starting in 2007 border crossing shuttles from the Continent to Southern/Middle Sweden have been established. This has been supplemented by a strategic intermodal ventures by large shippers as manufacturers as Volvo and wholesalers as COOP.

The intermodal transports have increased slowly from 3.1 million tonnes 1985 (Jensen, 1987) to 4, 0 million tonnes 2000 (Swedish Rail administration, 2001). After 2000 the intermodal transports in Sweden have increased significantly to 8, 2 million tonnes in 2007. In figure 7 an overview of the intermodal freight volumes transported (in tonkm) from 1995 to 2008 is shown. From stagnant or declining volumes, 1995-2001, volumes of intermodal shipments have increased by 70% since 2001 and transport work by 107%. The domestic annual volumes have increased by an average 6% and transport work by 9% per year. Hence, growth is higher in the border crossing transport, with an annual volume growth of 15% and a growth in transport work by 22%. Notice the clear break of trend in 2001, affected by the previous three inducement factors. The market share for intermodal transport was 5% in 2008; hence the market share has doubled since 1995.

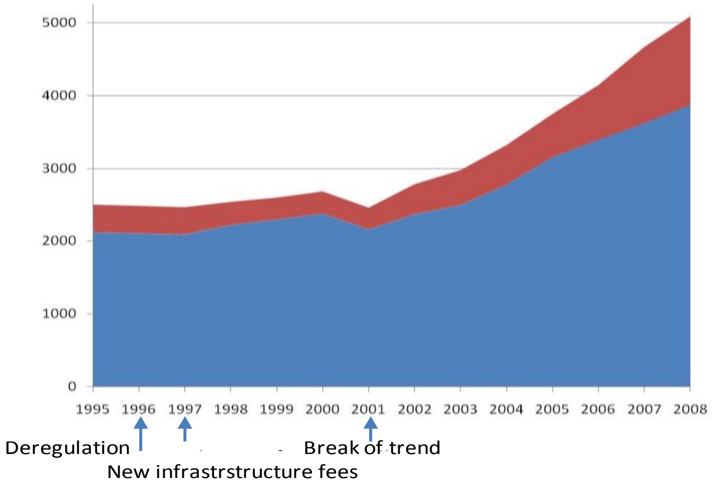


Figure 30 Growth of intermodal freight transport work in Sweden from 1995 to 2008 (Adapted from SIKA, 2009).

The latest trend in Sweden is shippers investing in intermodal transport, so-called customer-driven, agent-initiated intermodal transport. Companies that strategically focused on increased intermodality in the period 2009-2010 include COOP, Intercontainer Scandinavia, LKW Walter van Dieren and Volvo Logistics, All these players have strategies to use intermodal transport for a significant part of their freight flows and mainly use semi-trailers as load unit. Several of these actors indicate that deregulation of railways is an important factor to increase the share of intermodal transport without the risk of putting all eggs in one basket (Storhagen et al, 2008, Barthel et al, 2009), but most companies also point out the lack of the top-down incentives from institutional sources as a barrier to intermodal investments (ibid.).

4.2.2 Volumes and break even distances

The market share for intermodal transport in Sweden is 5% (tonkm) and for rails another 20 (Swedish Freight Association, 2009). Rail's market share increases with the transport distance, but road transport has increased its market share of all transport distance since 1987.

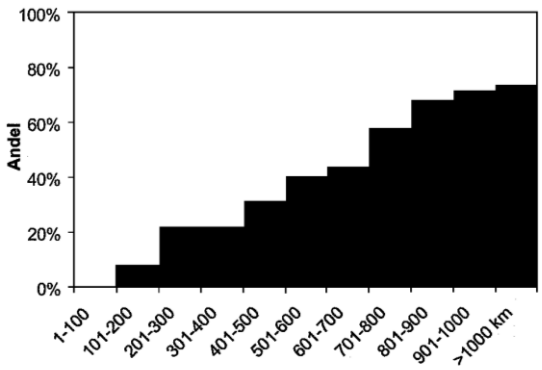


Figure 31 The market share for rail as a function of distance (Swedfreight, 2009).

On the domestic market intermodal transport is competitive to unimodal road transport over 400 km and for transportation in port hinterland relations 180-200 km. Hence, the market for intermodal transport is limited and if we exclude existing rail and intermodal transport volumes, a theoretical potential will be 61 million ton over 200 km, 32 million ton over 300 km, 21 million tons over 400 km and 13 million ton over 500 km. The theoretical potential for significant increase of intermodal transport volumes is thus limited to the market on medium distances, i.e.200-600 km. Over 600 km requires frequent change of drivers, or scheduled transport planning in order to use the drivers efficiently. Hence intermodal transport is used on the long distances, except for transports of time scheduled deliveries.

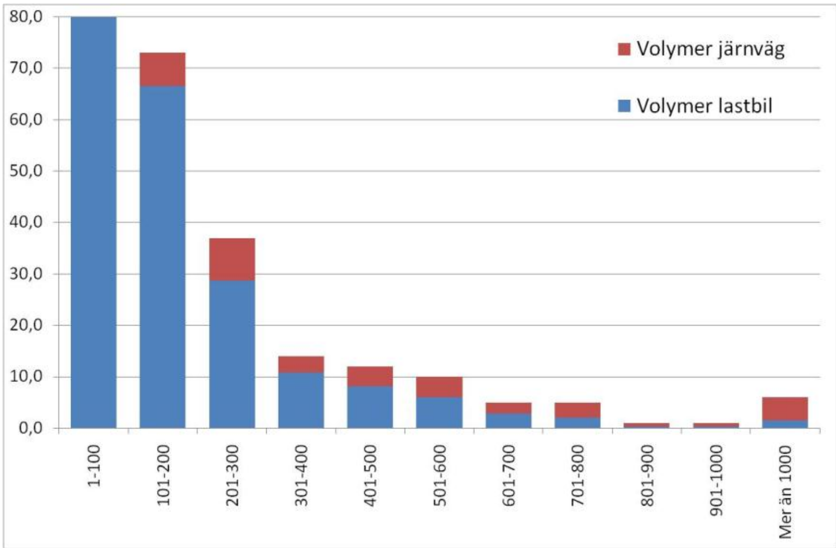


Figure 32 **The Swedish transport market as a function of transport distance. Sea transport is not included (Source: Swedfreight, 2009).**

4.2.3 Estimated future development

SIKA has a government commission to make forecasts for freight transportation and the previous results were presented in 2005 (SIKA, 2005). The prediction estimated increasing freight flows of high value products (by weight) by 55%, air freight by 74% and transports of containers by 100% from 2001 to 2020. The changes for each transport mode were expected to be: Road +18%, Rail +13%, Sea +20% and Ferry +38%. In the report SIKA point out that there are some sources of significant errors. The oil/energy prices, costs for infrastructure investments are two mentioned sources of errors, which affect transportation patterns.

The prognosis was questioned by the Swedish Rail Administration in a memo from 2008. The Swedish Rail Administration (2008) compared the actual development between 1997 and 2007 with the forecast made by SIKA in 2005. The freight forecast for 2010 assumes an increase for all modes of transport to be 25% and this is actually close to present development (until 2007 was +20%). However, if the transport modes are studied separately, large deviations might be found. In the figure below a trend projection for 2010 based on the years 1997-2007 is presented. The freight volumes of rail are significantly higher than the forecast for 2010, while for Maritime the projections are good. The increase for road is below the forecast for 2010. The projections were carried out before the recession in autumn 2008 and hence before the sharp decline in freight volumes by rail, as well as for the whole transport sector. The recession hit rail base volumes, the cyclical steel and paper industry, hard, and in combination with a more stable price structure this led to a sharp downturn. Transport volumes, except from containers via the Port of Gothenburg, fell by 25-30% (SIKA, 2010), but has recovered and in Q1 2010 volumes are in line with the volumes before the recession.

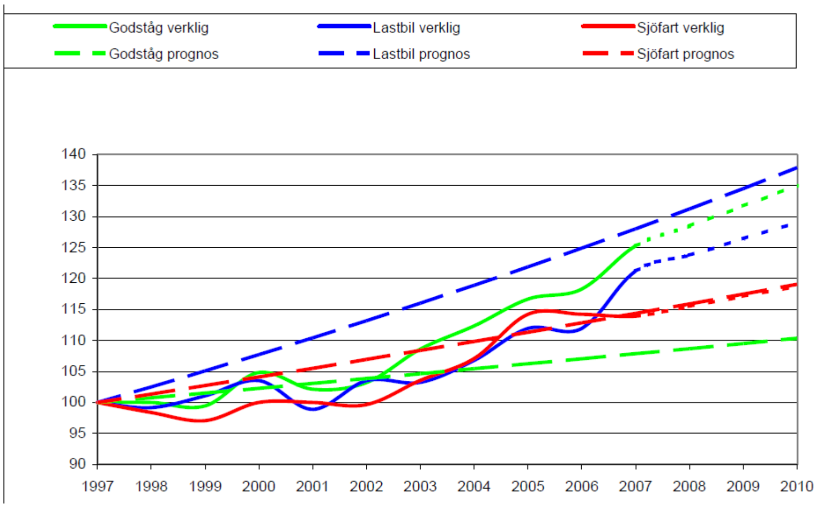


Figure 33 Trends regarding modal split on the Swedish transport market based on the prognosis from 1997 (Source: Swedish Rail Administration, 2008).

The studies carried out by VTI / SIKA (for example, SIKA, 2008) differs in general from the forecasts presented by the Swedish Rail Administration (Wajsman, 2008). The studies differ mainly on:

The Swedish Rail Administration indicates that there is a significant surface of competition between the modes, which is contradicted by results presented by VTI/SIKA. The latter indicates that the modal shift is almost unaffected if the cost structure for a mode is changed. This is completely inconsistent with Swedish Rail Administration’s forecasts.

The results also reveal that the Swedish Infrastructure Authorities as well as VTI / SIKA on a regularly basis underestimated the intermodal development in their forecasts. The methodologies used do not include functions to depict the significant leaps resulting from large transfers of shipments from road to intermodal transport solutions. This is clearly present at the Swedish transport market where large shipping agencies as Maersk, large shippers as Volvo, COOP, Stora-Enso and large forwarders as Van Dieren is starting to use intermodal transport on a more strategic and regular basis than the previously.

Hence, the differences should be interpreted that there is a need to include more factors in the analysis rather than focusing on infrastructure and cost structure as today. One neglected group of factors is related to the organization of transport chains (transport strategies) and its effects on the scale operation of intermodal flows. This cannot be modeled and thus not taken into account in the prognosis.

4.3 The supply side of Intermodal transport in Norway

The intermodal network in Norway is primarily operated by the Cargo Net A/S, but also rail by other rail operators as Green Cargo and Hector Rail. The last mentioned offer border crossing services between Sweden and Norwegian terminals. There is also cooperation between Cargo Net and TX Logistics, since TX Logistics is not authorized to operate the Norwegian network.

4.3.1 Intermodal Service Providers – Cargo Net A/S

Cargo Net, the former Cargo division of the Norwegian Rail Authority, is the largest intermodal service provider on the Nordic transport market. During 2005 Cargo Net and the Swedish intermodal operator RailCombi merged and hence the merged operator became a network wide operator for the Scandinavian intermodal market. The merged company was owned 55% owned by Norwegian State Railways, NSB, and to 45% by Green Cargo. Due to financial problems in 2011 the company made a strategic decision to abolish almost all transport in Sweden, except for some few transnational connections.

The business concept is to promote, produce and develop intermodal transport operators, rail operators, freight forwarders and logistics companies in domestic and international traffic. Cargo Net is investing in intermodal transport systems and supply transport with the aim is to provide transport for high value products to meet customers' requirements. The operators argue asserts that the wagon loads do not meet customer demands for quality and flexibility.

Cargo Net has since the change in strategy shown strong growth with growth rates of 14-20 % yearly. As a result, the company has a market share of the major relationships in Southern Norway on 30-50% and in North Norway 80%. The turnover in 2006 was 1 500 MNOK (+27 MNOK). Number of employees has fallen sharply. The company had 860 employees including 160 in Sweden, in 2008.

The market strategy is to maintain and develop a linked Nordic network and to provide transport between all major population and industrial centers in the Nordic countries as well as between Scandinavia and the Continent in alliances with UIRR companies. The aim is not to compete with shipping rather to focus on transferring freight from road to intermodal freight through a supply of high quality service offering time quality and frequency. The target a supply of at least 2-3 trains on each link, an average speed of 70 km/h and a time precision of 90% (+/- 15 min). Today, Cargo Net offers domestic intermodal connections with an average speed of 70 km/h, while the international ones offer an average speed of around 50 km/h. Hence, the exception, the famous international ARE Train, has an average speed of 74 km/h and a time precision of over 90 % (+/- 15). Compared to the 67 % offered in the border crossing transport from Norway to Germany (+/- 120 min) ARE is an exception on the European intermodal market. The diverging time windows in the border crossing transport services is related to international problems, but affects the trust for intermodal freight transport among all transport service providers using Cargo Net domestically. Hence, the international service was closed. Nowadays, the carriers use the TT-Line or Cargo Nets connection from Malmö to Duisburg. The lack of quality in Europe is due to shortage of infrastructural capacity and lack of engine drivers.

Internationally, the company strives towards improved quality of transport through strategic alliances with the intermodal company Kombiverkehr German and Swiss HUPAC. These companies are working on similar basis as Cargo Net. For the border crossing transports the terminal in Malmö is used as a gateway in order to separate the international and the Scandinavian production system.. Here, the load units are transshipped instead of shunted or marshaled. A direct connection between Malmo - Duisburg was established in 2005 in cooperation with Kombiverkehr. The 918 km long stretch cut of 13.5 hours, giving an average speed of 68 kilometers per hour. Cargo Net indicates that volume growth in the O/D relation is good. The bulk of the international volumes use Malmo as a gateway and the introduction of direct train from the Øresund Bridge has been a time saver of around four hours. Previously the ferries were used as marshalling yards, and it means that companies will save a wagon set and avoid cross-border management issues. The goal is that of international traffic to increase to 70 km/h by intensifying cooperation with Kombiverkehr and HUPAC.

4.4 The supply side of Intermodal transport in Sweden

The supply side of the intermodal freight transport market has traditionally divided between companies based upon rail and road transport respectively. Considering regulated monopolies and the historic scope of concessions, the borderlines between market segments have been drawn according to types of ILU and geographical markets (Bukold, 1996). Due to the deregulation of the transport market in Sweden, this practice is now diminishing.

The classic role of the *rail operators* has been to sell rail haulage between intermodal transshipment terminals. They also operate terminals and supply rail wagons. In addition, the railway companies have owner interests in virtually all of the other actor categories needed for producing intermodal freight services.

4.4.1 Intermodal service providers

In 2002 the Scandinavian markets were dominated by the rail operator Green Cargo and NSB Gods, complemented by the subsidiary RailCombi as intermodal service provider. Ten years later the market has changed radically. The market is still dominated by these actors, but the market shares have decreased from 95 % towards 60 %. Today all former authorities carry all types of ILUs. The national freight operator n Norway Cargo Net (former NSB Gods) have merged with the Swedish Intermodal operator, RailCombi, and together they offer intermodal transport in a network wide scale. Green Cargo has implemented its own intermodal service and offers this partly in competition with Cargo Net. Today, Hector Rail - a comet in the industry, should be added.

Green Cargo

The company Green Cargo AB was established in 2000/01 when the national rail operator, the Swedish State Railways, SJ, was split into several independent companies. Green Cargo, today one of Sweden's largest Transport and Logistics Companies, has undergone an extensive structural rationalization and market orientation. The company is continuously working with its internal and external efficiency and quality to meet customer requirements. Hans Paridon, Green Cargo Road (2008), stated that today’s domestic rail transport today is “quality secured”.

The business strategy is to offer competitive logistics solutions meeting high standards of safety, quality and environment. The goal is, in-house or in strong alliances, to offer and gradually develop a range of logistics services, i.e. to label the company as a logistics company who takes full responsibility for customers' logistics activities. The company has thus ambitions to be a significant player in the transport market or to be able to offer pure transport services.

The company offers intermodal transportation terminal to terminal and door-to-door in a large number of O/D-relations. The service is especially designed for smaller flows (block trains), where the wagons and wagon groups is directed through Green Cargo's conventional wagon load system, i.e. offering a high market coverage, but not as fast lead times as the operator Cargo Net. A strategy to be an important player on the Swedish transport market for intermodal transports was established during 2006, but it took until the end of 2007 before the first major contract with ICA and COOP was signed. The amount of TEUs in 2007 was 170 000.

Hector Rail

Hector Rail was founded in the autumn 2004 with the investment company Höegh Capital Partners as a financier. The target is to create a network for freight trains between various destinations in Scandinavian and between Scandinavia and the Continent. The market for the railway company is freight forwarders and cargo owners with sufficient volume to fill a full train. Hence the company transfers the risk to fill a train to its customers.

The company's turnover has had a strong growth since its establishment in autumn 2004. A yearly growth rate of 50% since 2005 has entailed a market share of 6-9 % on the Swedish Transport Market. Turnover is 300-350 million.

4.4.2 New entrants on the Swedish market

Intermodal operators entering the Swedish market has mainly focused on the oversee container transport segment, but also, increasingly, trailer transport to and from the European continent. However, there is no actor that offers domestic intermodal door-to-door. There are clear shortcomings in the intermodal service supply from the road forwarders/hauliers (as DB Schenker, DHL and DSV) and the rail operator Green Cargo Intermodal supply is focused on the rail production and not on the door-to-door solutions.

There are several intermodal operators supplying intermodal service and today there are 8-10 rail operators providing rail traction. The newer companies have found niche markets to transport containers to and from our major ports, but now also cross-border shipments of semi-trailer and container freight. Hector Rail and ICS are two newcomers who have challenged the older companies, forcing them to improve cost, quality and support services. There have been regional companies, as Tågåkeriet and Midcargo, who has a flexible production organization and can, in close cooperation with customers find logistical solutions to short and medium-long transport distances.

The growth of intermodal container transport from port to hinterland has been supported by increased cooperation between local truck operators, terminal operators and smaller railway companies. These companies in cooperation with an intermodal operator have created new competitive transport products with competitiveness towards road transport down to 150-200 km. The new organizational structure shows that intermodal transport is competitive at the right organizational structure and with the right tools for marketing. Local cooperation among equal and regional operators reduces competition and increase opportunities for cooperation.

The difficulty for new players entering the market is to make available terminal slots and attractive scheduling modes, as this principle is still in the methodology of "grand fathers-right". New transparent rules have been called for a long time by carriers, transport buyers and intermodal operators.

Another barrier is the lack of access to modern locomotives (diesel and electric locomotives). The investment cost of electric locomotives is 25-35 million, which is a huge amount for a smaller company. To cope with these investments an increased cooperation between transport buyers - intermodal operators and railway companies would be desirable to provide continuity and economic opportunities for the railway company to make the right investment with the goal of a sustainable transport system.

4.4.3 Tågåkeriet i Bergslagen AB (TÅGAB)

The transport case is based on a present transport solution developed by the Swedish Rail hauiler ”Tågåkeriet i Bergslagen AB” (TÅGAB). TÅGAB was developed in the aftermath of the Swedish rail deregulation, when the CEO Lars Yngström and a handful dedicated key resources (knowledge) started to co-operate with the dominating rail operator, Green Cargo, as short line. The company is the sole surviving short line in Sweden and the key for this progress is a well-planned business strategy, formed around three business areas; passenger transport, freight transport (both as transport service provider and sub-contractor) and maintenance of transport resources. The company had 150 employees and the turnover of 20 MEuro (+0,5 MEuro) in 2011.

The business plan is, as mentioned, based on the three corner stones; passenger transport, freight transport (both as transport service provider and sub-contractor) and maintenance of transport resources. Each of the three cornerstones represent one-third of the turnover. In the field of freight transport the company operates hauling service as sub-contractor for Green Cargo between Kristinehamn – Persberg, Kristinehamn – Hällefors samt Kristinehamn – Bofors. The short line network operated by TÅGAB is represented by the yellow lines in the sub sequent figure. The turnover as short line has declined, both relatively and in real figures. There are several reasons for the declining short line activities. For Steel transports from Ovako Steel in Hällefors the main reason has been closure of an intermediate storage in France and hence the ability to maintain required lead time to the end customer. For food transports from Wasa Bröd, Filipstad, the removal of several consignees’ private sidings, the railway authority’s inability to primarily adapt their pricing models to support high resource utilization in both directions and to develop cost efficient intermodal solutions have resulted in almost abandoned service.

The second corner stone in the freight transport strategy is to supply rail service to shippers and forwarders. Transport solutions for the commodity group’s paper and pulp, round wood, recycled paper and lime slurry are developed and operated on a regular basis. The lines operated are represented by the red lines in the sub sequent figure. This corner stone also includes supplying hauling capacity to the Swedish and Norwegian Transport Administrations.

The third corner stone in the business plan is business area: adaption, planned and corrective maintenance service. For the planned and corrective maintenance of passenger rail buses and rail cars a dedicated workshop have been built and since the year 2000 TÅGAB represent Electro-Motive, Vossloh, ZTR and for General Motors (spare parts for diesel engines) on the Scandinavian market.

The transport operator is, in co-operation with Vänerexpressen and Mälarexpressen, operating an intermodal service between the Port of Göteborg and Karlstad, Kristinehamn, Hällefors, Avesta-Krylbo, Insjön, Borlänge och Västerås with one or two departures each weekday. This transport network connects the Port of Göteborg with the Import region Mälardalen and the Export regions Värmland and Dalarna, by a triangular operational structure. The base volume for the service was export consignments from the Saw Mill Group Karl Hedin, and the incentive to change transport mode was a cost difference of 10-30 % per shipment.

One major competitive advantage is the staff's education in Norwegian transport regulations and TÅGAB has for long been the sole foreign company allowed to drive on all railway line categories in Norway. Despite of transport for the Norwegian Rail Administration, the operator has been operating a transport service for DHL with one train per week from Hallsberg to Trondheim. The consignment group is waste paper northbound and potential finished paper products southbound. The present status of these transports is unclear after the bankruptcy of the Norwegian Rail operator Peterson Rail.

The rail operator disposes several electrical en diesel engines. For line haul the company possesses 7 engines class Rc and 10 large line diesel engines. Over 85 % of the transport work is carried out by electrical engines, which was supported by the recent finalization of the electrification of the line Kristinehamn – Herrhult. Further investments in new electrical engines are assumed. A majority of the electrical engines was bought from the Austrian State Railway in 2001. For intermodal and timber transport the company has invested in a large number of Sgns waggons produced in Romania, whickh is scomplemented by a large number of older L-wagons for container transports.

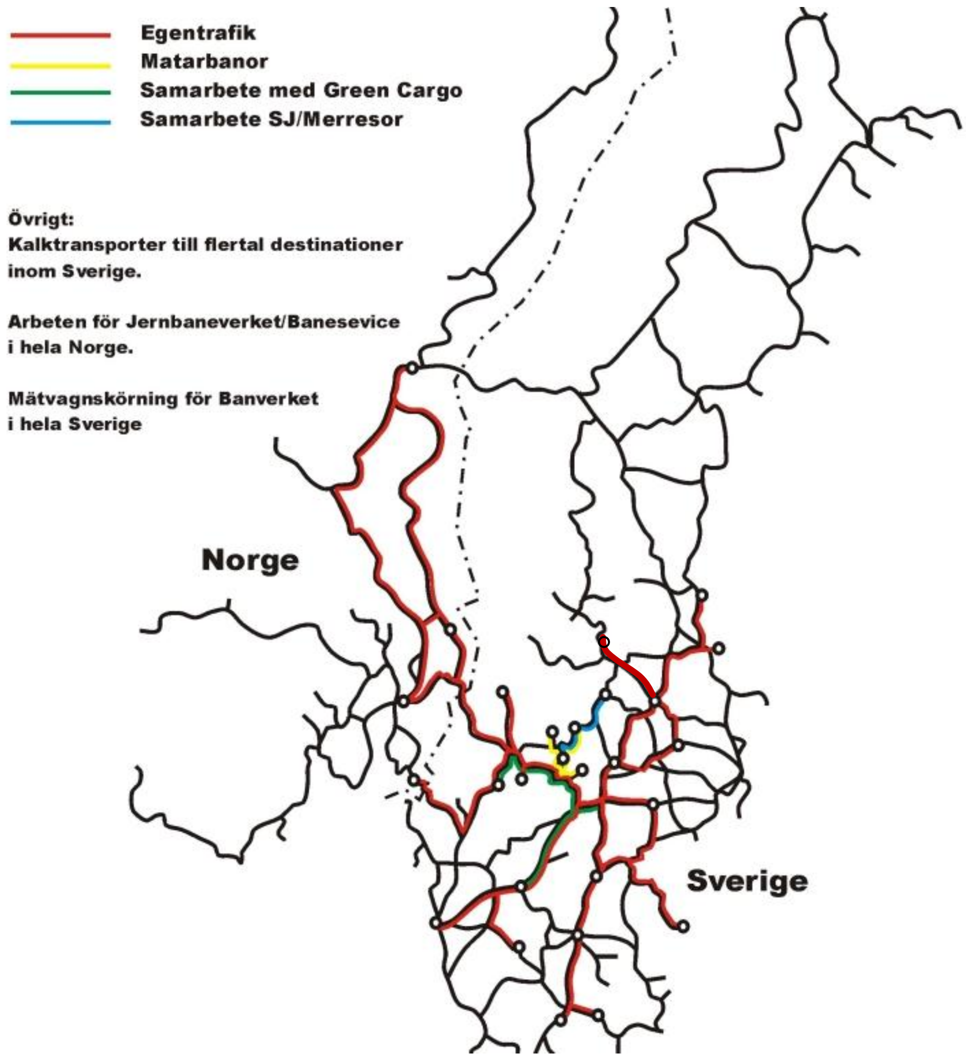


Figure 34 **Rail network operated by TÅGAB. Observe: TÅGAB operates a far distant train from Drammen to Narvik which is not included. (Source: Adopted from www.tagakeriet.se)**

4.4.4 Terminal operators

Most terminals are operated by actors, who also maintain other roles, but increasingly by dedicated terminal operators. In line with the Dry Port concept, local and regional hauliers have expanded their services to inland terminal handling in a large scale These organizations consist of local companies operating a single terminal, often with local authorities, rail or intermodal operators, hauliers and dominant shippers as co-owners.

Location and service supply at intermodal terminals will be critical factors in the future. The intermodal terminal needs to be developed towards a logistical node where intra-urban and inter-urban transportation is coordinated. At the terminal local, regional, national and international consignments are coordinated and consolidated to increase resource utilization in distribution and long haul activities. Shipments in different distances and transport modes need to be efficiently cross docked, stored and transshipped. Thus, we have a future planning problem and to facilitate increased intermodality a joint planning process for increased efficiency in planning logistical structures and activities is needed.

The way the intermodal freight transport providers approach the shippers varies depending on whether the service is domestic or international and also on the history and strategies of the intermodal operators. Green Cargo offer their services to shippers or intermediaries, while the Cargo Net, the regional shuttle operators and ICS offers their services only to proxy customers, as the shipping companies and the forwarders. Thus, most of the new entrants strictly limit their offers to forwarders, shipping agencies and hauliers. On demand, the former operators offer PPH while the latter ones leave this to their customers. The railways do not often maintain a forwarding role to offer door-to-door intermodal freight transport.

The deregulation of the Scandinavian intermodal freight transport system has decreased the implementation barriers for intermodal systems. This problem needs to be handled on a strategic, tactical as well as operational level including new organization and new forms or channels for communication between the system’s stakeholders and users.

On a strategic level an organizational form based on neutral forums has been established on local and regional levels to increase co-operation and communication between local/regional authorities, transport authorities and transport operators/shippers. This new organization has other opportunities to discuss and plan infrastructure and development plans through a change from sequential plans towards parallel development plan.

4.5 Terminal resources

The conventional terminal technology in all countries is based on vertical handling with gantry cranes, reach stackers, or fork lift trucks. Handling Units, like the Reachstackers commercialized by Kalmar Industries in 1985, are the most common terminal technologies for small and medium-sized terminals in Scandinavia. A reach stacker is a counterbalance forklift truck with a lifting device consisting of a telescopic boom which is raised or lowered. The Reachstackers has a rotating spreader which is suspended by a telescopic boom. At most terminals these trucks have replaced the forklifts trucks. The primary disadvantage is the very high surface pressure on the ground and hence the requirements to strengthen the ground to stand even when the reach stacker are handling heavy load units in second or third row. These surfaces cost around 150-200 Euro/m2, compared with 40-50 Euro/m2 from surfaces adapted to conventional fork lift truck handling equipment. The secondary disadvantage is the inability to handle load units under the catenaries. The investment costs for a new Reachstacker are 400 – 450 kEuro (including spreader), while a used one might be bought for some 200 kEuro. Like a counterbalanced truck, a reach stacker might handle 20-25 units per hour, but in general seldom more than 10-12 per hour.

A gantry crane, also called block or bridge crane is consisting of a handling bridge mounted on support legs. Together, these elements form a portal, which rests on wheels riding on rails or directly on the ground. Lifting is done via a trolley moving along the bridge. A portal crane can be rail mounted or equipped with pneumatic tires.

Portal cranes are used primarily at major intermodal terminals and at hubs/ports. Large amount of handled units is required to reach the same cost level as for handling with reachstackers or fork lift trucks. In Scandinavia, the gantry cranes have been replaced by Reachstackers or Fork lift trucks on all terminals except from the metropolitan terminals in Malmo, Gothenburg, Oslo and Stockholm. At terminals with train-train transshipment these transshipment technology has advantages, but seldom on small terminals with a large share of transshipment train-road or train –

4.6 Operational structure/philosophies

In order to combine economies of scale and frequency in the rail connections and a dense terminal network the intermodal freight transport industry uses a number of operational philosophies as instruments to design their networks. These design principles are schematically illustrated in the figure below.

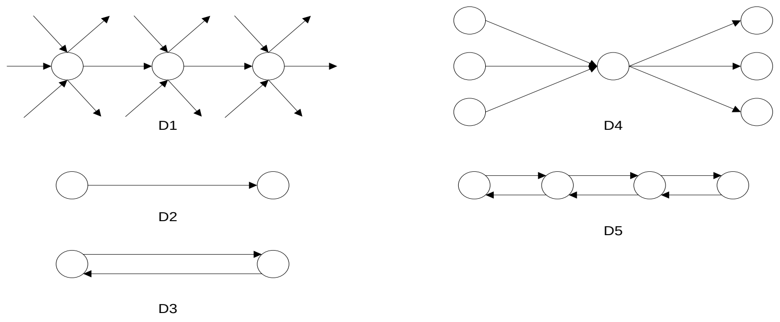


Figure 35 **Network designs for intermodal freight systems: (1) hierarchic network, (2) direct connection, (3) shuttle train, (4) hub and spoke network and (5) transport corridors (Source: Woxenius and Bärthel, 2008).**

An operational network design consisting of a hierarchic network (D1) forms the foundation in the traditional wagon load network. The networks are operated with interregional trains between shunting and marshalling yards forming routes and local or regional feeder trains operating the distance between a marshalling/shunting yard and the private siding or wagon load terminal. In this kind of network a large number of intermodal units is transported in Green Cargo and Hector Rail’s load wagons.

Economies of scale is clearly present in intermodal transport systems and since approximately 1990 the Swedish intermodal operators have abandoned their networks and focused on transport quality (primarily transport time and reliability), economies of scale and a high utilization rate for each train. Thereby the operational philosophy has changed dramatically from D1 towards focusing implementation and operation of intermodal shuttle or direct trains between logistic and economic centers as well as between ports and logistics centers.

The second operational philosophy (D2) aims at large flows transported directly between origin and destination terminals transported over medium and long distances. Direct connections require large flows, some 15 000 – 25 000 TEU per year, for daily departures, which limits this operational philosophy to a small fraction of the total transport demand. These connections are operated according to the traditional night-leap philosophy. Cargo Nets network in Sweden (see even D4) operates according to operational philosophy D2 where the company offers direct full trains between terminals.

The operational philosophy shuttle trains (D3) is a special application of D2 distinguished by the fixed formation train sets operating specific origin destination connections. This creates a base for reliable and cheap operations since there is neither need for cost consuming activities as shunting or marshalling of wagons is not needed, nor is sophisticated information systems needed. The time schedule could easily be tailor made, since there are no dependences with other trains, thus there is a high degree of flexibility in the time planning. The fourth operational philosophy is primarily used for intermodal connections between the ports on the Swedish South and West Coast and a large number of hinterland terminals.

In the fourth operational philosophy a centralized located terminal is selected as a hub and all transports are directed through this terminal, where wagons are marshaled or bundled between the train connections. The advantage is potential good market coverage despite insufficient transport volumes for direct trains between the origin and destination terminals.

Cargo Nets Norwegian network operates as a combination of traffic principles D3 and D4 where the terminal in Alnabru is designed as hub in the system. This network is operated by fixed formation train sets, frequency 2-7 departures per working day, connecting the hub terminal and twelve conventional intermodal terminals in different economic regions around the country as presented in the figure below. The hub Alnabru is the second largest terminal in Europe, volume 600 000 TEU:s annually and of the volumes transported in Norway less than 10 % of the transported volume is short circuit and thus not transferred, bundled or handled at the Alnabru terminal.

Even Intercontainer Scandinavia (ICS) uses a combination of operation principles D2 and D4 to unite their network. The system is based on intermodal links that unite the harbour of Gothenburg and Helsinborg to inland's terminals in Norrköping, Södertälje, Gävle, Västerås, Eskilstuna and Borlänge with Eskilstuna as a hub terminal. The network transports 100 000 – 150 000 TEU per year.

The fifth operational philosophy is denoted corridor design or line train system design (D5). The intermodal trains make short stops along a corridor route and thus cover the intermediate markets. Along each route trains are operating at high frequency making short stops each 100 – 200 kms according to a tight and précis time schedule. Transfer time must be kept at minimum at the intermediate terminals so as not to prolong the total transport time from begin to end terminal. Further detachability is needed at the terminals, thus there is need for intermediate storage at the terminals.

This operational philosophy is designed for dual transport markets – dispersed freight flows over medium and long transport distances and more dense flows over short distances – and by combining these markets the service might attract enough shipment for sufficient resource utilization. Interconnected corridor trains permit large areas to be covered at relatively low costs, but this operational philosophy underlines the importance of fast train-forming, marshalling, bundling and transfer activities to facilitate both market coverage and high average speed.

Gateway Terminals are used to connect two or more networks, either through direct routing or through a related high-frequency link between the gateway terminal for network A and the gateway terminal for network B, i.e. a direct link with regional or national collection and distribution. In region A coordinated flows from the region at the terminal and consolidated into a long-distance transport to the terminal in the region B. Once in the region B the train is deconsolidated and the wagons are spread in the network. A gateway terminal in an intermodal network can be a port or terminal with extensive train-train transshipments. What distinguishes a gateway terminal of a conventional terminal is that handling is done by lifting and not with marshalling or shunting, i.e. what Bontekoning and Kreutzberger (2001) terms bundling.

Table 16 Operational philosophies used in Scandinavia

	Green Cargo Intermodal	Green Cargo Light-combi	Green Cargo Dry Port Shuttles	Cargo Net	Vänerexpressen/Mälarpendeln	Intercontainer Scandinavia	SCT/SCT Rail	Eurocarrier Rail Logistics AB	Svensk Loistik Partner	ERS Railways	North Rail	Railion Scandinavia	Hector Rail	TX Logistik
Wagon load (D1)	X		X											
Block/Direct trains				X	X		X					X	X	
Shuttle trains			X		X	X	X	X	X	X	X			X
Hub and spoke (D4)						X								
Corridor (D5)		X												
Gateway (D6)	X			X										

4.6.1 Summary

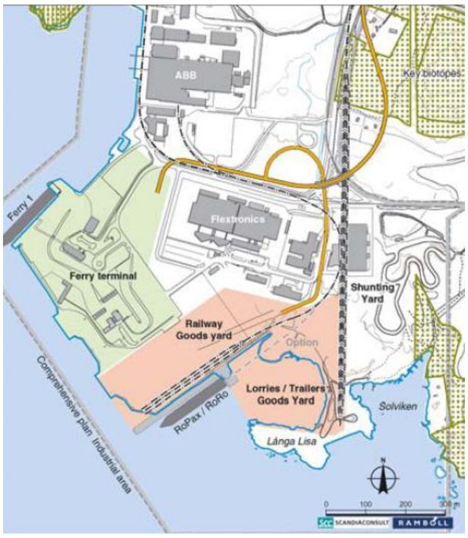
In the following table the actors offering intermodal freight transport in Sweden is presented. In the left column the intermodal activities are listed and in the right column the corresponding resources. The activities offered by each actor, with corresponding resources are depicted in the table as D for domestic, I for international and SI for international occasionally.

Table 17 The Swedish Intermodal operators and their activities.

Closed	Launched	Supply Rail engines	Supply Rail waggons	Supply ILU:s	Coordinate/arrange Core IFT	Coordinate/arrange IFT	Market to Proxy customers	Market to shippers	Rail haulage	Terminal Operational Services	Terminal Logistics Services	Terminal Transhipment	Pre/End haulage	Activities/Actors
	2008	D	D	D	D	D	D	D	D	D	D	D	D	Green Cargo Intermodal
2001	1998	D	D	D	D	D	D	D	D	D	D	D	D	Green Cargo Light-combi
	2002	D	D		D		D	D	D			D	D	Green Cargo Dry Port Shuttles
	1992		D/SI		D/I		D/I			D/I		D/I		Cargo Net
	1993/2001		DI		DI	DI	DI	DI						Intercontainer Scandinavia
	1998/2004				D		D	D						Vänerexpressen/Mälarpendeln
	2006				D		D	D		D		D	D	SCT
	2008				D		D	D		D	D	D	D	Svensk Logistik Partner
	2008				D		D	D		D		D		North Rail
	2008				D		D	D						European Rail Shuttle
	1991/2006			I	I	I	I	I					I	Euroshuttle/Hangartner
	2008	I	I						I					Railion Scandinavia
	2005	DI	DI						DI					Hector Rail
	2005	DI	DI						DI					TX Logistik
	1996/2004	D	D						D					MidCargo
	1988	D	D						D					TGOJ Trafik
	2006	D	D						D					Tågfrakt AB
	1992	D	D						D					RailCare
	1994	D	D						D					Tågåkeriet i Bergslagen AB
										D	D	D		Port authorities
	2004									D		D		Regional terminal operators
												D		Private siding terminals (shippers)
		Rail engines	Rail waggons	Unit loads	Adm syst for Core IFT	Adm syst for tot IFT	Marketing system	Marketing system	Time slots	TS equipment	LS - facilities	Terminal w equip.	Road trsp equip.	Actor/Respurces

4.7 Infrastructure

In this subchapter the infrastructure around the Port of Karlskrona is presented. The reason is the newly built terminal in Karlskrona, at Port at Verkö. The Port, including the ferry terminal, at is classified by EU as a TEN-T category A port. The category A status is applied to ports that handle more than 1.5 million tons of goods per year and/or transit more than 200 000 passengers. One of the requirements for a TEN-T port is to have adequate access to the port with road and rail. Stena Lines is the majority owner of the ferry terminal- since July 2010. The map below illustrated the ferry terminal area at the port of Karlskrona.



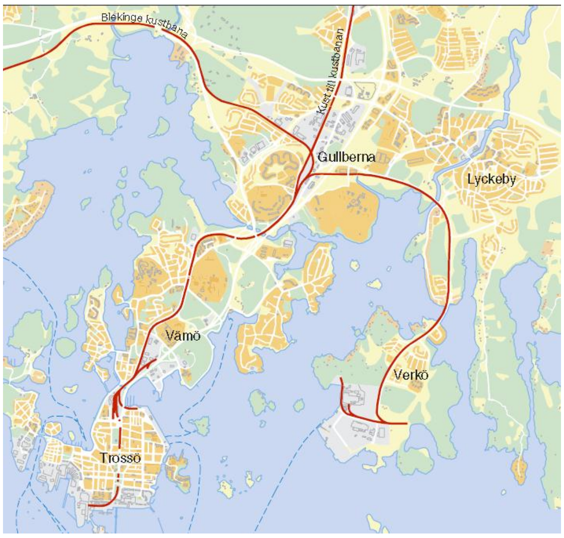


Figure 36 Map of ferry terminal at the port of Karlskrona and the railway infrastructure connecting the Port of Karlskrona with the infrastructure network. .

A single track railway line connects the harbor with two national railway line at Gullberna, approximately two kilometers north of Verkö ferry terminal. One of these national railway lines, Coast-to-Coast line (Kust till kust banan), and runs via Emmaboda to the north towards the middle and northern parts of Scandinavia and has recently been upgraded for 150 MEURO. The other railway the Blekinge Coast Line (Blekinge kustbana), runs to the west towards Kristanstad/Hässleholm with connection to Malmö/Copenhagen and Helsingborg. Hubs like the main national shunting yard in Hallsberg and the port of Gothenburg are reachable respectively within 5 and 7 hours.

The port at Verkö is connected to the European highway E22 in Karlskrona, and the National highway Rv27 and Rv28. This means good accessibility for road transports to the harbor from most parts of southern Scandinavia. E22 is a part of the TEN-T, while highway Rv27, as part of the TEN-T corridor, is intended to be.

The feeder road connecting the harbor with the national highways consists of Österleden and Verkövägen which are two main arterials of the road system of Karlskrona. The road standards are fairly good. Both Österleden and Verkövägen are two-lane carriageways with shoulders. The traffic volume along the feeder road varies from approximately 4 000 vehicles per day on Verkövägen at the entrance to Verkö to a maximum of almost 20 000 vehicles on Österleden. The impact of the harbor activities on these traffic volumes is almost negligible.

Approximately 63 000 (87 %) of road transport per year to and from the ferries at the port of Karlskrona constitute transit traffic through Skåne and Blekinge, while 13 % originate are destined within the region. Transit traffic is mainly going though Blekinge. Approximately one third of traffic is transported along E22 eastwards. Other major roads are Rv28 (24%) and Rv27 (23 %). Around 2 % of traffic goes through E22 and E20 to/from Denmark. (Vägverket 2006) The figure below illustrates the use of different roads for transport to/from Karlskrona.

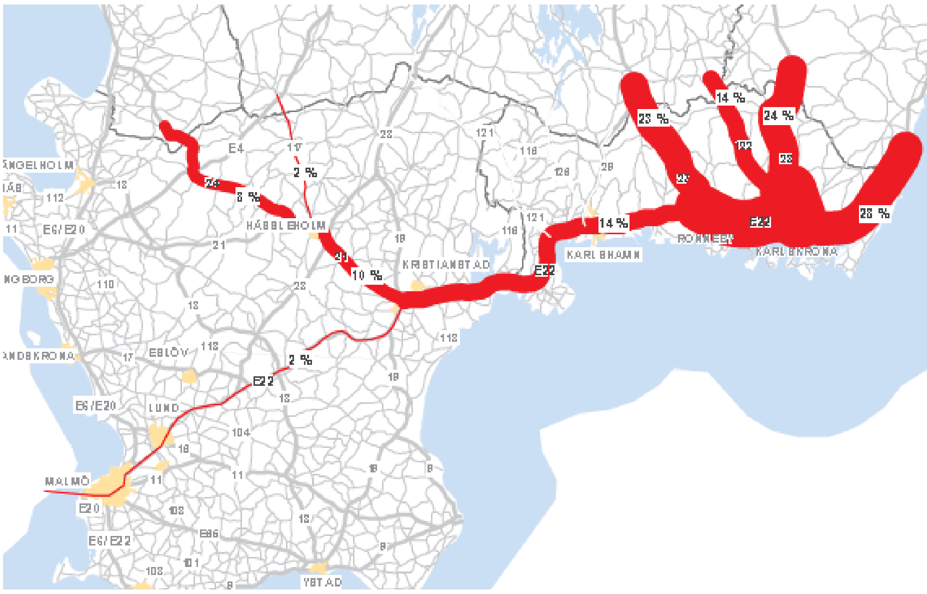


Figure 37 **Transit traffic via Karlskrona and through Skåne/ Blekinge, % of transports 2005 (Vägverket 2006)**

Statistics from Stena Line show that goods carried in the southbound direction mainly originate from Norway, Stockholm and the area north of Gävle. Final Destination in Poland is the country's northern part, with an emphasis in the northeastern part in connection to Warsaw. For goods transported from Poland to the north is the relationship differently. Northern Poland also dominate here, but not to the same extent. The final destination is clearly concentrated in Sweden's northern parts of the country, north of Gävle, followed by the Norwegian market. (Handel Polen-Sverige-Norge).

Competitiveness of intermodal transport is often contextual. The research has largely focused on operational and technical aspects, while

5 Overall assessment

Based on the description presented in the previous chapters we have made an attempt to sort out the decisive opportunities (incentives) and barriers affecting the development and implementation of a competitive transport service in the studied transport corridor. If there were no barriers the transport service would be a reality and if there were no incentives a potential service unnecessary. In the subsequent chapter we have; (1) structured these incentives and barriers and (2) grouped them in relation to the deciding actors groups. These categories have continuously appeared during the process and follow the structure in the figure below.

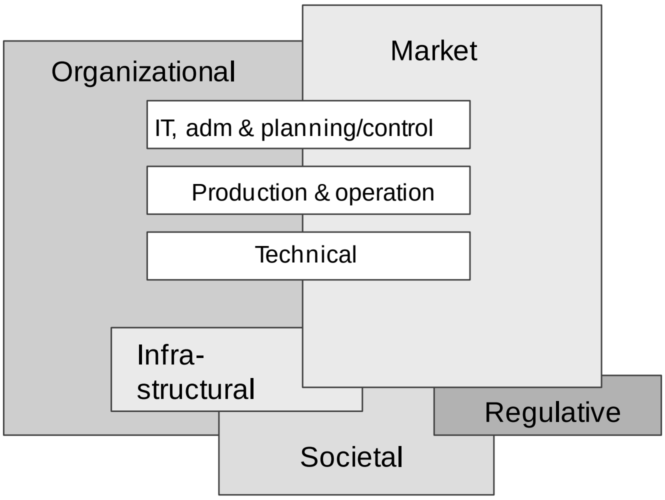


Figure 38. Categories of incentives and barriers identified throughout the project process. These categories are visible and possible to structure, however often overlapping.

The structure presented is not obvious since incentives and barriers are in general often overlapping. We have identified a large share of these incentives/barriers within the marketing and organizational dimensions (partly overlapping perspectives). The IT, administrative and planning/control, production and operational as well as technical perspectives are closely related to the organizational perspectives. The infrastructural perspectives are more stand-alone than the other aspects. The regulative and societal aspects are both closely related to all other aspects. To conclude: we have made a far going attempt to structure these dimensions, however as said with large grey zones in between the dimensions.

In this analysis our ambition has been not to present a detailed list of incentives and barriers. Hence, rather to present these dimensions in the wider transport corridor perspective in order to sort out more general options and barriers that is inducing or hampering the development and implementation of a transport service in the corridor. In practice this is a combination of analysis and reflection. A large number of aspects have been presented and is discussed; however it will not be possible to present all. We will in the following chapter present those dimensions we have come across and what dimensions we find as decisive in the process to establish sustainable and competitive transport corridor.

Market aspects		
Shipper perspective	**Transport operators perspective**	**Societal aspects**
Complex work to procure an intermodal service	**Intermodal transport competitor to wagon load services**	**Passenger trains prioritized ahead of freight.**
An intermodal transport solution is organizationally and administrative more complex to procure than a unimodal transport service (e.g. road transport). None of the transport service providers offers a standard intermodal service in their portfolio and hence a new project has to be initiated at all times when a customer requests an intermodal service. For the rail or road operator it is easier to offer a standard service and the choice whether to use intermodality or not is transferred from the customer to the actor responsible for supplying the physical transport service. This organizational complexity is difficult for the shippers to understand and to accept.	In general rail operators develop and implement intermodal services, however due to economical or operational reason these intermodal volumes are directed through the wagon load network together with less time sensitive shipments. Commodities as automotive, perishable, non-durables and other time sensitive shipments need short and reliable transport services in order to fit into the complex time controlled logistics networks stretching from supplier via central warehouses, distribution centers to the final assembly site/store. This requires new or adapted intermodal systems and services.	A frequent comment has been the conclusion that the traffic management at the rail authorities in general prioritizes passenger transport in their daily operational work, which is a clear disadvantage for the development of freight transports by rail. The work procedure as well as directives adopted by the trail transport authorities need to be revised.
The complexity in organization and operations has a tendency to increase related to increased number of actors, transport resources and how planning support systems are developed. This development is positive; however there is need for an agent responsible for the coordination and co-operation within the corridor.	The deregulation of the rail transport systems in Sweden and partly in Finland and Russia has proceeded stepwise, however the differences in between these countries are significant. The most significant effect of the deregulation in Sweden is an increased competitive pressure where the new entrants compete with the traditional railway companies in the markets for shuttle trains through lower pricing. However, in general these companies are built up by and around traditional railway knowledge and hence the increase in railway volumes in Sweden is related to the traditional railway segments.	EU Directives and the deregulation of the rail transport sector are two main reasons for the prolonged and more static time table planning procedure. These do affect the abilities to provide and continiously develop transport services.
By tradition a focus on wagon loads	**Inertia due to initial quality deficiencies**	
The sole shipper has seldom enough transport volumes to utilize a block train capacity – the minimum transport volume offered by a rail transport operator if a new service should be implemented. If the coordinated transport volume between one begin and one end terminal (including back haul) a shuttle train established. However, if the volumes is not enough for a shuttle train the transport service provider or rail operator has to coordinate several wagon groups with different begin and end terminals in a transport network including coordination nodes. This in order to be able to offer the transport service at a competitive cost and frequency. To conclude: it is necessary for the agent to handle this consolidation and coordination complexity.	Intermodal border crossing transports are characterized by lack of quality. Particularly for the initial phase where investigated transport solutions was hampered by severe quality problems during the first couple of months. These operational deficiencies are related to transport resources, transport and loading equipment, cargo securing and above all poor time reliability. The four first mentioned are related to the production process within the rail operator. The latter is connected to both the operational process of the rail operator, the process regarding planning and execution of the time table, including reserve plans. However the rail operator cannot effect the time planning process and particularly not the operational planning and re-planning occurring due to shortcomings in the infrastructure, resources and other actors in the system. The latter are difficult to correct due to rules of prioritization and planning horizons for different actors.	A knew re-developed methodology for time table planning and re-planning is requested by the respondents by the shippers. The present does not take the changing conditions reviled by the shippers and mostly take the regional/interregional perspective of the passenger transport into account. A new model need a top-down perspective focusing on the supply chain needs of the shippers. This knowledge is often a decisive argument for the shippers not to use rail transport.
	By time the rail transport solutions often functions according to the requirements, however for the initial user you need patients. There is need for the rail operators to establish plans and procedures both to prevent and correct quality deficiencies in the intermodal transport chains.	
	The interesting subject is the coherence regarding the travailing of a rail transport system/solution but also that the transport system runs like a clock after the initial period.	
Time perspectives in conflict	**Poor market response**	
Due to the structure and the organization of intermodal transport a longer contractual and planning horizon is needed. This in deep contrast to the traditional way of procuring transport services – i.e. short contractual terms where negotiations focuses on buy-sell rather than long term win-win partnership.	The shippers perceive the rail operators as slow and inadequate in the shipper-transport operator relation. The rail operators require large freight volumes to interested at all and it takes months to get an offer or price indication. Thus, the shippers feel reluctant to send a tender to the rail operators due to poor response rate and this hampers the initiation to start discussions about the future – i.e. the requirement to co-ordinate enough volumes for long term profitability in intermodal transport chains. There is a large gap between the requests on and the abilities of the transport operator.	
	Three identified causes to this gap:	
In the operational planning the fluctuation transport volumes have to be handled. This are in conflict with the available transport and handling resources in the transport system as well as the static time slot planning and re-planning process offered by the Transport authorities (EU directive). This could be facilitated through better sharing of prognosis and information between the actors involved in the transport service. In general this is a major weakness among the shippers and transport service providers, where transport planning more or less is carried out on a day-by-day procedure.	The production culture within the rail companies due to large share of fixed costs and thereby a focus on high resource utilization and capacity securing in all sub functions. The response time from tender to price indication is too long and these time spans is even worse in international connections due to the complex organizational structure as well as complex time table planning. Cost leaps and problems occur when new production resources need to be allocated and when the shipper's requirement cannot be coordinated with the conventional shunting and line haul operations offered by the rail operator.	
	The transport branch normally handles the transport complexity by initiating customer projects. However, when consolidating freight volumes from different shippers the short comings of this approach are evident. This requires a new approach to handle several customers simultaneously.	
	Another cause to the reluctant interest to develop is the inadequate profitability within the rail transport industry. Development and expansion require economical control and profitability within the core business.	

5.1.1 Summing up the market aspects

- The shipper will be the set the requirements, since it is the shippers requirements that need to be fulfilled. The consumer power increases in the same pace as the supply of products increases. The marketing channels increases and the customer loyalty decreases. The assortment is increased and if you cannot procure a product in store one you will proceed to the next. One aspect of consumer power is the increasing awareness of environmental friendly products. The development increases the willingness among firms to invest in environmental friendlier solutions – as intermodal solutions. The knowledge and awareness of this consumer power strengthens the curiousness and willingness towards co-operation and coordination among the actors along the supply chains.
- The service portfolio and the market supply can be changed towards a combination of road, rail, sea and intermodality – if the solutions get one marketing channel, the same planning and control function (one-stop-shop). Interview with freight forwarders from Poland using the Karlskrona-Gdynia ferry connection: Too large extent freight forwarders not

interested in discussing the issue. This can be explained both by the fact that it concerns sensitive information regarding their core business, but also intermodal solution can be seen as a threat for the road-based forwarders.

- The foundation for new service development is changed organizational forms for increased collaboration or cooperation including actors as the shipper, the transport operator, the haulier, the terminal operator and the transport administrations. We have identified a genuine interest for a change at all parties (except the Polish Freight Forwarders), however in order to fully exploit the benefits of this potential cooperation a neutral platform for collaboration/cooperation is needed. A forum for open and stimulating knowledge sharing in order to increase the dialogue between the actors. In the changing environment this is a clear opportunity. Well defined strategic core processes are the base for the competitive interfaces between the actors and thus indicating the none-core ones where cooperation could be arranged.
- The transport corridor from Norway to Gdynia is regarded as competitive neutral among the shippers and thus one fundamental requirement for prosperous cooperation based on larger freight flows is fulfilled. Such cooperation also increases the power of negotiation towards the train operators and the transport administrations. Cooperation between branches increases, not only the volumes, but also the experience and knowledge within the development projects.
- The operators have an outspoken focus on volumes; however need to change focus towards profitability.
- There may be significant opportunities for value creation in logistics, for example through the coordination of product flows, delivery, information, labeling, traceability, etc. Ex works as a delivery condition means that the logistics directed by the trade. High proportion of ex-works may limit the possibility that Norwegian actors to influence transport patterns.
- There is an inherent locking in the development of intermodal systems since no actors are willing or able to invest financially. Partly this situation is explained by the time perspective, i.e. no one will make long term agreements in a rapidly changing world. Partly, this situation is explained by the unequal sharing of costs and benefits in an intermodal transport chain. The question is what organization that makes the investment and what organization that gains from the investment – in short and long term. In worst case this will benefit a core competitor.
- The operators develop and offer transport services based on one transport mode and not intermodal transport or logistics solutions.
- Negative perception of rail towards non-users. Despite the problems with road transport, users are relatively satisfied with existing services. Road -"too cheap" and tan attitude survey among major producers and exporters has shown that the industry does not see a major increase of the transport price in the coming future. Price seen as a primary factor in making transport buying decisions and road transport has been relatively cheap.
- Supply chain adaptation: slaughtering has to be coordinated with train/ferry schedules for fresh fish
- Increased accessibility, service and geographical availability are a necessity.
- Rationalizing the warehouse structure has been a threat towards rail, however; the new strategies can bridge this and turn it into an incentive. Terminal location: transport distance from the slaughterhouses to the nearest railway junction in the Northern Norway is between 3-6 hours (Jensen 2012)
- The time table is fundamental; however two subsequent time dependent chains both need an interrelated schedule and acceptable time reliability. When delays occur large shipments are affected (vs. one truck).
- The food industry and importers in Sweden are largely concentrated in the region around Helsingborg.
- Today the development of intermodal transport services is hampered by different issues. In Sweden by the cost and time inefficient handling of semitrailers in intermodal terminals, however based on new intermodal technology, e.g. Trailertrain, the cultural acceptance of trailers-on-trains could be increased.

Organsational aspects		
Shippers perspective	**Transport operators perspective**	**Societal perspective**
All stick to their perspective	**Functional structures delimits**	**Conflicts of objectives on a local level**
There are similarities between management of Intermodal transport and Supply Chain. In both cases several actors are involved in different structures and levels in order to optimize the final solution. One important aspect is openness between actors (e.g. sharing knowledge and information). The actors regard lack of knowledge and willingness to share information [in advance] as two main barriers to obtain larger planning horizons and hereby ability to act.	One actor need, based on the requirement of the transport user, to link the functions into a complete intermodal service available to the customer by one phone call. Today none of the transport service providers offers intermodal transports (inter transport mode services) in their base service portfolio, but only intra transport mode services. There is significant need for an agent to co-ordinate and consolidate freight flows emphasizing on intermodality. Often a gap between the knowledge and willingness to change can be found in the interaction between the marketing and production sub organizations within each transport operator.	The area in between the rail road infrastructure, where transshipment or cross-docking facilities are located is very often owned and planned by other stately, publicly or locally owned enterprises. This often hampers the development of intermodal transport solutions due to the fact that these companies are controlled by other objectives than the transport sector. These actors offer, in compliance with their directives, the transport actors to rent these areas at market prices. However on these areas other actors have constructed tracks and other facilities (not owned by the land owner). This market pricing is not in compliance with the transport policy of neither the European Union's nor the Swedish policy. This organizational and contractual situation often results in Conflicts of objectives on a local level between the transport, terminal operators and the land owner. The respondents agree upon that in those cases where the land is owned by local or regional publicly owned actors both pricing and the development processes is stimulated by optimal benefits for the industry in the region and not for a certain company. .
	The perspectives of intermodal transport delimits	
	Intermodal has, by tradition, been regarded as a rail transport service and as a result been developed as a rail service. Not as an additional and integration transport service as should be. The structure and this perspective hampers the development and marketing process, where all actors are not willing to share risks but rather only focus on optimization of own resources. Short contractual agreement periods and with the present transport resources it is difficult for the change towards intermodal transport without being exposed to large perceived economic risks. Small actors neither have sufficient volumes, transport resources nor economic resources to make a strategic change towards intermodal transport.	
	A large share of the transport demand require special attention	
	A large share of the transported amount of goods in the Kvarken Strait are high value products within the commodities automotive, durable and non-durable products – all requiring the shipment to be at the right location, at the right time, in required number and condition. All shipments can be defined as either requiring special attention due to intrinsic characteristics as risk for theft, sensitive for impacts/shocks, time sensitive and temperature sensitive. This is partly a technical problem but actually in general an organizational issue. Lack of surveillance, lack of track and trace, lack of opportunities to perform corrective actions when the technology/system fails in combination with liability issues make hauliers and transport service providers reluctant to use intermodal freight transport services. Surveillance and equipment for temperature sensitive shipments are already available on the ferry, but normally not during an intermodal rail transport. However the wagons in Finland are equipped with diesel generators, but the locos are not equipped with equipment for centralized surveillance.	

5.1.2 Summing up the organizational aspects

- Intermodal transport solutions are designed and developed originating its sub functions (bottom-up) and not as a complete transport service (supply chain) (top-down). In order to design/develop a system from the latter point of view the system functionality need to be stressed in order to link the sub functions/components together and to establish efficient interfaces and communication between the sub functions.
- I frequent question is the terminals. How many, located where, design characteristics and what size, financing and responsibility are some of the issues. Public authorities and private enterprises have different strategies, aims and objectives are involved in the same project. Hence, the main issues are what public authorities to responsible for a long term sustainable terminal network in the corridor?
- One opportunity to utilize the terminals and their resources is to consider what actor to do what activity. For example what benefits can the transport chain gain if the haulier offers both pre/end haulage and terminal services?
- A critical question is how to consolidate enough freight flows. The key questions are new organizational forms including both vertical and horizontal cooperation along the supply chain. Consolidation of freight flows not only at the origin and end of the supply chain but also along the transport chain in a more complex network. These questions and strategies how to equal transport flows, will be important for future studies.

- New transport solutions require cooperation and hence the need for long term market agreements. Today this process is characterized by short term buy-sell agreements and hence the question is how to mediate between these perspectives.
- A significant share of the gap between these actors are related to communication, inherent knowledge and understanding. The actors do not listen to each other and there is a lot inherent in the organizations.
- The competence within the subsystems is high and these competences need to be coordinated. Today these prerequisites are not present in the development process, but are needed more than ever. Previously these contacts were characterized by competition rather than collaboration. Increased transport distances, increased transport costs by road and interest in developing the infrastructure, the terminals and other nodes is emerging, i.e. increased share of intermodal transport on the long transport distances.
- No one puts themselves in the pole position. The main reason is that this is not my business and/or the suspiciousness from other actors. Someone needs to take the initiative and the sole question is who? Are there need for a 3PL or will the transport operators do it on its own. There is a need and there is an opportunity to coordinate flows!
- There is also need for a corridor forum in order to market and process important questions, conduct a dialogue with authorities? What are the benefits and what are the purposes?
- There is a large share of the freight volumes that are regarded as goods requiring special attention. Hence incremental innovations can bring large effects and also that the coordination of flows with/without GRSA jointly will increase the opportunities to consolidate enough freight flows.

IT, administrative and planning control aspects		
Shippers perspective	**Transport operators perspective**	**Societal perspective**
Gaps in planning horizon	**Freight volume is the fundamental issue for planning activities**	**The Role of transport administrations**
Shippers, transport operators and infrastructure authorities have adapted different planning horizons. Intermodal transport solutions require, due to structural and organizational complexity long term planning during both the development process as well as the operational phase. All included actors need to be involved in the pre-operational and operational phases with the overall aim to develop and operate an efficient transport solution. Shippers are, in most cases, less long term and often neither the patients nor the demand/strategies stretches as long as the time horizon for infrastructure development.	As a result of the focus on operational issues within the rail operating companies – we have identified a business focus on the amount of transported tons and not profitability.	The respondents often claim the importance of a more visible and transparent time table allocation procedure, including the prioritization of passenger and freight trains. This procedure is vital for the rail operators in their offers to their customers. However; this is not only important during the development phase, but also to be able to offer a suitable transport service from year to year. A delay of the time slots by 15 minutes from year 1 to year 2 might have significant impact on the market offer and the relation between the rail operator and the shipper in a larger network.
Option to level freight flows and work load	**The planning horizons control the service supply**	
The consignor and consignees using rail above a certain break-even level often point out the cost and resource utilization advantages of using both rail and road as supplementary transport solutions. The rational is the ability to level the work load on the loading/unloading staff if the shipper is using both wagon loads (direct loading/unloading to rail wagons from loading dock) as well as trailer/lorries. The fundamental for this is the characteristics of the different transport modes, where the consignor/consignee dispose the wagon load for eight hour, however the trucks need to be loaded/unloaded promptly. The respondents often point out this advantage in order to level the work load on the staff if the rail wagon load volumes exceed a certain level.	The time table planning process is an important control parameter deciding what transport solutions to offer. The planning horizon from application for time slots to the final allocation of time slots are both long in relation to the standard contract time horizon and also the timing of tenders/application is not coordinated. This also makes it difficult to quality secure transport solutions since new transport solutions – in the initial phase – need to rely on spare capacity. This is a significant barrier which magnitude has increased after the deregulation and new directive from the EU.	
	Non-adapted IT solutions	
	The IT solutions adapted to intermodal transport is a delimiting factor. The present system mainly solves functional issues and is not able to handle intermodal transport solutions consisting of several serial coordinated functions. Referring to the previously discussed an issue to address is who to make such an investment in a standardized intermodal IT-system.	
	Fluctuation volumes and staffing is a doubtful question	
	There are doubts of how the transport services provider and the transport operators cover to delimit the consequences of disturbances and fluctuating freight volumes. This refers to all functions within these transport chains and particularly the terminal functions. The volumes at a terminal fluctuate during day, week and month and due to the fluctuating volumes these functions are difficult to dimension the resources needed. The intermodal system is dependent on the total volume transported, however due to fluctuations it is important to allocate a sufficient number of resources to an activity and also to allocate the activity to the most suitable actor.	

5.1.3 Summing up IT, administrative and planning/control aspects

- The sum of several small and dispersed freight flows along the strait results in a complexity in time and space. There is need to develop and implement intermodal planning and control systems to handle this complexity.
- The transported volume is essential. Decreasing volumes might lead to a termination of the transport service. For increasing volumes the opposite, however it is evident that there is a break even volume and volume leaps for intermodal services, terminals and private sidings. Increased volumes, above the minimum level, is necessary – i.e. to get the business going in the right direction.
- There is no need for customer solutions, rather several integrated customer solutions.
- There is an need for new intermodal information systems; however no one will invest. There are several functionally adapted systems, but no coordination function.
- One critical issue is to reduce the leap in planning horizon. Both from a development perspective, time table planning perspective and the pure operational perspective, e.g. compare the static table in relation with the road transport spot market.
- A organizational question, which is important from a planning perspective is the preconditions, prerequisites and the potential for consolidation and coordination of flows outside the fish farming industry.
- Most likely the advantages using intelligent transport systems will in the future have a great impact. Further studies are needed.

Infrastrutural aspects		
Shippers perspective	**Transport operators perspective**	**Societal perspective**
Termination of Stations, terminals and private sidings	**Poor capacity utilization of the infrastructure**	**Poor track maintenance**
The number of stations, terminals and private sidings are continuously decreasing in both Sweden and Norway The conditions for maintaining and using these facilities need to be changed and the conditions need to be leveled related to road transport. The respondents argue; less bureaucracy regarding permission and infrastructure agreements with the Transport administration as well as the Transport Authority as well as subsidies to develop or redevelop the infrastructure.	The rail operators agree upon that the rail infrastructure in time is badly utilized. Some parts of the network are overloaded and other parts underutilized. Hence there is capacity and there is need to optimize the system for both passenger and freight from national perspectives.	The frequently mentioned poor infrastructure standard affects the time reliability.

5.1.4 Summing up the infrastructural aspects

- It is of importance to leave the functional perspective of the transport modes and the infrastructure and to a perspective where rail and sea is an important cornerstone in several companies' logistics networks. A reliable infrastructure is fundamental for this perspective.
- The terminals and other similar facilities are important to link the transport modes and to link the supply chains. Here there are two schools; the group preferring few large terminals and the group preferring a large number of small terminals. In this report we have argued the need for small functional terminals in order to implement the transport services.
- It is of vital importance to use the rail capacity more efficiently (24/7) and also to ensure the quality of the infrastructure.
- Capacity on the railway is for most of the stretch quite good. The capacity and the average speed is mainly limited by the single tracks along the corridor from Mo i Rana to the Port of Karlskrona. Average speed for freight trains on single track lines is 55-65 km/h and on double track lines 80-85 km/h, however the latter is dependent upon the number of passenger trains on the lines.
- Most routes are electrified, except for the line north of Trondheim.

Production- and operational aspects		
Shippers perspective	**Transport operators perspective**	**Societal perspective**
Lack of rail services	**Focus on shuttle trains**	**The perspective of infrastructure delimits**
A rather given aspect, is the lack of rail service within a reasonable distance. Lot Owner's location and rail location does not always.	Train Operating Companies still have a traditional focus on blocks or shuttle train volumes. Ideally, you see "500-600 meter train for a customer from sender to receiver without shunting." That is a simple production with low revenue per ton-km in the markets where competition with other rail companies is highest. A first limitation is that the number of customers with volumes of this type of transportation is few. A second limitation is that a too strong focus on unit trains for the same customer may lead to the renunciation of other shops that maybe with a different approach could be profitable. Complex inter-modal transport solutions with several customers have trouble making themselves heard with this view from the train operator	Even if you can see opportunities for better use of existing infrastructure on the rail side still cannot transport authorities offer more than the given infrastructure that you are responsible? Initial investment in infrastructure is therefore an important issue. Investments that open up system and increased intermodal volumes have priority over regional interests. This is not the decisional methodology obvious today.
	Lack of infrastructure capacity	
	It's not just the infrastructure that puts limitations. There is considerable lack of intermodal wagons for transporting semi-trailers and it is beginning to be a shortage of wagons for transportation of ISO containers and swap bodies. The lack of coaches also highlights the issue of railway operator's use their resources efficiently. Rail operators are designing their transport arrangements with excess capacity under traditional wagonload thinking. Whereas high-quality intermodal transport solution requires capacity fuse at each stage of production and transportation infrastructure. Respondents indicate that this is an important limitation in the intermodal transport system and press forward on the development of priority rules on the terminal and rail networks so that shipments are handled in logistical order.	A similar issue relates to investments in terminals. Must transport authorities and other agencies focus on a few major intermodal terminals or shall act through a dense network of small, simple terminals. A few large nationwide intermodal terminals mean that these terminals, provided freight volumes, can be operated in an efficient and effective manner. But a few large-scale terminals also disadvantages and lockups. The disadvantages include long transport distances and feeder locks for example, changing the flow of goods.
	Rail is not profitable on short diatances	
	This is a fact and a statement of fact. Intermodal transport solutions are normally assessed as competitive for more than 400-450 km over 700-800 domestic and cross-border flows. It is of course a relative concept; the critical distance limit varies with the types of goods, availability, etc. But there must always be interesting to work on short distance and still achieve profitability. Such a development favorable conditions for intermodal solutions. But as long as there is only considered as such a restriction will be unchanged remain	The alternative to a few large-scale terminals is a dense network of smaller, simpler terminals, in the simplest case, a surface for cargo handling, which can easily be re-prioritized and moved. There are many indications that the latter option is the most interesting for intermodal solutions. Although this is an interesting question for in-depth model and system-related studies.

5.1.5 Summing up production and operational aspects

- The business concept of a coordinating production functions must be to combine different continuous flow rates at the same time requirements. A system can be created for basic volumes that are complemented by another system that manages the other volumes and fluctuations / deviations. Flows must generally be differentiated in terms of needs. The intermodal operators need to act more shippers and hunt return flows. It is important to ensure the effectiveness of return shipments.

- Lack of and use of rail wagons to be resolved.
  Increased speed of trains called in some quarters, but the question is whether the time for terminal handling are generally more critical. In time-critical systems, a score with faster trains is that thanks to the train speed can incorporate timing margins.
  Arguments for faster trains are also to enable faster trips than by truck.

- More "day trains" is something that is desirable. One of the foundations of production and operational priorities. Increased regional coverage (line terminals and line network) is a prerequisite for increasing volumes of intermodal transport.
  Using feedback to what has previously been discussed on the perception of intermodality, where, among other things, it was found that it is often regarded as a rail product, foresees an operating philosophy for intermodal solutions approaching si g truck's characteristics.

Regulative aspects	
Shippers perspective	**Societal perspective**
The need for both the carrot and stick	**Subsidies for change and investments**
A genuine interest for increased transports in the Kvarken Strait has been identified; However, the actors also identify a political direction favoring road transport instead of the more environmental friendly alternatives, i.e. sea and rail. Instead of supporting the development of intermodal transport chains the policy indicates increased costs for intermodality.	There are requests for new or modified prerequisites for investments in terminals and private sidings. This aspect is highlighted by both the shippers and transport operators based on the fact that private enterprises often get public support to build local road infrastructure. However; when investing in rail access the operators need to make 100 % of these investments and particularly the connecting switch to the main railway is extremely expensive. These high investment costs often make private siding unprofitable if the transported volume do not exceed 30 000 tons.
	New infrastructure charges for rail and road
	The regulative changes occurring during the 1990s increased the competitiveness of road transport at the detriment of the rail and sea transport systems. New legislation and regulation in Europe; Austria, Germany, Poland and Switzerland, indicates a political willingness to equal the cost levels of the infrastructure charges between the transport modes. However in Sweden the politicians are reluctant to introduce this road charge and will instead increase the rail infrastructure charges four times until 2020. According to several studies this will transfer significant volumes from rail to road instead of trying to level the balance between the transport systems.

5.1.6 Summing up the regulative aspects

- A fundamental issue is if it is the private or public sector that will form the conditions and incentives for change? Who is responsible and who has the competence.
- A closely related question is the role of the public authorities. In Sweden we can see a tendency in the opposite direction – leading away from the increased intermodality.
- The development and favoring road transport and still the shippers, without hesitation, buy more or less illegal low cost transports with low Euro-classes. This means that the Scandinavian transport operator's efficiency improvements, environmental concerns and strive towards efficient freight flow systems are threaten to be overrun by operators not following the regulations, not paying taxes and hence sets rules of the market out of play..
- A smooth flow of goods across borders is hampered today by different legislations. In addition to administrative obstacles, the various provisions that shipments passing through the border do not have the same economic conditions as domestic transport. One example of such regulations and administrative barriers is the environmental regulations for maritime traffic in the Baltic Sea The new EU Sulphur Directive means that ships sailing in the Baltic Sea must have fuel with lower sulphur content, which is considerably more expensive than the fuel used today.

Technical aspects
The transport operators perspective
Technical solutions for shipments requiring special attention
We have stated that there is a large number of transports requiring special attention due to requirement of lead time, time reliability, temperature restrictions, cargo securing etc. This is mainly an organizational issue, but there is also a technical component involved. There is need to develop new technical solutions to better be able to transport these kind of sensitive shipments.
New technical solutions for intermodal transport
New technical solutions for intermodal transport are frequently introduced, however seldom implemented in large scale. These technical functions often solve the intermodal problems for a bottom-up perspective focusing on the rail or terminal function. However, in order to be apple to penetrate the transport market dominated by the road transports, these new systems need to be compatible with the road transport system in the most significant aspects (compatibility). Secondly, who is going to invest in a new technology?
Adapted load units
The load units have an impact on the success of intermodal transport solutions, In this project we have only concluded, based on the interviews and based on previous work, that the standard unit today and in foreseeable future will be 13600 mm long. Either a semitrailer or a European wide container/swap body.

5.1.7 Summing up the technical aspects

- Different categories of transshipment technologies have to at the same spot/location in order to increase the flexibility. The terminals need to be able to handle different types of load units – for example both loading/unloading and cross docking.
- Available fast, reliable and cheap transshipment is a necessity.
- The flexibility in transhipment is important to handle large and fluctuation volumes. Here there is important to discuss whether to use one large or several small terminals.
- The load unit standard based on a 13 600 mm long unit will be the standard in foreseeable future

Societal aspects	
Transport operators perspective	**Society perspective**
Time tables	**Ambiguous messages**
With transport authorities including the social aspects of coming out of the operator's perspective, once again the question of whether transport authorities role in general and more specifically on timetables is a major issue for operators.	The perceived uncertainty about society's intentions and actions. An uncertainty that is sometimes interpreted as mixed messages, on the one hand, operates one from the authorities the issue of intermodality and are clear in their message that the percentage should be increased, on the other hand feels that authorities do not create the necessary conditions to achieve it. This applies to investments in infrastructure.

5.1.8 Summing up societal aspects

- The need for a clearer and more purposeful traffic policy with greater attention to intermodality.
- Increasing intermodality requires investment in infrastructure.
- It requires a new methodology for evaluation of investments in infrastructure including terminals and for timetable planning on including the temporal availability of infrastructure and terminals. With current methods and models, you can never recoup investments in the freight transport infrastructure.
- The methodology and models need to cover intermodal investments and also deal with organizational issues.
- The conditions must be the same for different modes.
- Long turnaround time for planning of infrastructure. A formidable slow process. What are the consequences?
- From a societal perspective, we note that the general debate at the moment in the long run will benefit the railroad. We can also see an increased interest from the authorities.
- Support by the state to facilitate and support the establishment of industrial tracks and intermodal terminals. In it is also a desire for cost-neutral charging for the industrial track and infrastructure at terminals relative road transport.

6 Conclusions

In the report we have tried to answer five hypotheses with the aim to discuss and analyze if an intermodal transport solution connected to the ferry line Gdynia – Port of Karlskrona could increase the attractiveness and competitiveness of the transport corridor via Port of Karlskrona. The hypothesis was; (1) The intermodal service provider needs to design and implement a logistics service, which offers its potential users the following cornerstones; (1) a significant, sustainable competitive advantage (SSCA), (2) is integrable with the dominating transport systems and (3) is implemented based on a well-developed marketing orientation (spatial and commodity) in order to secure a base volume; (2) Hypothesis 2: Hence, of vital importance is the identification process where one or several complementing commodity groups, alone or in combination could provide a base volume for the transport service and hence, ensure the profitability during the implementation phases. (3) hypothesis 3: Restructuring of the marketing-, logistics- and transport channels is vital to allow adaptation to an intermodal set up, (4) Hypothesis 4: According to Storhagen et al (2008) the barriers towards adaptation of an intermodal strategy (for time and temperature sensitive shipments) could be categorized according to; (1) market, (2) organization, (3) production and operation, (4) Planning, administration and ICT, (5) Technology, (6) Infrastructure, (7) Regulation and (8) Societal barriers. Hence, to understand both incentives and barriers towards such change a well structures analysis and segmentation of these obstacles is needed in order to identify measures to strengthen or bridge the obstacles and (5) there is need to stimulate efforts in the industry to change logistics system with trans-/national measures or regulations top-down. Our hypothesis; there is need for national or transnational support or subsidies for the industry to overcome the inertia of change. Today, there are only transnational programs (Marco Polo) to stimulate such change, however these require very large volumes over long distances and is according to Woxenius and Bärthel (2008) not suited for countries, as Norway and Sweden, where a majority of freight flows is small and dispersed.

For the first two hypotheses we have found complex relationships between the volume (base volume) and the ability to design a system that has a significant sustainable competitive advantage and is compatible with the existing system. The case study, including the studies of backhaul and complementing cargo indicates that farmed fish is not a cargo commodity suitable for forming the base volume in an intermodal transport system. As pointed out there are several reasons for this, however there are complementing cargo commodities that might serve as base volume. For instance, in the southbound direction, paper and pulp, aluminium, while northbound - colonial foods, perishables and recycled paper. In the report these flows are presented and discussed extensively based on the knowledge gathered about flows of aluminum bars to sub-suppliers for the automotive and furniture manufacturers from Mo i Rana, Farsand (South coast) and Sundalsöyra (West coast), based on recycled paper (northbound), tissues (Northbound) and paper products (south bound). Together these commodities form a base flow with a hub in Vetlanda and Alvesta/Räppe. However these commodities are not as time sensitive as farmed fish and hence there is an important correlation between the base volume and the requiring farmed fish. Even though these volumes are smaller and fluctuating an intermodal transport solution need to be designed for these characteristics, i.e. with lead time requirement of 24-48 transport hours from the slaughtering house to the Processing industry and with a time table dictated by the slaughtering houses (departure in the afternoon – around 16-17h).

In the report two different set ups are presented and discussed. The first is based on the national intermodal operator Cargo Net and the second on a present set up operated by the Swedish Rail operator TÅGAB. Due to the complex structure and the service supply Vectura has favored the latter solutions for a potential pilot between the countries and base it on a conventional wagon load solution. In previous studies local terminals have been proposed for certain commodity groups and these in combination with the newly developed terminal in Räppe, owned and operated by Alwex, a network of terminals could be established and between the manufacturers in Norway and these terminals a frequent transport service could be established. The respondents indicate a frequent service of at least on connection peer week, i.e. the frequency and the time reliability is the decisive parameters together with the transport price. In the northbound direction there is a need for transport of Tissue Paper to the Norwegian groceries as well of Waste paper to the Paper Mill in Levanger (Norske Skog). The Tissue Paper is produced by Metsä-Tissue (Paulistróm) and Swedish Tissue and is transported to the distribution Centres for the Norwegian Market. Some of these volumes are already transported by rail, however the shipper is not satisfied with neither the service nor the ability to find balanced freight flows (affecting the transport costs). Other shippers indicating a need for transport services in the axis investigated is saw mills and chemical industries. All these shippers have small and dispersed freight volumes, i.e. not enough volumes for initiating a transport service on their own. However together a service connecting Oslo and Småland/Blekinge via Hallsberg – Nässjö could be established with sufficient frequency and freight balances for profitability.

A fundamental factor in intermodal transport have difficulty competing with truckloads and clean road transport are: first, that intermodal cargo carrier has a load capacity that is 15–20 % lower than the load unit adapted for road transport. Secondly, it reduces the load capacity by 5-8% if an intermodal transport unit used (loaded on an L-wagon) or 15-20% of the number of EURO-pallets are counted. If both the consignor and the consignee have private sidings the transport is competitive to road, however an intermodal transportation is also burdened by the lifting and pre- and end haulage costs, resulting in a railway carriage that had a cost advantage (relative to the truck), 10-30% will be 15-60% more expensive than road.

Finally we have identified the need to overcome the inertia of change by supporting the companies willing to introduce wagon loads and intermodal transport with staring subsidies, representing 10 % of the operating costs, like the EU Marco Polo, however adapted to the Scandinavian market of small and dispersed freight flows. This is needed to overcome the obstacles (restructuring marketing, logistics and transportation) for the shippers as well as the risk incorporated in the business of the operators. This conclusion is supported by the fact that few transnational intermodal solutions have survived the implementation phase without subsidies.

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