



# New intermodal solutions combining containers

Report of  
StratMoS





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# 1 Purpose and Objectives

This study should highlight container and RoRo transports within the North and Baltic Sea regions as well as related hinterland areas. It will be assumed that a combined and integrated sea transport of container and RoRo cargo generates a modal shift in hinterland transportation from road to sea (compare figure 1).

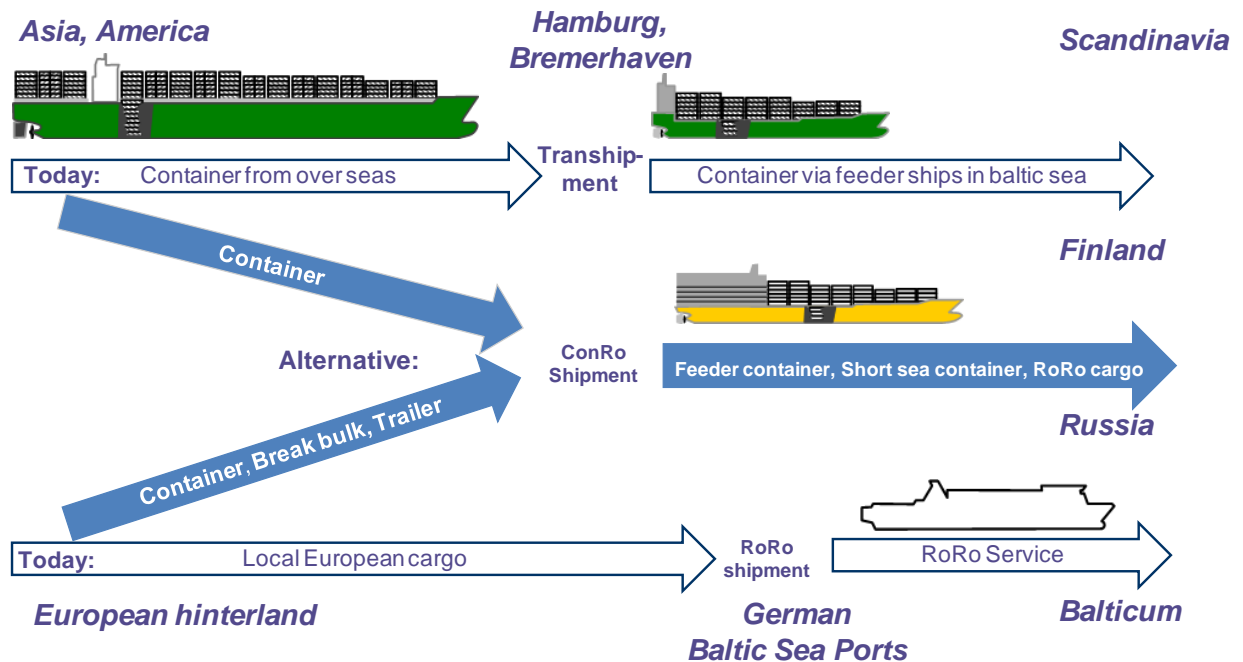


Figure 1: Integrated ConRo services as alternative to separated container and RoRo sea transports

Container and RoRo cargo are the most important break bulk commodities in Baltic Sea transports [1]. Normally containers are transported by overseas carriers to North Sea ports like Hamburg or Rotterdam and feeder ships which fulfill the Kiel Canal requirements. Containerized Baltic Sea cargo had a share of around 42% of the total handlings in the Port of Hamburg until 2009<sup>1</sup>. In contrast import/export of RoRo cargo from/to Baltic Sea is low in the North Sea ports. Baltic Sea RoRo cargo predominantly runs via southern Baltic Sea Ports like Luebeck, Kiel or Rostock. Until today RoRo cargo was not an essential cargo potential of the North Sea ports. It often requires fast transport speed and the location of the North Sea ports was not adequate for fast transport services in the Baltic Sea because of the Kiel Canal. Cargo which has high requirements on transport speed is not very sensitive in terms of transport price. Under the influence of the current economic crises a stronger orientation on transport prices is expected in the future. Today RoRo cargo can have more requirements on the transport price as in the past and these requirements can enable new changes for the North Sea ports. In relation to Scandinavia, Finland, Russia on one hand and Western Europe on the other hand, the North Sea ports offers a shorter road transport within the total transport chain as the southern Baltic Sea Ports due to there geographical upstream location. However for the longer and more expensive sea transport through the Kiel Canal and Elbe, the use of combined container and RoRo carriers (ConRo carriers) is necessary. The concentration of more cargo on a ConRo ship offers a large scale effect which aims in lower transport costs per unit.

Objective of the present study is the theoretical evidence that under specific circumstances of the North Sea ports ConRo services can work and that they can lead to a modal shift from road to sea or rather road to rail. The following methodology is planned.

<sup>1</sup> Source: Official modal split published by Hafen Hamburg Marketing e.V.

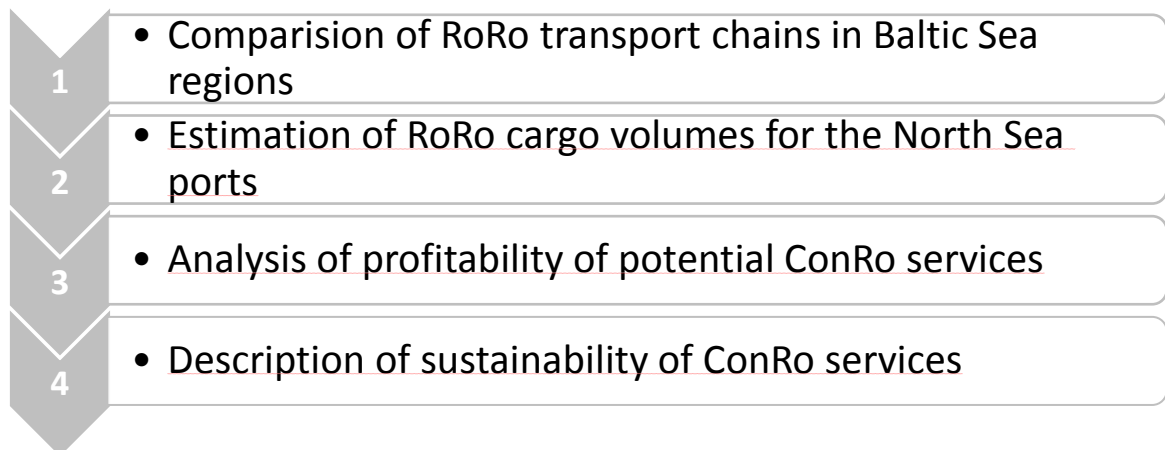


Figure 2: Planned methodology

First the existing and potential transportation chains between southern Baltic Sea ports, the North Sea ports and Scandinavia, Finland and Russia will be compared for evaluating the locational advantage of the North Sea ports in terms of time and costs. An estimation of the potential RoRo cargo volumes for the North Sea ports follows up which based on already existing results of a study of the company Baltic Marine Consult GmbH from 2006. To show that ConRo services via the North Sea ports are more profitable than RoRo services via the Baltic Sea ports an analysis of profitability will be done under consideration of specific local costs. Based on these results environmental and sustainability aspects will be investigated especially under the focus of saving road kilometers.

## 2 Comparison of RoRo transport chains in Baltic Sea regions

Due to the current crises the cost pressure on all kind of logistics services is also increasing on transport services. The requirement on high transport speed today is often replaced by the requirement of low transport costs. The so called “slow steaming” of container ships in overseas transports is an evidence of this requirement. For a lot of industrial transports accuracy not speed is important. “Just in time” was often contrary to high transport speed. If a “just in time” transport is cheaper than a high speed transport, a lot of consignees and consignors would accept an increase in transportation time. An example of different transport chains between the German hinterland city Kassel and Helsinki can underline this thesis.

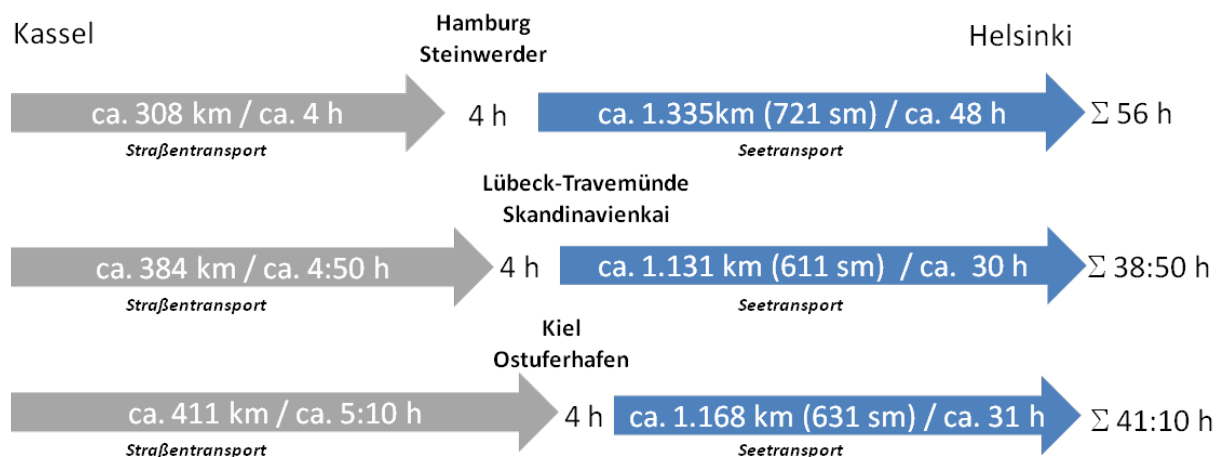


Figure 3: Comparison of distance and transport times of different transport chains between Kassel and Helsinki using RoRo sea transports

For example, considering the German hinterland, the Port of Hamburg has shorter road distances as e.g. Luebeck (ca. 80km) or Kiel (ca. 100km). A truck based pre and on carriage would be faster via the Port of Hamburg. The effect is much higher considering Bremerhaven. 80km is not a high distance, but the European truck driving laws says that e.g. Nurnberg would be inside an 8h truck driving action radius from the Port Hamburg or Bremerhaven but not from the Baltic Sea ports. A round trip within 8h driving time between Kassel and Hamburg is also possible but not for the Baltic Sea ports. Trucks are typical cargo for RoRo services. Under this assumption the hinterland RoRo cargo attractiveness of the North Sea ports especially in the high industrial developed regions of Germany is higher than the attractiveness of the Baltic Sea ports. Unfortunately today no Baltic Sea RoRo transport via the North Sea ports is in operation.

Considering the same cargo emergence in the German hinterland, road transport cost savings would be possible by RoRo sea transport via the North Sea ports. Assuming specific truck transport costs of 1Euro/km<sup>2</sup> the potential savings would be around 160-200Euro per each truck round trip.

The distance advantage in the rail sector is unimportant in the North Sea ports. The advantage of the Port of Hamburg in comparison to Luebeck-Travemuende is smaller because of the route split near to Luenburg (German hinterland). The train operation area relating to current number of trains is more or less equal, also the accessibility to the hinterland. But the train departure frequency in the Port of Hamburg is higher than in Luebeck. In comparison to the Port of Kiel, Hamburg as well as Luebeck have better rail hinterland connections [3].

Concerning inland waterway a transport, the Port of Hamburg has the best conditions for pre- and on carriage by barges compared with all remaining German North Sea Ports. Luebeck-Travemuende is only

<sup>2</sup> Average value of different freight matrixes of forwarders for a trailer transport

accessible via seven small locks [4]. Kiel is accessible by great barges via the Kiel Canal but not with pusher units of the river Elbe which are often used [5].

Chart 1 highlights the comparison of the three ports Luebeck, Hamburg and Kiel concerning hinterland connection with three different carriers.

Chart 1: Comparison of the hinterland connection of the three ports Luebeck, Hamburg and Kiel in the relation Kassel-Helsinki

Pre and On carriage to W-Europe via:	Kassel-Helsinki via Luebeck	Kassel-Helsinki via Hamburg	Kassel-Helsinki via Kiel
Train	++	++	o
Truck	+	++	o
Barge	o	+	-

++ very good ; + good; o sufficient; - not companionable ; -- not existing

The Port of Hamburg has the best pre- and on carriage conditions of RoRo transports. Especially in road transportation Hamburg would be an interesting alternative if the price conditions are the same as in Kiel or Luebeck.

Chart 2 figures out a comparison of a trailer transport on the basis on equal sea freight costs. The chart demonstrates the above assumed advantage.

Chart 2: Time and costs comparison of a trailer transport under the assumption of equal sea freight costs

Parameter	Kassel-Helsinki via Lübeck	Kassel-Helsinki via Hamburg	Kassel-Helsinki via Kiel	[Dim]
Average transport time	39	56	41	[h]
Transport costs road	384	308	411	[€Trailer]
RoRo handling in two ports	74	74	74	[€Trailer]
Transport costs sea	400	400	400	[€Trailer]
<b>Total costs</b>	<b>858</b>	<b>782</b>	<b>885</b>	<b>[€Trailer]</b>

If there's a possibility to use a RoRo service in Hamburg with the same sea transport prices as in Luebeck or Kiel, the service would have a market opportunity and could generate new short sea cargo volumes. The use of a ConRo ship instead of a simple RoRo ship could enable this service because of scale effects. A ConRo ship has more or less the double cargo capacity as a container or RoRo vessel. The scale effect is one of the most important reasons concerning ship growth in container ship sector [6].

Before looking at the economic effects, the potential cargo volumes and transport routes have to be estimated.

### 3 Estimation of RoRo cargo volumes for the Port of Hamburg

#### 3.1 Cargo area and main transport routes

Figure 4 shows the investigation area and main transport routes of potential RoRo and ConRo cargo volumes.

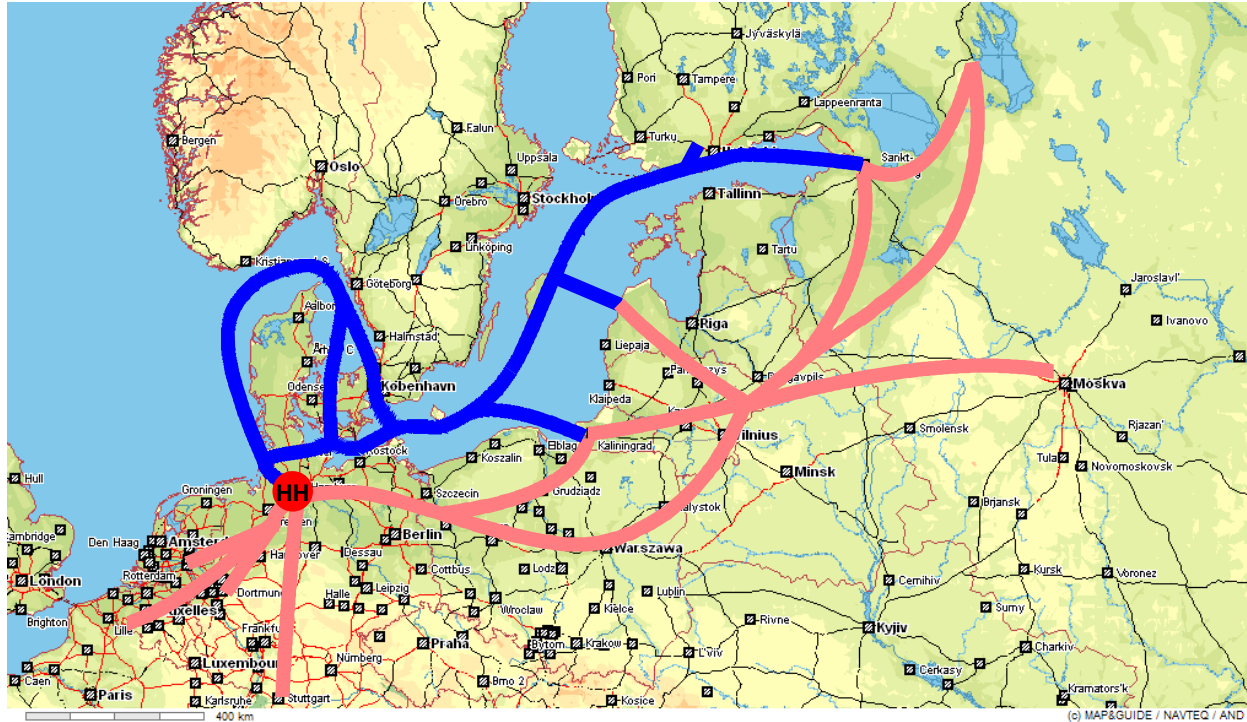


Figure 4: European cargo area of RoRo sea transports on the north south relation via Baltic Sea (Red = Land transports, Blue = RoRo sea transports)

Chart 3 highlights different transport solutions within the investigated area.

Chart 3: Transport solutions within the investigated area

Parameter	Solutions				
	Container (Overseas)	Container (Intra Europe)	Trailer resp. Trucks	Swaps	Mixed cargo
Western Europe	Benelux	North East France	Ruhr	Baden Württemberg	
Eastern Europe	North West-Russia	Central Russia	Finland		
Ports Western Europe	Hamburg				
Ports Eastern Europe	St. Petersburg	Ust Luga (Russia)	Helsinki/Vousaari	Ventspils (Latvia)	Kaliningrad Baltijsk
Transshipment ports (optional)	Kiel	Rostock	Trelleborg (Sweden)	Gdynia (Poland)	
Transport versions	Truck (direct)	Train (with Pre- and Oncarriage)	RoRo (with Pre- and On-carriage)	Container Feeder (North Sea)	ConRo (North sea)



The potential cargo volumes for a ConRo service between Hamburg and North East Europe consists of the following parts:

- Oversea container with origin/destination North East Baltic Sea
- Intra European container with origin/destination North East Baltic Sea
- Trailer and Swaps from/to central Europe from/to North East Baltic Sea
- Heavy cargo from Western Europe from/to North East Baltic Sea

Beside the cargo volumes along the Baltic Sea longitudinal axis the relation Germany-Norway offers a sufficient cargo volume for at least one ConRo service. In the frame of the cargo volume estimation especially the non urgent cargo is of note. Urgent RoRo cargo will probably use the existing RoRo services via the Baltic Sea Ports. Therefore the cargo volumes for a potential ConRo service is located in the non urgent and low cost demanding RoRo cargo sector. The influence of the transport costs and cargo values on the transport mode`s selection can be demonstrated on the cargo flow between Russia and Western Europe. 95% of the Russian export goods (predominantly raw materials) are transported by sea transport from East to West. Only 40% of all goods are transported by sea transports from West to East because more expensive consumer goods dominate the foreign trade (2007) [7].

All existing traffic prognoses (e.g. [8]) assume that cargo flows will increase in the future. In addition the existing cargo flows still have a small potential of more containerization. More containerization will also effect the European intra traffic. Besides it will be assumed that economic crises have no permanent effect on the international division of labour. There will be a disproportionate dynamic in cargo transportation in the future for the relations North and Eastern Europe. Transports from and to Northern Europe will have a share of around 35-40% in German Sea ports (e.g. [9]). This assumption is underlined by the massive investments of international conglomerates in the regions of Moscow, Kaliningrad and St. Petersburg in automotive Industries and consumer goods production. With the implementation of various free economic zones, perfect conditions for foreign investors are implemented in Russia. On the other hand, Russian energy, steel and machinery concerns invest a lot of money in Western Europe. So the integration of the Russian economy will be continuing in the future.

Chart 4: Total estimated transport volume of RoRo cargo for a ConRo service according [2]

Investigation area	Relation	Basis 2005 Mill. T.	Basis 2007 Mill. T.	2015 Mill. T.	2020 Mill. T.
Russia	Westbound	2,87	2,01	3,81	4,64
	Eastbound	13,75	14,44	20,20	25,78
	<b>Total:</b>	<b>16,62</b>	<b>17,45</b>	<b>24,01</b>	<b>30,42</b>
Baltic States	Westbound	1,59	1,64	2,06	2,39
	Eastbound	1,94	2,00	2,52	2,93
	<b>Total:</b>	<b>3,53</b>	<b>3,64</b>	<b>4,58</b>	<b>5,32</b>
South Finland North Sea Ports	Westbound	10,45	10,97	12,73	13,72
	Eastbound	4,86	5,10	6,28	7,11
	<b>Total:</b>	<b>15,51</b>	<b>16,08</b>	<b>19,01</b>	<b>20,83</b>
Over Seas container	Westbound				
	Eastbound				
	<b>Total:</b>				

Asia railway container	Westbound	0	0	0,01	0,01
	Eastbound	0	0	0	0
	<b>Total:</b>	<b>0</b>	<b>0</b>	<b>0,01</b>	<b>0,01</b>
South East Europe	Westbound	0		0	0
	Eastbound	0,03	0,03	0,03	0,04
	<b>Total:</b>	<b>0,03</b>	<b>0,03</b>	<b>0,03</b>	<b>0,04</b>
Total cargo potential	Westbound	14,91	15,62	18,61	20,76
	Eastbound	27,88	21,57	29,03	35,86
	<b>Total:</b>	<b>35,69</b>	<b>37,19</b>	<b>47,64</b>	<b>56,62</b>

In the regarded area of Chart 4 the Russian cargo flows in 2007 were around 17,5 mill. t. Under the assumption of the further integration of the Russian economy for 2020, 30 mill. t of cargo will be expected.

The development of the three Baltic States (Lithuania, Latvia and Estonia) will be evaluated similarly [10]. The expected RoRo cargo volume for the Baltic States in 2020 is around 5.3 mill. t.

Because the economy of Finland is deep integrated in the world economy, the foreign trade of Finland related to the number of citizen is much higher than the foreign trade of Eastern European countries [11]. Beside transport to Russia, the foreign trade of Finland is mostly based on sea transports. Around 70 mill. t of cargo are handled in Finnish ports. The Western European countries have a share of around 40% on this throughput. Around 70% of this amount is RoRo cargo. For 2020 it will be assumed that the RoRo cargo between Western Europe and Finland will have an amount of around 20 mill. t.

An additional cargo potential exists in the field of transit cargo, especially for the Russian railways from Europe to Asia. This potential cargo amount can also be handled via Russian or Finnish ports. Chart 4 shows the different estimated RoRo cargo volumes for the regarded investigation area. In total a cargo volume of 57 mill. t is assumed for 2020.

Overseas containers (today's feeder traffic) are not considered because they are already transported via North Sea ports and do not represent additional cargo volumes. But they will be considered in the business calculation of potential ConRo services from and to the North Sea ports.

### 3.2 Suitable relation and departure frequencies

Taking into account that cargo declines in the last two years, the existing potential of RoRo cargo of about 26-30 mill. t per year would be already big enough for ConRo services between North Sea ports and the Baltic sea. The estimated distribution on several Baltic Sea regions is shown in chart 5.

Chart 5: Distribution of the assumed potential of RoRo cargo in the regarded area (detailed investigation in [2])

Baltic Sea port as counterpart for a North Sea port	Basis 2005 [Mill. t]	Basis 2007 [Mill. t]	Assumption 2015 [Mill. t]	Assumption 2020 [Mio. t]
Russian Baltic Sea ports	4,81	3,51	4,72	5,95
Finnish Baltic Sea ports	14,84	11,88	14,63	16,82
Baltic States Sea ports	7,8	7,03	9,13	10,97
Kaliningrad	2,97	2,2	3,1	3,94
Total Baltic Sea	44,62	37,19	47,64	56,62



There exists a potential volume of approximately 16 mill. t per annum from the Port of Hamburg to Finland [2]. Most important is the Port of Helsinki-Vousaari. This new port is designed for RoRo and container handlings. A potential ConRo service could be integrated as needed.

Besides, the Port of Ust Luga (North West Russia) could be adjusted very easy for a ConRo service. Furthermore the competition to Russian ports is weaker than to Finish ports.

To extend the potential amount of cargo other transport relations could be integrated. The relation between a North Sea port and Helsinki could be extended to the Port of Nynäshamm for loading and unloading cargo of Stockholm`s metropolitan area. Furthermore the relation to Ust-Luga could be enhanced by a stop in Gdansk/Gdynia for cargo of Belarus, Ukraine and West Russia.

Nevertheless the first additional ConRo service should be started between Hamburg or Bremerhaven and Helsinki on the basis of the existing data and assumptions. The North Sea ports have important feeder container volumes. E.g. in 2007 the container volume from Hamburg to Helsinki was around 500.000 TEU. Even under the latest declines of 30% in feeder traffic, today`s container volumes are big enough for a new ConRo service from the North Sea ports to Helsinki, as aforementioned.

## 4 Calculation of profitability of a potential ConRo service form the Port of Hamburg

A ConRo service from a North Sea ports can only works when the service is more profitable than an existing (simple) RoRo one from a Baltic Sea port. The relation Hamburg-Helsinki in ConRo mode as well as the relation Lübeck-Helsinki in RoRo mode will be compared in order to show the difference in profitability. To do so chart 6 lists performance and cost parameters in comparison between a ConRo with a RoRo service as input values for the calculation.

Chart 6: Performance and cost parameter in comparison between a ConRo with a RoRo service

Ship parameter	ConRo	RoRo	[Dim]
Year of construction	2005	2009	[ ]
LOA	205	193	[m]
max. beam water line	26,2	26	[m]
max. beam for Kiel canal	29	-	[m]
max. draught	8,4	6,45	[m]
Gt	28.301	26.000	[ ]
tdw	18.250	9.830	[t]
eff. engine power	25.200	14.850	[kW]
power of auxiliary engines	2.500	2500	[kW]
Service speed	22	22	[kn]
Loading capacity RoRo	2900	3200	[lm]
Loading capacity Trailer [17,5 t/Trailer]	210	232	[n]
Loading capacity container	640	0	[TEU]
<b>Important cost parameter</b>			
Fuel consumption at service speed	103,42	61,2	[t/24h]
Fuel consumption port	10,26	10,26	[t/24h]
Fuel consumption canal and estuary trip	2,10	1,24	[t/24h]
New building price (according FSG)	60	40	[Mill. €]
Crew costs HTV See 2008	1,46	1,46	[Mill. €/a]
Capital costs accord. AfA 10%/a	6	4	[Mill. €/a]
Maintenance accord. VDI 7% of Capital costs	0,43	0,28	[Mill. €/a]

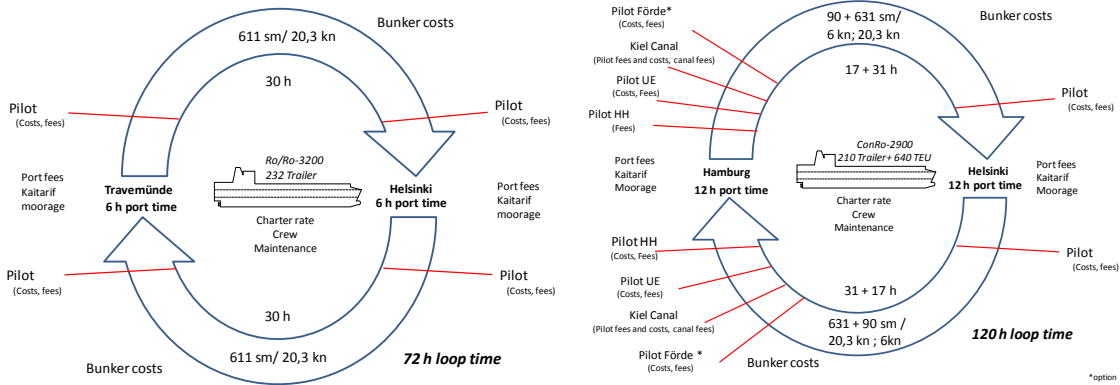


Figure 5: Comparison of a RoRo with a ConRo service

The basis of the fuel consumption calculation is a specific engine consumption of 170 g/kWh [12] and the similarity law of naval architecture to estimate the engine power of different ship speeds [6].

The average price for a tone of heavy fuel IFO amounts to 180 euro, while this one for a tone of MDO amounts to 467 euro according to the data record of [13].

The port and canal fees for each loop are shown in chart 7. For Helsinki the average of the port fees of Hamburg and Travemünde will be assumed as no data was available.

Chart 7: Port, pilot and canal fees [14], [15],[16],[17]

Costs	RoRo Travemünde	ConRo Hamburg	[DIM]
Port fee	4,4	3,9	€/100 GT
Pilot per Port	552	310	€per departure
Passage Unterelbe	nil	2394	€per voyage
Passage Kiel canal	nil	6860	€per voyage
Passage Kieler Förde	nil	654	€per voyage
Berthing per call	500	500	€, estimated
Kaitarif per Trailer	47*	37	€per Unit;* 10,- €Kaitarif included
Kaitarif per TEU	nil	0	FIOS, Handling payed by carrier

The handling costs of a container are not included in the cost model because of the transport mode “free in, out and stowed” (FIOS) which is applicable for most shipments. That means that a feeder shipping line does not pay for the container handlings in a port. The overseas carrier is responsible for the respective fee. Furthermore the terminal handling charge (THC) is not part of the income of a feeder operator as he has to pay it to the terminal operator himself.

The calculated income (freight rate) under presented terms and conditions of the shipping line per trailer respectively TEU is visualized in chart 8.

Chart 8: Estimated freight rates

Freight rate	€
Trailer Travemünde <-> Helsinki	350
Trailer Hamburg <-> Helsinki	350
1 TEU Hamburg <-> Helsinki	160

The freight rate for containers on TEU basis is a mixt calculation depending on full and empty containers. The average utilization of the ship was estimated by 70%.

The basis for the following calculation is the maximum annual number of loops or turnarounds per each service. On the basis of these data, the following costs and earnings are calculated for each service:

Chart 9: Estimated costs and earnings of the alternatives transport modes

<b>Parameter of service</b>	<b>Travemünde Helsinki RoRo</b>	<b>Hamburg Helsinki ConRo</b>	<b>[Dim]</b>
Loops per year	121	73	[ ]
Fixed costs	5.740.000	7.880.000	[€a]
Bunker costs	5.191.024	5.577.243	[€a]
Canal and pilot fees	236.525	1.601.474	[€a]
Port fees	268.983	166.311	[€a]
Berthing	121.000	73.000	[€a]
Quay tariff	1.847.138	794.094	[€a]
<b>Total costs</b>	<b>13.404.669</b>	<b>16.092.122</b>	<b>[€a]</b>
<b>Earnings</b>	<b>13.755.280</b>	<b>17.976.980</b>	<b>[€a]</b>
<b>Annual profability of ship</b>	<b>2,6</b>	<b>11,7</b>	<b>[%/a]</b>

The profitability<sup>3</sup> of a potential ConRo service amounts to 9%. This result is a better one than the existing pure RoRo service can possess within the Baltic Sea. However, for a service within the Baltic Sea only three ships are necessary while five ships (higher expensive in investments) are necessary for a ConRo service from Hamburg. Nevertheless each of these five ships in ConRo service has a higher profitability.

<sup>3</sup> Profability = (Earnings-Costs)/Costs

## 5 Sustainability and environmental effects of a potential ConRo service

### 5.1 Economic Sustainability

The profitability calculations of the ConRo and RoRo services are based on current earning and cost parameters. For an evaluation of the economic sustainability, the comparison of the costs structure is necessary. According to figure 6 and 7, the share of public fees like port charges is higher at the ConRo service as at the RoRo service. Especially the canal and pilot fees are very high.

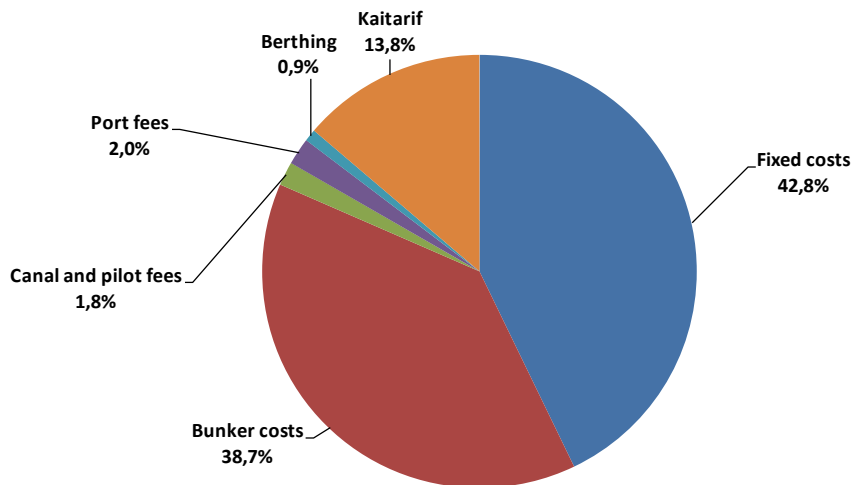


Figure 6: Costs structure of RoRo service Travemünde – Helsinki

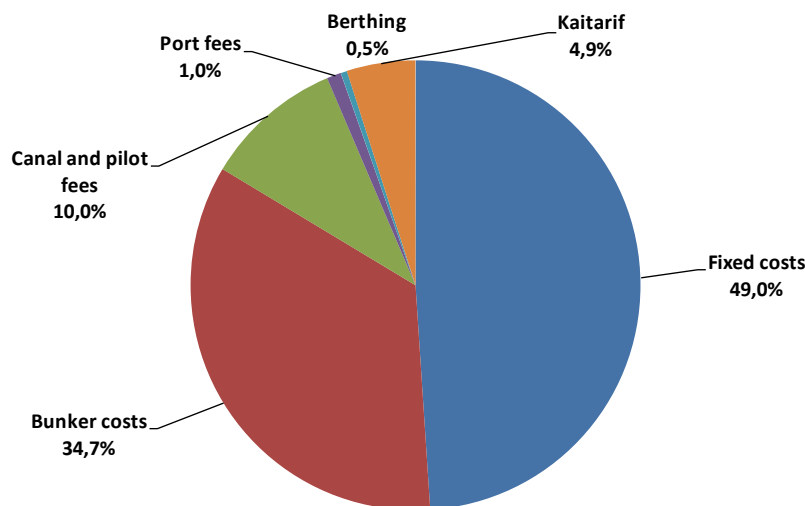


Figure 7: Costs structure of ConRo service Hamburg – Helsinki

A reduction of the canal and pilot fees would be desirable for the economic sustainability of the ConRo service. Furthermore the question “Why does a crew which passes more than 30 times per year the Kiel Canal need to have a pilot each time?” should be asked.

An approved and important criterion for sustainability of a shipping line service is the sensitivity against fuel price variability. The fuel price had a variance of more than 50% within one year [13]. But the different shipping services have diverse behavior of fuel price variances. The simple RoRo service would profit by a reduction of the fuel price. In case of a fuel price increase, the ConRo service would have a better competitive capability.

Chart 10: Alteration of relative costs in dependency of fuel price development

<b>Fuel price development (100% =today)</b>	<b>60%</b>	<b>80%</b>	<b>100%</b>	<b>120%</b>	<b>140%</b>
Costs index Travemünde Helsinki RoRo	0,85	0,93	1	1,07	1,15
Costs index Hamburg Helsinki ConRo	0,86	0,94	1	1,06	1,13

Regarding the income per trailer similar income for each port was assumed up to now. The different road distance from the hinterland regions to the different ports were not considered. In case of considering the North Sea ports would have an important advantage compared to the Baltic Sea Ports, as the North Sea ports are deeper located in the relevant cargo hinterland as the Baltic Sea ports.

Costs for road transportation to e.g. Hamburg are equal to the costs difference about 80 euros for the benefit of Hamburg. This means that theoretically the freight rates from Hamburg could be increased by about 80 euro.

Chart 11: The development of profitability of a ConRo service from Hamburg to Helsinki in dependency of the increase of trailer freight rates

<b>Increase of Trailer freight rates[€]</b>	<b>0</b>	<b>+20</b>	<b>+40</b>	<b>+60</b>	<b>+80</b>
Profitability Hamburg-Helsinki ConRo [%]	11,7	14,4	17	19,7	22,4

This short consideration of the profitability shows the sustainability of a potential ConRo service from a North Sea port (in this example Hamburg) to the Baltic Sea.

## 5.2 Environmental aspects

According to environmental aspects an important advantage of a North Sea port is the shorter road distance in comparison to a Baltic Sea port within the considered investigated area. By using a ConRo service instead of an existing RoRo service from Baltic Sea ports could be more profitable on basis of the presented example calculation. If an average weight of 17.5 t per trailer is assumed, the shift from road to sea would be approximately 128 mill. tkm per year (dead weight of towing vehicle not included). CO2 emissions can be lowered by approximately 3.8 mill. kg per year. Turning the view to the seaside the CO2 ejection of the two different services is equal.





## 6 Conclusion

This study highlighted the theoretical possibility of introducing ConRo services as a new mode for short sea traffic from North Sea ports in the Baltic Sea regions.

ConRo is the combined transport of container and RoRo cargo with a new ship class, called ConRo Vessel. Transport by ConRo vessels offer a better profitability as simple RoRo transports. The potential RoRo cargo volume for North Sea ports in the Baltic Sea regions was estimated up to 30 mill. t per year. As container volumes already exist and transports are executed, they were not included in this study. On basis on a fictive route between Hamburg and Helsinki, the profitability of ConRo services was calculated in comparison to existing RoRo services between Travemünde and Helsinki within the Baltic Sea region. The result of this example shows that both - the profitability as well as the sustainability - is higher with ConRO services.

ConRo services could be an interesting option for the North Sea ports to enter or open new RoRo markets in the North Sea.

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