Development of Swedish bases for decision-making and ranking of terminal solutions within the TEN and Motorways of the Sea (MOS) programmes

WP 2.2 – Selection of Ports – a multi criteria analysis

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Hamburg, September 2007

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1 Summary

This report discloses the methodology for the selection of Swedish and European ports. These Swedish ports have been selected through a multi-criteria analysis as the most relevant for the scope of this study. :

1. Göteborg, Varberg — Port Region Westsweden
2. Trelleborg, Malmö, Helsingborg, Ystad — Port Region Skåne
3. Stockholm, Gävle — Port Region Stockholm/Ö. Mellansverige
4. Karlshamn, Karlskrona — Port Region Blekinge

The following ports and port regions outside Sweden for have been selected through a Multi-Criteria analysis:

1. Lübeck, Kiel, Rostock — Port Region German Baltic Sea
2. Hamburg, Bremerhaven — Port Region German North Sea
3. Helsinki, Turku — Port Region Southern Finland
4. Zeebrügge, Antwerp, Rotterdam — Port Region Benelux
5. Southampton, Portsmouth, Felixstowe, London ports Immingham, Port Region Western UK
6. Dublin, Belfast — Port Region Ireland and N. Ireland
7. Aarhus, Esbjerg — Port Region Jutland
8. Tallinn
9. Gdynia

In WP 3, the links between theses ports will be selected.

2 Selection of ports and port regions for potential MOS links

2.1 Selection of to be connected EU-member states ports outside Sweden

A multi criteria selection process has been applied to identify EU-member states ports and port regions.[1] The selection process has the purpose to limit the vast number of possible port-to-port combinations and choose only such ports, which qualify through their size, their location and their suitability towards Motorways of the Sea (MOS) short sea shipping transport from/to Sweden.

The chosen multi-criteria analysis to select the ports and port regions takes dimensions of ports into account, but also integrates other criteria.

These characteristics of the ports are taken into account for a selection

- Annual volumes
- Number of vessel calls
- Connected transport modes
- Location of port, position towards TEN-T axes
- Location of port, position towards major road flows
- Additional criteria in relation to the pre-definition of Motorways of the Sea

Not taken into account has been any other port criteria data, such as efficiency of port, size of port in ha, port capacity or environmental performance. This data was not included because of unbearable difficulties to obtain coherent data sets about these issues.

2.1.1 All ports bigger than an annual volume of 1,5 mill tonnes

First, only ports are considered, that fulfil the TEN-T A port definition of a minimum annual volume of 1,5 tonnes. This results in a high number of European ports. However, if port volumes are measured in tonnes, bulk ports usually appear very high on the list. The list includes a total of 240 ports in the EU.

2.1.2 All ports bigger than an annual unitised cargo volume of 1,5 mill tonnes

MOS are however dedicated to unitised cargo, either RoRo or LoLo operations. To avoid the not suitable bulk ports in the list, the step 2 was undertaken. This second step eliminates large bulk ports from the list. Ports like e.g. Wilhelmshaven and Frederica, which have total volumes high above the TEN-T A port criteria, but which are not considered as MOS ports, since they often do not have adequate facilities for unitised cargo. This new list after step 2 includes 99 ports.

[1] The finding of this chapter correspond to the results of the study Desk study on goods flows in Europe for a pre-definition of Motorways of the Sea (MOS), BMT Transport Solutions GmbH, Hamburg. 2006. However, additional criteria has been applied to take the Swedish perspective into account.

Table 1: All ports bigger than an annual unitised cargo volume of 1,5 mill tonnes in 1000 tonnes 2004 source: Eurostat

Country	Port	Total	Container and RoRo volumes in 1000 tonnes per year	Share of unitised non bulk cargo in %
BE	Antwerp	113298	50052	44%
	Ostende	4919	3771	77%
	Zeebrugge	24893	19437	78%
CY	Limassol	3367	2142	64%
DE	Bremerhaven	31757	30106	95%
	Hamburg	99528	59459	60%
	Kiel	2987	1635	55%
	Luebeck	19169	17429	91%
	Puttgarden	3574	3574	100%
	Rostock	16367	6848	42%
	Sassnitz	2859	2627	92%
DK	Aarhus	10356	5850	56%
	Esbjerg	3665	1694	46%
	Frederikshavn	2887	2866	99%
	Helsingor	4415	4415	100%
	Kalundborg	3401	2893	85%
	Rodby	4911	4911	100%
EE	Tallinn	37115	4059	11%
ES	Algeciras	50837	27484	54%
	Barcelona	36321	19188	53%
	Bilbao	31635	4219	13%
	Cadiz	5193	2511	48%
	Las Palmas	17728	10785	61%
	Palma Mallorca	11652	7376	63%
	S.C. De Tenerife	15425	4183	27%
	Valencia	32660	19761	61%
	Vigo	4221	2511	59%
GR	Antirio	5575	5575	100%
	Patras	4201	3757	89%
	Heraklion	3516	1767	50%
	Igoumenitsa	3367	2489	74%
	Paloukia Salaminas	1590	1590	100%
	Piraeus	20296	19526	96%
	Rio	6941	5574	80%
	Thessaloniki	15840	2919	18%
FR	Cherbourg	2194	1659	76%
	Calais	17100	15968	93%
	Dunkerque	51003	1534	3%
	Le Havre	71878	19585	27%
	Nantes	32013	1514	5%
	Marseille	90810	9419	10%
IE	Dublin	17930	12178	68%
IT	Ancona	4681	2686	57%
	Cagliari	9904	8793	89%
	Catania	2142	1601	75%
	Civitavecchia	5658	1992	35%
	Gioia Tauro	29403	29307	100%
	Genova	45881	20390	44%
	Livorno	21239	9737	46%
	Napoli	10538	3845	36%
	Olbia	4798	4735	99%
	Piombino	7786	1803	23%
	Palermo	4322	2805	65%
	Ravenna	25406	2391	9%
	Salerno	5516	4520	82%
	La Spezia	13835	7737	56%
	Taranto	39369	9592	24%
	Trieste	41515	5088	12%
	Venezia	28882	2834	10%
LT	Klaipeda	25842	2774	11%
NL	Rotterdam	330865	76115	23%
	Scheveningen	3169	3103	98%
	Vlissingen	14516	2154	15%
PL	Gdynia	9106	3758	41%
	Swinoujscie	9443	1966	21%
PT	Leixoes	12982	2842	22%
	Lisboa	10679	4159	39%
SL	Koper	11986	1571	13%
FI	Helsinki	12252	9666	79%
	Hanko	3074	2337	76%
	Hamina	6033	1501	25%
	Kotka	8634	2835	33%
	Naantali	7410	2040	28%
	Turku	3933	3089	79%
UK	Belfast	13559	5504	41%
	Cairnryan	1855	1855	100%
	Dover	20734	19416	94%
	Felixstowe	23363	22548	97%
	Holyhead	10902	7939	73%
	Harwich	4209	2849	68%
	Hull	12448	4817	39%
	Heysham	3293	3142	95%
	Grimsby & Immingham	57847	15663	27%
	Ipswich	3558	1506	42%
	Larne	3758	2940	78%
	Liverpool	62413	22499	36%
	London	53289	14425	27%
	Medway	17866	6711	38%
	Tees &	53820	3221	6%

Country	Port	Total	Container and RoRo volumes in 1000 tonnes per year	Share of unitised non bulk cargo in %
	Hartlepool			
	Portsmouth	4605	3318	72%
	Ramsgate	1669	1667	100%

Country	Port	Total	Container and RoRo volumes in 1000 tonnes per year	Share of unitised non bulk cargo in %
	Southampton	40978	7557	18%

For these remaining ports a multi criteria analysis was carried out, that results in a ranking of the ports to be selected for the MOS simulation.

2.1.3 Transhipment volume

The following scheme has been applied to attribute the size of RoRo and container transhipment volume of a port. The ports have been separated in quartiles of the same size.

Total throughput per year (2004) in 1000 tonnes	**Points**
Quartile 1: 608 to 2416	**1**
Quartile 2: 2489 to 3771	**2**
Quartile 3: 3845 to 9419	**3**
Quartile 4: 9592 plus	**4**

2.1.4 Number of vessel calls

The ports have been separated in quartiles. The first quartile covers the ports with the lowest number of ships calling per week while the forth quartile includes the ports with the highest values.

Average number of all vessel calling per week	**Points**
Quartile 1: 19 to 51	**1**
Quartile 2: 52 to 84	**2**
Quartile 3: 90 to 184	**3**
Quartile 4: 190 plus	**4**

2.1.5 Location of port, economic importance of region

The value of GDP/capita per Nuts III region in KEUR/capita indicates the purchasing (economic) power of the region a ports is located in. The ports have been separated in quartiles. The first quartile covers the ports with the lowest GDP per capita while the forth quartile includes the ports with the ports indicating the highest values.

	Points
Quartile 1: 5181 to 14168	**1**
Quartile 2: 14263 to 22528	**2**
Quartile 3: 23145 to 26134	**3**
Quartile 4: 26274 to 44189	**4**

2.1.6 Location of port, position towards TEN-T axes

This value shall reflect, how well or bad a port is connected to defined TEN-T land infrastructure.

	Points
Port is part of or related to a TEN-T priority axis or project	**4**
Port is part of a TEN-T axis	**3**
Port is closely located to a TEN-T axis, < 50 km	**2**
Port is not closely located to a TEN-T axis, > 50 km	**1**

2.1.7 Location of port, position towards major road flows

This value reflects the location of a port in relation to major road traffic corridors. The road traffic corridors have been compiled from studies like Ten-Stac, Intermoda and ISIC[2]. This assessment was rather difficult and has to be regarded as a rough indication. That is why, in the criteria not points from 1 to 4 were attributed to the ports, but only 1 to 2 points.

Port is closely located to major European road traffic flows, < 50 km	**2**
Port is not closely located to major European road traffic flows, > 50 km	**1**

2.1.8 Connected modes

For each terrestrial mode that is directly connected to the port one point is given. These points are summed up to a total value (maximum would be the value 3 for road, rail and inland waterway).

2.1.9 Additional criteria

In a 2nd step, however, additional criteria were applied:

- Is the high position in the intermediate first list only reasoned by a small-distance frequent ferry connection?
    - This means, that mono-functional ferry ports like Puttgarden or Helsingör are overvalued due to the number and frequency of vessels calling the port. A high negative value suit the purpose to eliminate these specialised ports from the top ranked MOS port list.
- Is the port an oversea container hub?
    - Oversea container hubs are already sufficiently linked by the container sea transport system. Such an established hub and feeder system is not a major issue for Motorways of the Sea, because the modal shift is expected to be rather limited.
- Is the port situated on an island, where apparently only limited road flows could be shifted?

[2] TEN STAC; Scenarios, Traffic Forecasts, and Analyses of Corridors on the Trans-European Transport Network, NEA 2003; Intermoda Integrated Solutions for Intermodal Transport, TINA Vienna 2003, ISIC, Integrated Services in the intermodal chain.

- Not much modal shift can be expected regarding island connections, since islands and certain peninsulas can only be reached by vessels anyway. It is understood, that existing services already cover the demand for transport for islands to a large extent. If a port is situated on an island, any modal shift effects are reasonably questioned. This would include e.g. Faröre islands, Åland islands[3].

- Would a short sea connection from/to Sweden be competitive in terms of transport time and detour factor?

  - Excluded from the ports selection list for the next steps of the analysis are all ports in the Mediterranean. Because of the large detour factor and long distances, Short Sea Shipping services are not considered feasible in that sense that the MOS concept is envisaging. The same is true for any ports in the Atlantic Arc such as Nantes or Bilbao. Also these ports have been excluded. Motorway of the Sea links should be high frequent sea links with a minimum frequency of one departure per day. The longer the nautical distance is, the more vessels a service would require to sustain such a frequency. E.g. between Gothenburg and Bilbao even a fleet of six vessels would not be able to sustain such a frequency.

[3] Even though geographically an island this is not the case for Ireland (transit trough UK), UK (large domestic flows), Finland (domestic flows, Russian transit and transit through Sweden or via the Via Baltica), Islands, which connected by road links to other islands or to the continent are not meant with the "island definition" applied here. This would include locations like the Danish island like Sealand and Fyn, and the German islands Fehmarn and Rügen

2.2 Selection of to be connected Swedish ports

The analysis of the Swedish ports is based on the statistics collected by Ports of Sweden and related ports and additionally on interviews. There are 58 port companies, listed in Table 2. These ports have a market share of almost 100 % regarding unit loads at the Swedish transport market. During the year 2007 1.700.000 unit loads were handled in Sweden and the ports related to Ports of Sweden have a market share of 99,8 %.

2.2.1 Transhipment volume

A run-through of the statistics gathered from the organisation Port of Sweden reveals that only ten ports attract enough freight volumes to qualify as a TEN-A or TEN-B port. Six ports qualify as TEN-A ports and the remaining four in the category TEN-B.

The changes in freight volumes are significant for the dominant port constellations, as Goteborg, Trelleborg, Helsingborg and Stockholm. The growth are significant and continuous (in real terms), but the effects of the opening of the Öresund Bridge is clearly visible for Ports as Trelleborg, Malmo and Helsingborg. Trelleborg lost some in the early years of the opening 500.000 tonnes and Helsingborg some 2.500.000 tonnes between 2000 and 2001. Recently especially Trelleborg has gained a lot of additional volumes from their lines connecting central Europe.

There are several market cases where the ports try to increase their market power and competitiveness through establishment of strategic co-operation between different ports. Primarily strategic alliances between ports in the same geographical region, but also based on foreland markets for the different ports. As an example the port of Goteborg has initiated and is the leading organization in a strategic alliance between the ports in Goteborg, Varberg and Uddevalla. Another example is the three ports on the North Swedish coast that co-operate to strengthen its market position.

The relatively most significant growth in transport volumes is related to the ports of Karlshamn and Karlskrona. The cause is an obvious dislocation of Sweden's import and export to and from the Baltic countries and Poland. Though, the transport volumes are small in relation to the handled volumes in the Ports of the West Coast as well as Skåne. In the prognosis the freight flows to the Baltic Countries as well as Poland will continue to grow significantly until the year 2015. In short term there are other ports or port constellations with freight volumes around 300.000 – 400.000 tonnes that will however not qualify as potential TEN-ports.

Table 2 Port constellations with open access to service in Sweden in 2007.

Port organisation	Owner	Port included in the organisation			
Bergkvara Hamn och Stuveri AB	Public				
Gävle Hamn AB	Public				
Göteborgs Hamn AB	Public				
Helsingborgs Hamn AB	Public				
Karlshamns Hamn AB	Public				
Karlskrona Stuveri AB	Public				
Mälarhamnar AB	Public	Köping	Västerås		
Mälarhamnar Försäljnings AB*	Public				
Piteå Hamn AB	Public				
Stockholms Hamnar	Public	Stockholm	Roslagshamnar	Nynäshamn	
Södertälje Hamn AB	Public				
Terminal West AB	Public	Varberg			
Umeå Hamn AB	Public				
Wallhamnbolagen AB	Public				
Ystad Hamn och Logistik AB	Public				
Örnsköldsviks Buss AB/hamn	Public				
Delta Terminal AB	Private	Timrå			
Falkenbergs Terminal AB	Private				
Finlandshamnen AB	Private	Kapellskär			
Gävle Stuveri AB	Private				
Götaälvdalens Stuveri AB	Private	Surte			
Interforest Terminal AB	Private	Umeå			
Mönsterås Hamn AB	Private				
Norrsundets Stuveri AB	Private				
Pålgård & Söner Kran AB	Private				
Rundviks Stuveri AB	Private				
Skärnäs Terminal AB	Private	Iggesund			
Stenungssunds Hamntjänst AB	Private				
Söderhamns Stuveri och Hamn AB	Private				
Trollhättans Terminal AB	Private				
Västerviks Logistik och Industri AB	Private				
Ådalens Stuveri AB	Private	Sundsvall			
Örnsköldsviks Stuveri AB	Private				
Bottenvikens Stuveri AB	Other	Kalix	Luleå	Piteå	Skellefteå
Copenhagen Malmö Port AB	Other	Malmö	Köpenhamn		
Gotlands Stuveri AB	Other				
Halmstads Hamn och Stuveri AB	Other				
Hargs Hamn AB	Other				
Kalmar Stuveri AB	Other				
Landskrona Hamn AB	Other				
Lysekils Stuveri AB	Other				
Malmö Hamn AB	Other				
Norrköpings Hamn och Stuveri AB	Other				
Oskarhamns Hamn AB	Other				
Oxelösunds Hamn AB	Other				
Sundsvalls Hamn AB	Other				
Sölvesborgs Stuveri och Hamn AB	Other				
Trelleborgs Hamn AB	Other				
Uddevalla Hamnterminal AB	Other				
Vänerhamn AB	Other				
Åhus Hamn och Stuveri AB	Other				

The analysis is based on different parameters including the present number of unit loads handled in Swedish ports. As pointed out by for example Transportindustriförbundet (2006) and Woxenius *et al* (2001) the number of cargo types suitable for efficient unit load transportation increases continuously. This fact increases the complexity in the analysis, but requires a separate analysis outside the scope of this project. The second obvious trend is the strong relative growth for the ports connected to the Baltic countries as well as other parts of the former Eastern Europe.

Table 3 Unit loaded freight transported to and from Swedish Ports 1999 – 2006 in tonnes. 10 ports will qualify in the TEN segment (Source: Ports of Sweden).

	1999	2000	2001	2002	2003	2004	2005	2006	Diff
Göteborg	11808	12231	12279	13017	13518	13163	13752	14212	20%
Trelleborg	10153	10230	9740	10206	10484	10596	10542	10966	8%
Stockholm	4937	5417	5166	5299	5639	6051	6155	6526	32%
Helsingborg	8600	7757	5324	5223	5134	5520	5461	5858	-32%
Malmö	3414	3436	3109	2984	3130	3721	3784	4428	30%
Ystad	1557	1775	1900	1785	1879	2029	2459	2882	85%
Karlshamn	166	211	430	699	853	983	1154	1360	719%
Karlskrona	223	221	254	459	653	801	963	1092	390%
Varberg	444	394	435	472	622	376	733	634	43%
Gävle	319	356	319	377	407	433	502	628	97%
Västerås	212	239	270	270	347	320	348	386	82%
Bottenviken	147	104	122	108	115	219	295	338	130%
Strömstad	168	203	219	278	288	295	298	284	69%
Oskarshamn	213	238	250	241	236	262	263	278	31%
Wallhamn	92	52	76	165	196	171	164	208	126%
Åhus	159	185	206	203	163	206	153	192	21%
Södertälje	79	89	85	152	127	130	142	170	115%
Halmstad	306	419	207	103	133	227	236	126	-59%
Norrköping	141	120	143	186	172	137	114	120	-15%
Lysekil	44	78	62	61	54	50	51	46	5%
Skärnäs					2	4	2	34	

Table 4 Trailer flows to and from Swedish ports 1999 – 2007 in tonnes (Source: Ports of Sweden).

Trailer	1999	2000	2001	2002	2003	2004	2005	2006	
Trelleborg	6267	6812	6907	7468	7635	7886	8018	8336	33%
Goteborg	6482	6599	6543	6785	8269	7166	7342	7614	17%
Stockholm	4390	4788	4508	4629	4942	5338	5490	5918	35%
Helsingborg	5277	5316	4574	4443	4332	4588	4441	4674	-11%
Malmo	3057	3129	2912	2745	2931	3464	3471	4042	32%
Ystad	1155	1375	1464	1413	1495	1623	2008	2360	104%
Karlshamn	123	172	404	699	853	983	1154	1360	1006%
Karlskrona	223	220	240	459	653	801	962	1086	387%
Varberg	413	367	405	440	590	344	665	634	54%
Strömstad	168	203	219	278	288	295	298	284	69%
Oskarshamn	213	236	222	238	236	262	263	278	31%
Bottenviken	138	63	61	66	59	159	223	212	54%
Skärnäs								18	
Gävle	1	2		1	2	2	4	4	
Halmstad	136	259	107	1	25	96	60		
Lysekil									
Norrköping		2							
Södertälje				29					
Mälarhamn									
Wallhamn				1					
Åhus	86	90	68	8					

2.2.2 Number of vessel calls

In the analysis vessel calls one parameter. On short distances, and especially on distances where the ships and shipping lines acts as infrastructure replacement, frequent ferries provide sufficient service as an alternative to a bridge. On many geographical distances the ferries has almost the same mission as the Rolling Highway through the Alps. The ferries operate a specific relation in a frequent manner and as an example Helsingborg – Helsingör can be mentioned. ´

On mid-range distances there is usually enough freight volumes for dedicated freight services. A mix of trailers, cassettes, swap bodies and other unit loads are transported and on some distances also rail wagon. Reliability and frequent departures from the base for this service an often one or a few large shippers or forwarders guarantee a base volume for such services.

Table 5 Port calls in Swedish ports between 1999-2006 (Source: Ports of Sweden).

	1999	2000	2001	2002	2003	2004	2005	2006
Helsingborg	48737	50340	48758	46537	46079	45575	45383	44844
Stockholm	8482	8164	8355	8500	8569	8771	8896	8668
Göteborg	10077	9802	8614	9210	8112	8356	7886	7990
Trelleborg	6139	6307	6410	6437	6478	6275	5533	5538
Ystad	2342	2662	2796	2806	3254	3295	3244	3192
Malmö	22299	15054	6734	3170	1993	2459	3217	2716
Bottenviken	2086	2171	2183	2155	2062	2151	2298	2064
Karlshamn	1852	1854	1744	1937	1906	1939	2110	1786
Strömstad	2202	2135	2422	2131	2120	2077	2099	1766
Mälarhamnar	1412	1259	1212	1274	1402	1219	1198	1262
Varberg	1277	1270	1634	1494	1222	987	1363	1206
Halmstad	1290	1307	1030	922	958	1016	1317	1146
Oskarshamn	1042	1199	858	881	762	688	685	1092
Gävle	1131	1065	1020	1013	931	886	912	978
Norrköping	1536	1411	1344	1424	1345	1289	1120	948
Karlskrona	355	327	328	585	641	639	701	740
Södertälje	619	603	522	615	576	567	609	630
Skärnäs	511	525	449	474	421	445	463	544
Åhus	692	646	656	517	453	430	392	348
Lysekil	450	481	432	368	315	311	310	316
Wallhamn	354	203	233	238	153	141	173	164

The ship sizes increases continuously, and in combination with increasing fuel prices and increased pressure to improve the environmental standards of the ships, the focus on increased resource utilisation will be highlighted. The trend with increasing ship sizes is also discussed later in this text. The large shipping companies will probably go on to concentrate their network structure to one load centre and thus to decrease the number of direct shipping connection to medium sized ports as the Port of Goteborg.

The effect will be a decreasing number of direct shipping calls to and from Swedish port and these will be replaced by an increasing number of feeder calls. The effect might be a stimulation of intermodal freight transportation between Scandinavia and Europe and also stimulate the use of ISO-containers in the Intra-European transport system by using LoLo or ConRo ships. This trend is already visible and for example the shipping line MSC Sweden state that 5 % of their shipments handled in the Port of Goteborg is bound for the European market. 10 years ago the share of Intra European transportation was zero (Holmgren, 2006).

The tremendous increase in container flows, in both real and relative terms, is observed in all port ranges except from the Stockholm region. The increase in this region is rather related to the ports of Västerås and Södertälje. The strong position for the Port of Goteborg is clearly visible, but the increases of the ports in Gavle and Helsingborg need to be highlighted.

Economies of scale in shipping are tremendous and the ship sizes are continuously increasing. This trend is confirmed of the increasing handled volumes in the port while the number of vessel calls is decreasing or stable.

2.2.3 Location of port, economic importance of region

The Swedish import and export are geographically unbalanced, which results in large flow to reposition the unit loads from import to export regions and there is also frequent flow of empty containers, in both directions, in the international feeder transport to Rotterdam, Hamburg, Bremerhaven, Zeebrügge and Antwerp. Within the local area around a port (< 150 kms radius) road transportation is the dominating transport mode. Availability, lead time and the transport cost to the port are the determining factors for a shipper to choose a specific port. On medium distances (150 – 500 kms radius) intermodal inland transportation has emerged as a strong competitor to unimodal road transportation.

Some ports use intermodal inland transportation to increase their hinterlands and thus the competitive situation between the different ports has changed. On long distances (more than 500 kms) rail and road transportation can seldom compete with the frequent feeder transportation to ports closer than the port offering intermodal inland transportation. This is true on the Scandinavian Peninsula, due to the spatial and infrastructural conditions around the Baltic Sea.

Table 6 Import and export regions including distances to the eleven ports.

Import regions

	Skåne (Lund)	Mälardalen (Eskilstuna)	Västsverige (Göteborg)	Jönköping (Jönköping)
Gävle	699	190	518	434
Göteborg	270	359	0	149
Helsingborg	57	511	221	238
Karlshamn	140	368	326	211
Karlskrona	190	442	334	343
Malmö	25	566	276	293
Stockholm	592	116	478	330
Trelleborg	59	599	310	326
Bottenviken	1174	665	993	909
Varberg	196	430	78	171
Ystad	69	565	332	292

Export regions

	Skåne (Lund)	Bergslagen (Borlänge)	Västernorrland (Umeå)	Västsverige (Göteborg)	Jönköping (Jönköping)
Gävle	699	111	481	518	434
Göteborg	270	448	993	0	149
Helsingborg	57	601	1146	221	238
Karlshamn	140	574	1119	326	211
Karlskrona	190	584	1096	334	343
Malmö	25	656	1201	276	293
Stockholm	592	215	649	478	330
Trelleborg	59	689	1234	310	326
Bottenviken	1174	586	0	993	909
Varberg	196	519	1064	78	171
Ystad	69	655	1199	332	292

The analysed handled volumes in Sweden are transported by ferry, RoRo-, RoPax and ConRo-shipping or conventional freight ships. The feeder ships are primarily adapted to transport containers between a load centre and small or medium sized ports around Europe. The transport structure is not adapted to Intra European transport requirements, but the share of Intra European transports using feeder transport is increasing. In 1996 the share was 0 % and has now increased to 5 % and is primarily suitable for cost sensitive transport market segments. This previously nonexistent market segment will probably continue to grow during the next decade.

Table 7 Container flows to and from Swedish ports1999 – 2007 (Source: Ports of Sweden).

	1999	2000	2001	2002	2003	2004	2005	2006	Diff
Göteborg	5309	5622	5736	6232	5249	5997	6410	6594	24%
Helsingborg	710	752	750	780	802	932	1020	1184	67%
Gävle	318	354	319	376	405	431	498	624	96%
Mälarhamn	212	239	270	270	347	320	348	386	82%
Malmö	218	298	197	238	199	257	303	332	52%
Stockholm	230	214	261	258	242	231	243	216	-6%
Wallhamn	92	52	76	164	196	171	164	208	126%
Åhus	73	95	138	195	163	206	153	192	163%
Södertälje	79	89	85	123	127	130	142	170	115%
Halmstad	170	160	100	102	108	131	176	126	-26%
Bottenviken	9	41	61	42	56	60	72	126	1300%
Norrköping	141	118	143	186	172	137	114	120	-15%
Lysekil	44	78	62	61	54	50	51	46	5%
Skärnäs					2	4	2	16	
Karlskrona		1	14				1	6	
Karlshamn	43	39	26						
Oskarshamn		2	28	3					
Strömstad									
Trelleborg									
Varberg	31	27	30	32	32	32	68		
Ystad									

The concept RoPax is based on ships offering service for both passengers as well as freight. The ship type might be used for passenger transportation during season and is a flexible but expensive alternative in freight transportation. Two examples are the Stena Line ferries Goteborg – Kiel or the TT-line/Scandlines Trelleborg – Travemünde/Rostock. The ship type is frequently used on the Baltic Sea since its capabilities attract the freight, which to a large part consists of accompanied trailer freight.

The RoRo transportation concept is used for industrial systems between dedicated terminals. It is frequently used in Sweden and Finland and is often operated as a system where the inland transportation and sea transportation is detached in the port terminals. In these port terminals the different shipments are consolidated in time to match a specific service. These consolidated freight shipments are loaded on the ship by trucks, i.e. sto-ro. All these terminal specific transport systems have a limited accessibility for external shippers since they have been developed for one or a few customers with a certain requirements. Previously this has resulted in systems with large unbalances, but due to increasing fuel prices, handling costs in the ports as well as increasing environmental pressure the shipping lines or forwarders are striving towards an increasing resource utilisation in both directions.

The strict boundaries between the different transportation systems such as RoRo and LoLo are difficult to draw, which results in some difficulties in the reported study. Categorisation, competitive situation and market areas need to be determined from case to case. Thus, the prognosis for RoRo shipping is difficult to predict, but Transportindustriförbundet (2006) states that the freight transportation will increase by 4-5% yearly until the year 2015. This prognosis however questioned through the recent trend to transport both containers and trailers in the same shipping unit (ConRo or multipurpose RoRo).

Research in the field of harbours, ports and shipping has traditionally been concentrated to the sea link or the port function. Since the competitive situation have been changed the focus on the land transport links and the service on these have certainly been highlighted.

2.2.4 Location towards infrastructure

In this analysis also the location towards infrastructure the is analysed based on its capabilities and closeness to the port with a special attention on the infrastructure defined as strategic by the Freight Transport Delegation (2003). The analysis in this matter shows that the existing large port, except from the ports in Blekinge, is located close or directly on the strategic networks. The risk by pointing out a strategic networks thus become notable, since the largest relative growth during the period 1999 – 2006 is found in these regions outside the strategic network. The rail and road networks is weighted by 1 each.

The next dimension is the service offered at the present infrastructure, i.e. the traffic analysed by calculating the number of inland vessel calls and the number of frequent intermodal connections (combined transportation). The number of O/D links where intermodal transportation is offered on a daily basis is calculated and then weighted by 1. 7.

In this part a brief analysis is made determining and analyzing the effects of lack of infrastructure capacity in the rail as well as road links to and from each port. It is primarily in the ports of Stockholm, Malmo and Göteborg where there are capacity limitations and in short time there is also certain economical and social barriers in this regions to build out the existing infrastructure.

Table 8 Intermodal inland connections.

	Number of operators	Avesta-Krylbo	Borlänge	Eskilstuna	Falköping	Gävle	Göteborg	Hallsberg	Helsingborg	Hällefors	Insjön	Jönköping	Karlstad	Luleå	Malmö	Motala	Norrköping	Nässjö	Oslo/Norge	Stockholm	Sundsvall	Södertälje	Trelleborg	Uddevalla	Umeå	Västerås	Åhus	Åmål	Älmhult	Örebro	No of connectic
Gävle	2	0	1	1	0		1	0	1	0	1	0	0	0	1	0	1	1	0	0	0	1	1	0	0	1	0	0	0	0	11
Göteborg	6	1	1	1	1	1		1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	26
Helsingbor	2	0	1	1	0	1	1	0		0	0	0	0	1	0	0	1	0	0	1	0	1	0	0	1	1	0	0	0	0	10
Karlshamn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Karlskrona	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Malmö	2	0	0	1	0	1	1	1	0	0	0	0	0	1		0	0	0	1	1	1	0	0	0	1	0	0	0	0	0	9
Stockholm	2	0	0	0	0	1	1	0	1	0	0	1	0	1	1	0	0	0	1		1	0	1	0	1	0	0	0	0	0	10
Trelleborg	1	0	0	0	0	1	1	1	0	0	0	1	0	1	0	0	0	1	1	1		0	1	0	0	0	1	0	1	0	11
Bottenviker	1	0	0	0	0	1	1	0	1	0	0	0	0		1	0	0	1	0	1	1	0	1	0		0	0	0	1	0	9
Varberg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ystad	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

2.2.5 Additional criteria

Like within the selection process for the non-Swedish ports, additional criteria were applied. These additional criteria included the following items:

- if the port is situated on an island,
- if it is a small distance ferry connection,
- if it is only an oversea container hub,
- if there are already well developed SSS links and
- the latest trend in traffic figures.

The chosen multi-criteria analysis to select the ports and port regions takes dimensions of ports into account, but also integrates other criteria.

These characteristics of the ports are taken into account for a selection

- Annual volumes
- Number of vessel calls
- Connected transport modes
- Location of port, position towards TEN-T axes
- Location of port, position towards major road flows
- Additional criteria

Not taken into account has been any other port criteria data, such as efficiency of port, size of port in ha, port capacity or environmental performance. This data was not included because of unbearable difficulties to obtain coherent data sets about these issues.

3 Results of the port ranking

All the points gained by each port in through the different criteria are summed up to a total figure. As an indicative number for this study within its limits, the number of 20 ports has been chosen.

Table 9: Port ranking of EU members states ports, Top 20 placed ports according to the selection scheme[4]

	Country	Port	Volume	Calls	ected modes				Location								Result
					Rail	Road	IWW	Total	Economical importance of region	TEN-T axis	main road traffic flows	Island	Small distance ferry connection	Oversea container hub	well developed SSS link to Sweden	detour factor/ time duration of link	
		Weighting factor	***9,09%***	***9,09%***				***9,09%***	***9,09%***	***9,09%***	***9,09%***	***9,09%***	***9,09%***	***9,09%***	***9,09%***	***9,09%***	*100,00%*
1	DE	Hamburg	4	4	1	1	1	3	4	4	2			-1	2		**2,00**
2	DE	Luebeck	4	3	1	1	1	3	4	3	2				2		**1,91**
3	DE	Bremerhaven	4	3	1	1	1	3	4	4	2			-1	2		**1,91**
4	BE	Antwerp	4	4	1	1	1	3	4	3	2			-1	1		**1,82**
5	FI	Helsinki	4	4	1	1		2	4	4	2	-2			2		**1,82**
6	NL	Rotterdam	4	4	1	1	1	3	2	4	2			-1	2		**1,82**
7	UK	London Ports	4	4	1	1	1	3	4	4	2	-2			1		**1,82**
8	BE	Zeebrugge	4	3	1	1	1	3	3	3	1				2		**1,73**
9	EST	Tallinn	3	4	1	1		2	1	4	2				2		**1,64**
10	DK	Aarhus	3	3	1	1		2	4	3	2				1		**1,64**
11	UK	Grimsby & Immingh	4	3	1	1		2	3	3	2	-2			2		**1,55**
12	DE	Rostock	3	3	1	1		2	3	3	1				2		**1,55**
13	FI	Turku	2	2	1	1		2	4	4	2	-2			2		**1,45**
14	DE	Kiel	1	1	1	1	1	3	4	3	2				2		**1,45**
15	UK	Southampton	3	3	1	1		2	4	3	2	-2			1		**1,45**
16	IRE	Dublin	4	3	1	1		2	4	4	1	-2			0		**1,45**
17	DK	Esbjerg	1	4	1	1		2	4	3	1				0		**1,36**
18	ES	Bilbao	3	2	1	1		2	2	4	2				0		**1,36**
19	UK	Belfast	3	4		1		1	4	4	1	-2			0		**1,36**
20	UK	Felixstowe	4	3	1	1		2	3	4	1	-2		-1	1		**1,36**

Table 10: Port ranking of Swedish ports, Top 10 placed ports according to the selection scheme

	Country	Port	Volume	Calls	ected modes				Location									Result
					Rail	Road	IWW	Total	Economical importance of region	TEN-T axis	main road traffic flows	Density of intermodal land conncetions	Island	Small distance ferry connection	Oversea container hub	well developed SSS link to the continent	Latest traffic trend	
		Weighting factor	***8,33%***	***8,33%***				***8,33%***	***8,33%***	***8,33%***	***8,33%***	***8,33%***	***8,33%***	***8,33%***	***8,33%***	***8,33%***	***8,33%***	*100,00%*
1	SE	Goteborg	4	3	1	1	1	3	4	4	2	2				2	0	**2,00**
2	SE	Trelleborg	4	3	1	1		2	3	2	2	2				2	1	**1,75**
3	SE	Stockholm	2	3	1	1	1	3	4	4	1	2				1	0	**1,67**
4	SE	Malmö	3	1	1	1		2	3	3	2	1				0	0	**1,25**
5	SE	Helsingborg	3	4		1		1	3	3	1	2		-5		2	-1	**1,08**
6	SE	Karlshamn	2	2	1	1		2	2							1	1	**0,83**
7	SE	Varberg	1	1		1		1	2	3	1					1	0	**0,83**
8	SE	Gävle	2	2	1	1		2	1			2				1	0	**0,83**
9	SE	Ystad	1	2	1	1		2	3	2	1					0	-1	**0,83**
10	SE	Karlskrona	1	1	1	1		2	2							2	1	**0,75**

[4] The selection parameter detour factor was applied for all ports in the Mediterranean and in the Atlantic Arc. However, even though these ports were levelled down, ports like Genoa, Bilbao or Trieste were among the Top 20 ranked ports. They have been deleted manually from the list as discussed under 2.1.9. This is why for all other remaining ports this column has no value.

3.1 Ports aggregated into port regions

Ports being close to each other are combined into port regions. This is necessary to limit the high number of to be simulated links in the study. It is furthermore reasoned by the fact that no individual port data such as efficiency, environmental performance or port terminal capacity is taken into account.

A port in the model is a transfer node that enables the freight flows to change at certain cost and time levels the transport modes in a certain geographical location. This transfer node has a general setting of costs and time consumption and capacity. It is however unique in its geographical position, its hinterland links and the multi-modal network, that it is connected to (road, rail and sea links).

Carried out tests with the EFM STAN modal confirm, that ports within the same region show the same results for transport demand within a range of 10-20%, in case their hinterland links are comparable. Ports of the port selection list, which are situated not in any close vicinity of another selected port, are not aggregated into a port region. The name of the port can however be interpreted as the name of the port region, since from a modelling perspective the differences between ports in one region are quite limited (if no individual port constraints are implemented).

Table 11: Aggregated port regions Europe

Selected ports	Name of port region for this study
Lübeck, Kiel, Rostock	Port Region German Baltic Sea
Hamburg, Bremerhaven	Port Region German North Sea
Helsinki, Turku	Port Region Southern Finland
Zeebrügge, Antwerp, Rotterdam	Port Region Benelux
Southampton, Portsmouth, Felixstowe, London ports Immingham	Port Region Western UK
Dublin, Belfast	Port Region Ireland and Northern Ireland
Aarhus, Esbjerg	Port Region Jutland

Furthermore, the Polish port Gdynia is added to the list. Even though, Gdynia is on position 25 of the port selection list, it is however considered as an important port for Swedish transports that should be included into the analysis of this study.

As for the Swedish ports, the following port regions have been defined.

Table 12: Aggregated port regions Sweden

Selected ports	Name of port region for this study
Göteborg, Varberg	Port Region Westsweden
Trelleborg, Malmö, Helsingborg, Ystad	Port Region Skåne
Stockholm, Gävle	Port Region Stockholm/Ö. Mellansverige
Karlshamn, Karlskrona	Port Region Blekinge

3.2 Final list of ports selected

The final list of to be linked ports consists of the following ones:

1. Lübeck, Kiel, Rostock — Port Region German Baltic Sea
2. Hamburg, Bremerhaven — Port Region German North Sea
3. Helsinki, Turku — Port Region Southern Finland
4. Zeebrügge, Antwerp, Rotterdam — Port Region Benelux
5. Southampton, Portsmouth, Felixstowe, London ports, Immingham, Port Region Western UK
6. Dublin, Belfast — Port Region Ireland and N. Ireland
7. Aarhus, Esbjerg — Port Region Jutland
8. Tallinn
9. Gdynia
10. Göteborg, Varberg — Port Region Westsweden
11. Trelleborg, Malmö, Helsingborg, Ystad — Port Region Skåne
12. Stockholm — Port Region Stockholm/Ö. Mellansverige
13. Karlshamn, Karlskrona — Port Region Blekinge

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