BaSIM – Baltic Sea Information Motorways

WP 3 Feasibility Study

- Analysis of feasibility of the proposed concepts and solutions for innovative transport corridor development incl. spatial planning impacts.

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Preface

The general overview of the BaSIM project is:

"The BaSIM Project has been initiated in order to promote the concept of the Baltic Sea Motorways, which is one of the key elements in the Northern Dimension transport market. Baltic Sea Motorways are aiming at promotion of maritime transport, multimodality covering also hinterland and logistics in general. Baltic Sea Motorways is a future vision manifested in the strategy of TEDIM, an organization carried by most of the Baltic Sea countries, including Russian Federation, to enhance cooperation and to optimise transport system of the Baltic Sea Region. The vision is implemented by BaSIM, under the TEDIM umbrella and will be one of the first Baltic Sea Motorways projects. BaSIM will create a sustainable basis for investments in the future aiming at solving existing and coming up bottlenecks in the BSR and transnational communication and cooperation. Therefore BaSIM emphasizes simultaneous actions, which are needed to develop both physical and information infrastructure within the BSR, for an overall improvement of logistics productivity and competitiveness."

This report is part of Work Package (WP) 3 comprising transport corridors and the relation to information exchange in the BSR. It is the second step (the first step was the *"Report on best practice on freight transport corridors and concepts"*) in the planned results of WP 3 during the project period (2004-2006) and will be the backbone for the future analyses in WP 3. The vision of the report is through the feasibility to investigate selected connections and hereby deliver results to the overall the Motorways of the Baltic Sea concept.

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1. Introduction

Transport corridors and/or sea motorways as part of the logistic chain and short sea shipping thus the search, development and optimisation thereof is the main task for researchers and practitioners who work in transportation and logistics. Such regions like Baltic Sea are very important for the new maritime transport corridors and/or sea motorways development as there are big industry and population concentration areas featured around the Baltic Sea, and sea motorways must link production chains and people interests. The most important tasks within the integration process are good transport and logistic links and this work has to be done in both fields of science and practice.

There are still vast reserves for cooperation in developing the transport sector together with Baltic Region countries

Transport networks are very important for shifting the force of markets. Therefore, in the process of EU extension, the priority attention has to be given to the development and modernisation of transport infrastructure to duly coincide in terms of time with the revision period of Trans-European Transport Network. Maritime transport corridors and/or sea motorways are a new adding system to the Trans-European Transport Network.

The Trans-European Transport Network has to be planned, developed and subsequently constructed according to European economic criteria; since the Trans-European Network cannot be created in a single effort – for financial and technical reasons, it has to be developed in stages according to a schedule. Priorities have to be clearly defined. These should not be decided on the basis of national criteria, in other words, from the point of view of the greatest possible advantage for the country adjoining the respective traffic route. Planning and development measures must be carried out according to the requirements of European trade and Pan-European freight transport. Cost-benefit related planning and appropriate development measures to be applied; the criteria of benefit have to be understood specifically from the perspective of European trade and Trans-European freight transport requirements.

However, it would also be rational to develop the maritime transport corridors and/or sea motorways on East-West direction in the Southern (ice-free) area of the Baltic and South – North directions, integrating them into the future Trans-European Transport Networks. It would be necessary to form a network of motorways on sea that would serve best for the interests of extended Europe.

Sea motorways main elements can be point out as follow:

- Sea motorways as a part of the European transport corridors network;

- Sea motorways as part of logistics network;
- Sea motorways are new adding system to the transport and logistics network;
- New Ro-Ro lines situation in Baltic Sea.

Sea motorways main tasks can be mention as follow:

- Continuation of the European transport corridors;
- Link different European transport corridors;
- Link logistics centres network;
- Optimisation transport links.

Sea motorways deep study and investigations must support correct actions for the transport systems optimisation, added value, received new products and increase European products competition.

2. Population and industry concentration around the BSR

International trade generates transport. Based on the correlation GDP>Trade>Transport, the future trade flows by merchandise groups between the relevant European countries can be modelled and forecasted.

Population and industry concentration in the Baltic Sea region with the integration of the new EU Countries is the main basis for the forecasting cargo flows that have influence on maritime transport corridors and/or sea motorways. Population and turnover in the ports in Baltic Sea regions are shown in Table 1 (EU Energy and Transport in Figures, 2003).

Table 1. Population and Turnover in the Baltic Sea Regions

Region	Population, mil.	Turnover in region ports, mil. Tons
Denmark, South Sweden	8	60
North Germany	12	30
North Poland	6	45
Lithuania	3,5	32
Latvia	2,6	52
Estonia	1,5	42
Russia (St.-Petersburg region)	8	45
South Finland	3	37
Central Sweden	3	20

A lot of transit cargo goes via Baltic ports and regions that are on the same distance scale from the Baltic Sea and imply major influence on the Baltic transport system. Regions close to the Baltic that have real influence on the Baltic transport system and average distances from these regions to the Baltic Sea ports are shown in Table 2 (EU Energy and Transport in Figures, 2003).

Table 2. Regions Neighbouring the Baltic Sea and Average Distances to the Ports

Regions	Population, mil.	Distance to Baltic sea, km
West Germany	30	500
Benelux Countries	26	400
Central and East Germany	20	250
Central Poland	10	350
Belarus	10	500
Central Russia	30	1000
North-West Russia	5	600
Central and North Finland	3	300
North Sweden	2	200
Norway	2	500

Main maritime transport corridors directions in Baltic Sea between main industry and population concentration are shown on Fig. 1.

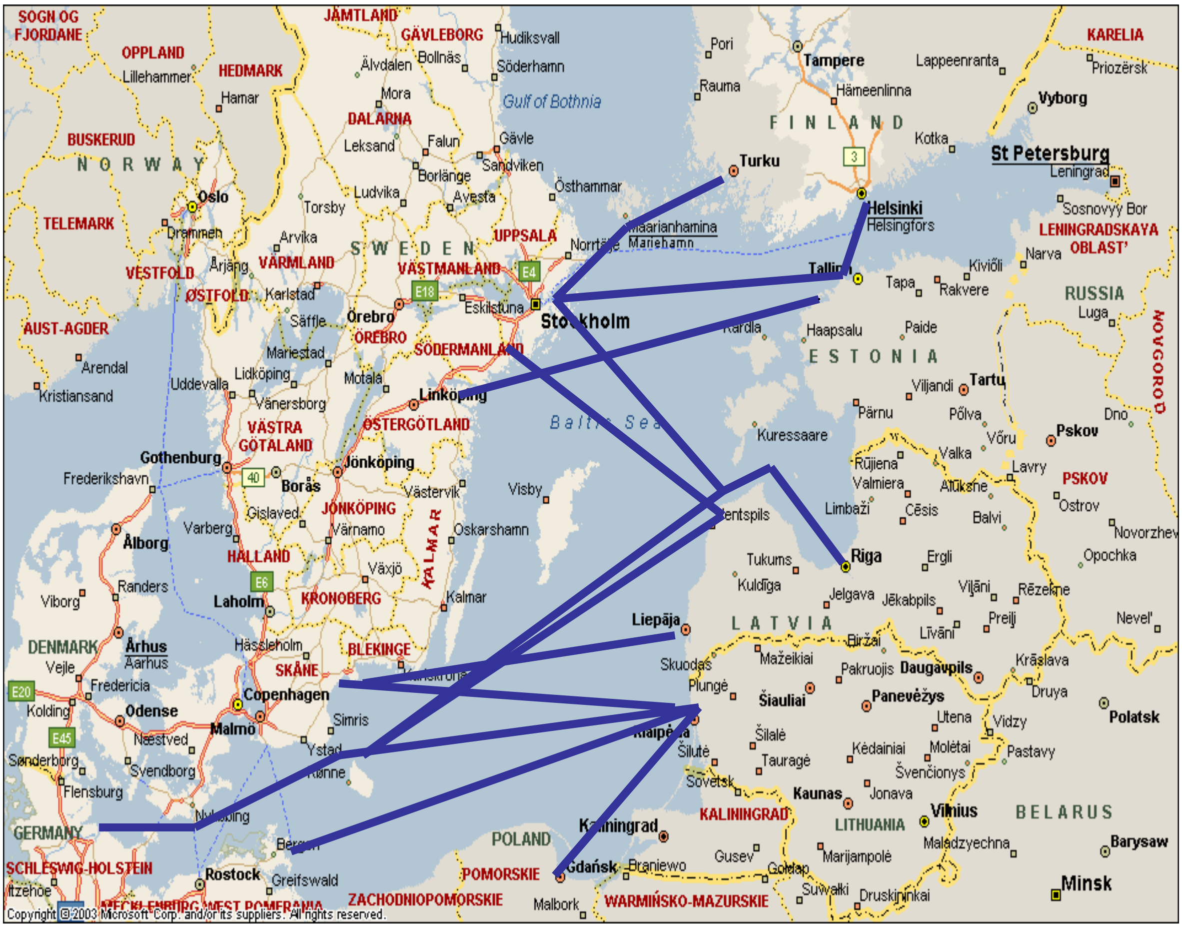

Fig. 1. Main Maritime transport corridor directions in Baltic sea.

For the investigations of the cargo flows to likely influence the maritime transport corridors and/or sea motorways as an example are taken Eastern Baltic ports and quantities of Ro-Ro units and container carriers (in TEU) in fixed points. Ro-Ro units and containers turnover in Eastern Baltic ports in 1996 – 2002 are shown in Table 3 and Table 4.

Table 3. Ro-Ro Unit Turnover through the Eastern Baltic Ports.

Port	1996	1997	1998	1999	2000	2001	2002	2003	2004
Kaliningrad	3200	7300	1420	320	1250	1560	2160	2538	3587
Klaipeda	158942	177475	144619	101315	116195	134735	136082	155866	156521
Liepaja	20429	29462	27148	20444	20856	25173	29263	40660	38220
Ventspils	-	-	4651	-	879	2882	3526	12030	14320
Riga	15396	14869	21211	17847	10460	10884	19173	34568	38716
Tallinn	119822	123415	137528	144965	146518	165128	160500	268830	268230
St.-Petersburg	580	1860	2510	1500	1850	3560	9500	1015	3450
TOTAL	318369	354379	339087	267991	298008	343922	360204	515507	523044

Table 4. Container (TEU) Turnover in the Eastern Baltic ports

Port	1996	1997	1998	1999	2000	2001	2002	2003	2004
Kaliningrad	2300	12000	10875	9122	16280	21313	22850	44687	72000
Klaipeda	35057	36736	32328	28668	39955	51675	71609	118366	174000
Liepaja	1158	3568	5129	4044	3278	2276	2798	1540	3000
Ventspils	-	-	852	195	207	-	1044	3688	1000
Riga	141408	132559	129580	85911	84928	101077	121784	132074	152000
Tallinn	45678	54585	54472	65535	76692	78072	84500	99440	108000
St. Petersburg	122500	157000	165200	188200	289730	480659	526000	656183	776000
TOTAL	348101	396448	398436	381675	511070	735072	830585	1055978	1286000

As an additional example is taken single Ro-Ro ferry line between Port Klaipeda (Lithuania) and Port Karlshamn (Blekinge area in Sweden) operated by two Ro-Ro ferries and transport corridors between Lübeck and Ventspils and Gdansk and Helsinki and St.-Petersburg (Fig. 2).

Fig. 2. Existing transport corridor Klaipeda – Karlshamn and Klaipeda – Gdansk and possible maritime transport corridors

The shipping line between Klaipeda and Karlshamn could be in feature as direct explanation of the sea motorways implementation possibility.

Table 5. Ro-Ro Cargo Transportation between Karlshamn and Klaipeda Ports during 2002 – 2004 (in loading meters)

Month	2002	2003	2004
01	12126	18559	21418
02	14801	19902	26692
03	15598	22589	31886
04	16564	24140	33450
05	20702	26997	35400
06	22168	27771	37650
07	19325	29562	38970
08	21312	31982	41100
09	22296	36744	47460
10	23444	37277	49870
11	22290	33972	51200
12	17523	25678	52200
Total	228849	335173	467296

Investigation of all cargo turnovers through maritime transport corridors and/or sea motorways is not quite correct since only specific cargo or goods transit has real influence on sea motorways. Ro-Ro and container transportation via ports could be taken as the basis for the sea motorways investigations.

3. Methodology of investigations

For the sea motorways investigations, Oilier method (Paulauskas, V. 2002) can be used which allows checking passenger or cargo flows at important fixed points and subsequently finding out requested parameters. As such main fixed points can be taken ports on one side of the sea. For more detailed investigations multi criteria investigation methods (Paulauskas, V.2002) can be applied.

According to Oilier method, in fixed points quantities are checked by field formulas that can be shown as below:

$$Q_x = q_x(x, y, z, t) \quad , \qquad (1)$$

$$Q_y = q_y(x, y, z, t) \quad , \qquad (2)$$

$$Q_z = q_z(x, y, z, t) \quad . \qquad (3)$$

here:

Q_x, Q_y, Q_z - investigated quantities in concrete fixed point on concrete directions;
q_x, q_y, q_z - commodities in fixed points;
x, y, z - fixed point coordinates;
t - time.

Based on this method it is possible to find the investigated cargo flow parameters for the actual directions or concrete transport corridors.

In order to check the development perspectives of the transport market for the forecast horizon, a forecast method based on the specific elasticity (multi criteria) method for each commodity groups can be used.

While assessing the importance of Pan-European transport corridor IX (map in the Annex II) (the middle section) in the extended EU it would be expedient to carry out forecasting and research of potential flows. It would also be of great importance to ascertain what kind of specific motorways (in the East - West or South - North directions) would serve the interests of the Baltic Sea Region and extended EU the best way.

The basic elements for the multi criteria forecasts are these:

- Population and industry concentration;
- GDP forecasts for the countries concerned;
- European export and import forecasts (values at constant prices) for the relevant countries;
- Calculation of import and export for the different commodity groups for each country;
- Projection of trade flows based on that calculated for all commodities and all countries (volumes), differentiated for exports and imports;
- Technical possibilities on selected directions;
- Geographical, hydro meteorological and other conditions on concrete directions.

Baltic sea area as very active and attractive industrial and trade area play an important role in Europe and World. Baltic area industry and transport activity can be spread in to main sectors:

- as single producing and consuming market from eight states around enclosed Baltic sea (cardinally new and unique phenomenon in a world);
- as to a certain extent integrated economical power, offering products and services to the world market;
- as a natural transit gateway to CIS;
- as industrial and logistical platform for industries, acting in CIS.

For the analysis of the mention transport activity sectors can be used multi-criteria evaluation and forecasting method. On basis mention method it is possible:

- find main parameters of the existing transport system;
- find bottlenecks in existing transport system;
- find more preference cargo and passenger flows directions and transport corridors;
- other aspects, such as internal and outer influence on transport activity.

Transport system analysis should be made in next main aspects:

- cargo and/or passenger flows;
- transport corridors;
- transport infrastructure;
- transport services.

In the same time maritime transport corridors and/or sea motorways must be taken as:

- Sea motorways as a part of the logistic chain and short sea shipping
- Good transport and logistics links between regions and cities.
- Sea motorways are new adding system to the transport network.
- Sea motorways would serve best for the interests of the Countries, regions and cities.

Based on the existing cargo flow and dynamic of the development of different merchandise, especially those of importance to the sea motorways, it is possible to note tendencies and forecast regions which could be developed.

Run time of ships sailing between ports is very important for the maritime transport corridors and/or sea motorways in order to maintain proper compatibility with other transport corridors, like for instance in the Baltic region - with inland transport corridors via Poland.

Full Ro-Ro ferry voyage time can be calculated as follows:

$$T = 2 \cdot T_r + T_{rez} \quad , \tag{4}$$

here: T_r - ship's time for sailing and port operations, between leaving one quay wall to other quay wall;

T_{rez} - reserve time that depends on the distance between ports.

Ship's sailing and port operations times can be calculated as follows:

$$T_r = \frac{S}{v} + T_p + T_l \quad , \tag{5}$$

here: S - distance between the ports;
v - average sailing speed in-between the ports;
T_p - time necessary for sailing within port and port formality arrangement;
T_l - time necessary for discharge and loading.

Time factor is very important for the sea motorways regarding possibilities to operate optimal timetable based on week schedule with minimum number of ships, especially on first stage.

Safety factors in sea motorways compared to other transport corridors, play very important role because by Ro-Ro units are usually carrying the expensive goods. Safety factor in transportation can be calculated as follows:

$$P = \frac{1}{\eta_k}((1-Q_1)(1-Q_2)(1-Q_3)(...)) \quad , \tag{6}$$

here: P - positive probability;
Q_i - opposite probability;
η_k - correlation coefficient.

Safety is calculated as a positive probability.

For the comparison between transport corridors as well as between sea motorways and inland transport corridors a complex evaluation method can be used that can be calculated for the concrete sea motorway direction as follows:

$$E = \frac{1}{\eta_E} \sum (k_i \cdot M_j) \,, \qquad (7)$$

here: M_j - factors like costs, time of delivery, safety, environmental impact, navigational conditions, ice conditions etc;
k_i - weight of the factors to depend on the type of cargo, transportation possibilities etc that can be found on the basis of multi criteria analysis;
η_E - correlation coefficient that depends on number of factors used in evaluations.

On the basis of the multi-criteria analysis it is possible to make evaluation of the concrete cargo or passenger flow directions or transport corridor together with other parts of the whole transport corridor and find the difference between transport corridors as follows:

$$\Delta = \frac{E_i}{E_0} \,, \qquad (8)$$

here: E_i - investigated cargo flow direction or transport corridor;
E_0 - basic cargo flow direction or transport corridor, to be taken as standard.

On the multi-criteria evaluation basis, it is possible to establish more accurately all the advantages and disadvantages that would able to take final decision and provide correct explanations for investors and other market players on an existing concrete cargo or passenger flow direction or transport corridor as well as sea potential possibilities.

Cargo or passenger flow trends can be shown as follow:

$$Q_i \approx (Q_0 + BT) \cdot M \,, \qquad (9)$$

here: Q_0 – cargo or passenger flow in last statistical point;
B – coefficient, which can be find on statistical basis;
T – forecasting period;
M – trend limitation coefficient.

Coefficient B can be find on basis statistical information and calculate as follow:

$$B_i = \frac{Q_i - Q_{i-1}}{\Delta T} \,, \qquad (10)$$

here: ΔT – period between cargo or passenger flows Q_i and Q_{i-1}.

Finally coefficient *B* will be:

$$B = \frac{\Sigma B_i}{n_i}. \qquad (11)$$

Trend limitation coefficient can be found on basis regression dependents in case of enough statistical data or on basis expert evaluation and should include:

- political influence on cargo or passenger flows;
- economical situation and especially economical crisis;
- transport systems technical limitations;
- competition influence;
- non typical hydro meteorological influence;
- other influence, such as changes in regions policy and so on.

In concrete situation should be study real conditions for the concrete transport and maritime corridor and /or sea motorway and find trend limitation coefficient as time, price, safety or other dependent and limitation. Transport corridors must be taken in account and should study all aspects of the transport corridors that will be possible to find potential possibilities and especially bottlenecks of the transport corridors. On basis transport corridors study and especially technical bottlenecks of the transport corridors it is possible to find right decisions regarding use of existing transport corridor or create new one on basis existing and forecasting transport or passengers flows.

In transport infrastructure studies and evaluation by the multi-criteria methods it is important to link existing and potential cargo or passenger flows, that will be possible take decision it is enough or not infrastructure and fulfil or planning new transport means and technologies and what actions will be necessary take.

On basis transport infrastructure evaluation should be calculate request investments on concrete transport flows directions and select concrete infrastructure objects which is necessary to construct or renovate.

Transport services include next main elements:

- transport superstructure;
- transport means;
- cargo handling technologies and equipment;
- services companies like stevedoring, cargo forwarding, ships agency, survey and other companies and its practice;
- state control institutions and its practice;
- other services which have influence on passenger and cargo flows.

For the transport corridors and/or sea motorways evaluation can be used next methodology, which based on evaluation same elements. In this case a main formula can be used:

$$E = \eta_k (k_1 \cdot K_1 + k_2 \cdot K_2 + k_3 \cdot K_3 + k_4 \cdot K_4)$$

where: η_k - correlation coefficient, which is received on basis statistical data;
k_i - weight of the factors;
K_i - factors, which can be calculate as follows;

$$K_i = \sum m_i \cdot q_i$$

As example for the geographical factor, can be used next formula:

$$K_1 = m_1 \cdot q_s + m_2 \cdot q_{ch} + m_3 \cdot q_p$$

Where: mi - weight of sub factors;
q_j - sub factors, which can be calculate as follows:

$$q_s = \frac{S_i}{S_{\max}}$$

Si- distance of the investigating transport corridor;
$S_{\max}$ - transport corridor with maximum distance.

For the concrete region or transport route on basis multi-criteria evaluation methodology, which is presented, can be made evaluation, but in the same time detail or elements on mention methodology must be study in advance. Study must cover geographical, economical, political, metrological and other aspects, which are important for the concrete region or country, or group of the countries.

Finally, as direct sea motorways investigation elements should be taken in account:

- Investigation of the existing transport corridors;
- Investigation of the Ro-Ro shipping lines;
- Investigation Sea and Shore interface;
- Investigation of the existing and prospects transport means;
- Investigation of the transport means technical and organization links.

On basis investigations should be find out best solutions, advantages and disadvantages of the sea motorways and sea transport corridors, that will be possible optimise final solutions, solve bottlenecks and other difficulties in the links between European transport corridors and sea motorways.

4. New sea Motorways Systems

Sea motorways development on basis new links between different transport means. New block train, which used on concrete directions and link ports with big population concentration regions or other ports, improve new possibilities:

- decrease transportation costs;
- decrease transportation time;
- increase cargo and transport means, especially road transport means, safety.

Sea motorways link directly with Ro-Ro shipping. Depends Countries and EU policy in maritime transport sector, could be different solutions regarding Ro-Ro and in same time Sea motorways situation. Sea motorways must link European transport corridors and it request make changes in legal, organization and technical possibilities, which minimum time goods stay in one place.

Sea motorways main elements can be point out as follow:

- Sea motorways as a part of the European transport corridors network;
- Sea motorways as part of logistics network;
- Sea motorways are new adding system to the transport and logistics network;
- New Ro-Ro lines situation in Baltic sea.

Sea motorways main tasks can be mention as follow:

- Continuation of the European transport corridors;
- Link different European transport corridors;
- Link logistics centres network;
- Optimisation transport links.

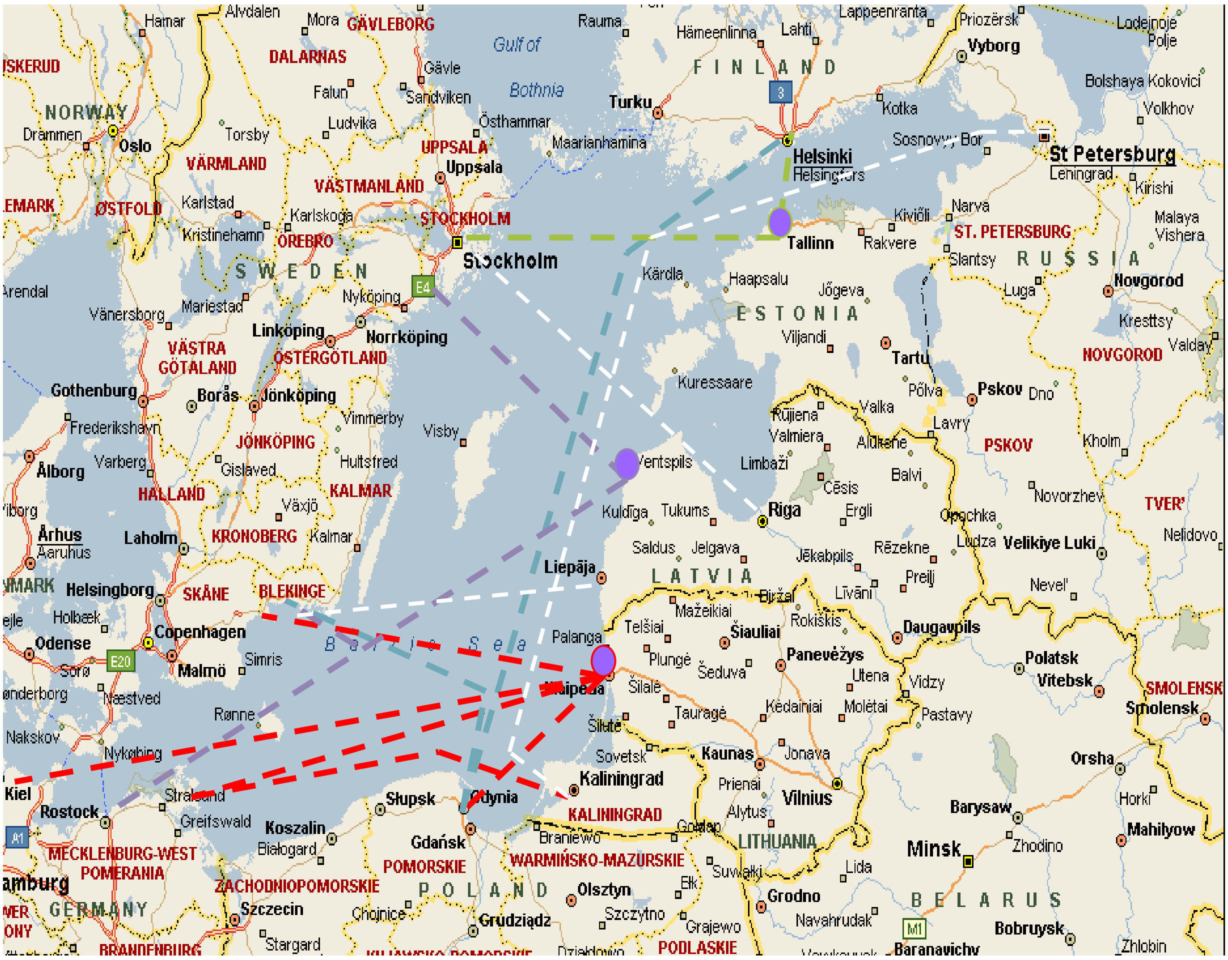

Fig. 3. Transport corridors link by sea motorways

On links of the European transport corridors, change Ro-Ro shipping lines and main Ro-Ro ports. Today it looks so, that three main (hub) Ro-Ro ports create on East Baltic: Klaipeda (concentrate DFDS Ro-Ro lines), Ventspils (concentrate Scanlines Ro-Ro lines) and Tallinn port.

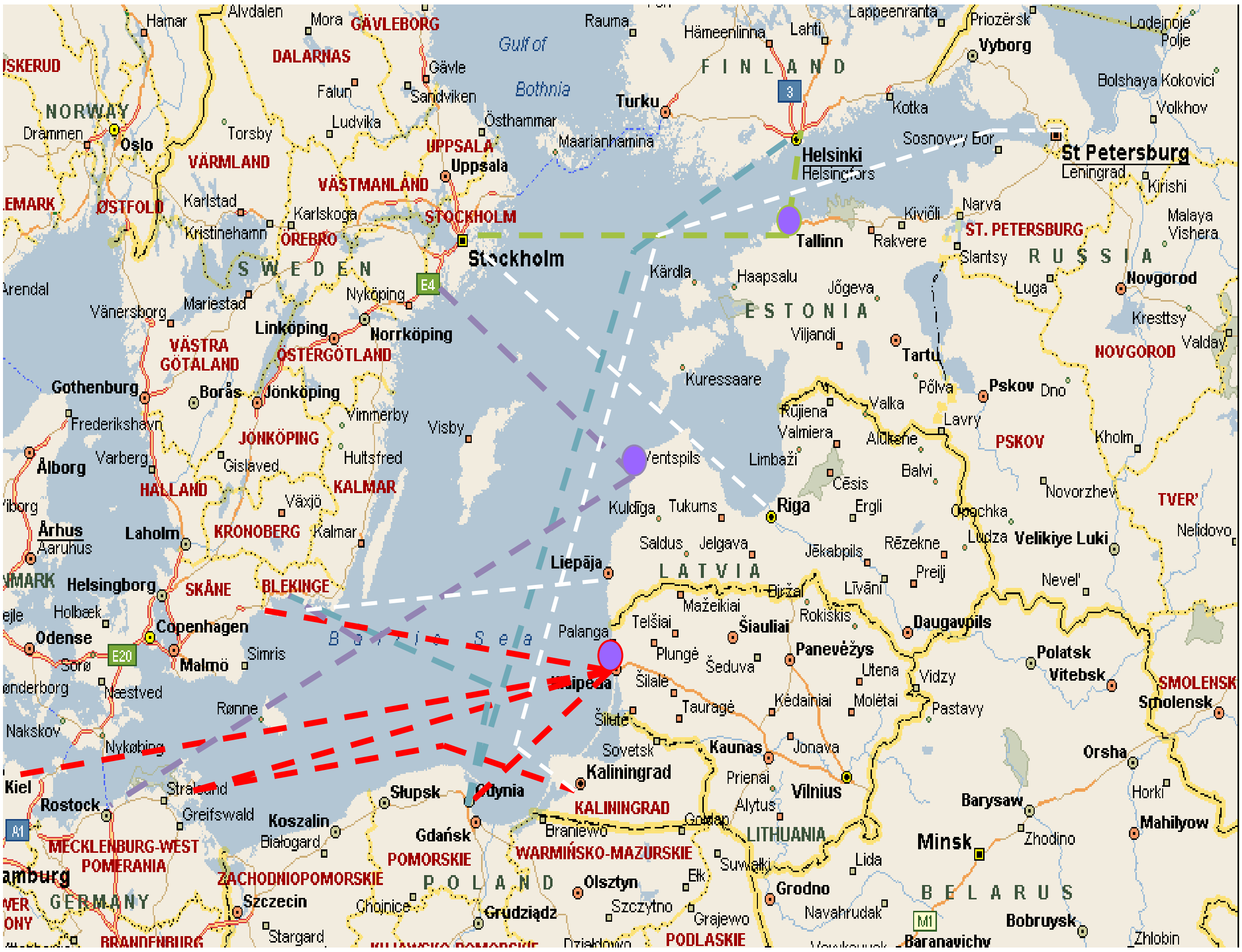

Fig. 4. Hub Ro-Ro ports in East Baltic.

Sea motorways and other transport systems links is main legal and organisation problem today. In general exist or can be next link systems:

- No system in all;
- Bridge system in sea part;
- Network system in sea part;
- Bridge system in sea and shore;
- Network system in sea and shore.

Links system creation it is not short and easy process, but this process must be implemented and just network system in sea and shore parts can make real transport systems optimization.

At moment are implemented block train in East Baltic ports (Fig. 5):

- VIKING train system between Klaipeda and Iliciovsk (Ukraine) via Vilnius, Minsk, Kiev, Odessa;

- MERCURY train system between Klaipeda – Kaliningrad and Moscow via Vilnius, Minsk, Smolensk.

Fig. 5. Block trains systems VIKING (----) and MERCURY (___)

Same systems are planning from Riga, Tallinn, St.-Petersburg ports and Moscow or Far East. This new block trains systems together with shipping lines and ports can solve many disadvantages or bottlenecks, which exist now, such as traffic jumps on roads, long waiting time on border crossing places, avoid roads with very high accident probability and so on.

Sea motorways link directly with Ro-Ro shipping. Depends Countries and EU policy in maritime transport sector, could be different solutions regarding Ro-Ro and in same time Sea motorways situation. Sea motorways must link European transport corridors and it request make changes in legal, organization and technical possibilities, which minimum time goods stay in one place.

Sea motorways as parts of the transport corridors must link different transport corridors by sea and information systems, which can link different transport corridors and transport systems in all, could optimise transport processes, decrease transportation costs and time, increase transport means and cargo safety, increase products competition.

Information systems of the sea motorways, safety and security of the transport system in all, optimisation sea motorways transport legal basis is main task which sea motorways and transport corridors in all.

5. Practical calculations for the Sea Motorways directions

Main transport corridors, especially on East Cost of Baltic Sea play very important role for the co-operation East and West market. Main transport corridors are presented on fig. 6

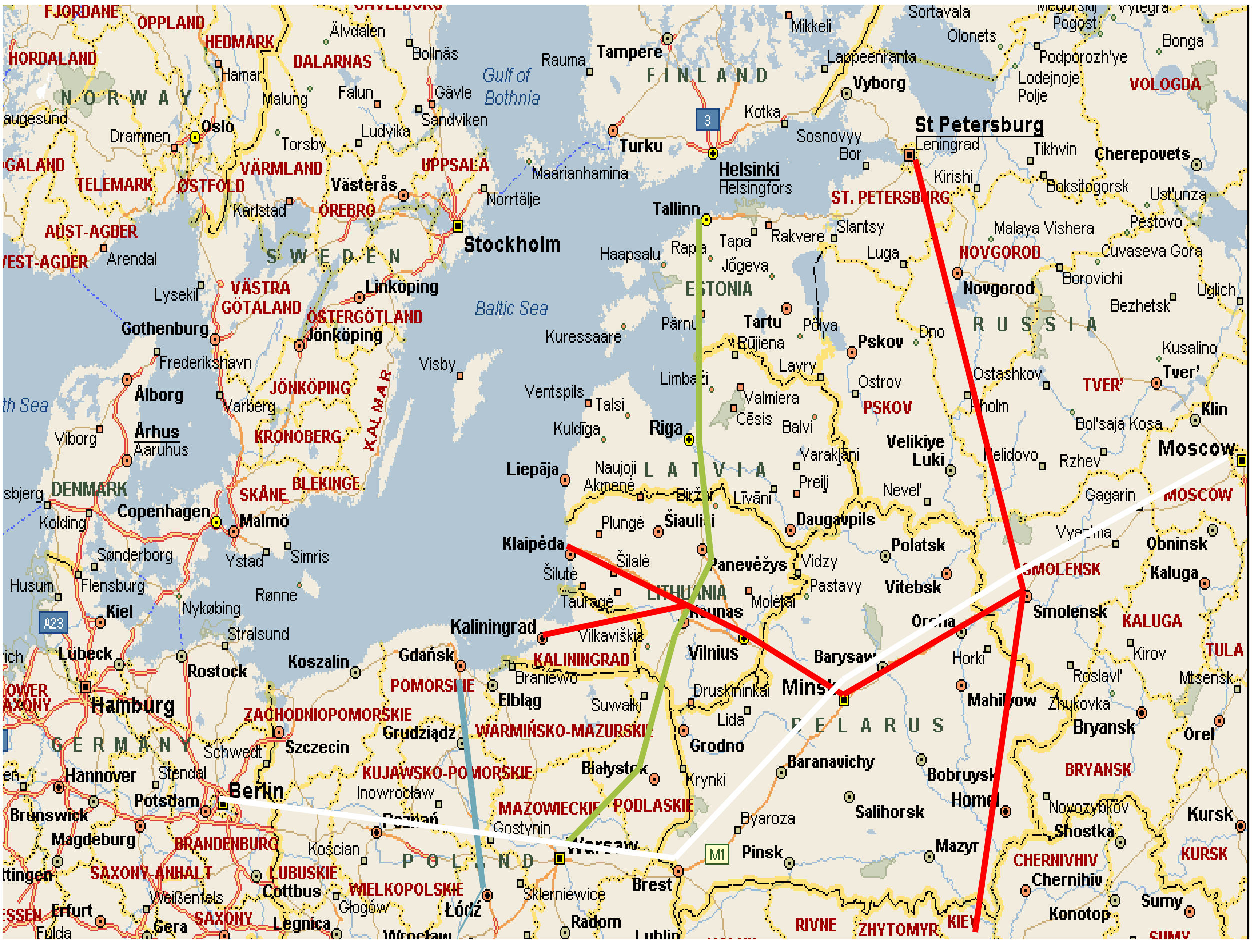

Fig. 6. Main European transport corridors on East Baltic part.

Based on the information and following the methodology presented in this report, calculations for the different profiles are to be made, such as Ro-Ro development in different Baltic Sea regions, ships voyage time between different ports, time and safety factors, for instance, for a road transport unit between Vilnius and Hanover in case of use of sea way (potential sea motorway) and inland ways, maritime transport corridors between Lübeck and Ventspils and maritime transport corridor between Gdansk and Helsinki – St.-Petersburg, and finally are made complex evaluations of the concrete transport corridors.

Ro-Ro transport dynamic for the directions on transport corridor No. IX and other directions are spread as follows:

- Kaliningrad, Klaipeda, Liepaja are included in transport corridor No. IX direction (West – East direction);
- second direction – Riga direction (West – East direction), include Riga and Ventspils ports.;
- third direction – South – North direction (South West part of the Baltic and Finland Bay ports).

Statistics and calculation results are presented in tables.

Table 6. Ro-Ro units dynamic on transport corridor No. IX direction and other directions. (East Baltic ports statistics)

Direction	1996	1997	1998	1999	2000	2001	2002	2003	2004
Corridor No. 9	182500	214200	173180	122079	138300	161460	167505	199064	198328
Riga Bay	15400	14860	21210	17840	10460	10880	19170	34568	38716
Finland Bay	72470	75900	85020	88470	89760	102630	105800	103670	107120
TOTAL	270370	304960	279410	228389	238520	274970	292475	337302	344164

Remark: 1st of May 2004 Lithuania, Latvia, Estonia and Poland joint to EU and shore border was opened for the Ro-Ro transport.

As shown in Table 6, the main Ro-Ro direction is the direction of Transport corridor No. IX and the reason of such dynamic is good Ro-Ro shipping lines connections, good road network eastward from the Baltic ports and lighter hydro meteorological conditions in comparison with other directions. Table 6 does not include Ro-Ro flows between Central and Northern part of Sweden to Helsinki and Tallinn – Helsinki routes.

For the investigations of the cargo flows which will influence on, are taken as example South-Eastern Baltic ports and Baltic sea region of Ro-Ro units and containers (in TEU) in fixed points. Ro-Ro units and containers turnover in South-East Baltic ports in 1996 – 2003 is shown in table 7 and table 8.

Table 7. The turnover of Ro-Ro units in the South-Eastern Baltic ports.

Port	1996	1997	1998	1999	2000	2001	2002	2003	2004
Kaliningrad	3200	7300	1420	320	1250	1560	2160	2538	3587
Klaipeda	158942	177475	144619	101315	116195	134735	136082	155866	156521
Liepaja	20429	29462	27148	20444	20856	25173	29263	40660	38270
TOTAL	182571	214237	173187	122079	138275	161468	167505	199064	198328

Table 8. Containers (TEU) turnover in the South-Eastern Baltic ports

Port	1996	1997	1998	1999	2000	2001	2002	2003	2004
Kaliningrad	2300	12000	10875	9122	16280	21313	22850	44687	72000
Klaipeda	35057	36736	32328	28668	39955	51675	71609	118366	174000
Liepaja	1158	3568	5129	4044	3278	2276	2798	1540	3000
TOTAL	38515	53865	48332	41834	59513	75264	97257	164593	249000

Voyage time of the Ro-Ro ships between the main population and industry concentration regions located close to the South-West of the Baltic, and Eastern Baltic and Finland Bay ports based on the methodology presented in this report are produced in Table 9.

Table 9. Ro-Ro voyage time between South-West Baltic ports (Kiel, Lubeck, Rostock, Copenhagen, Frederica etc.) and Eastern Baltic and Finland Bay ports in relation to Ro-Ro ship speed.

Port	16 knots	20 knots	24 knots
Kaliningrad	58 h = 2,4 d.	50 h = 2,1 d.	45 h = 1,9 d.
Klaipeda	64 h = 2,6 d.	55 h = 2,3 d.	48 h = 2,0 d.
Liepaja	68 h = 2,8 d.	58 h = 2,4 d.	51 h = 2,1 d.
Ventspils	75 h = 3,1 d.	65 h = 2,7 d.	58 h = 2,4 d.
Riga	98 h = 4,0 d.	83 h = 3,5 d.	74 h = 3,0 d.
Tallinn	110 h = 4,6 d.	93 h = 3,8 d.	82 h = 3,4 d.
Helsinki	116 h = 4,8 d.	98 h = 4,0 d.	86 h = 3,6 d.
St.-Petersburg	144 h = 6,0 d.	122 h = 5,1 d.	107 h = 4,5 d.

Results seen in Table 9 show how the weekly timetable depends, and that best position of having ports is transport corridor No. IX, as sailing speed depends on this direction where it is possible to make 3 voyages per week per one Ro-Ro ship.

Ro-Ro ferries voyage time at the shortest distance between Eastern and Western coasts of the Baltic (corridor No. IX on the Eastern Baltic) is presented in Table 10.

Table 10. South-Eastern Baltic ports in relation to Ro-Ro speed.

Port	16 knots	20 knots	24 knots
Klaipeda	43 h = 1,8 d.	38 h = 1,6 d.	34 h = 1,4 d
Kaliningrad	46 h = 1,9 d.	41 h = 1,7 d.	36 h = 1,5 d.
Liepaja	43 h = 1,8 d.	38 h = 1,6 d.	34 h = 1,4 d.
Ventspils	45 h = 1,9 d	40 h = 1,7 d.	35 h = 1,5 d

Ro-Ro voyage time in Table 9 and Table 10 includes a return sailing from one port to another, loading and unloading time, ship's sailing time within ports and reserve time. Fast ferries have not been investigated meanwhile, yet they could be very perspective in future especially en route between South-West Baltic region and South-Eastern Baltic ports.

On the basis of the existing cargo flows and dynamics of the development of different commodities it is possible to find tendencies and forecast transport flows. As example is presented container flow forecasting for the Klaipeda port in case investments used for the container terminal development.

Table 11. Forecasting container flow for the Klaipeda port on basis multi-criteria forecasting method. (Paulauskas V. 2005)

Year	Liner fore-casting method	*M* value in case investments in terminal	*M'* value in case without investments	Forecasting container flow in case *M* value	Forecasting container flow in case *M'* value
2006	185636	0,96	0,96	178000	178000
2007	208060	0,91	1,00	190000	208060
2008	230484	0,92	1,10	212000	235532
2009	252908	0,84	1,05	213000	265553
2010	275332	0,72	0,94	201000	258812
2011	297756	0,72	0,94	215000	279891
2012	320180	0,77	1,00	247000	320180
2013	342604	0,81	1,05	276000	359734
2014	365028	0,83	1,08	303000	394230
2015	378452	0,83	1,08	320000	408728

Based on the methodology used herein, road transport voyage from Vilnius (Lithuania) to Hanover (North Germany) has been considered, when using transport corridor with potential sea motorway Ro-Ro ferry Klaipeda – Kiel, Klaipeda - Karlshamn and inland transport corridor via Poland. Results of these investigations as example are showed in Table 12.

Table 12. Voyage Vilnius – Hanover investigation results

Transport Corridor	One-Way Trip Time consumption, hours	Costs (Basic Prices), EUR	Safety Factor: Positive Probability
By Ro-Ro ferry Klaipeda – Kiel	36	998	0,988
Inland transport corridor via Poland	48	1200	0,973
By Ro-Ro ferry line via Karlshamn	30	1020	0,985

In Table 12, the Ro-Ro ferry speed is taken as per conventional ferry with the same 22 -24 knots speed on both directions.

The above results have been checked within more than 30 transport companies that use all the three transport corridors, and they confirmed the presented results to be realistic in case the companies would pay taxes as due everywhere and road transport units drive according to the regulations.

Maritime transport corridors between Gdansk and Helsinki – St. Petersburg, and maritime transport corridor between Ventspils and Lübeck main parameters are presented in tables 13 and 14.

Table 13. Main transport corridor between Gdansk and Helsinki – St.-Petersburg parameters. (Baltic Sea region maps)

Basic points	Distance, km	Transport means	Conditions	Remarks
Gdansk - Helsinki	950	Sea	Good	Ro-Ro ferry
Helsinki –St.-Petersburg	300	Sea	Ice winter	Ro-Ro ferry
Gdansk - Klaipeda	200	Sea	Good	Ro-Ro ferry
Klaipeda - Tallinn	620	Road	Good	
Tallinn -Helsinki	90	Sea	Good	Ro-Ro ferry
Helsinki –St.-Petersburg	430	Road	Good	
Klaipeda –St.-Petersburg	900	Road	Different	50% good road

Table 14. Main transport corridor between Ventspils and Lübeck parameters. (Baltic Sea region maps)

Basic points	Distance, km	Transport means	Conditions	Remarks
Lübeck - Ventspils	730	Sea	Good	Ro-Ro ferry
Lübeck - Trelleborg	270	Sea	Good	Ro-Ro ferry
Trelleborg - Norrkoping	480	Road	Good	
Norrkoping - Ventspils	300	Sea	Good	Ro-Ro ferry

For the complex evaluation, weights of the factors, as example can be used:

- price with weight coefficient 0,35;
- time with weight coefficient 0,20;
- safety with coefficient 0,25;
- hydro metrological conditions in with weight coefficient 0,1;

- border crossing with weight coefficient 0,05 (after 1st of May 2004 safety control according ISPS Code);
- other factors with weight coefficient 0,05.

Evaluation of the transport corridors Vilnius and Hanover as example are presented in table 15 below (the results to be considered as guiding indication, since every single case requires additional study and decisions regarding factors to be included and respective weights of the factors).

Table 15. Evaluation of the transport corridors between Vilnius and Hanover when using an inland transport corridor via Poland and Ro-Ro ferries via Kiel and Karlshamn as maritime transport corridor and/or sea motorway.

Factors and Weights	Transport Corridor with Ro-Ro Ferry via Karlshamn	Transport Corridor with Ro-Ro Ferry via Kiel	Inland transport Corridor via Poland
Price factor	0,85	0,84	1,0
Weight of the price factor	0,35	0,35	0,35
Time factor	0,62	0,75	1,0
Weight of the time factor	0,20	0,20	0,2
Safety factor	0,988	0,985	1,0
Weight of the safety factor	0,25	0,25	0,25
Hydro-meteorological factor	1,0	1,0	0,95
Weight of the hydro meteorological factor	0,1	0,1	0,1
Border crossing factor	1,0	1,0	0,93
Weight of the border crossing factor	0,05	0,05	0,05
Other factors	1,0	1,0	1,0
Weight of the other factors	0,05	0,05	0,05
Correlation coefficient	0,95	0,95	0,95
TOTAL	0,914	0,937	1,043

In Table 15, factors were calculated as the best result divided to other results.

Based on the results received as provided in Table 15, we may conclude that a transport corridor with Ro-Ro ferry via Karlshamn with the existing possibilities, is the best if compared with a transport corridor via Kiel at ca.2,5 %, and in comparison with inland transport corridor it shows better at ca.14,1 %.

Karlshamn and Karlskrona are located very close to the main roads network in Sweden, and this position ensures very fast passage to Copenhagen and reach of other regions. The second field of maritime transport corridors and/or sea motorways activities where reserves for extensive cooperation could be found in the areas of transport investigation as well as transport practical activities is the development of modern logistics centre network throughout the Baltic Sea Region. The networking of logistics centres will have a positive effect on maritime transport corridors and/or sea motorways in these respects:

- Increased mobility of freight using efficiently various possibilities of interconnection between different transport modes;
- Increasing the use of existing infrastructure;
- Increasing of the quality of transport services;
- Creation of new permanent jobs;
- The efficient use of modern information and communication technology;
- Better business conditions for small and medium transport companies.

Common multilateral investigations and studies will be very functional for all parties aiming to reveal possibilities and ways on how to develop the intermodal transport, create and optimise maritime transport corridors and/or sea motorways and network the best links between the multiple countries on the Baltic Sea Region.

New Sea motorways and new maritime transport directions will be developed and based on new challenges and changes in the Countries around Baltic Sea. Methodology, which is described in this Feasibility Report, can be used for the Sea motorways and maritime transport corridors planning and evaluation. An example is presented in Annex I.

6. Conclusions

1. The Baltic Sea region develops very rapidly and features as very important for all the Europe and in particular for the states and regions located around the Baltic Sea.

2. Transport links in the Baltic region are very important not only for the Baltic Sea countries or neighbouring states, yet for the countries and regions that are located close to this region and have great interest into the Baltic Sea transport network.

3. Maritime transport corridors and/or sea motorways on the Baltic Sea have obvious advantages in comparison with other transport systems, as great deal of transport units employ Ro-Ro ferry lines as the main transport system which is the basis for the sea motorways, especially in case using links with other transport means.

4. Sea motorways and European Transport corridors must function as one network.

5. Ro-Ro transportation in Southern part of the Baltic Sea has rapidly enhanced over last years, and the hydro meteorological conditions, good roads and railway network on the Eastern side of the Baltic Sea have combined to make real possibilities to develop the main East–West transport corridors direction and sea motorways as well.

6. Transport corridor No. IX, roads and railways linked to this transport corridor will play more important role in the new EC framework, and thus optimal prolongation of this transport corridor on the other side (Western part) of the Baltic Sea should be initiated.

7. Southern part of Sweden which is geographically very close to South-Eastern Baltic ports like Klaipeda, Liepaja, Ventspils, Kaliningrad and other ports, should play more important role in future transport and industry development. Now two hub Ro-Ro ports Klaipeda and Ventspils on East Baltic play more and more important role.

8. Proper dynamic of passenger and cargo flows development over last years on transport links between South-Western and Eastern Baltic ports indicates this transport direction as having good perspectives and can optimise transportation between West and East markets.

9. Maritime transport corridors and/or sea motorways in the Baltic Sea have big advantages in comparison with other transport systems. Future of the sea motorways must be joint network system on sea and shore.

10. The Methodology, which is described in this Feasibility Report, will be used and utilised in the forthcoming activities in WP 3 during the project period. Hereby to evaluate and optimise the ”Measure Handbook for creating a framework for maritime freight corridors and dedicated Motorways to Sea in the Baltic Sea”, “Scenario analysis of the feasible framework conditions and measures for new maritime corridors” and “Political analysis of each of the BSR countries on transport corridors and political recommendations on maritime transport corridor”.

11. Transport corridors, which were studied in the project, are feasible, existing alternatives of the transport corridors, which is linked by sea motorways via different ports, in case of good information support, can optimise the transportation process between East and West Europe on the main PAN European transport corridors.

12. Transport corridors including sea motorways between Gdansk and St.-Petersburg via Helsinki or other ports, same as transport corridor between North part of Germany (Lübeck, Rostock etc.) region and Ventspils or other ports in this regions are feasible and good information support can assist in choosing the best transport corridor in concrete time to minimize waiting time of the transport units and goods.

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8. Annex

ANNEX I

"Analysing the Gdansk- Helsinki (with connection to St. Petersburg) corridor by integrating relevant stakeholders (incl. Spatial planning)"

Transport corridors, including Sea motorways, between Gdansk and Helsinki with connection to St.-Petersburg, as example, was evaluate on basis methodology, which is presented in Feasibility Report. As well as transport corridors between Lübeck and Ventspils evaluation was made on basis same methodology.

For the evaluation ports, prices and other parameters are indicate as follows:

- Gdansk (G); Klaipeda (K); Tallinn (T); Helsinki (H); St.-Petersburg (P); Lubeck (L); Trelleborg (T); Nineshamn (N); Ventspils (V)
- Sea: Price – 0,58 EUR/km; Speed – 18 kn; Safety – 0,00002S;
- Road: Price – 0,81 EUR/km; Speed – 50 km/h; Safety – 0,0001S

Results of the evaluation as examples are presented in table 1 for the transport corridors between Gdansk and Helsinki – St.-Petersburg and in table 2 for the transport corridors between Lubeck and Ventspils.

Table 1. Evaluation of different transport corridors between Gdansk and Helsinki - St.-Petersburg.

Factor	G – H - P	G – K – T – H - P	G – K – P
Price (0,4)	0,71	1	0,83
Time (0,4)	1	0,86	0,67
Safety (0,2)	0,45	1	0,85
Complex	0,774	0,994	0,770

Table 2. Evaluation of different transport corridors between Lübeck and Ventspils.

Factor	L – V	L – T – N – V
Price (0,4)	1	0,59
Time (0,4)	1	0,87
Safety (0,2)	1	0,40
Complex	1,0	0,664

Received complex evaluation show best possible solutions.

ANNEX II

SPATIAL PLANNING IMPACTS

Spatial planning impacts on transport corridors and/or Sea Motorways can use the following methodology:

- Study existing concrete cargo flows and transport corridors, which used for the transportation;
- Study possible alternative transport corridors with sea motorway part;
- Study costs, delivery time, safety factors an possible transport corridors by the methodology, which is described in report;
- Make evaluation of the results;
- Study time schedules of the Ro-Ro ferry ships on the alternative transport corridors;
- Choose best result and link with Ro-Ro ferry ships time schedules;
- Execute planning transportation;
- Monitoring real results;
- Monitoring results include in information system and used for the next planning.

Some examples of spatial planning impact on concrete selected transport corridors – including maritime transport corridors and/or sea motorways – can be found in this Feasibility report.

A more detailed methodology will be included in WP 3´s forthcoming "Measure-Handbook for creating a framework for maritime freight corridors and dedicated Motorways to Sea in the Baltic Sea".

ANNEX III

Pan-European Networks (PAN)