Maritime Transport in the Gulf of Bothnia 2030

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Abstract Scenarios for shipping traffic in the Gulf of Bothnia (GoB) by 2030 are described in order to identify the main factors that should be taken into account when preparing a Maritime Spatial Plan (MSP) for the area. The application of future research methodology to planning of marine areas was also assessed. The methods include applying existing large scale quantitative scenarios for maritime traffic in the GoB and using real-time Delphi in which an expert group discussed different factors contributing to future maritime traffic in the GoB to find out the probability and significance of the factors having an impact on maritime traffic. MSP was tested on transnational scale in the Bothnian Sea area as a pilot project.

Keywords Maritime transport · Future scenarios · The Gulf of Bothnia · Maritime spatial planning · Delphi method

INTRODUCTION

Maritime spatial planning (MSP) is gaining importance as an emergent approach to manage marine areas (Douvere and Ehler 2008; Jay 2010). The pressures in utilizing off-shore areas have grown as new forms of using marine

areas, such as wind parks and aquaculture compete for space with more traditional uses such as fisheries, maritime transportation, and nature conservation (Backer 2011). According to Ehler (2011), MSP is a public process of analyzing and allocating the spatial and temporal distribution of human activities to specific marine areas to achieve ecological, economic, and social goals and objectives that are specified through a political process. The European Union proposed legislation to create a common framework for MSP and integrated coastal management (European Commission 2013).

There is relatively little consensus over how to undertake a MSP process most effectively. It is generally agreed upon that stakeholder participation is important for the success of the process (Pomeroy and Douvere 2008; Fletcher et al. 2013). In the Gulf of Bothnia (GoB), a pilot project Plan Bothnia begun in 2010 and tested MSP between Finland and Sweden (Backer and Frias 2012). The project also tested whether future research methods could be utilized to develop background material for MSP, and at the same time engage stakeholders and experts in the process.

Lack of information is often a major obstacle for planning the sea (e.g., Shaw et al. 2013). However, there is a considerable amount of information available on the past and present situation of the maritime transport. To make a Maritime Spatial Plan, area-specific information on the present day situation as well as on future development is needed. Area-specific future scenarios are often lacking, or the existing large scale scenarios do not give the kind of information that could be readily utilized in MSP projects concentrating on small areas. This study describes the development of scenarios using future research methods for maritime transport in the GoB and discusses their usability in MSP of the area and in general.

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MATERIALS AND METHODS

Research Area Description

Definition of the GoB in this study is based on the HELCOM COMBINE manual (HELCOM 2006). The research area includes the sub-areas Bothnian Bay, Bothnian Sea, and The Quarks. In 2010, around 1.4 million people inhabited the municipalities with direct coastline to the GoB (SVT 2011; SCB 2011).

The GoB coasts are characterized by several small ports rather than large centralized port complexes. There are 14 ports on the Finnish side and 18 ports on the Swedish side. Iron ores and metal waste are the largest export groups in the Finnish ports. In Swedish ports, wood products are the largest commodity group, but iron ores are not far behind. Total international transport in the GoB in 2010 was 54 million ton. Oil transports in the area consisted mainly of imported oil products and no raw oil was transported to the GoB ports (Holma et al. 2011).

Northern Sweden, Finland, Norway, and Russia are rich in mineral resources. Mining activities have a long history in the area, and increases in raw material prices and new technology have made previously nonviable deposits extractable (Lahtinen et al. 2011). In a global context, the quantities mined in Finland and Sweden are relatively small but mines have great importance for the EU that is dependent on imports of metals and has a strategy to strengthen the domestic sources of raw materials (Toimialaportti 2011).

Building Future Scenarios

In order to make future scenarios for maritime transport in GoB in 2030, topics such as the current situation of maritime transports (2010), economic development, development of key industries, and infrastructure in the GoB were studied. Information was gathered from existing studies, plans and strategies, and development of different industries.

Predictions or forecasts for the future are often made using a combination of existing methods (Höjer 2000). For this study, a combination of methodologies was also used, and it could be called a forecasting Delphi study. The Delphi method was developed in 1950–1960 to collect expert judgements on variety of topics and described in detail by Linstone and Turoff (1975).

In phase I future scenarios for cargo volume were constructed by applying existing quantitative scenarios for maritime transport from Baltic Maritime Outlook (2006). As the BMO scenario (2006) was made only until 2020 and we wanted to extend the GoB scenarios until 2030, a few assumptions were made based on the Finnish Maritime Administration (FMA) scenario (Lehto et al. 2006). The

magnitude of modal shift in the GoB about the effects of the MARPOL annex VI regulations was based on ENTEC report (ENTEC 2010) as well as Swedish Maritime Administrations report (Sjöfartsverket 2009) on the same topic. Transit traffic estimations for 2030 were taken from the FMA scenario (Lehto et al. 2006). All these figures were then applied to the GoB context based on the share of GoB ports for all international transports of Finland and Sweden in 2010 (Holma et al. 2011). With these assumptions, we ended up with three scenarios for traffic growth. Similar methods were used to build scenarios for the Gulf of Finland by Kuronen et al. (2008).

- Strong Growth: 60 % growth in maritime transport by 2030 (87 million ton year⁻¹). A modal shift of about 1 million ton occurs. Maximum growth scenario for transit traffic.
- Average growth: 43 % growth in maritime transport by 2030 (78 million ton year⁻¹). A modal shift of about 2 million ton occurs in Sweden.
- Modest growth: 30 % growth in maritime transport by 2030 (70 million ton year⁻¹). A modal shift of about 1 million ton occurs in Sweden. No transit traffic.

For the purposes of this study, it is important to consider also a possibility of much lower growth and decreasing trend of maritime transports. Therefore, a decision was made to make two more scenarios for the second part of this study, by calculating cargo volumes with +10 % (slow growth) and –10 % (decreasing) compared to the situation in 2010. The panelists were asked to assess the probability of these scenarios.

Phase II aimed to identify and assess key factors for development, and assess what kind of spatial developments they could cause in the GoB. The key factors were identified by literature review, phone, and e-mail interviews as well as group discussions in a Plan Bothnia project meeting. The key factors are described in detail in Appendix S1. The probability and significance of these identified key factors were assessed using the real-time Delphi method (RT-Delphi), described by Gordon and Pease (2006). As the future scenarios served as background material for MSP, ensuring stakeholder participation and expert views in evaluating the probability and significance is important (Pomeroy and Douvere 2008). The Delphi method gives the stakeholders an opportunity to express their personal ideas and opinions more freely, as the panel is anonymous.

RT-Delphi differs from the traditional Delphi in number of questionnaire rounds. While the traditional Delphi is done in three or more rounds to reach consensus, RT-Delphi requires only one round. The goal is to develop new ideas concerning future developments but not necessarily reach consensus. The expert group is also somewhat smaller than in traditional Delphi. According to Gordon and Pease

(2006), an RT-Delphi expert group can consist of about 10–15 panelists in contrast to the 20–50 recommended for traditional Delphi. The panelists receive a report of the answers of other participants immediately after answering and they are encouraged to comment and elaborate them.

In this study, of the 19 panelists invited to participate 12 answered and provided comments. The panel consisted of experts from fields of maritime transport/ports, academics, national agencies, and regional agencies, from Finland and Sweden. The local industrial sector was unfortunately not able to participate.

Based on the comments from the RT-Delphi round, a futures table was constructed to serve as a basis for scenario building. Using futures tables for scenario building is described by Seppälä in his book “84 thousand futures” (1984). The idea is to identify the developments that cannot exist simultaneously and construct scenarios that do not contain conflicting elements. The futures table was constructed by making a matrix of the comments received during the RT-Delphi round and marking whether or not the described events and ideas (a) support each other, (b) do not have considerable effect on each other, and (c) cannot coexist at the same time or in the same scenario. The scenarios were then built by following paths in the matrix and finding possible combinations of the events and ideas described by the panelists.

Megatrends

Megatrends are defined as developments that “overarch and impact on everything else.” The Nordic cooperation project Norden has prepared a Megatrends report for the Arctic (Norden 2011) and Boverket has prepared a report: visions for Sweden 2025 that include also four megatrends (Boverket 2012). From the megatrends identified in these reports, those most significant for the maritime traffic in the GoB are discussed here.

Of the megatrends in the Norden report, dependency on transfers and natural resources has possibly the greatest importance in the GoB area. Mining in the Fennoscandian shield is one of the main driving forces for transportation.

Pollution and climate change were seen as megatrends in both reports. They can affect maritime transportation in several ways. First, climate warming may open new opportunities for maritime transport when ice conditions get easier in the GoB and in the Northern Sea route from the North Atlantic to the Pacific Ocean. Opening of this route would create new business opportunities for GoB transportation but improved connections to the northern areas would be needed. Increased accessibility and traffic would create also new environmental risks for the whole Baltic Sea (Laulajainen 2009). Connections to the north and northern railroad projects have been studied previously

(Rautajoki et al. 2003; Corneliussen and Allertsen 2009). Novel environmental regulations will have a major impact on the future of shipping (Kalli et al. 2012, 2013). Renewable energy such as biofuels will have an impact on ship building technology and marine transportation of energy (Bengtsson et al. 2012). Also digitalization that was recognized as a megatrend by Boverket will aid the sustainability and efficiency of shipping industry when utilizing intelligent transport solutions.

Private and public sector interaction is also relevant in GoB maritime transport. It plays a key role in mining activities, as mining companies are private while the public sector is still mainly responsible for infrastructure. Private and public sector interaction also plays a role in port development and in different services for shipping. For example privatization of ports is anticipated, and could make them more rapidly adaptable to a changing business environment. On the other hand, the decisions concerning ports and their development influence large stakeholder groups including local residents whose voice may not be heard as readily if ports are privately owned.

Trends

Raw material price development is one of the most important trends affecting the maritime transport in the GoB. The supply of certain raw materials cannot follow the demand fast enough as launching of mining projects is a slow process.

Unitized cargo is a strong maritime transport trend (Meriläinen et al. 2010). According to the Transbaltic scenarios, the largest growth of maritime transport in the Baltic Sea Region can be expected to be containerized cargo. Directing transport from roads to sea and rail to decrease congestion is also an important trend.

One important trend is the recent growth in the Eastern and Southern economies. This means also a shift of industries from west to east and from north to south. Especially transportation of containers between Europe and Asia has been estimated to grow in the Baltic Sea area (Transbaltic 2010). On the other hand, general shifting of interest toward the Arctic is also a relevant factor in the GoB.

Wild Cards

Possible development of carbon dioxide liquefaction plants can be mentioned as a wild card. This technology is still in a developing phase but it has the possibility to change the future of maritime transport. Transportation of liquefied carbon dioxide would require transportation capacity and specialized vessels. One plant is planned near the port of Kemi and the projected volume for this is about 0.5 million ton year⁻¹ (Viitala 2011). A severe economic crisis is

another possible wild card affecting the future of maritime transport.

Based on trends, megatrends, and wild cards, 18 key factors were identified (Appendix S1 in [Electronic Supplementary Material](#)). They were expressed as theses or multiple choice questions in the RT-Delphi round. The panelists were asked to assess the probability and significance of the factors and provide comments to support their choice as well as mention if the effects concentrated on a specific port or area in GoB. The Delphi round was made with an internet-based open source program developed specifically for conducting Delphi studies.

RESULTS

The panel results indicate that transportation volume is likely to grow but that expectations of magnitude of the growth vary. Of the scenarios presented, the strong growth scenario (+60 %) and the slow growth scenario (+10 %) were considered the most probable. None of the respondents believed that cargo volumes would decrease.

Results for the probability–significance analysis for the 15 theses that were not presented as multiple choice questions are presented in Fig. 1. Ice conditions, mining projects, raw

material prices, and transit traffic were considered the most significant and probable factors for future developments in the GoB. Carbon liquefaction processes were considered the least probable factor in the GoB, most panelists assessing zero probability and zero significance. The significance and probability results do not include some important factors, such as Sulfur Emission Control Area (SECA) effects and raw wood transport. These factors were handled with direct questions rather than probability–significance assessment. Forest industry transport was not considered important although forest industry transport is the main commodity group in the Bothnian Sea. The panel was lacking input from the local industries and as it is the industries that decide which transport option or route to use, their input would have been important. The panelists were asked if they believed that SECA and Nitrogen Emission Control Area (NECA) will have effects on maritime transport. A small majority believed that SECA will have major effects on shipping. However, it was also seen as a business opportunity for several fields of industry offering technology to tackle the sulfur emissions as well as railway transportation.

Not many results were obtained on the spatial implications of the key factors in the panel. The spatial implications are thus mainly based on reviewing literature on existing and planned railway and ports infrastructures, international transport corridors, and depth of fairways leading to ports.

The basic assumptions for all scenarios were:

- Raw materials prices will stay relatively high. Catastrophic wild card events such as economic crises will not occur.
- Mining activities, raw materials prices, ice conditions, and transit traffic are the strongest drivers for development in the area.
- Ice conditions will eventually get easier but the speed of this development varies.
- Centralization of industries and port activities to larger entities is a common trend.

Assumptions for maps are as follows:

- The ports that are a part of the Bothnian corridor or the Mid-Nordic corridor are considered to benefit equally if the corridors are developed.
- The main growth is assumed to be in bulk transport except in the east–west transit scenario where the Mid-Nordic corridor is assumed to handle intermodal unitized cargo.
- The ports that have made recent or planned investments in fairway dredging are considered to benefit.
- The ports where pilot biofuel operations currently exist or are planned are considered to be the most important ports for biofuel developments also in 2030.

Fig. 1 Key factors. Averages from the probability and significance analysis

Strong European industry 2030

Main logic:

- Production moves closer to markets.
- GoB and the Bothnian corridor is an important transport route for Northern mining products.
- The Northern Sea route has not opened for commercial shipping.
- Strong cooperation between Northern countries.

High demand for raw materials and warming make conditions favorable to the Nordic countries and Russia. Sustainability is taken seriously in economic development and industries tend to move closer to markets (Fig. 2).

The Baltic countries and Eastern European countries act as strong drivers for the European economy and the Baltic Sea Region is an area of global importance. The Bothnian corridor and associated investments prove necessary and goods flow to and from the GoB ports belonging to this corridor as secondary links. Russia becoming a member of WTO has improved trade conditions and relations. Finnish–Russian border operations have been made more efficient to handle cargo flows. Transit traffic increases in GoB ports.

Fig. 2 Strong European industry 2030. Railroad network is drawn partly based on data from National Land survey of Finland[©] MML (2011). National Geographic ESRI Basemap (2011)

Of the proposed railway connections in Northern Fennoscandia, the Salla–Kandalaksha connection is built and increases the connectivity between the Nordic countries and Kola area to make it a strong mineral region for European needs. The Northern Sea route has not opened for commercial traffic. The ice conditions are still too unpredictable. The port of Murmansk is strong due to Arctic energy transport and the railway connection foresees great increase in cargo volumes. The ports that are closely linked to the new railroad connection gain benefit.

The ice conditions have become easier in the GoB which increases the reliability of the Bay of Bothnia winter transport. The reliability of transport does not suffice for large scale international container transports and GoB transports mainly bulk.

The Narvik railroad has been improved to ensure flow of Northern minerals to the customers in Europe. Bulk cargo is the most common cargo type in the Bothnian Sea. Forest industries in Sweden have shifted a large part of their transport to the improved Bothnian railways and small private industrial ports have only marginal importance.

New MARPOL VI regulations have had a strong effect on shipping during the timeline 2015–2025, but they have also created possibilities for ship building industry, railroad projects as well as LNG distribution networks. The shipping companies that have overcome the transition phase are going strong by 2030. The renewable energy targets of Finland and Sweden have been more or less reached. Biofuels have global markets and the plants in GoB are viable. The forestry of Finland and Sweden cannot provide raw material for both biofuel industry and traditional forest industries and wood is imported mainly from Russia but also from other countries.

The Bothnia corridor has improved the connections in east–west direction and the Mid-Nordic Green corridor ensures that the cross-Bothnian trade has local importance. However, when it comes to international transport chains between Asia and North America, the Mid-Nordic corridor has not gained considerable importance.

Toward Arctic 2030

Main logic:

- Northern railroad projects have been realized but cooperation between the Northern regions is not successful.
- The Northern Sea route opens for commercial transport.
- MARPOL regulations have had a strong effect on transports in GoB.
- Competition between Russian and Scandinavian ports in the Arctic.

Global interest has shifted strongly toward the Arctic as the Northern Sea route offers great possibilities for world trade. A strong effect on trade patterns comes from European and Russian trading relations which have not improved considerably even though Russia is part of WTO. Lack of trust between the Northern countries has led to Nordic countries trading with each other and competition between Murmansk and Kirkenes ports in the Arctic (Fig. 3).

Of the Northern railroad projects, Salla–Kandalaksha has been built but the route has not been successful as the bottlenecks in Murmansk–South Kola railroad have not been solved and border controls at the Finnish–Russian border are still not efficient enough. Murmansk is a hub for oil and gas, minerals, and timber transports but this does not have a significant effect on the GoB due to high cost of intermodal land transport. Transit traffic in the GoB has reduced considerably.

As most of the customers for raw material trade are in Asia, Nordic mining industries need good connections to the Barents Sea and the Northern Sea route. This has been ensured with building of the Kolari–Svappavaara and

Rovaniemi–Kirkkonen roads as well as improving the Narvik Iron Ore railway to the Norwegian Sea coast.

The effects in the GoB concentrate on the Bay of Bothnia. The Mid-Nordic corridor has not proved successful as a large scale international transport route. Small Bothnian Sea ports have not been able to grow as international hubs due to their remoteness. Investments are made elsewhere. Some trade activity of local importance between Nordic countries exists in the area but cross-Bothnian connections are generally not profitable. Container transports continue in ports that are currently handling unitized cargo. Centralization of industries in the GoB is strong and smaller ports have lost importance. Transport has concentrated in larger ports that are part of the Bothnia Corridor. The Bothnia Corridor serves industries with connections to mainland Europe and modal shift has been strong in Sweden due to MARPOL VI regulations. The ice conditions get easier also in the GoB but this has no considerable effect on cargo volumes.

Mining activities have generally increased their importance in the GoB area but reduction of transport from other industries slows down growth in the area. Russian raw wood transport remains economically nonviable and wood is imported through the GoB ports to satisfy the needs of forest industry and biofuel production.

East–West Transit 2030

Main logic:

- The Northern Sea route does not open for commercial traffic.
- No new northern railroad projects—development of existing routes.
- The Mid-Nordic corridor is an important international transport chain between Atlantic and Asia.

The North Sea route has not opened for commercial traffic as the ice conditions are still not predictable enough. Demand of raw materials has settled to a lower level in Asia and decreased price pressure. Northern railroad projects have not been realized due to profitability issues and the uncertainty concerning the Northern Sea route. Some of the suggested mining projects have been realized and there is north–south transport through the GoB and coastal railroads (Fig. 4).

Environmental damage to remote areas has also been considered too great for new large railroad projects. A decision is made to develop existing connections instead of building new ones.

The Narvik railroad has been improved. The Baltic Proper is severely congested with oil and gas transport. The need for

Fig. 3 Toward arctic 2030. Railroad network is drawn partly based on data from National Land survey of Finland[©] MML (2011). National Geographic ESRI Basemap (2011)

Fig. 4 East–west transit 2030. Railroad network is drawn partly based on data from National Land survey of Finland[©] MML (2011). National Geographic ESRI Basemap

reliable trade connections between Finland, Sweden, Norway, Russia, and Asia makes the Mid-Nordic corridor a good option. East–west direction traffic in the GoB increases greatly. MARPOL regulations do not have a significant effect on shipping in the GoB. Regular Mid-Nordic connections are operated by specialized fleets fulfilling the environmental regulations. Ice conditions have not become significantly easier in the GoB but the high ice class of operating ships makes the need of ice breakers rare. This requires investments in relevant infrastructure such as Mid-Scandinavian, Russian and Finnish railroads, railway connections to Russia, handling of cargo in the international borders, and cargo handling facilities in relevant ports.

The Mid-Nordic corridor offers employment and possibilities for the adjacent regions and communities and improves their connectivity and development as well as economic sustainability. It employs the under-used resources of the Mid-Bothnian ports.

Centralization of industries and port activities is a common trend. Only ports that participate in mining products transport, large centralized forest industry transports, or international corridors have importance. Forestry raw materials are needed to satisfy the needs of biofuels, paper pulp and sawn wood industries, and imports. The container ports in the southern GoB can benefit from increasing container transports in the Baltic Sea.

DISCUSSION

The results obtained from the panel work have implications for planning. As the cargo volumes in the GoB can be expected to grow, according to some of the panelists as much as 60 %, the MSP should prepare for possible new routing measures. The routing measures, such as Traffic Separation Schemes (TSS), Deep Water Routes (DWR), and Areas To Be Avoided (ATBA), to direct shipping in offshore areas are decided in IMO.

Based on the scenarios, it would be recommended to reserve space for a TSS or a DWR in the main route between the North and the South Quark. The width of this kind of area could be similar to the TSS areas in the Gulf of Finland. The question of cross-Bothnian connections is interesting; how to take into account the possibility of an increase in transport in the east–west direction in planning. If large scale future developments in cross-Bothnian transport as suggested in east–west transit scenario would happen, measures comparable to the South Åland sea circular TSS could be taken. Currently, there is no need to point out exact areas for routing measures. The areas around the shipping routes in the offshore GoB are likely to be classified as areas with no particular activities or interests. No fairways exist or are planned within Finnish and Swedish EEZs in the Bothnian Sea. All fairways for commercial ships begin when they enter the territorial waters of the coastal states. The fairways are usually 1–2 nautical miles wide and get narrower toward the coastline. There is no standard width for fairways; their planning is done case by case. In the Bothnian Sea area, the difficult ice conditions must be taken into account when planning fairways. Outside the TSS areas, the ships generally navigate the shortest possible way to the ports. The automatic identification system (AIS) tracks (HELCOM 2012a) show that most of the ships follow the same, mostly straight-line routes to main ports, as if they were navigating on a fairway. This data gives a good basis for MSP, when defining the important areas for maritime transportation (Backer and Frias 2012).

An ATBA status could be applied for some of the ecologically important banks in the area. As reliable data on the ecologically important areas and the effects of shipping on them in the Bothnian Sea accumulates, it should be kept in mind that an ATBA is an underutilized measure in the Baltic Sea with the Particularly Sensitive Sea Area (PSSA) status. On the other hand, there are current development plans for wind power installations for large bank areas especially in Sweden. From the point of view of maritime cargo traffic, this would basically have an effect comparable to an ATBA; shipping routes and wind power installations cannot exist in the same area. From the point of view of the environment, there is a large

Fig. 5 Implications for planning: possible areas for routing measures are the routes that seem to have great importance in the scenarios. Maritime transport areas I are based on the strategic network identified by BTO (2011), planned port investments, and depth of the fairway to ports. Maritime transport areas II are based on AIS tracks and Swedish National interest fairways (from HELCOM Plan Bothnian map service 2012a, b) as well as planned and existing cross-Bothnian connections (2011)

difference, however. In addition to the disturbances during building of the wind power park, there will be also maintenance traffic that will be handled by smaller vessels.

The areas that are important for maritime transport but are not likely to get a legally binding status under IMO should be designated as maritime transport priority areas (Maritime transport areas I and II in Fig. 5). Such areas could be established as recommendations to encourage the ships to navigate in certain areas and ensure that no barriers for shipping will be built in these areas. From the point of view of ecosystem based planning, concentrating the maritime traffic is efficient because the environmental impacts can be restricted to certain areas. Unfortunately, the information on ecologically important areas in the GoB is still insufficient for good planning. However, allowing activities such as offshore wind parks or aquaculture installations that could create obstacles for shipping is not economically or environmentally sound. Longer routes for ships increase the prices for cargo and create a lot of emissions (i.e., CO₂, SO_x, NO_x, and fine particles) to the air (Kalli et al. 2012). Also the safety of shipping should

always be prioritized. Both the required space for shipping and possibilities for building of offshore installations are strongly dependent on future ice conditions in the GoB, as the actual taken routes strongly depend on the ice conditions of the winter (Backer and Frias 2012, p. 44).

The port developments are also important from the point of view of the environment. In most ports, continuous dredging is needed to ensure normal port operations. In addition, ports may have development and construction plans that may require additional dredging and building on shore. There is a tendency to centralize ports to large entities that from the point of view of the environment would mean increased constructions in some ports and less disturbances in others compared to present situation.

Priority areas are not likely to be printed on navigational maps. If the information on the priority areas could be offered as supplementary information with electronic chart systems, good results could be obtained. There are projects aiming to enhance economical route planning of ships. The Mona Lisa (Motorways and Electronic Navigation by Intelligence at sea) project aims to develop the Motorways of the Sea concept in the Baltic Sea and contribute to EU's strategy for the Baltic Sea. Mona Lisa also contributes to development of e-navigation applications and optimized shipping routes to reduce emissions, basically offering the ships a possibility to make the shortest possible route plan. Cooperation with this project and using the information they have gathered from the area would be recommended. For example the depth-surveyed routes could be used as a basis for establishing priority areas for shipping.

CONCLUSIONS

The main value of this study was to serve as a pilot project for using future research methodology for MSP purposes. During the process, it was noticed that there are both great challenges and great possibilities with this sort of research. The methodology has the potential to contribute to the integrated, future-oriented, participatory, adaptive, and area-based nature of MSP and therefore the experiences gained during this study give an incentive to study the possibilities further. More research is needed on testing the RT-Delphi method for providing stakeholder input and a future-oriented point of view to the MSP process. It would be necessary to include the other sectors such as energy and fisheries and their experts in the panels as well.

The transport plans of the northern mining industries should be studied in depth and considered as one entity rather than separate projects, in order to reach a conclusion on the most sensible targets for infrastructure investments and development, from economic, social, and

environmental point of view. The future perspective should be a solid part of MSP, especially when it comes to activities that can evolve rapidly, such as shipping. This should be clearly indicated in MSP policies.

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