



**PUBLICATIONS OF THE HAZARD PROJECT
1:2016**

SEAPORT SAFETY AND SECURITY ISSUES IN THE BALTIC SEA REGION

- Outline and relevant issues of project HAZARD in 2016–2019

Editors:
Lauri Ojala
Mariikka Whiteman
Jarmo Malmsten



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FOREWORD

The HAZARD project aims at mitigating the effects of major accidents and emergencies in major multimodal seaports in the Baltic Sea Region. The 4.3 M€ project is partly funded by the EU's Interreg BSR programme and the project will be executed in spring 2016 – spring 2019.

The partners in the HAZARD project consortium are rescue services, port authorities/operators, universities as knowledge partners and one municipality. The project provides a unique transnational learning platform, where the project partners can evaluate and improve their procedures and practices in emergencies supported by strong knowledge partners.

SEAPORT SAFETY AND SECURITY ISSUES IN THE BALTIC SEA REGION – Outline and relevant issues of project HAZARD in 2016–2019 is the first issue in the series entitled PUBLICATIONS OF THE HAZARD PROJECT.

The first issue includes an overview of the seaports and maritime transportation in the Baltic Sea Region and the introductions of the relevant topics related to the project. The short descriptions provide an outline and give an idea of some of the key inputs by knowledge partners in the HAZARD project dealing with seaport safety and security in the Baltic Sea Region. These abstracts are prepared in the first period of HAZARD, and they reflect many of the anticipated knowledge inputs as described in the project application. The first publication also includes two inputs from authors whose organisations are not directly linked to HAZARD, but they are included here due to their contextual relevance.

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1 PRESENTING THE HAZARD PROJECT

1.1 Description of the Project

HAZARD project aims at mitigating the effects of major accidents and emergencies in major multimodal seaports in the Baltic Sea Region, all handling large volumes of cargo and/or passengers. Ports, terminals and storage facilities are often located close to residential areas, thus potentially exposing a large number of people to the consequences of accidents. The HAZARD project deals with these concerns by bringing together Rescue Services, other authorities, logistics operators and established knowledge partners.

HAZARD enables better preparedness, coordination and communication, more efficient actions to reduce damages and loss of life in emergencies, and handling of post-emergency situations by making a number of improvements. These include harmonization and implementation of safety and security standards and regulations, communication between key actors, the use of risk analysis methods and adoption of new technologies.

Joint live exercises that reflect the concerns of partner seaports are an important part of the project. These will be dealing with, for example, leakage of hazardous materials, fire on a passenger ship at a port, oil spill in port areas as well as explosion of gases or chemicals. HAZARD provides a unique transnational learning platform, where Rescue Services and Seaports can evaluate and improve their procedures and practices in emergencies supported by strong knowledge partners.

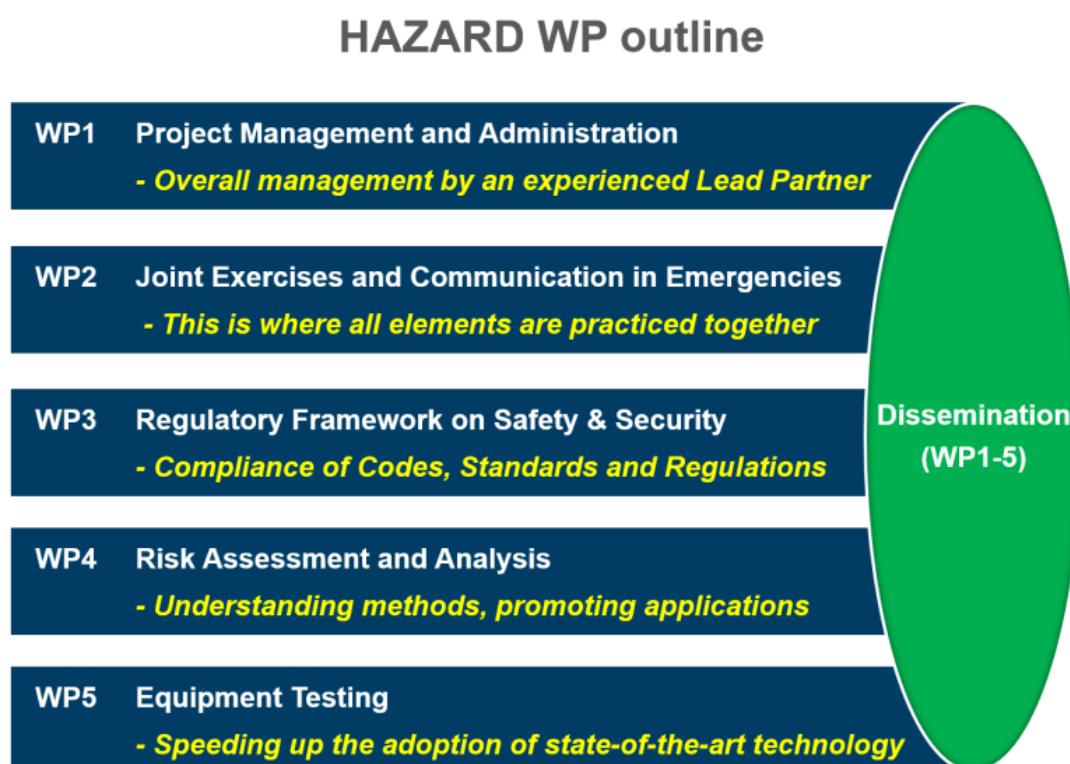
HAZARD has 15 project partners from six countries in the Baltic Sea Region, with University of Turku (FI) as the Lead Partner. The consortium consists of Rescue Services and other authorities, Seaports and analytic and knowledge partners.

HAZARD is executed in Spring 2016- Spring 2019, and it is a Flagship Project in the EU Strategy for the Baltic Sea Region (EUSBSR). The total budget of the project is 4.3 M€, which is partly funded by the EU's Interreg Baltic Sea Region programme (<http://www.interreg-baltic.eu>).

1.2 Work Packages and Activities

The HAZARD project has five different work packages:

Figure1. HAZARD Work Packages



WP1 Project management

The University of Turku is the Lead partner of the project and thus is responsible for the overall project management. The project management includes both the coordination of Activity implementation and administrative and financial management of the project and its accounts.

WP2 Joint exercises and communication in emergencies

WP2 brings all the elements in HAZARD together. The activities in this WP are joint exercises, communication practices in emergencies and short term staff exchange. WP2 leader is the Southwest Finland Emergency Services.

Joint exercises (JE) are executed in all Project Partner regions on relevant themes. The exercises are very concrete rescue, emergency and security exercises, which are planned and executed by the participating seaports and relevant authorities.

Communication between key actors and towards the general public during and after emergencies (or exercises thereof) is an important element of HAZARD. Increased knowledge in the format, channel,

speed and accuracy of information and communication practices are sought after through joint activity and exercises in HAZARD.

A large number of short term staff exchange visits are planned In the course of the project. Staff exchange programme is organized separate from joint exercises, which constitute a separate activity. Instead, the participating staff is engaged for two to maximum five days in the daily work of the host Partner's Organisation. This provides an opportunity to compare the operational methods of the two organisations.

WP3 Regulatory framework on safety & security

The overall aim of the WP 3 is better compliance and implementation of existing and future regulation on safety and security, where progress is monitored throughout the project to verify the improvement achieved. WP leader is the University of Borås.

Much of the work in WP3 includes collecting and analyzing data on the regulatory framework itself, and in particular on the status how these are followed and/or enforced among PP's and beyond.

WP 4 Risk assessment and analysis

The aim of the WP4 is to improve the use of risk analysis and assessment methods. The project helps Project Partners as well as their non-partner peers to better understand and apply risk analysis and assessment methods in mitigating accident risks in seaports and areas adjacent to these. Hamburg University of Technology is the WP4 leader.

Better utilization of suitable risk analysis and assessment methods and procedures help mitigate the adverse effects of major accidents or emergencies, or security concerns that may occur. They are also needed to plan, use and procure the available human, technological and organisational resources better.

WP5 Equipment testing and development

The core of WP5 is to increase awareness of, and improve knowledge about the available state-of-the-art technology. Increased knowledge of state-of-the-art equipment and technology is used to mitigate the adverse effects of major accidents or emergencies, or security concerns that may occur especially in relation to seaports, and in similar industrial plants. WP leader is Fire and Rescue Board of Klaipeda County.

1.3 Project Partners and Associated Organisations

HAZARD has 15 project partners from six countries in the Baltic Sea Region. The consortium consists of Rescue Services and other authorities, Seaports and analytic and knowledge partners.

Figure 2. Project Partners



Partners representing Rescue Services or other authorities:

- Southwest Finland Emergency Services (FI)
- Hamburg Fire and Rescue Service (DE)
- Fire and Rescue Board of Klaipeda County (LT)
- Viimsi Municipality (EE)

Partners representing Seaports:

Port of Turku Ltd (FI)
 Klaipeda State Seaport Authority (LT)
 Port of Naantali Ltd (FI)
 Neste Corporation, Logistics (FI)
 Hamburg Hafen und Logistik AG (DE)

Analytic and Knowledge Partners:

Vilnius Gediminas Technical University (LT)
 Hamburg University of Technology (DE)
 Polis Safety and Reliability Association (PL)
 University of Turku (FI)
 Euroacademy (EE)
 University of Borås (SE)

HAZARD also has 10 associated organisations, which support the project implementation and may take part in activities, but do not receive programme financing. The associated partners are:

FEU (Federation of the European Union Fire Officer Associations)
 CTIF (International Technical Committee for the Prevention and Extinction of Fire)
 Estonian Rescue Board, Northern Rescue Center (EE)
 Swedish Civil Contingencies Agency (SE)
 Fire and Rescue Services Region South (SE)
 Ports of Stockholm (SE)
 Baltic Port Organisation (PL)
 Finnish Transport Safety Agency (FI)
 Finnish Port Association (FI)
 Regional Council of SW Finland (FI)

2 SEAPORTS AND MARITIME TRANSPORT IN THE BALTIC SEA REGION

Lauri Ojala – Turku School of Economics, University of Turku, Finland

Executive summary

Project HAZARD deals with seaport safety and security by bringing together seaports, other logistics operators, rescue services and relevant regional and local authorities and Knowledge Partners in core Trans-European Transport Network (TEN-T) multimodal nodes – essentially Core TEN-T Seaports- in the Baltic Sea Region (BSR).

There are 94 so-called Core TEN-T Seaports in the EU (EC 2016). 24 of these are located in the BSR (incl. German North Sea ports), which handle over 700 million tonnes of cargo and over 50 million passengers. Harbours, terminals and storage facilities incl. those for dangerous goods are often located close to residential areas, thus potentially exposing a large number of people to the consequences of accidents. Against this backdrop, it is useful to take a closer look at the seaport and maritime transport situation in the region.

Demand for maritime transport is derived demand, and changes in the level of economic activity tend to amplify in logistics services, i.e. logistics demand changes more than that of economic activity. Maritime transport activity in the Baltic Sea reflects this phenomenon very well.

Baltic Sea Region ports handled around 830 tonnes of cargo in 2015, which is about the same amount than in 2008, and about 8.4% of the world total in 2015. The BSR maritime and seaport market has been stagnant over past years, whereas maritime transport has globally grown annually by 3 to 4% since 2012.

The overall market outlook is bleak especially for bulk, tanker and container shipping companies. Maritime freights have generally been at low levels since summer 2008. However, this is good news for shippers, but even record low freight levels do not necessarily generate more transport volumes. The outlook in the maritime world in general, and in the Baltic Sea shipping markets in particular, does not show any signs of imminent improvement for ship owners and operators.

The maritime transport sector has recently been and will be subject to substantial regulatory changes with mainly environmental goals. Complying with these generally involves additional costs as various type of emission or other rules become more stringent. This naturally tends to increase transport costs. Perhaps the most widely known of these is the Sulphur Emission Control Area (SECA), which entered into force on January 1, 2015 with much less problems than what was predicted. This is mainly due to the unexpectedly low oil prices, and subsequently low prices of low-sulphur marine gasoil.

Several other regulatory amendments on e.g. nitrogen oxygen emission, ballast water treatment, and energy efficiency of ships are coming during the next years. Complying with these requires arrangements and involves costs, which the cash-strapped shipping companies are not well prepared for. The next few years will not be easy for the Baltic Sea maritime industry, as no imminent economic recovery, and hence higher demand for maritime and other logistics services seems to be in sight for the region as a whole.

2.1 Introduction

Demand for logistics services, such as maritime transport and port services, is always derived demand. This means that the actual performance of shipping and ports measured, for example, in tonnes or tonne-kilometres reflects the level of overall economic development. Furthermore, the impact of changes of economic activity – and especially those of merchandise trade – is typically amplified in logistics services, i.e. logistics demand changes more than that of economic activity. Maritime transport in the Baltic Sea is no exception to this general principle.

Export volume of the Baltic Sea Region (BSR) measured in monetary terms has barely reached the pre-crisis level of 2008, and the volume has, in fact, decreased both in 2012 and 2014 compared to the year before (

Figure 1). The developments in 2015 and early 2016 have shown no overall improvement despite the growing Swedish and German economies. By contrast, the weakening economy in Russia and lower trade volumes with Russia affect BSR maritime transport significantly, especially for transit and transshipment cargoes.

Figure 1. Annual growth of export value 2006-2014 in the world and the Baltic Sea Region¹



Source: Ketels and Pedersen 2015; data source WTO 2015.

As a result, the Baltic Sea Region ports² handled about the same cargo volume in 2015 than in 2008. This volume has been around 830 million tonnes per annum. Overall, the BSR maritime and especially seaport market has been stagnant, but some relative changes have taken place between cargo groups.

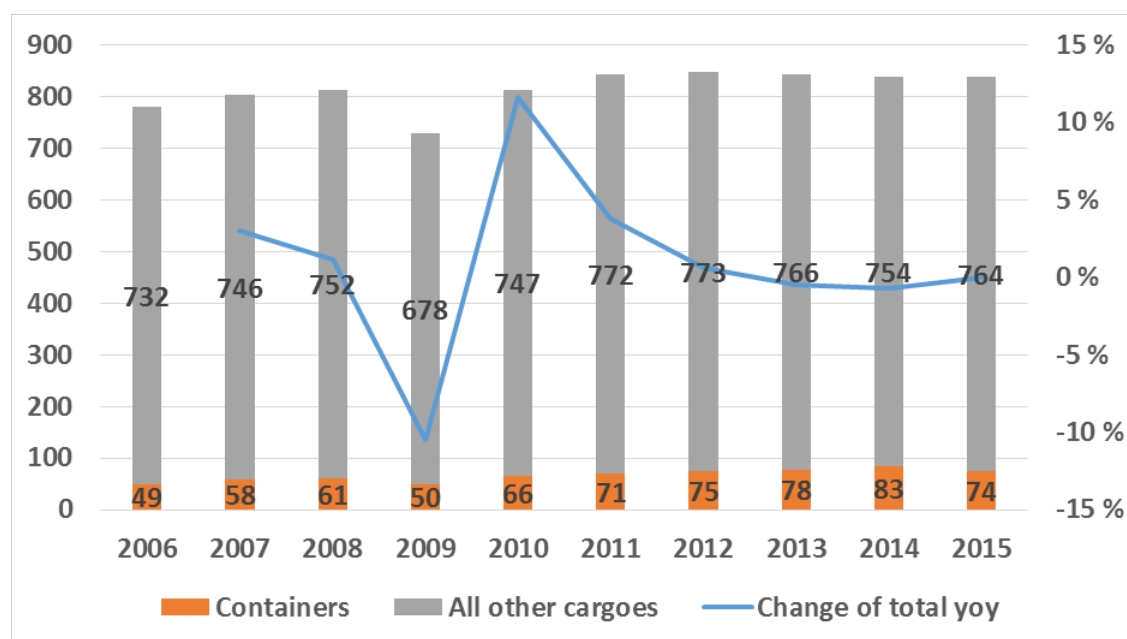
¹ Here, the BSR includes Denmark, Estonia, Finland, Iceland, Latvia, Lithuania, Norway and Sweden as countries, and northern Germany, northern Poland and most parts of Russia's Northwestern Federal District (for a more detailed definition, see Ketels and Pedersen 2015, p. 5)

² The definition used by Matczak includes all seaports within the Baltic Sea and the Swedish ports on the west coast. German or Danish ports on the North Sea side, and all Russian ports outside the Baltic Sea are excluded.

Figure 2. By comparison, the volume of goods transported by sea in the world reached 9,840 million tonnes in 2014 and the global growth rate of maritime transport since 2012 has been around 3 to 4% per annum (UNCTAD 2015).

Using these two values as a proxy, the BSR maritime freight transport comprises about 8.4% of the world total. This is considerably less than the HELCOM estimate from 2009, according to which 15% of global seaborne trade would have taken place in the Baltic Sea. This is not to say that the HELCOM estimate would have been far off³. It rather reflects the fact that the **relative share** of the BSR in trade and also in maritime transport has, in fact, grown smaller. WTO's trade data shows a similar trend: while the BSR's relative share of world exports by value was around 5.2% in 2005-2008, the corresponding share was around 4.5% in 2014 (Ketels and Pedersen 2015).

Figure 2. Market dynamics of seaports in the Baltic Sea 2006-2015 in million tonnes of container and all other cargoes handled (left axis), and annual %-change of total traffic (right axis)



NOTE: Seaborne traffic over all German ports in 2014 was 300 million tonnes (incl. North Sea and inland waterway ports).

Sources: Adapted from Matczak (2016a) and Baltic Sea seaport data. For Germany: EUROSTAT.

³ As indicated by the two previous and somewhat differing definitions of the Baltic Sea (Region), a word of caution is in place, when different statistical sources are compared. Country-level data includes, for example, all of Germany, Poland and Russia, while regionally (dis)aggregated data on BSR may exclude substantial parts of these three countries. Furthermore, statistics on country-level maritime transport may also differ from statistics that are gathered from individual ports for the following reason. Every tonne or cargo unit, such as a container, that is loaded on a ship somewhere (e.g. Port A) will eventually be unloaded somewhere else (e.g. Port B). This means that data of cargo handled in ports is actually counted twice, whereas the cargo is moved from A to B only once. This distinction is not always easy to see in the published statistics.

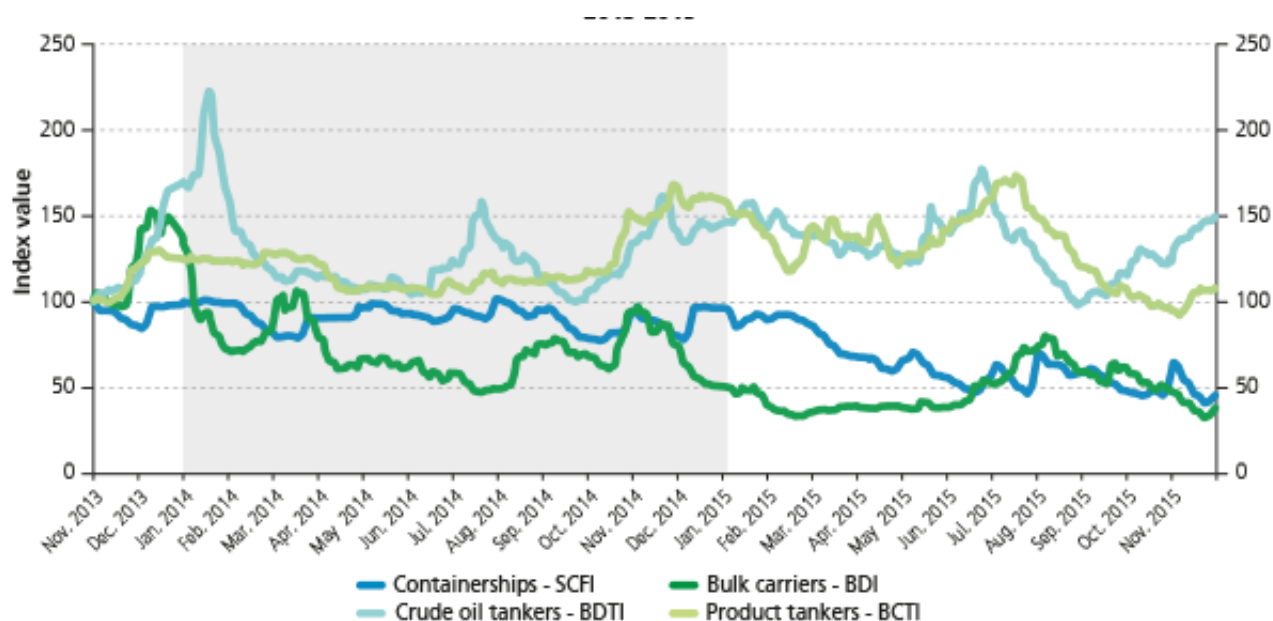
The actual development of maritime traffic in the Baltic Sea is in stark contrast to market estimates made during the past decade. Baltic Maritime Outlook 2006, for example, predicted that intra-regional maritime traffic in the Baltic Sea would grow by +55% from year 2003 to 2020, and the inbound maritime volumes from outside the region would grow by +30%, while outbound volumes would increase by 45% in the same period. The combined increase of these three types of flow was predicted at 630 million tonnes, meaning that the overall volume would have reached 1,100 million tonnes.

Data from 2015 indicates that barely half of that predicted growth has materialised, and the overall volume is at approximately 830 million tonnes. A more modest prediction was made in the Baltic Transport Outlook 2030 study published in 2012, but also it overestimated the growth. On the other hand, many political and economic events and their impact on transport markets are – and have been – extremely difficult to estimate.

The overall bleak market outlook for shipping companies is evident from Figure 3, which provides the indexed development of worldwide maritime freights for bulk, tanker and container shipping. The dire situation is clear, when you consider that these freights have generally been at similarly low levels since summer 2008.

The corresponding freight levels before the worldwide economic downturn in summer 2008 were typically 4 (containers) to 8-10 (dry and liquid bulk) times higher compared to the levels in 2014-2015 (BIMCO 2016; see also UNCTAD 2015a). The persistent overcapacity in most shipping segments and the imbalance of maritime transport demand and supply is the main reason for this situation.

Figure 3. Maritime freight rate developments 2013-2015 for selected types of worldwide shipping; indexed; November 2013 = 100



Source: BIMCO (2016); data sources: BIMCO, Baltic Exchange and Shanghai Shipping Exchange.

What is bad news for shipping companies, is good news for shippers, as low freight levels mean low transport costs. But even these record low freight levels do not necessarily generate more transports. The outlook in the maritime world in general, and in the Baltic Sea shipping markets in particular, does not show any signs of imminent improvement for ship owners and operators.

2.2 Baltic Sea Countries as Maritime Countries and Their Logistics Posture

The Baltic Sea Region countries dependence of shipping and position in the maritime sector varies a lot. By country of ownership⁴, Germany has the world's 4th largest fleet, while Norway ranks 10th and Denmark 13th. By the same measure, Russia is 20th and Sweden 34th, whereas the land-locked Belarus has no merchant marine (UNCTAD 2015a)⁵. Most Baltic Sea countries are also significant providers of a wide range of shipping, maritime industry and shipbuilding services and technology.

The ranking of these countries varies also significantly in other selected shipping, logistics and connectivity indices, which put together provide a useful insight into their differing postures in world trade and logistics.

Table 1. Baltic Sea countries' maritime cargoes handled in ports and merchandise fleet in 2014 in million cargo or deadweight tonnes (DWT), and rankings in selected logistics and connectivity indices

	Goods handled in all ports million tonnes Million DWT LPI Rank in 2014 ¹ in 2014 ¹ 2010-2016 ²			LSCI 2015 rank ³	GCI 2014 rank ⁴
Germany	303.7	127.3	1	6	9
Norway	200.8 ^{a)}	61.5	17	131	15
Denmark	92.2	42.5	16	23	8
Russia	n.a.	23.4	98	33	69
Sweden	166.9	7.2	4	20	10
Poland	68.7	2.8	33	25	43
Finland	105.5	2.1	15	88	25
Latvia	71.8	1.2	40	145	49
Estonia	43.6	0.5	39	123	51
Lithuania	41.1	0.4	35	114	52
Belarus	n.a.	n.a.	114	n.a.	97

⁴ Measured as the fleet's DWT size as of January 1, 2015 (UNCTAD 2015a).

⁵ On March 24, 2016, UNCTAD launched a website that provides a two-page basic "Maritime Country Profile" for almost every country in the world – naturally including all the Baltic Sea countries. This repository can be accessed at: <http://unctadstat.unctad.org/CountryProfile/MaritimeProfile/en-GB/004/index.html>

Sources:

- 1) Eurostat; at: http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=mar_mg_aa_cwhd&lang=en; For Norway incl. loading of oil and gas offshore
- 2) UNCTAD 2014; DWT is a measure of ships' cargo carrying capacity in tonnes. According to the "real nationality", which reflects the nationality of the controlling interest(s) of the ship, not the flag of registration of the ships. The total DWT fleet in "real nationality" terms is about 10 % higher for the BSR countries than the fleet by registry.
- 3) Arvis et al. 2016; Appendix 4; LPI = Logistics Performance Index.
- 4) UNCTAD 2015b; LSCI = Liner Shipping Connectivity Index (covers only container shipping connectivity).
- 5) Ghemawat and Altman 2014; GCI = Global Connectivity Index.

The international comparison in **World Bank's Logistics Performance Index (LPI)** looks at six dimensions that capture the most important aspects of countries trade logistics performance, where each dimension is rated on a 5-point scale (Arvis et al. 2014):

- 1) Customs; efficiency of the customs clearance process.
- 2) Infrastructure; quality of trade and transport-related infrastructure.
- 3) International Shipments; ease of arranging competitively priced shipments.
- 4) Logistics Quality; competence and quality of logistics services.
- 5) Tracking and Tracing; ability to track and trace consignments.
- 6) Timeliness; frequency with which shipments reach the consignee within the scheduled or expected time.

The overall index is based on the six dimensions listed above. The LPI is an overall metric of country level supply chain efficiency. It provides an idea where a country stands and a broad indication of problem areas. As shown in Table 1, the Baltic Sea region countries' trade logistics performance range from the 1st of Germany to 98th of Belarus, and the three Nordic countries Finland, Denmark and Sweden are all among the top 10% of the surveyed 166 countries.

UNCTAD's Liner Shipping Connectivity Index (LSCI) is an indicator of each coastal country's access to the Global container shipping network⁶. The LSCI is generated from five components that capture the deployment of container ships by liner shipping companies to a country's ports of call:

- (a) the number of ships;
- (b) their total container-carrying capacity;
- (c) the number of companies providing services with their own operated ships;
- (d) the number of services provided; and
- (e) the size (in TEUs) of the largest ship deployed.

The LSCI score of a country is not only determined by its trade volume, but increasingly by its position, i.e. its degree of connectivity, within the global liner shipping network. The country with the highest LSCI scores in 2015 is China, followed by Singapore, Hong Kong (China), Korea, Malaysia, and Germany

⁶ UNCTAD 2015a; UNCTAD 2015b and UNCTAD 2015c; the data is available at UNCTADstat at <http://stats.unctad.org/lsci>

(6th). The following four Baltic Sea countries assuming ranks 20 to 33 are Sweden (20th), Denmark (23rd), Poland (25th) and Russia (33rd) (see Table 1).

The LSCI comprises only container shipping data. Thus, countries that rely predominantly on ro-ro shipping (shortsea liner shipping loading trucks and trailers on wheels) typically receive low scores, even when their shipping operations can be quite well developed. Examples of such countries in the Baltic Sea Region are Estonia, Finland and Norway.

A spin-off of the LSCI is the more detailed **Liner Shipping Bilateral Connectivity Index (LSBCI)**, which uses the same underlying container shipping data to study the connectivity of country pairs, hence the name “bilateral”.

Table 2. Liner Shipping Bilateral Connectivity Index 2015 of Baltic Sea countries (LSBCI)

	Estonia	Finland	Germany	Latvia	Lithuania	Norway	Poland	Russia	Sweden
Denmark	0,28	0,30	0,58	0,21	0,27	0,30	0,50	0,36	0,56
Estonia		0,30	0,35	0,27	0,28	0,26	0,28	0,32	0,29
Finland			0,38	0,27	0,28	0,26	0,32	0,36	0,33
Germany				0,31	0,32	0,35	0,59	0,55	0,64
Latvia					0,26	0,20	0,27	0,29	0,28
Lithuania						0,20	0,28	0,31	0,29
Norway							0,23	0,26	0,31
Poland								0,37	0,53
Russia									0,40
Germany's rank	1st	1st	*)	1st	1st	3rd	1st	9th	1st
Colour scale	< 0,3	0,3-0,49	0,5-0,59	> 0,6	*) The highest BSR country Sweden, 20th				

Source: UNCTAD 2015c; Maximum score (tightest possible connection) = 1.0; Minimum score = 0.0.

Despite the absence of ro-ro shipping data, which substantially undermines the scores of e.g. Estonia and Finland, the LSBCI provides a useful insight into how tightly – or loosely – Baltic Sea countries are tied to each other by container shipping. It also underscores Germany's role as the main trading (and container shipping) node in Europe. When considering the intensity of container shipping connections with all countries in the World, Germany ranks first for all other countries in Table 2 except for Norway (Germany ranked 3rd) and Russia (Germany ranked 9th). The tightest connection between any country pair in Table 2 is between Sweden and Germany, whereas container shipping linkages from Lithuania (and understandably from Norway) in the Baltic Sea range tend to be the weakest.

The DHL Global Connectedness Index (GCI) index is composed of a large number of existing globalisation indicators around the world on the movement of goods (trade), people, investments and information. GCI takes a look at the depth of international interactions (of trade, people, investments

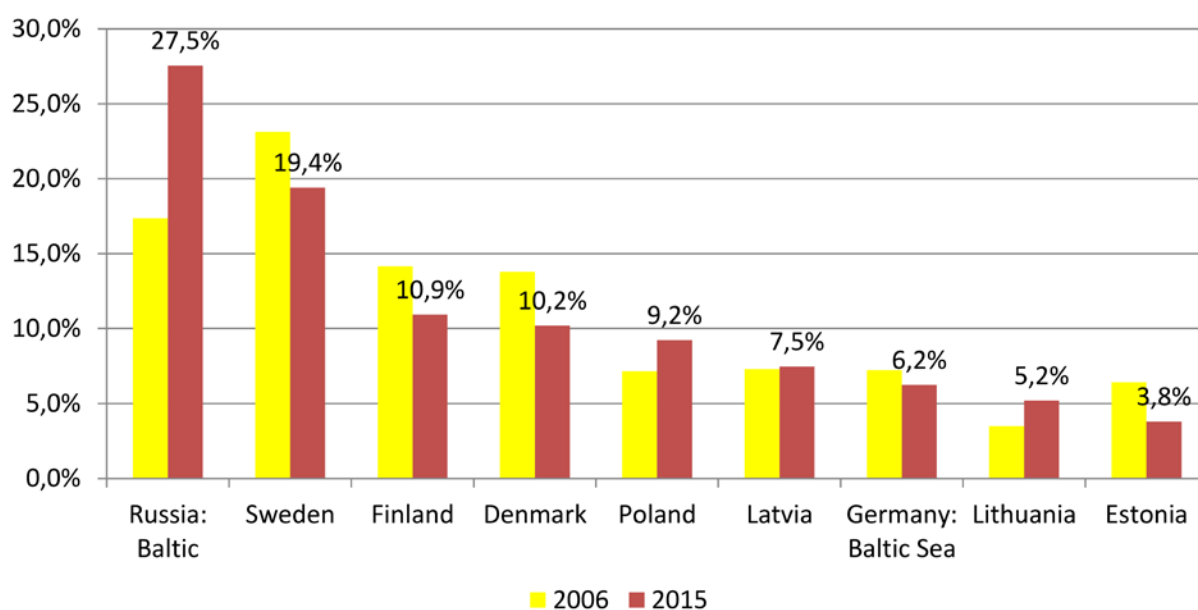
and information), their geographic distribution (breadth) and their directionality (outward versus inward). Depth measures countries' international flows relative to the size of their domestic economies. Breadth measures how closely a country's distribution of international flows across its partner countries matches the global distribution of the same type of flows.

The leading Baltic Sea countries in the overall GCI, which combine depth and breadth measures are Denmark (8th), Germany (9th) and Sweden (10th), while the three lowest ranking ones are Lithuania (52nd), Russia (69th) and Belarus (97th). These correlate rather well with the LPI, for example.

2.3 Baltic Sea ports

Over the past 10 years, the relative market share of Russian ports has grown from about 17 to 27.5% of the total cargo volumes handled in Baltic Sea ports. The only two other countries, which have been able to grow their market share over the same period are Poland and Lithuania (see Figure 4).

Figure 4. Baltic Sea Region seaport market dynamics from 2006 to 2015 in percentage of the total market



Source: Matczak (2016a).

Since 2011, especially the EU seaports in the Baltic Sea (including Swedish west coast ports) have seen their cargo handling volumes diminish by -3 to -2% year-on-year till 2014, with a further decrease of -1% from 2014 to 2015 (see Figure 2 and Figure 4).

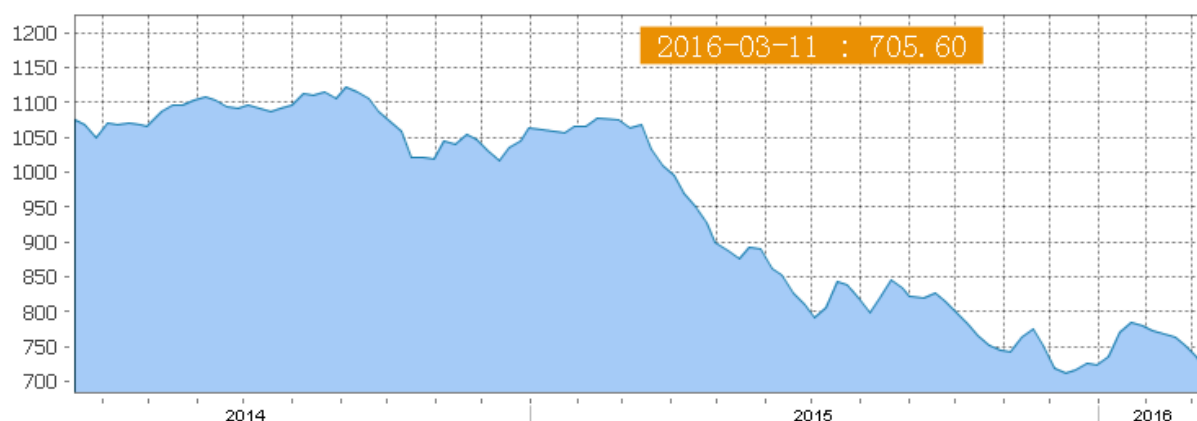
Country-specific differences have been large: for example, Finnish ports witnessed a -7.3% drop in traffic from 81.5 million tonnes in 2014 to 87.9 million tonnes in 2015 (Kauppalehti March 8, 2016). The Polish seaports registered a new record level of turnover of 77 million tonnes in 2015, which was 2.2 million tonnes, or 2.9%, higher than in 2014 (Maczak 2016b). Russian ports in the Baltic Sea have had slight increases at a level of +1 to +3% per annum during the period 2011-2015.

Dynamics at the level of individual ports is naturally even higher. The growth of Russian ports over the past decade, as measured in tonnes, is mainly attributed to the rapidly growing shipments of crude oil and other commodities. Liquid bulk has typically been the cargo type that has been growing in many other Baltic Sea ports, too (see also Baltic Port Barometer 2015). The ports sector is discussed in more detail elsewhere in this report (e.g. Oldakowski 2016)

2.4 Container shipping developments

The worldwide container shipping market is still very volatile and plagued by substantial overcapacity as well as historically low freight rates (Figure 5. *China Containerised Freight Index, March 2014-March 2016. (January 1, 1998 = 1,000)*). However, the number of containers measured in twenty foot equivalent units (TEU) has been growing globally at an annualised pace of about 6% (CAGR) (Figure 5).

Figure 5. *China Containerised Freight Index, March 2014-March 2016. (January 1, 1998 = 1,000)*



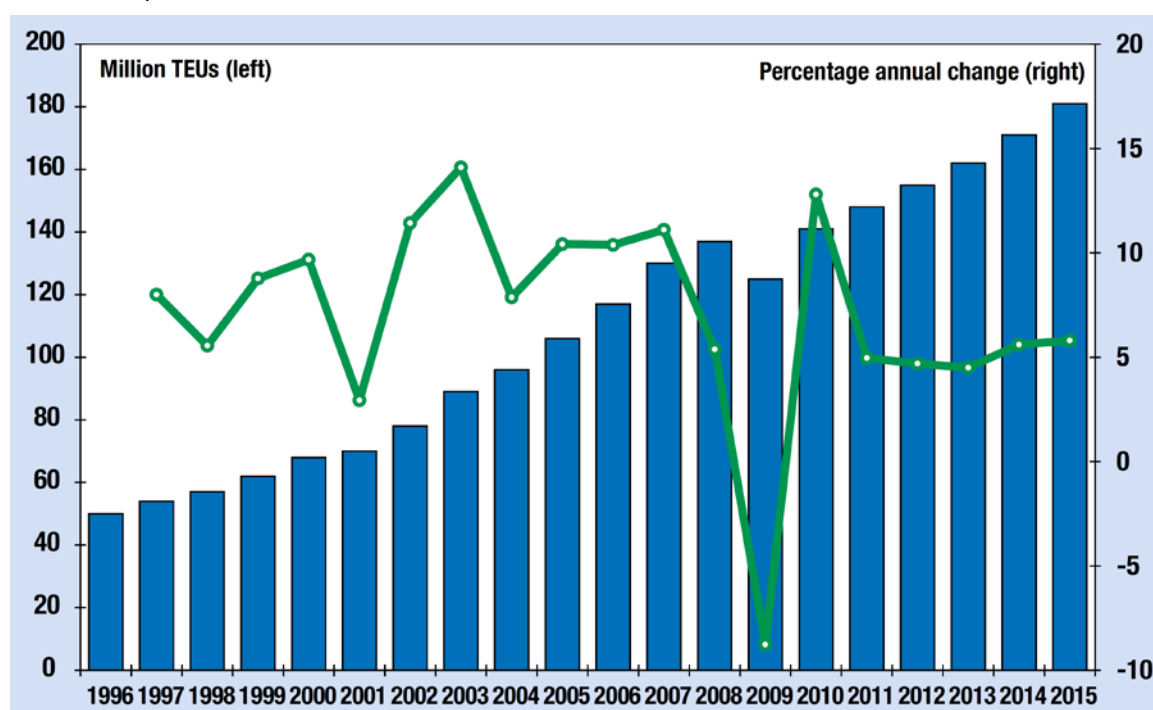
Source: Shanghai Shipping Exchange; available at: <http://en.sse.net.cn/indices/ccfinew.jsp>

In 2014, the volumes on the Asia–Europe and trans-Pacific container trade lanes reversed the downward trend seen since year 2009. Both of these main trade lanes showed robust growth in 2014. However, growth in 2015 and early 2016 has remained vulnerable, however, given continued uncertainties in connection with weaker growth in emerging economies, particularly a potential sharp slowdown in China, as well as concerns about the fragile and uneven recovery in the European Union (UNCTAD 2015a). This affects the Baltic Sea sub-market in a number of ways.

The market dynamics of container shipping in the Baltic Sea is illustrated in Figure 6. It shows that the container sub-market in the Baltic Sea was growing roughly at pace with the worldwide market from 2010 until 2014, but suffered a severe downturn in 2015. The decline is evident in both containerised tonnes and in the volume of TEUs transported by sea.

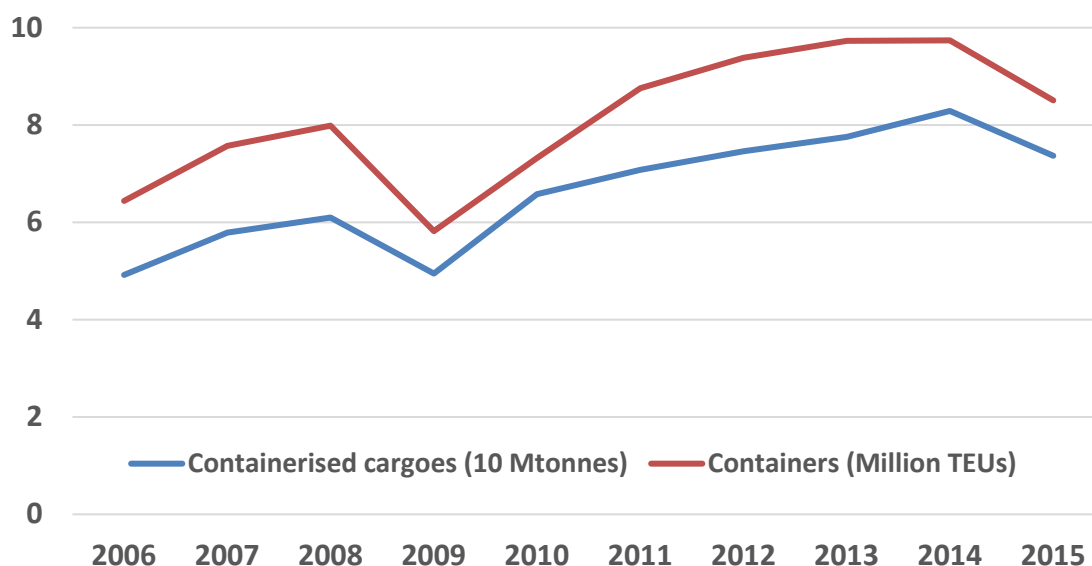
Hence, the Baltic Sea TEU volumes in 2015 were almost 13% lower than in 2014 despite 15 to 20% lower container freight rates compared to year 2014. In addition, there is a substantial imbalance in containerised cargo flows: empty containers account for approximately 25% of traffic.

Figure 5. Global containerised trade, 1996-2015 (million TEUs as bars and percentage annual change as solid line)



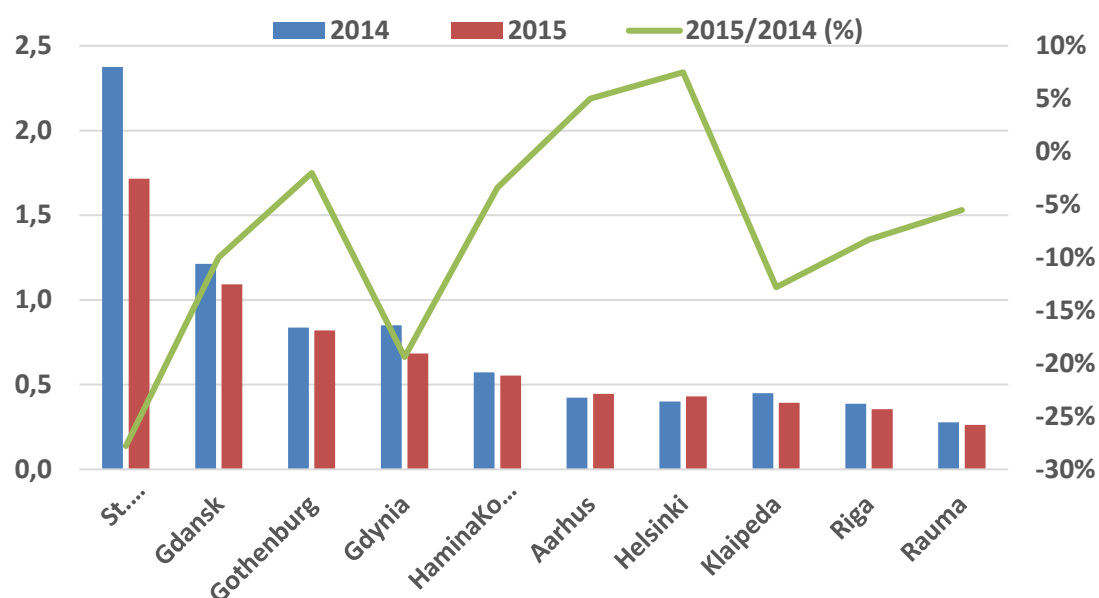
Source: UNCTAD 2015a.

Figure 6. Container volumes in Baltic Sea seaports 2006-2015 in 10 million tonnes of containerised cargo and in millions of TEU handled



Source: Adapted from Matczak (2016).

Figure 7. Top Baltic Sea container ports 2015 in millions of TEU handled (left axis), and the percentage change from 2014 to 2015 (right axis)



NOTE: Total container throughput (of which empty containers in brackets) in 2014 in Hamburg was 9.8 (1.3) million TEU, and in Bremerhaven 8.8 (0.8) million TEU

Sources: Adapted from Baltic Transport Journal 1/2016, p. 33. Data for Hamburg and Bremerhaven: Eurostat 2016

This was caused by a combination of slow economic growth in the region compounded by the rapidly weakening demand of manufactured goods in Russia⁷. This is vividly illustrated in Figure 7, which shows the latest available data of the largest Baltic Sea container ports. The volumes in St. Petersburg, Russia's main container port, dived dramatically by almost 28% from 2014 to 2015. All other container ports also lost traffic, except for the increases in Aarhus (+5%) and Helsinki (+7.5%).

2.5 Key regulatory developments and their impact on Baltic Sea shipping

The maritime transport sector has recently been and will be subject to substantial regulatory changes, that are mainly motivated by environmental reasons. Many of these are seen by shipping companies as complicated, and often difficult to control once enforced. They generally involve additional costs to comply with the more stringent emission or other rules, which tends to increase the pressure to increase transport costs. The main concurrent or near-future regulatory amendments in shipping include, but are not limited to the following:

- **Sulphur Emission Control Area (SECA)**; Amendment to Annex VI of IMO Marpol Convention; sets strict sulphur emission limits to ships at sea. Entered into force January 1, 2015, and covers in Europe all of the Baltic Sea, and most part of the North Sea.
- **MRV**: Rules for the accurate **monitoring, reporting and verification** of carbon dioxide (CO₂) emissions and of other relevant information from ships arriving at, within or departing from ports under the jurisdiction of a Member State, in order to promote the reduction of CO₂ emissions from maritime transport in a cost effective manner⁸. To enter into force in the EU on January 1, 2018.
- **Ballast waters**: International Convention for the Control and Management of Ships' Ballast Water and Sediments (**BWM**) by IMO⁹, which will mandate on disposal of ballast waters of ships.
- **Discharge of cargo hold washing waters**; Bulk cargo hold wash water discharge and cargo declarations under MARPOL Annex V (IMO).
- **Energy Efficiency Index (EEDI)**¹⁰ that limits the engine power of ships, and affect especially ice-strengthened ships needed in ice-infested waters.
- **Nitrogen oxide emission control areas (NECA) by IMO**¹¹; for new ships built after January 1, 2016.

⁷ This data refers to the Baltic Sea ports, but excludes German North Sea ports as well as Russian ports outside the Baltic Sea. If the country-level data were used including these other German and Russian ports, the total container port throughput in these countries was over 30 million TEUs in 2014, according to UNCTAD 2015 a. Thus, the more limited definition shows 3.5 times less cargo than the country-level data.

⁸ REGULATION (EU) 2015/757 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 29 April 2015.

⁹ <http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Control-and-Management-of-Ships'-Ballast-Water-and-Sediments-%28BWM%29.aspx>

¹⁰ <http://www.imo.org/en/MediaCentre/HotTopics/GHG/Pages/default.aspx>

¹¹ <http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Nitrogen-oxides-%28NOx%29-%E2%80%93-Regulation-13.aspx>

- **Weighing of containers in seaports;** IMO SOLAS Convention amendment for the mandatory weighing of all sea-bound containers to be loaded on a vessel. This entered into force on July 1, 2016.

The entry into force of the SECA areas passed without a massive devastating effect on shipping, which the industry was predicting, or fearing to happen. This is mainly due to the unexpectedly low oil prices, and subsequently low prices of low-sulphur marine gasoil (LSMGO; see

Figure 8).

Figure 8. Rotterdam price indications of Low-Sulphur Marine Gas Oil (LSMGO) at Rotterdam from March 2015 until March 2016 in US dollars per metric tonne



LSMGO (Low-Sulphur Marine Gas Oil) is Max **0.10% Sulphur** Distillate Complying with 2015 ECA Regulations

Source: Ship & Bunker at <http://shipandbunker.com/prices/emea/nwe/nl-rtm-rotterdam#LSMGO>

Approximately 1,500 ships are exclusively in traffic within the Baltic Sea, which are directly affected by the SECA regulation (Rozmarynowska-Mrozek 2016). Also ships occasionally in these waters are subject to the SECA regulation; Gritschenko (2016) cites that during 2014, 8,570 merchant vessels could be identified trafficking in the Baltic Sea.

On the other hand, some ship owners – especially those operating ro-ro ships and ferries – have installed so-called scrubbers on their ships; approximately 73 such ships existed at the end of 2015 in the EU SECA area (Rozmarynowska-Mrozek 2016). Scrubbers allow ships to use marine fuel oils with much higher level of sulphur than the 0.1% level allowed in the SECA region. These retrofitted scrubbers are large pieces of equipment, which cost several million US dollars per ship, and it is not certain that the currently low freight levels will allow these investments costs to be recovered.

The other listed regulatory amendments are coming into force mainly in 2016-2018, which means that several such changes are expected in a relatively limited period of time. Complying with these requires series of arrangements, such as extraordinary dockings or instalments, and involves costs, which the cash-strapped shipping companies are not well prepared for. The next few years will not be easy for the Baltic Sea shipping industry.

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3 OUTLINE OF SELECTED KNOWLEDGE PARTNERS' INPUT IN PROJECT HAZARD

The subsequent short descriptions provide an outline and give an idea of some of the key inputs by Knowledge Partners in Project HAZARD dealing with seaport safety and security in the Baltic Sea Region. The project lifetime is March 2016 till spring 2019.

These abstracts are prepared in spring 2016 at a very early stage of the first period of HAZARD, and they reflect many of the anticipated knowledge inputs as described in the project application.

The project application was formally accepted by BSR Interreg Programme in August 2016 after some technical amendments to the application.

The abstracts also include two inputs from authors whose organisations are not directly linked to HAZARD, but they are included here due to their contextual relevance. These are the texts by Ms. Eva Branten and Prof. Alari Purju from Tallinn Technical University on port investments issues and by Commodore (ret.) Bo Österlund affiliated to the Finnish National Defence University on security of seaborne supply issues.

3.1 Ojala and Malmsten: PROJECT HAZARD – THE LOGICAL FRAMEWORK

Lauri Ojala*
Jarmo Malmsten**

*) University of Turku, Turku School of Economics, Department of Marketing and International Business, 20014, Turku, Finland, <https://blogit.utu.fi/hazard>, E-mail: lauri.ojala@utu.fi, Tel: +358 50 502 7031

**) University of Turku, Turku School of Economics, Department of Marketing and International Business, 20014, Turku, Finland, E-mail: jarmo.malmsten@utu.fi, Tel: +358 50 409 1493

Purpose

The HAZARD project aims at mitigating the effects of emergencies in major seaports in the Baltic Sea Region (BSR).

Design/methodology/approach

HAZARD is a regional cooperation project which deals with safety and security issues by bringing together rescue services, other authorities, logistics operators and established knowledge partners.

Findings

The status quo in the target field is that stakeholders, such as Rescue Services and seaport actors, have identified a need to further develop cross-border cooperation regarding the safety and security issues.

Research limitations/implications

The project is a regional and cross-sectoral cooperation project, which limits the scope of research activities.

Practical implications

HAZARD helps seaports and Rescue Services to i) better mitigate accidents and emergencies; ii) comply more efficiently regulation; iii) cope with accidents and emergencies iv) manage communication; v) better understand and apply risk assessment methods and iv) increase the use of state-of-the-art technologies.

Social implications

HAZARD contributes to the Policy Area Secure of the Action Plan to the EU Strategy for the BSR. The core issue for this priority area is civil protection cooperation in a macro-regional context where countries are linked to each other. The project will contribute to achieving the objectives of the strategy by improving cross-border and cross-sectoral cooperation in civil protection.

Original/value

An effective sharing of experiences across all themes in the project ensures that HAZARD reaches its results in a transnational setting.

Keywords: Baltic Sea Region, TEN-T ports, Rescue Services, safety and security, HAZARD project, risk assessment

3.1.1 Project HAZARD and its Knowledge Partners

HAZARD project aims at mitigating the effects of major accidents and emergencies in major multimodal seaports in the Baltic Sea Region. Ports, terminals and storage facilities are often located close to residential areas, thus potentially exposing a large number of people to the consequences of accidents. The 4.3 M€ project will be executed in Spring 2016 – Spring 2019.

HAZARD brings together Rescue Services, other authorities, logistics operators and established knowledge partners, and provides a unique transnational learning platform, where Partners can evaluate and improve their procedures and practices in emergencies supported by strong knowledge partners.

The knowledge partners in HAZARD (i) provide knowledge support the seaports and rescue services to improve their performance; (ii) enhance the use of analytical work on e.g. risk assessment methods; (iii) support joint exercises¹²; and (iv) provide overall analysis and reporting work for the project.

HAZARD knowledge partners are 1) University of Turku (FI)¹³; 2) Hamburg University of Technology (DE); 3) Vilnius Gedimino Technical University (LT); 4) Euroacademy (EE); 5) University of Borås (SE); and 6) Polish Safety and Reliability Association (PL).

3.1.2 Regulatory Framework on Safety and Security

Core TEN-T seaports are essential nodes for seamless passenger and cargo transports in the EU. Their ability to provide well-functioning traffic services also in case of major accidents and/or emergencies is important for the people and businesses.

The body safety & security regulation in ports is comprehensive and complicated. Much of it is multilateral (e.g. UN or EC based), but there is large variation on national level enforcement of and national/local level additions to this regulatory framework. HAZARD aims at better compliance and implementation of existing and future regulation on safety and security, where progress is monitored to verify the achieved improvements.

3.1.3 Risk Assessment and Analysis in HAZARD

HAZARD helps Project Partners and their peers to better understand and apply risk analysis and assessment methods in mitigating accident risks in seaports and areas adjacent to these.

In addition to mitigating the effects of emergencies to people and the environment, risk analysis in ports is important for ensuring reliability, supply chain resilience, and transport safety & security in logistics both for commercial actors and relevant Competent Authorities.

Within the framework of HAZARD it is possible to make better use of risk analysis and assessment methods. Steps to be taken in order to develop the main output:

Determine target group-specific requirements for the application of risk methods;

Evaluate theoretical approaches for their suitability in the present context;

Use of requirements and theoretical foundation to develop a guideline to improve the use of risk analysis and assessment methods; and

Validation of guideline with selected representatives of the target group

¹² Over 12 large joint exercises dealing with, for example, leakage of hazardous materials, fire on a passenger ship at a port, oil spill in port areas as well as explosion of gases or chemicals.

¹³ The two-round Delphi study on Communication needs in emergencies; see Laakso and Ahokas (2016).

Table 1 The role of the knowledge partners in HAZARD.

Project objectives in HAZARD	Activities in HAZARD	The role of knowledge partners in HAZARD
<p>HAZARD helps major seaports, Rescue Services and related Competent Authorities to</p> <p>1) better mitigate accidents and emergencies in seaports and areas adjacent to these;</p> <p>2) manage communication in emergencies between key actors, and towards the general public; and</p> <p>3) enforce current and future safety & security regulation/ comply with them more efficiently.</p>	Organizing Emergency Exercises in Seaports.	<p>Knowledge partners support with suitable risk analysis and assessment methods, and they provide the background information needed to target the joint exercises.</p> <p>Knowledge partners are essential in analyzing the results and experiences gained through joint exercises.</p>
	Communication Practices in Emergencies.	The Delphi study will be conducted during Autumn 2016–Spring 2017. It creates an overall picture of the communicational and regulatory challenges among Project Partners and beyond.
	Regulatory Framework on Seaport Safety & Security	<p>Collecting and analyzing data on the regulatory framework; a comprehensive structure of the relevant regulatory.</p> <p>Identifying how these are followed and/or enforced among Project Partners and beyond; an empirical investigation as to how well the stakeholders are a) following the changes in the relevant regulatory frameworks; and b) to identify and analyse the challenges to comply with the current regulatory framework in their operations.</p>
	Compliance with Safety & Security Regulation	<p>Dissemination of the findings and verification of how to deal with upcoming changes in the regulatory framework is done in close cooperation with other Project Partners.</p>
<p>HAZARD helps project partners to:</p> <p>1) better understand and apply risk analysis and assessment methods in mitigating accident risks in seaports and areas adjacent to these;</p> <p>2) increase use of state-of-the-art technologies and accelerated adoption of these.</p>	Risk Assessment Methods & Models	Collecting and analyzing data on the risk analysis and assessment methods especially applied to the issues related to seaport safety and security.
	The Use of Risk Assessment Methods	Identifying how risk assessment/analysis methods are used among project partners and beyond.
	Rescue Service Equipment	<p>Knowledge partners will have a supporting role in the equipment testing.</p> <p>They provide input to help HAZARD Rescue Service and seaport partners assess and disseminate the findings including some verification and reporting activities.</p>
	Seaport safety & security equipment and IT systems	The knowledge partners are important in increasing and sharing knowledge of available technologies and equipment to improve safety and security levels among all Project Partners.

3.2 Ekwall: SUPPLY CHAIN RISK MANAGEMENT – IT’S ALL ABOUT CAPACITY

Daniel Ekwall*

*) Faculty of Textiles, Engineering and Business, University of Borås, 501 90 Borås, Sweden. Supply Chain Management and Corporate Geography, Hanken School of Economics, 00101 Helsinki, Finland, E-mail: daniel.ekwall@hb.se, Tel: +46 33 435 46 57

Purpose of this paper

This paper examines supply chain risk management (SCRM) from a systems perspective by considering the main risk reduction strategies for supply chains suggested in literature. The strategies will be linked to the traditional supply chain management (SCM) problems of effectiveness, efficiency and capacity. The purpose of this paper is to identify if SCRM addresses the same problem of effectiveness, efficiency and capacity, but expressed and utilized in new way.

Design/methodology/approach

The research is based on a system approach, which emphasizes a holistic view instead of the characteristics of the different parts. This research is mainly conceptual, based on a literature review of relevant SCRM-papers in SCM journals.

Findings

Traditional SCM focus more on efficiency (do things right/upstream attention) than on effectiveness (do the right things/downstream attention). The same perspective is found in SCRM strategies. Thus, the main concern in SCRM is linked to capacity problems either as a shortage, potentially lost sales, or a surplus creating high inventory.

Research limitations/implications

This research is primarily based on scientific literature sources, which limits the generalisation possibilities for the finding.

Practical implications

Increase the understanding of how SCRM strategies can be applied to classical SCM problems as well as how the two areas can be combined to target common problems for companies today.

What is original/value of paper

The holistic perspective on SCRM in this paper linked to traditional SCM problems brings clarity to the SCRM area as it identifies what is truly new and what is just “emperors new clothes”.

Keywords: Supply chain risk management, Supply chain management, Capacity, Retrospective analysis, Business strategy, Hazard project

3.2.1 Introduction

The foundation of trade is the ability to move or transport a product from the source to the customer and still make a profit (Landes, 1998). The foundation of businesses can be described with the two fundamental major problems - finding or creating demand and how to supply it. Supply and demand are two sides of the same coin in business; by controlling either supply or demand, one organisation can increase its ability to affect the price of a certain commodity within a certain geographical area (Mankiw, 1997). Normally the supply side is considered easier to control than demand. The supply side can be described as the question of how to produce or acquire parts for the complete product.

In their proposal for a comprehensive risk management and mitigation model for global supply chains, Manuj and Mentzer (2008a) argue that the risk of any particular type of loss should be conceptualized as the probability of the loss multiplied by the impact of the loss. Similar definitions of risk can be found in much of the contemporary supply chain risk management (SCRM) research (e.g., Khan and Burnes, 2007; Norrman and Jansson, 2004; Tummala and Schoenherr, 2011; Wagner and Bode, 2008). Thus, according to this view, risk should be seen as the combination of probability or frequency of occurrence of a certain hazard and the value or impact of its occurrence. In SCRM practice, however, the distinction between probability and impact is usually overlooked, as risks are often measured or discussed on the aggregate level.

3.2.2 Background

Gihson et al. (2005) defines supply chain management (SCM) as *“the planning and management of all activities involved in sourcing and procurement, conversion, and all Logistics Management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, Supply Chain Management integrates supply and demand management within and across companies.”* The different building blocks integrated in a supply chain can be located throughout the world and connected through a transport network. The transport network only physically integrates the supply chain with the fulfillment of its transport demands (Bowersox et al., 2002). Current economic trends suggest the necessity of specialization rather than vertical integration (e.g., economies of scale). This trend forces large organizations to rely on partners, suppliers, consultants, and other types of external firms to deliver customer value to their marketplaces. Different risks are attached to all these SCM activities; one of these is the risk of products being stolen during transport, primarily during road transport. According to Souter (2000), companies should focus on risks from links in their supply chain, rather than just their own risks. Sharing both risks and rewards among the members of the supply chain is a key component of SCM (Lambert and Cooper, 2000; Mentzer et al., 2001). This reinforces the need to both understand and manage risks from a supply chain perspective to reduce ripple effects of all magnitudes. The usage of risk management tools and processes within the scope of logistics and SCM is described by Norrman and Lindroth (2002) as follows: *“Supply chain risk management is to [collaborate] with partners in a supply chain applying risk management process tools to deal with risks and uncertainties caused by, or impacting on, logistics related activities or resources.”* This description

stresses the need for interdisciplinary research, as risk management practice is included in SCM (Sanders and Wagner, 2011).

According to Colicchia and Strozzi (2012), current research in SCRM has received increasing interest from both the practitioners' perspective and as a research area. This area is relatively new and began with research on risks and purchase (Khan and Burnes, 2007). The current research in this area is based, both in the literature and in practice, on a wide consensus that it is critical to manage risks within supply chain capability (Colicchia and Strozzi, 2012). Studies of supply chain risk seldom address the causes of risk (Christopher and Lee, 2004, Christopher and Peck 2004; Cousins et al., 2004; Juttner, 2005; Sheffi, 2001); they simply mention sources of risk without discussing causes such as theft, smuggling, sabotage, and criminal activity other than terrorism. Notwithstanding the reasons for excluding criminal activity (except terrorism) from general threats against the supply chain, crime exists and needs to be understood. The research has focused mainly on identifying research gaps (Khan and Burnes, 2007; Manuj and Mentzer, 2008b; Tang, 2006) and thereby pointing out future research directions for SCRM. Some authors have focused on strategies related to SCRM (Chopra and Sodhi, 2004; Huchzermeier and Cohen, 1996; Juttner and Maklan, 2011; Tang, 2006; Wieland and Wallenburg, 2012), whereas others have classified risk according to relative supply chain position (Christopher and Peck, 2004; Svensson, 2002, Zsidisin et al., 2000) or risk type (Barry 2004; Chapman et al., 2002, Juttner, 2005, Sheffi, 2001). Furthermore, some authors have focused on the effects of a played-out risk, mainly disruptions in the material flow (Craighead et al., 2007; Giunipero and Eltantawy, 2004; Kern et al., 2012).

3.2.3 Research Purpose

This paper examines supply chain risk management (SCRM) from a systems perspective by considering the main risk reduction strategies for supply chains suggested in literature. The purpose of this paper is to identify if SCRM addresses the same problem of effectiveness, efficiency and capacity, but expressed and utilized in new way.

3.2.4 Risk and Uncertainty

Scientific study of the term risk began in the seventeenth century and was/is associated with probability theory and gambling (Frosdick, 1997). The concept of risk combines the probability and consequence of a certain event (Hubbard, 2008). Risk and uncertainty are often seen as synonymous (Helliard et al., 2001), but risk can also be seen as the consequence of uncertainty (Lalwani et al., 2006). According to Waters (2007), the key difference between risk and uncertainty is that risk has some quantifiable measure for future events and uncertainty does not. Therefore, risks can be defined as quantifiable uncertainties. The definition of risk evolves over time, and the meaning changes depending on an individual's perception of the world (Frosdick, 1997). Therefore, risk can be said to hold both the possibility of loss and the hope of gain (Moore, 1983). Moore (1983) marks the importance of context in the perception of risk, stating, *"when terms like high risk or low risk are used, the meaning commonly depends on the starting asset base and the consequences that the occurrence*

of the risk would have for the asset base of the individual or organisation concerned." Mitchell (1999) takes a similar standpoint: *"Risk is, therefore, defined as a subjectively-determined expectation of loss; the greater the probability of this loss, the greater the risk thought to exist for an individual."* Both authors stress the perception of risk in relationship to its surroundings as the key to understanding the meaning of the term risk. Furthermore, it is possible to state that both authors are supporting the common understanding that risk is the combination of possibility and negative impact. This paper follows this understanding and utilizes cargo theft statistics to demonstrate how this works with real-life data about an unwanted effect.

The importance of global SCRM from both academic and practitioner points of view suggests that SCRM needs to be a top priority (Manuj and Mentzer, 2008b). As a risk matrix is commonly used to evaluate the relative riskiness of different identified risks (Frosdick, 1997, Manuj and Mentzer, 2008b), we translate the yearly quantified risk (possibility \times negative impact) based on cargo theft statistics into a risk matrix setup. This type of risk assessment is how practitioners address and compare different risks. The different risks presented in this paper are classified on a risk scale of one to four (one means low and four means high) for both the possibility (incident frequency) of occurrence and the impact of the risks. The combined possibility and impact factors are then the *de facto* quantified risk value for each combined incident category and location type. The result from this step is that all identified risks can have a quantified risk value between 1 and 16, where a risk value of 16 (4×4) means both high possibility (incident frequency) and high impact (cost/value) for the focal organization. The relative riskiness makes it possible to identify which risks must be addressed and which risks to live with (accept). Normally higher impact is more serious than higher possibility (Aggarwal and Bohinc, 2012; Bernstein, 1996). The outcome from a risk matrix gives the priority list for risk management activities, as the highest quantified risk is also the most critical to address. In this paper, the impact from a cargo theft incident is simplified as the value of the stolen products; in real life, indirect costs would also be included in the impact side of risk

3.3 Kersten and Indorf: RISK MANAGEMENT IN SEAPORTS – CURRENT STATE OF INTERREG PROJECT “HAZARD”

Wolfgang Kersten*

Marius Indorf**

*) Hamburg University of Technology, Institute of Business Logistics and General Management, 21073, Hamburg, Germany, E-mail: logu@tuhh.de, Tel: +49 40 42878-3525

**) Hamburg University of Technology, Institute of Business Logistics and General Management, 21073, Hamburg, Germany, E-mail: marius.indorf@tuhh.de, Tel: +49 40 42878-4383

3.3.1 Purpose

Sea transportation is of major significance for the European economy. Today, over 31% of the transport volume is forwarded by sea which makes it after road transport (approx. 49%) the second most important mode (Statista, 2013). Due to its geographical particularities, shipping of cargo and passengers especially for the Baltic Sea Region (BSR) is of high economical and ecological relevance. For many neighbouring countries of the Baltic Sea, sea transportation presents a vital channel for import and export of various economic commodities and therefore marks the economic base. In this logistic network, ports are essential as they ensure a fast and smooth transport operation, in particular in the modal shift of goods and people.

In this context, the purpose of this abstract is to outline the current state of activities in the project “HAZARD”. The project is co-funded by the Interreg Baltic Sea Region Programme and addresses the issue of sustainable transport with the specific objective of increasing the interoperability of transport modes. Therefore, HAZARD aims at mitigating emergencies in major seaports and at improving related safety and security preparedness in the BSR. The partners in the project consortium are rescue services, port authorities/operators, universities as knowledge partners and one municipality. As a result, the project combines all relevant stakeholders of safe and secure transport in port and sea shore areas.

In particular, our abstracts focuses on work package 4 “Risk Assessment and Analysis” (WP4) of the project. This work package helps the project partners as well as their non-partner peers to better understand and apply risk analysis and assessment methods in order to mitigate risks in seaports and areas adjacent to these. Risk analysis in ports is important for ensuring reliability, supply chain resilience, and transport safety and security in logistics operations. As a result, proper activities in this field provide the bases for a stable economic environment.

3.3.2 Design/Methodology/Approach

A supply chain is best described as a group of independent companies that are interconnected through flows of goods, information and cash in either up- or downstream processes (Mentzer et al., 2001). An

important element of managing supply chains is the concept of supply chain risk management (SCRM). It is dedicated to identifying possible risk sources and to determining proper mitigation strategies. For this purpose, a systematic risk management relies on a process that is divided into five steps: identification, analysis, assessment, handling and control.

In the first step (identification), potential risks within the company and its supply chain are identified. The results obtained are then compiled in risk portfolios for each company. In the second step (analysis), all risks on company level are aggregated and assessed in a qualitative manner. Thus, a first estimation in view of different priorities of risks is created. In the third step (assessment), a quantitative evaluation in terms of probability and extent of damage is performed giving a sufficiently detailed picture of the current situation. In case an intervention is required, suitable strategies and tools are selected and applied in the fourth step (handling). Then, in the fifth step (control), a successful mitigation is examined and potential risk changes are monitored. The SCRM process is executed iteratively and thereby provides the basis for a successful risk management in supply chains (Kersten, 2008).

To apply methods and tools of SCRM in seaports the following steps are planned:

- Identification of risks in “port systems” considering the specifics of the BSR,
- Literature research (e.g. database and review of accidents),
- Case study research in different ports (Interviews and workshops with rescue services and port authorities/operators),
- Identification of the current status of risk management in port systems,
- Literature research (e.g. standards, methodologies, tools),
- Case study research in different ports (Interviews and workshops with rescue services and port authorities/operators),
- Development of a comprehensive framework for risk management in seaports contributing to an improved coordination of risk management activities.

3.3.3 Findings

We will report on the findings as they are achieved. As a result of our literature and empirical analysis, we hope to gain in depth insights in regional and trans-regional risk management activities of the respective actors in BSR seaports. By this approach, we strive to disclose any deficits and to develop an integrated approach to overcome these.

3.3.4 Practical Implications

At the end of the HAZARD project, proposals for improved risk management procedures in seaports in the BSR will be provided.

3.3.5 Social Implications

As a result, safety and security in seaports in the BSR can be enhanced and disruption risks for supply chains will be reduced.

3.3.6 Originality / Value

As an innovative measure, our approach combines the theoretical application of (supply chain) risk management methods and tools with empirical data from case studies of seaports. In order to obtain a comprehensive picture of the field, we focus on different ports in the BSR and strive to develop an integrated framework. We build our work on previous Interreg projects such as DAGOB and CASH.

Keywords: Risk management, seaports, case study research, Baltic sea region, framework.

3.4 Laakso and Ahokas: DELPHI METHOD APPLICATION – MITIGATING THE IMPACTS OF EMERGENCIES IN BALTIC SEA REGION

Kimmo Laakso*

Ira Ahokas**

*) University of Turku, Turku School of Economics, Pori Unit, FI-28101, Pori, Finland, E-mail: kimmo.laakso@utu.fi, Tel: +358 40 708 7987

**) University of Turku, Turku School of Economics, Finland Futures Research Centre, FI-20014, Turku, Finland, E-mail: ira.ahokas@utu.fi, Tel: +358 3339527

Abstract

Seaports are essential nodes for seamless passenger and cargo transport in the Baltic Sea Region (BSR) and across the EU. Thus their ability to provide well-functioning traffic services also in case of major accidents and/or emergencies is important for the public, businesses and the environment within the BSR and beyond. The ongoing HAZARD project aims at mitigating major accidents in major multimodal seaports in the BSR and deals with a range of relevant safety and security concerns in relation to port activities. The paper describes the planned Delphi study, which will bring together representatives of the relevant authorities (public sector actors), businesses (private sector actors) and research bodies to deal with communication practices in emergencies and address the complex regulatory safety and security framework within the seaport context.

Keywords: Planning, Preparedness, Disaster Management, Mitigation, Seaport, Delphi method, Foresight.

3.4.1 Introduction

The Baltic Sea is one of the most heavily trafficked seas in the world. The countries of the Baltic Sea Region (BSR) are heavily dependent on shipping for imports and exports, as well as for internal trade. Passenger transport and cruise tourism is also considerable. The current high level and expected growth in vessel traffic increases the risk that there will be more accidents in the future, unless improved safety and security procedures are set in place. Therefore, the EU's vision is that the Baltic Sea should become a leading region in maritime safety and security. (CEC 2015.)

Emergencies can be caused e.g. by fire, explosion, leakage of hazardous substances, or by natural causes such as flooding. Also security issues can pose a serious problem to supply chains through criminal activities related to cargo and/or vehicles, and to the mobility of people as evidenced by the rapidly changing situation with immigrants and asylum seekers. Subsequently, mitigating the adverse effects of such safety and security incidents is very much in the interest of seaports (see e.g. on safety DfT - Department for Transport 2015, and Haveman and Shatz 2006, Bichou 2008, Helmick 2008 on security). It is also the responsibility of competent authorities - notably rescue services or their equivalent - to deal with such incidents both before, during and after they might occur.

The joint research project HAZARD aims at mitigating major accidents in major multimodal seaports in the BSR, and deals with a range of relevant safety and security concerns in relation to port activities. HAZARD brings together rescue services, port authorities, logistics operators and universities from Estonia, Finland, Germany, Lithuania, Poland and Sweden. Totally fifteen partners and ten associated organizations are involved in the project. In order to get experts' views and development ideas on the topics especially related to WP2 and WP3 of the project, the method chosen is Delphi, because it is widely applied for structuring a group communication process so that it is effective in allowing a group of individuals, as a whole, to deal with a complex problem (Gordon 2011, Linstone and Turoff 1975).

3.4.2 Delphi Method Application

Authorities or companies specialized in their own fields act and communicate differently or use different concepts and terms for the same issue, although the object domain is the same. Some of this may be explained by cultural differences or differences in organization cultures (Carver and Turoff 2007, Hofstede et al. 2010, Lewis 2006). Thus, a Delphi study will be carried out at an early stage of the HAZARD project. In addition to its problem solving and future orientation, there are other advantages of the Delphi method for finding solutions to research questions: for example, its ability to take into account tacit knowledge and experiences of the experts. Furthermore, Delphi offers the experts the possibility to learn from other experts during the iterative process. (Linstone and Turoff 1975, Laakso and Palomäki 2013.)

An important aspect when applying the Delphi approach in HAZARD is to find ways of improving the communication between actors and towards the general public both during and after emergencies. Hence, the objective of the HAZARD Delphi study is to produce new knowledge on:

- Better communication practices in emergencies, which are also tested in several large joint emergency exercises, and
- How to cope with the complex regulatory framework on safety and security in a seaport context.

The aim is to study emergency situations using Delphi and to identify circumstances where different actors have recognized potential problems or risk situations related to emergencies in seaports, allowing us to create an overall picture of these challenges.

The Delphi study is a two-round process. Execution of the Delphi rounds is done by online questionnaires. Questions and claims for the rounds will be formulated based on the desk study and the analysis of material from the first round. The experts will be asked to answer not only as a representative of their own organization but also as a representative of their branch.

In a Delphi study, experts are selected from among the experts of a field of study, and the aim is to cover all the relevant aspects of the study subject (Okoli and Pawlowski 2004). Therefore, successful realization of Delphi requires the design of an expert group structure allowing for many knowledgeable individuals from different disciplines or specialties, who have a different working background and

experience, and who contribute information or assessments that are broader in scope than is possible for any single individual. (Gordon 2011, Kuusi 1999, Laakso et al. 2012, Linstone and Turoff 1975.)

In this Delphi application the panel of experts will be selected from the organizations of the fifteen project partners and ten associated organizations, i.e. rescue authorities, seaports and logistics companies, and universities. Three competence areas for experts were identified during the planning phase of HAZARD: experts are expected to have knowledge on (1) preparedness for major incidents (2) responding to major incidents, and (3) regulations related to major incidents. The organizations will be asked to nominate one to three experts for the panel. The total number of experts is expected to be fifty.

3.4.3 Conclusions

The Baltic Sea is one of the most heavily trafficked seas in the world, and a very high share of Baltic Sea Region (BSR) trade, as well as domestic transport within these countries, depends on shipping. Therefore, mitigating the adverse effects of safety and security incidents is very much in the interest of seaports. Effective collaboration and communication in emergencies require making sense of what has happened and what is going to happen; placing things in the right frameworks, comprehending, constructing meaning, interacting in pursuit of mutual understanding, and patterning.

The HAZARD project focuses on better coordination and communication, preparedness, helping reduce damage and loss of life in emergencies, and facilitating post-emergency actions in the BSR. In order to get an overall picture on challenges in joint exercises, communication, and regulatory framework, a two-round Delphi study will be carried out at the start of the HAZARD project. The results of the Delphi study will form one step for the project group towards their further work, and are anticipated to bring new information for seaport and logistics personnel and the authorities. The immediate beneficiaries of the findings include the seaport and rescue service partners in the project, but the results will also be effectively disseminated to relevant port community professionals and civil protection agencies within the EU and beyond.

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3.5 Kołowrocki: HAZARD PROJECT – RISK ASSESSMENT AND ANALYSIS

Krzysztof Kołowrocki*

*) Polish Safety and Reliability Association, 81-345, Gdynia, Poland. E-mail: k.kolowrocki@wn.am.gdynia.pl, Tel: +48535008093

3.5.1 Purpose

The paper intention is to present the Polish Safety and Reliability Association (PSRA) research team involved in the HAZARD project proposed methodology and approaches to fulfil the main aims of the project research focused on the mitigating the effects of emergencies in Baltic Sea region ports.

3.5.2 Methodology and Proposed Approaches

The following approaches to the project task “Risk Assessment and Analysis” are proposed.

Constructing stochastic models for investigation of dangerous events and accidents number in Baltic Sea region ports

The stochastic processes theory provides concepts and theorems that allow to build probabilistic models concerning incidents and accidents. The counting processes can be applied for modelling number of the dangerous events and accidents in Baltic Sea region ports during the fixed time intervals. A crucial role in construction of the models plays a Poisson process and its generalizations. Three models for determination of the incidents and accidents number in the seaports are going to be constructed. Moreover, some procedures of the models’ parameters identification and the computer procedures for anticipation of the dangerous events number will be proposed as well.

Investigating and mitigating accident consequences of maritime ferry operating at the Baltic Sea waters.

The approach is concerned with the prevention of a maritime ferry collision with static and dynamic installations at the Baltic Sea waters. Investigation of a ferry real collision with the oil terminal infrastructure inside the port will be carried out. Safety management and emergency preparedness procedures of maritime ferries will be reviewed. Direct causes like human error, fire on board, technical failure, lack of obey of safe operation procedures (or not adequate procedures) and heavy hydro-meteorological conditions will be analyzed on the basis of data coming from exemplary real scenarios of maritime ferry accidents. The collisions avoidance procedures and their consequences mitigation will be proposed as decision support for captains of ferries operating at Baltic Sea waters.

Mitigating consequences of oil spills at sea restricted areas based on their dynamic domains modelling, identification and prediction

Methods of oil spill domains determination will be reviewed and a new method based on a probabilistic approach to the solution of this problem will be proposed. To describe the oil spill central point position a two-dimensional stochastic process will be used and parametric equations of its drift trend curve will be determined. The oil spill domain motion general model for various hydro-meteorological conditions will be constructed and the methods of its parameters estimation will be proposed. The proposed methods will be presented in the form of procedures giving successive steps which should be done to estimate the unknown model parameters on the base of statistical data coming from experiments/exercises performed at sea to predict the spill domain movement and to prevent and mitigate the oil spill consequences.

Procedure based proactive functional safety management for the risk mitigation of hazardous events in the oil port installations including insurance aspects

The approach addresses selected technical and organization aspects of risk mitigation in the oil port installations with regard to functional safety and security requirements specified in standards IEC 61508, IEC 61511 and IEC 62443. The procedure for functional safety management will include the hazard identification, risk analysis and assessment, specification of overall safety requirements and definition of safety functions. Based on the risk evaluation results the safety integrity level (SIL) and security assurance level (SAL) will be determined for consecutive safety functions. The proposed approach will be composed of the following items: process and procedure based safety and security management, example of procedure based safety management including insurance, integrated safety and security assessment of industrial control system (ICS) of the oil port pipelines, tanks and critical infrastructure.

Modeling hazard related interactions between various processes in and around the Baltic Sea ports

The aim of this approach is to construct a model of hazard-related interdependence of the individual processes interacting in and around one of the ports located in the Baltic Sea area. This model should describe, in a formalized way, the impact of hazardous events involved in one process (caused by the operations carried out within this process alone) on the risks of events adversely affecting the other processes. The developed model will constitute a basis for the analysis of inter-process dependencies, including the feedback and cascading effects that can result from the dependencies between the hazardous events occurring in different processes, as well as the assessment and mitigation of their adverse effects. It will be applied to modelling, predicting, quantifying and mitigating the possible adverse effects of hazard-related mutual impacts between the oil terminal and the container terminal operation processes.

Mitigating potential major accidents and emergencies close to the Swinoujscie harbour based on LNG carrier emergency towing exercise

The exercise aims at mitigating potential major accidents and emergencies close to the harbour in Swinoujscie located at the Southern part of the Baltic Sea and the very sensitive coasts of Germany and Poland. The main goals of the exercise are as follows:

- to test the emergency towing capability including national and international resources,
- to test procedures connected to the Maritime Assistance Service (MAS procedures) rendered to the vessel in a need of assistance and connected to the emergency towing and use of the place of refuge,
- to check equipment and communication,
- to improve safety of LNG tankers emergency towing.

Trajectory planning during emergency ship to ship cargo transfer to mitigate oil spill at the Baltic Sea

One of the most important task during Ship to Ship (STS) lightering operations include maneuvering in close proximity during different weather conditions in order to come in position for operation alongside to commence cargo transfer. A STS lightering operation as a result of emergency situations at sea can be carried out when both ships are side by side and constant heading and drift velocity can be maintained. Collisions between the two ships typically occur as a result of incorrect approach angle between the maneuvering vessel and constant heading ship. To mitigate this risk of incidents, guidelines will be prepared for the navigator, which include information about reference trajectory in meaning references position, heading and velocity at each stage of the ship maneuvering.

Developing procedures for hazard identification

The reliable operation of the Baltic Sea area critical infrastructures have direct impact on the safety of this region and the whole country as well. Due to the complexity and vastness of such complex systems it is exposed to various types of events that could lead to failure. These risks may result directly from the operation and also be the result of external factors. Especially dangerous are the undesirable events with incidental character or unlikely events that constitute a serious threat to people and the environment and resulting in significant loss. The primary objective of risk management is to increase the safety of the considered complex technical system. The proposed approach will be composed of the following items: hazard identification methods, strategies for safety management, registration of undesirable hazard events at the Baltic Sea area.

Conception of decision support system for resilience management of seaport supply chains

The project is aimed at improvement of safety level of logistic support processes carried out in the corridor to the seaport and in the seaport in the context of proper performance of supply chain.

Following this, the approach is aimed at development of decision support system for seaports supply chain risk management in the aspect of vulnerability and resilience engineering. There will be done a literature review connected with resilience engineering of seaport infrastructure systems and their supply chains. Next, the decision support system conception will be proposed. The developed decision support system is to be based on the What if? approach and Bow-Tie method. The proposed approach will be applied to a selected seaport supply chain vulnerability and resilience assessment.

Prevention of oil spills during oil transfer between tankers and port oil terminal

Considering the operation process of port oil terminals, the approach will be focused on processes related to the cargo movement inside the pipeline system. Processes of crude oil loading and discharging and process of internal recirculation of crude oil will be described and their statistical identification will be given. Various types of accidents that have the potential to occur during oil transfer will be considered and subsequently classified. Analysis of potential threats that can cause oil spill during oil transfer in the terminal and their classification with distinction of internal and external causes will be performed. Further, a particular attention will be addressed to the pressure upsurge inside the pipelines caused by sudden valve closure on the oil reloading installation in port terminal. The main aim of this approach will be to find the uniform legal requirements in order to prevent such kind of accidents.

Keywords: Port accident, Maritime collision, Port operation safety, Port oil terminal, Oil transfer, Oil spill, Ship operation safety, Ship safe trajectory planning, Contingency prediction, Threats and hazards assessment, Threats and hazards response, Emergency prevention, Accident consequences mitigation, Resilience engineering, Inter-process dependence, Hazardous event, Risk analysis, Probabilistic models, Probabilistic anticipation, Statistical identification, Probabilistic prediction.

4 OTHER RELEVANT CONTRIBUTIONS

The abstracts also include two inputs from authors whose organisations are not directly linked to HAZARD, but they are included here due to their contextual relevance. These are the texts by Ms. Eva Branten and Prof. Alari Purju from Tallinn Technical University on port investments issues and by Commodore (ret.) Bo Österlund affiliated to the Finnish National Defence University on security of seaborne supply issues.

4.1 Branten & Purju: A GAME-THEORETIC MODEL FOR ANALYSIS OF INVESTMENT DECISIONS OF PORTS

Eva Branten*

Alari Purju**

*) Tallinn University of Technology, Department of Logistics and Transport, E-mail: Eva.branten@ttu.ee

**) Tallinn University of Technology, Department of Logistics and Transport, E-mail: alari.purju@ttu.ee

4.1.1 Purpose

The paper discusses the conditions and interrelationships for investments into infrastructure made by ports. Investments are divided into two groups: investments into common infrastructure (development of road, railway network etc.) and investments into port-specific infrastructure (investments on the territory of the port). The investments to the common infrastructure affect investments to the infrastructure related only to the specific port since ports are subject to budget constraint. Therefore, investments to the common infrastructure reduce the amount of resources available for investments related only to the specific port. At the same time, some investments related to the specific port are meaningful only provided the investments to the common infrastructure (e.g. quality of hinterland-connections) are on a certain level. In the game, two ports have to decide, whether or not to contribute to the investment into common infrastructure which is related to both ports and would benefit both ports. Common infrastructure can be considered as a public good. The paper addresses the following questions: Which are conditions for the cooperation of competing ports? Which are options to overcome the problem of free rider? Which are options to overcome the social traps and achieve the Pareto-efficient outcome? Also the role of public sector is of interest since public sector can influence the marginal utility of investments into the common infrastructure. A similar framework could also be applied to analyze the investment decisions with the aim to enhance the safety of ports.

4.1.2 Introduction

The formation of competitiveness of ports can be analysed with the help of the framework of game theory. The framework of game theory offers possibilities for the analysis in a dynamic context: as a result of the interaction, competition and cooperation of ports and the strategic decisions of ports having effect on each other.

The strategic decisions of competing ports have been analysed in the framework of game theory in different studies from different perspectives. These studies have considered different strategic decisions (e.g. decisions regarding charges, decisions regarding investments) in case of different players (e.g. the interaction between competing ports, between a port and its terminals, between a port and shipping lines, between container terminals of a port) in different game settings.

Some examples of these studies are Asgari et al (2013)¹⁴, Ishii et al (2013)¹⁵, Luo et al (2012)¹⁶, Saeed and Larsen (2010)¹⁷, Yang et al (2011)¹⁸, Wang et al (2014)¹⁹, to name but a few.

4.1.3 Method

The game theoretic models elaborated in the current study are related to the concepts of public economics. As important concepts, mechanism design, public good and problem of free rider can be pointed out.

The game is modelled in different settings to analyse how the solution of the game changes if the assumptions of the game change. The following cases are under observation: static game with complete information, static game with incomplete information, dynamic game with complete information, dynamic game with incomplete information. Also, the impact of change in the aim of the players presents interest.

In case of static games, the players make a decision simultaneously. In case of dynamic games, the players make decisions in a sequence meaning that the decisions already made in previous steps of the game are known to the players (the history of the game is known). In the games of complete information the players have information regarding each other's payoff functions. In case of games with incomplete information the players lack this information.

¹⁴ Asgari, N.; Farahani, R. Z.; Goh, M. (2013). Network design approach for hub ports-shipping companies competition and cooperation. – *Transportation Research Part A*, vol. 48, pp. 1-18.

¹⁵ Ishii, M.; Lee, P. T.-W.; Tezuka, K.; Chang, Y.-T. (2013). A game theoretical analysis of port competition. – *Transportation Research Part E*, vol. 49, pp. 92-106.

¹⁶ Luo, M.; Liu, L.; Gao, F. (2012). Post-entry container port capacity expansion. – *Transportation Research Part B*, vol. 46, pp. 120-138.

¹⁷ Saeed, N.; Larsen, O. I. (2010). An application of cooperative game among container terminals of one port. – *European Journal of Operational Research*, vol. 203, pp. 393-403.

¹⁸ Yang, D.; Liu, M.; Shi, X. (2011). Verifying liner Shipping Alliance's stability by applying core theory. – *Research in Transportation Economics*, vol. 32, pp. 15-24.

¹⁹ Wang, H.; Meng, Q.; Zhang, X. (2014). Game-theoretical models for competition analysis in a new emerging liner container shipping market. – *Transportation Research Part B*, vol. 70, pp. 201-227.

If the players lack dominant strategies, it is assumed that they will apply mixed strategies in case of which both pure strategies (to contribute or not to contribute to the common infrastructure) are applied with equal probability.

In the elaborated models, the players are two competing ports which have a common hinterland. The general aim of a port is to enhance its competitiveness. Competitiveness can be described in various ways. Here, the throughput of a port is considered as a proxy for competitiveness. In different models the aim of the ports is formulated in different ways:

- The aim of a port is to maximize its throughput.
- The aim of a port is to attain larger level of throughput than that of its competitor.

In the game two ports have to make the decision whether or not to support investment into common infrastructure. The essence of the game is described in the section “Purpose”.

The payoff function of the first port is defined as follows:

$$y_1 = \alpha_1 + \alpha_2(C + A_1)^2 + \alpha_3(I + A_2 + B_2) + \alpha_4(A_3)$$

where A_1 is the investment to the infrastructure related only to the first port; A_2 is the contribution of the first port to the common infrastructure; B_2 refers to the contribution of the second port to the common infrastructure; A_3 are other factors affecting the competitiveness of the first port; C refers to the level of investments already made to the first port's infrastructure before decisions of the game; I refers to the level of investments already made to the general infrastructure before decisions of the game; $\alpha_1, \alpha_2, \alpha_3, \alpha_4$ are parameters of the model.

The budget constraint of the port is $A_1 + A_2 = 2$. With the substitution $A_1 = 2 - A_2$, the payoff function above can be rewritten $y_1 = \alpha_1 + \alpha_2(C + 2 - A_2)^2 + \alpha_3(I + A_2 + B_2) + \alpha_4(A_3)$

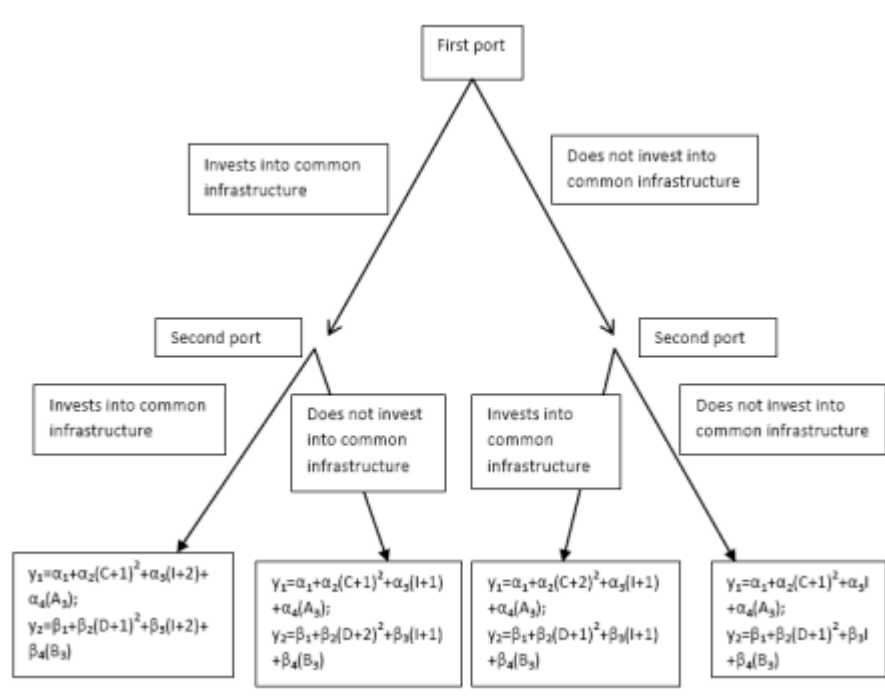
The assumption of the game is that A_2 can obtain values 0 or 1. Hence, A_1 can obtain values 2 or 1. Another assumption is that some investments to the port-specific infrastructure are meaningful only provided that investments to the common infrastructure are at least on the level 1 ($A_2 + B_2 \geq 1$). Let $A_1 = 2$ be possible only provided that $A_2 + B_2 \geq 1$.

Similarly, the payoff function of the second port is defined as $y_2 = \beta_1 + \beta_2(D + 2 - B_2)^2 + \beta_3(I + A_2 + B_2) + \beta_4(B_3)$ where $\beta_1, \beta_2, \beta_3, \beta_4$ are parameters of the model; D refers to the level of investments already made to the second port's infrastructure before the start of the game; B_2 refers to the contribution of the second port to the common infrastructure whereas $B_2 = 2 - B_1$, where B_1 is the investment to the infrastructure related only to the second port; B_3 are other factors affecting the competitiveness of the second port.

In the following, the normal form of the static game is presented.

		Second port	
		Contribute	Not to contribute
First port	Contribute	$y_1 = \alpha_1 + \alpha_2(C+1)^2 + \alpha_3(I+2) + \alpha_4(A_3);$ $y_2 = \beta_1 + \beta_2(D+1)^2 + \beta_3(I+2) + \beta_4(B_3)$	$y_1 = \alpha_1 + \alpha_2(C+1)^2 + \alpha_3(I+1) + \alpha_4(A_3);$ $y_2 = \beta_1 + \beta_2(D+2)^2 + \beta_3(I+1) + \beta_4(B_3)$
	Not to contribute	$y_1 = \alpha_1 + \alpha_2(C+2)^2 + \alpha_3(I+1) + \alpha_4(A_3);$ $y_2 = \beta_1 + \beta_2(D+1)^2 + \beta_3(I+1) + \beta_4(B_3)$	$y_1 = \alpha_1 + \alpha_2(C+1)^2 + \alpha_3 I + \alpha_4(A_3);$ $y_2 = \beta_1 + \beta_2(D+1)^2 + \beta_3 I + \beta_4(B_3)$

In the following, the extended form of dynamic game is presented.



The equilibrium solutions of the game depend on the values of parameters α_2 , α_3 , β_2 , β_3 and the levels of investments already made to the port-specific infrastructure, C and D.

In dynamic games the fact that the second player has information regarding the decisions of the first player has an impact on the solution of the game.

4.1.4 Findings

Generally, two solutions of the game are of interest: 1) the solution where both ports contribute to the common infrastructure, i.e. cooperation is the outcome; 2) the solution where neither of the ports contributes to the common infrastructure.

In very general theoretical terms, the cooperation of ports in supporting common infrastructure projects makes headway, if for both ports the marginal utility of the common infrastructure is higher than the marginal utility of the infrastructure related only to one port. The probability for this solution is relatively higher if the level of previous investments to the common infrastructure is low or in case where both the levels of previous investments to common infrastructure as well as to port-specific infrastructure are high but additional investments to enhance the capacity of a port require additional investments to common infrastructure.

In case of static games, both in case of the game with complete information as well as the game with incomplete information, one possible outcome, among others, is the situation where neither of the ports contributes to the common infrastructure. This outcome can be considered as the social trap since the competitiveness of both ports would increase if at least one of the ports would contribute to the common infrastructure. In case of dynamic games, the social trap can be avoided and the Pareto-efficient outcome can be attained.

The mathematical form of the payoff function used here bases on an assumption that the marginal utility of port-specific investments depends on the initial level of these investments. However, the detailed specification of the payoff function is subject to discussion. Also, the values of the parameters α_2 , α_3 , β_2 , β_3 which influence the actual solution of the game can be subject to further research.

4.1.5 Contribution of the Research

The research provides an analytical theoretical framework to consider the strategic decisions related to infrastructure investments of the ports. In particular, the study addresses the potential cooperation between competing ports and the importance of infrastructure related to hinterland-connections in the formation of competitiveness of ports. Also, on the basis of the results of the model, the role of the public sector in influencing the outcome of the game can be discussed.

A similar framework could also be applied to analyze the investment decisions with the aim to enhance the safety of ports. The impact of different stakeholders on the solution of the game is an interesting field for further research.

Keywords: competitiveness of ports, game-theoretic modelling, infrastructure investments, cooperation of ports, free rider problem

4.2 Österlund: FINLAND'S TARGETS FOR SECURITY OF SEABORNE SUPPLY AND THEIR ACHIEVEMENT

Bo Österlund*

*) Finnish National Defence University, E-mail: bo.osterlund@pp1.inet.fi, Tel: +358 407070404

4.2.1 Abstract

Purpose of the paper

The research aims at creating a realistic description of Finland's security of seaborne supply situation based on the structure of current fleet and dependency on seaborne maritime trade. The research question is formulated as: *“Does the Finnish merchant fleet meet the targets set for security of seaborne supply.”*

The *sufficient and necessary* merchant fleet capacity mentioned in recent state budget proposals (SBP 2008, 2009–2016) can be seen as a target level and desired state of affairs. According to the budget proposals, Finland needs to have domestic tonnage *for carrying out the necessary and at the very least the essential foreign freight traffic, also during disruptions in normal conditions and during exceptional circumstances.*

During years 2002-2014, the number of merchant vessels sailing under the Finnish flag has varied between 129 (2002) and 108 (2014), while the gross tonnage (GT) of the vessels is growing. The share of trade carried by Finnish vessels has decreased from some 40% in 1980 to 33% in 2014 seems to indicate a weakened security of supply in transport performance.

One of the challenges is determining whether it is possible to define a *sufficient* level for the Finnish merchant fleet in a scientific manner, for instance in the form of the number of vessels, the total deadweight tonnage, the performance of the vessels or the tonne-nautical miles covered by the vessels.

The research problem is formulated as follows: *“Does the Finnish merchant fleet meet the targets set for security of seaborne supply.”*, and it is broken down into the following sub-questions:

1. What are the constituents of security of seaborne supply?
2. Are the economic decisions being made to form and maintain a sufficient merchant fleet based on the correct figures?
3. What is the transport capacity and performance level of our merchant fleet?
4. Is the composition of our merchant fleet suitable for the different types, amounts and batches of cargo being transported?
5. Does Finland have a suitable and sufficient tonnage for its seaborne export and import activities?

Design/methodology/approach

This study aims at making the security of seaborne supply concept more concrete through qualitative interviews. The dissertation will include elements of both creating new scientific information and applied research producing practical results for public and private sector stakeholders.

In an abductive research strategy, the analysis of data is not directly based on theories, but researcher turns to theories to find support for their interpretations or to confirm their ideas. The abductive approach follows the *rule-result-case* pattern (Danermark & Kirkeby, op. cit. Kovács and Spens 2005).

The main data consists of shipping statistics provided by the Finnish Maritime Administration, Finnish Transport Agency, Finnish Customs, Statistics Finland, Finnish Port Association and Finnish Ship-owners Association and of government acts, decrees, guidelines, decisions and strategies.

The 34 qualitative interviews were carried out as expert interviews including structured questions about four different themes. The majority of the empirical data used in the thesis are collected through these interviews. For the interviews, I divided the subject into the following themes:

1. How the authorities see the security of supply concept and its requirements.
2. What is a sufficient merchant fleet and a suitable composition for it.
3. The port network required for seaborne import and export activities and its flexibility.
4. Safeguarding sea connections, managing sea traffic, maintaining suitable conditions for sea traffic and protecting sea traffic.

Findings

According to Finland's state budget proposal for 2016 (SBP 2015), the Finnish merchant fleet is estimated to include 114 vessels participating in foreign shipping traffic, of which 96 are cargo vessels and 18 passenger vessels²⁰. In the budget proposal, the gross tonnage of these vessels is estimated to be 1,635,000 tonnes. However, new tonnage regulations adopted by the International Maritime Organization (IMO) in 1969 entered into force in 1982. Since then, the tonnage of merchant ships has been presented using a logarithmic function that provides a unitless numerical value. Gross tonnage should therefore not be given in tonnes. Finland approved the International Convention on Tonnage Measurement of Ships with a decree in 1982 (A 31/1982). It seems that the use of a unitless tonnage system has impacted the lay assessment of the transport capacity of our merchant fleet.

One of the basic questions and a starting point to be examined is *“whether the economic decisions being made to form and maintain a sufficient merchant fleet are based on the correct figures, Gross or Net tonnage or the dead weight of the merchant fleet”*.

²⁰ In the 2017 budget proposal the gross tonnage for the Finnish merchant fleet is estimated to include 112 vessels comprising 96 cargo ships and 16 passenger vessels equivalent to a gross tonnage of 1,537,000. (N.B.: in the 2017 proposal, the gross tonnage figure was given without an explicit reference to a unit, such as in 2016 for “tonnes”, which is a misplaced unit in this context).

Research limitations/implications

This empirical analysis of this research is limited to Finland, and it covers mainly the period 2002-2014.

Practical implications

The aim of the research is to create a realistic description of Finland's current security of seaborne supply situation while taking the requirements set for it into account. The sufficiency of the Finnish merchant fleet is examined in relation to the current level of foreign sea transport.

Originality/value of the study

Finland's security of seaborne supply situation has not been systematically studied despite Finland's high degree of dependency on maritime transport. Therefore, the research provides valuable new information both for policymaking and for practitioners dealing with Finnish trade logistics.

The Finnish security of supply is also arranged in a rather unique way, analysis of which is also valuable in its own right.

4.2.2 Aims of the Research

The aim of my research is to create a realistic description of Finland's current security of seaborne supply situation while taking the requirements set for it into account. Once the current situation has been mapped, it will be possible to examine the following main research question:

Main RQ: Is Finland's security of seaborne supply at an acceptable level?

The purpose of my doctoral thesis is to determine whether Finland's merchant fleet in the 2010s is sufficient for ensuring security of seaborne supply. In various decisions, estimates and reports drafted by Finnish authorities, having a sufficient domestic merchant fleet has been set as a target and seen as a desired state of affairs. The sufficiency of the Finnish merchant fleet is examined in relation to the current level of foreign sea transport. Fleet data has been obtained from the Finnish merchant vessel list maintained by the Finnish Transport Agency (FTA), and the sufficiency of the fleet will be analysed based on transport statistics, merchant fleet register data and expert interviews. This analysis will provide an overall idea of how different operators see the security of supply situation and the development needs of the Finnish fleet.

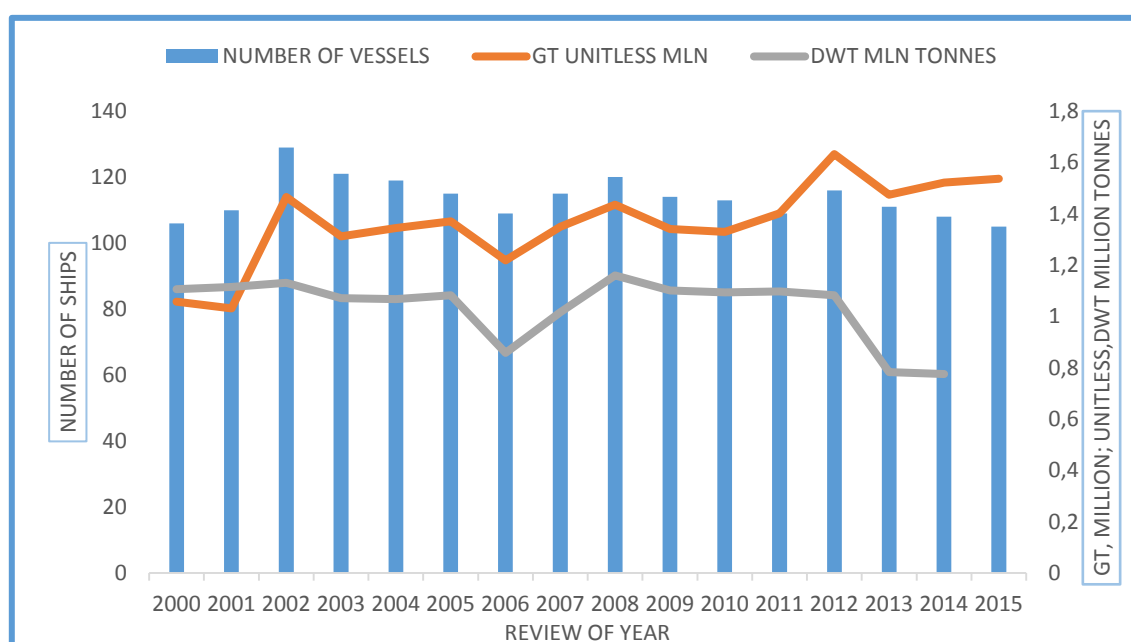
The analysis will also help to define the possible and/or necessary measures (mainly from the authorities' point-of-view) to ensure that the Finnish merchant fleet will meet the targets set for security of seaborne supply. The main research question has been broken down into several sub-questions:

1. What are the constituents of security of seaborne supply?
2. Are the economic decisions being made to form and maintain a sufficient merchant fleet based on the correct figures?
3. What is the transport capacity and performance level of our merchant fleet?

4. Is the composition of our merchant fleet suitable for the different types, amounts and batches of cargo being transported?
5. Does Finland have a suitable and sufficient tonnage for its seaborne export and import activities?

During the period being examined, the number of merchant vessels sailing under the Finnish flag has varied between 129 (2002) and 108 (2014) (see Figure 1). Some of the recent developments include Rettig Group's, a Finnish multi-branch firm, decision to sell its ro-ro fleet under the operating name Bore to the Dutch company Spliethoff on 21 April 2016. The Bore fleet includes 9 ro-ro vessels. This means that the deal will reduce the Finnish owned ro-ro fleet by 26 %, from 34 vessels to 25, and shrink the deadweight of the Finnish fleet by 88,254 tonnes.

Figure 1. The Development of Finnish Merchant Fleet 2000-2015



Sources: FMA (Finnish Maritime Administration), *Finnish Merchant Fleet Statistics 2000, 2005, 2008, 2010*, Trafi Publications, *Finnish Merchant Fleet Statistics 2012, 2013, 2014, 2015*; Finnish Traffic Agency 2000, 2005, 2008, 2010, 2012, 2014, 2015; Finnish Shipowners' Association Membership Rosters 2008, 2012, 2014.

The number of vessels presented for the year 2016 is only an estimate. In total, the capacity of the merchant fleet has decreased by 384,000 tonnes deadweight, or by over 33 %, during the research period. By contrast, the unitless gross tonnage has grown by a total of 464,700, or by 43 %, between 2000 and 2014. The share of foreign sea transport carried out by Finnish merchant vessels has decreased by approximately 9% unit points since 2000.

In the rationale section of government proposal 148/2008 (GvP 2008), the following is stated: “The general opinion is that the current tonnage is close to the risk threshold from the point of view of security of supply.”

The figures above show that of the factors affecting Finland's security of seaborne supply, the number of merchant vessels sailing under the Finnish flag, the capacity of merchant vessels, and the share of transport carried out by Finnish tonnage are declining. The gross tonnage (GT) of Finnish merchant vessels is, by contrast, growing. How will this affect the maintenance of security of supply or the general understanding of the security of supply situation?

By determining the target level or desired state of matters, it is possible to set the targets for maintaining Finland's overall security. This requires an analysis of the size of our merchant fleet, the number of vessels, the transport capacity of the fleet, the composition of the fleet, the share of foreign transport carried out by Finnish tonnage and the share of tonne-nautical miles covered by Finnish vessels. When the volumes of goods transported by sea are examined, the focus is on import and particularly on energy and chemical transport, which have been separately mentioned in the government decision on the security of supply goals (GvD 2013), and on assessing the importance of the share of energy and chemical transport carried out by Finnish vessels.

In my doctoral dissertation, one of the main challenges is determining whether it is possible to define a *sufficient* level for the Finnish merchant fleet in a scientific manner, for instance in the form of the number of vessels, the total deadweight tonnage, the performance of the vessels or the tonne-nautical miles covered by the vessels.

The fact that the share of foreign transport carried out by Finnish vessels has decreased from some 40% in 1980 to 33% in 2014 seems to indicate that our transport performance has weakened.

4.2.3 Findings

According to the state budget proposal for 2016 (SBP 2015), the Finnish merchant fleet is estimated to include 114 vessels participating in foreign shipping traffic, of which 96 are cargo vessels and 18 passenger vessels. In the budget proposal, the gross tonnage of these vessels is estimated to be 1,635,000 tonnes. However, new tonnage regulations adopted by the International Maritime Organization (IMO) in 1969 entered into force in 1982. Since then, the tonnage of merchant ships has been presented using a logarithmic function that provides a unitless numerical value. Gross tonnage should therefore not be given in tonnes. Finland approved the International Convention on Tonnage Measurement of Ships with a decree in 1982 (A 31/1982). It seems that the use of a unitless tonnage system has impacted the lay assessment of the transport capacity of our merchant fleet.

Deadweight (dwt) is a measure of a vessel's capacity in weight, and does not include the weight of the ship. Dwt is the combined weight of cargo, fuel, fresh water, ballast water, provisions, passengers and crew.

Gross tonnage (GT) is calculated using the formula $GT = V * (0.2 + 0.02 * \log V)$,

where

V is the ship's total volume in cubic meters (m³), and

K is a multiplier based on the ship volume.

(Wolfram Alpha 2016; A 31/1982)

Gross tonnage is the total tonnage of a vessel (a ship or a boat) that in practice covers the volume of all enclosed spaces. Gross tonnage is calculated using vessel volume (in accordance with the 1969 International Convention on Tonnage Measurement of Ships) and the formula

$$GT = K_1 V$$

where

- 1) *V* is the volume of all the enclosed spaces of the vessel (a ship or a boat) in cubic metres and
- 2) *K₁ = 0,2 + 0,02 log₁₀ V*

Official FTA statistics published after the year 2014 no longer contain information on vessel capacity. One of the basic questions and a starting point examined in my doctoral dissertation is *whether the economic decisions being made to form and maintain a sufficient merchant fleet are based on the correct figures, Gross or Net tonnage or the dead weight of the merchant fleet.*

4.2.4 Approach

While basic research focuses on creating new scientific information, applied research emphasises the practical application of science. My doctoral dissertation will include both forms of research.

It will also discuss the formulation of the research question, the selection and operationalisation of the variables, the sampling technique and the data collection and analysis methods used. The study design will make it possible to address the research problem and answer the research questions.

The *sufficient and necessary* merchant fleet capacity mentioned in recent state budget proposals (SBP 2008, 2009–2016) can be seen as a target level and desired state of affairs. According to the budget proposals, Finland needs to have domestic tonnage *for carrying out the necessary and at the very least the essential foreign freight traffic, also during disruptions in normal conditions and during exceptional circumstances.*

In this study, the aim is to make the security of seaborne supply concept more concrete through qualitative interviews.

The main data consists of sea transport and shipping statistics provided by the Finnish Maritime Administration (FMA), Finnish Transport Agency (FTA), Finnish Customs (FC), Statistics Finland (STF) Finnish Port Association (FPA) and Finnish Shipowners' Association (FSA) and of government acts, decrees, guidelines, decisions and strategies.

The qualitative interviews will be carried out as expert interviews including structured questions about four different themes. The majority of the empirical data used in the thesis will be collected through these interviews. For the interviews, I have divided the subject into the following themes:

1. How the authorities see the security of supply concept and the requirements it
2. poses?
What is a sufficient merchant fleet and a suitable composition for it?
3. The port network required for seaborne import and export activities and its flexibility.
4. Safeguarding sea connections, managing sea traffic, maintaining suitable conditions for sea traffic and protecting sea traffic.

Carrying out the interviews is currently under way, and the goal is to complete the interviews and the transcription work by the beginning of the summer. At the moment of writing this report, 26 of the planned 35 interviews have been completed, but the laborious transcription work has not progressed quite as swiftly.

I expect the interviews to provide qualitative material that will be supplemented with numerical values related to security of supply. The challenging part of this study will be comparing the central concepts and their meaning relationships with the empirical data. When quantitative and qualitative data are discussed in parallel, it is extremely important to stay focused and not to stray from the subject.

4.2.5 Methodology

From the group of theories available (positivism, hermeneutics and pragmatism), I have decided to base my study on positivism. Researchers have often applied positivism in logistics and the management of supply chains (Näslund, 2002). Positivism refers to what is real and true. When a positivist approach is used, it must be possible to test and try all statements using scientific methods and to prove that the statements are either true or false. According to the correspondence theory of truth, a proposition is true if the fact corresponding to it exists, i.e. if the proposition corresponds to the actual state of affairs.

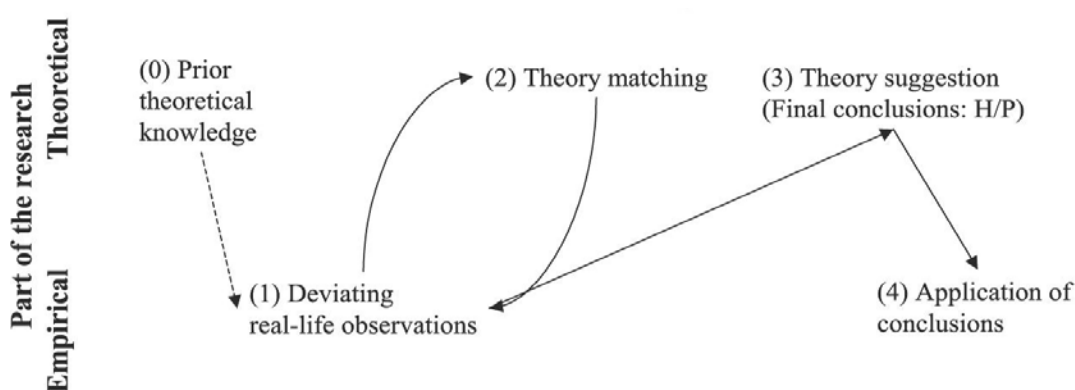
Antony Giddens (as cited in Vafidis 2007) suggests that positivism consists of two main elements. The first element is the *rule of phenomenalism* that states that knowledge is based on experiences and means that researchers must make their observations in the real world. Phenomenalism is a view found in epistemology and perceptual philosophy according to which physical objects do not exist in themselves, but only appear as perceptual phenomena or sensory stimuli situated in time and in space. As the second element, Giddens mentions that values are insignificant in science where only information that is directly perceived in the environment is accepted. In other words, values are not given any space to affect observations through prejudices. Defining the approach to be used and the theories and concepts to be examined in advance before collecting the empirical data is characteristic of positivism. Once the data has been analysed, it is possible to determine whether the initial propositions have been true or false.

Inference is the process of deriving conclusions, creating forecasts or building explanations based on existing information. Inference can be divided into three different types: deduction, induction and abduction.

In *data-based research*, the main focus is on the data and any theories are constructed inductively based on the data. Single observations lead to more general propositions (Eskola & Suoranta 1998, p. 83). The inductive approach follows the pattern *case-result-rule* (Kovács & Spens 2005, pp. 132–144). In *theory-based research*, the analysis of the research data is based on an existing theory or model. According to Tuomi and Sarajärvi (as cited in Saaranen-Kauppinen & Puusniekka 2006), the analysis of the data is guided by an existing model and often the purpose is to test this model or theory in a new situation. The logical sequence of the deductive research approach progresses from rule to case to result.

The abductive research strategy falls between theory-based and data-based research. In abductive research and inference, a theoretical framework is used to find explanations or confirmation for findings made in the data being examined. The analysis of data is not directly based on theories, but researchers do turn to theories to find support for their interpretations or to confirm their ideas. They may also make observations about how well the empirical data complies with the results of previous studies (Eskola 2001). The abductive approach follows the rule-result-case pattern (Danermark, Kirkeby, as cited in Kovács and Spens 2005). I have decided to apply the following abductive model by Kovács and Spens (2005; see Figure 2).

Figure 2. The abductive research process. Source: Kovács and Spens (2005).



The starting point of my research project is a prior understanding of the subject that will be supported by previously published literature, theory, interviews and prior personal experience. The theoretical framework of the project has been formed by exploring existing information and research literature on the subject and finding the aspects that are essential to this study. Defining the central concepts of the study constitutes the foundation of the work, as it will help readers understand security of seaborne supply without losing the thread of the study. The research results are based on a dialogue between prior knowledge and new observations.

Abductive reasoning typically begins with an incomplete set of observations and then proceeds to the likeliest possible explanation for the set. It yields the kind of daily decision-making that does its best with the information that is available. Often, this information is incomplete. (Butte 2016)

In abductive reasoning, the case presents a plausible but not logically necessary conclusion, provided that its anticipated rule is correct (Danermark, as cited in Kovács & Spens 2005). An empirical event or phenomenon is related to a rule, which gives new insight (or supposition) about the event or phenomenon. According to Kirkeby (as cited in Kovács & Spens 2005), abduction can also lead to “suggesting” general rules.

4.2.6 Research Process

In early 2016, the writing process explored the security of supply concept, its definition, the idea people have about it and the general understanding of the concept. This also involved the examination to what extent the concept has been applied for sea transport. Finland's security of supply arrangement will also be put into an international context by introducing examples from the EU, the United States, Sweden and a couple of countries located in Central Europe. Antola and Seppälä (2005) also provides useful points of view for the study.

In this study, the security of seaborne supply is discussed as part of Finland's general security of supply. In the performance evaluation of security of seaborne supply, I examine the subject based on the “Finnish Critical Industries, Maritime Transport Vulnerabilities and Social Implications” report published in 2011 by the University of Turku Centre for Maritime Studies. The report examines the consequences of the Finnish stevedore strike that affected public ports for 16 days in March 2010. The effects on maintaining industrial operations and processes and on security of supply are discussed.

Security of seaborne supply can also be examined as a function of sea transport demand and supply. The demand function of the market mechanism is based on the volume of goods handled in foreign sea transport, including both import and export. When performance is being evaluated, the volume of goods is multiplied by the distance travelled, resulting in tonne-nautical miles. Supply leverage is provided by the available cargo transport capacity.

The expert knowledge derived from the qualitative interviews will provide information on variables that cannot be assigned a numerical value. This will facilitate creating a framework for assessing whether the targets set for security of seaborne supply have been achieved. When the assumptions are true, the conclusions will also be true.

In summer 2016, the stage of the study is dividing the interview data into different categories and creating a codebook to carry out the content analysis. Using codes provides several benefits: codes can be used as internal notes, they structure the information the researcher is examining in the data, they help to describe text, they can be used to test the structuring of the data and they can be used to search for and check different parts of the text, in which case they act as an address (Eskola & Suoranta 1996, Eskola 2001).

The conclusions of the study present the essential measures that would be needed to bring the declining Finnish tonnage (only the gross tonnage is currently growing) to the estimated required level.

Keywords: Security of seaborne supply, Finland's maritime trade, Sea transport capacity

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5 CONCLUSIONS

The Baltic Sea is one of the most heavily trafficked seas in the world, and a very high share of Baltic Sea Region (BSR) trade, as well as domestic transport within these countries, depends on shipping. Passenger transport and cruise tourism are also substantial. The expected growth in vessel traffic increases the risks in future, and the on-going development in the field of safety and security is of importance. Therefore, the European Union's vision is that the Baltic Sea should become a leading region in maritime safety and security. The HAZARD project will contribute to achieving these objectives as well.

The aim of this report was to give an overview of the relevant issues of the HAZARD project. In the first chapter, the HAZARD Project was introduced. In the second chapter, facts about the BSR were presented. There are 94 so-called Core TEN-T Seaports in the EU. 24 of these are located in the BSR (incl. German North Sea ports), which handle over 700 million tonnes of cargo and over 50 million passengers. Harbours, terminals and storage facilities incl. those for dangerous goods are often located close to residential areas, thus potentially exposing a large number of people to the consequences of accidents. This is a starting point for HAZARD. The project deals with these concerns.

The third chapter discussed the role and inputs of the knowledge partners in the project. The short descriptions provided an outline of the knowledge partners' topics dealing with seaport safety and security in the BSR. In general, the knowledge partners provide support to the seaports and rescue services to improve their performance, enhance the use of analytical work on risk assessment methods, support joint exercises and provide overall analysis and reporting work for the project. Communication issues, risk analysis and the questions related to the regulations on port safety and security are all key topics in HAZARD.

The abstracts in the fourth chapter include two inputs from authors whose organisations are not directly linked to HAZARD, but they are included here due to their contextual relevance. These are the texts by Ms. Eva Branten and Prof. Alari Purju from Tallinn Technical University on port investments issues and by Commodore (ret.) Bo Österlund affiliated to the Finnish National Defence University on security of seaborne supply issues. The first paper discussed the conditions and interrelationships for investments into infrastructure made by ports. And the second paper asked whether the Finnish merchant fleet meets the targets set for security of seaborne supply. These two articles underlined the multifaceted nature of safety and security issues.

HAZARD is a cross-border and cross-sectoral project where the knowledge partners have an important role. The results of the knowledge partners' work in the context of the project will bring new information for seaports, rescue services and other authorities. The immediate beneficiaries of the findings include the seaport and Rescue Service Partners in the project, but the results will also be effectively disseminated to relevant port community professionals and Civil Protection agencies in the EU and beyond.

HAZARD project has 15 full Partners and a total budget of 4.3 million euros. It is executed from spring 2016 till spring 2019, and is part-funded by EU's Baltic Sea Region Interreg programme.

HAZARD aims at mitigating the effects of major accidents and emergencies in major multimodal seaports in the Baltic Sea Region, all handling large volumes of cargo and/or passengers.

Port facilities are often located close to residential areas, thus potentially exposing a large number of people to the consequences of accidents. The HAZARD project deals with these concerns by bringing together Rescue Services, other authorities, logistics operators and established knowledge partners.

HAZARD enables better preparedness, coordination and communication, more efficient actions to reduce damages and loss of life in emergencies, and handling of post-emergency situations by making a number of improvements.

These include harmonization and implementation of safety and security standards and regulations, communication between key actors, the use of risk analysis methods and adoption of new technologies.

See more at: <http://blogit.utu.fi/hazard/>

