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FOREWORD

Maritime transport represents critical infrastructure for Finland. Any disruption in maritime transports has negative consequences to many sectors in the Finnish economy. This report focuses on the importance of maritime transports to the security of supply in Finland and for the so called critical industries in particular. The report shows that possibilities to prepare against transport disruptions differ between industries. At the societal level the strike revealed vulnerabilities related to high import dependency of certain critical sectors, as well as concentration of cargo flows to certain ports with no alternatives.

This report was written as a part of the research project STOCA – Study of cargo flows in the Gulf of Finland in emergency situations, financed by the Central Baltic INTERREG IV A Programme 2007–2013 of the European Union Regional Development Fund, Regional Council of Southwest Finland, Estonian Maritime Academy, and National Emergency Supply Agency (NESA). The research was carried out by Ph.D. Johanna Yliskylä-Peuralahti, Ph.D. Mattias Spies and researcher Alexander Kämärä from the Centre for Maritime Studies of the University of Turku supported by Professor Ulla Tapaninen.

The Centre for Maritime Studies of the University of Turku expresses its gratitude to all those who took part in the interviews, and to other parties who have contributed to the drawing up of this report. In particular, National Emergency Supply Agency (NESA) has been active in the research with intensive guidance.

Kotka 30th March, 2011

Ulla Tapaninen
Professor
Centre for Maritime Studies

ABSTRACT

Maritime transports are very essential for Finland as over 80% of the foreign trade in the country is seaborne and possibilities to carry out these transports by are limited. Any disruption in maritime transports has negative consequences to many sectors in the Finnish economy. Maritime transport thus represents critical infrastructure for Finland. This report focuses on the importance of maritime transports on security of supply in Finland and for the so called critical industries in particular. The report summarizes the results of the Work Package 2 of the research project STOCA – “Study of cargo flows in the Gulf of Finland in emergency situations”. The aim of the research was to analyze the cargo flows and infrastructure that are vital for maintaining security of supply in Finland, as well as the consequences of disruptions in the maritime traffic for the Finnish critical industries and for the Finnish society.

In the report we give a presentation of the infrastructure and transport routes which are critical for maintaining security of supply in Finland. We discuss import dependency of the critical industries, and the importance of the Gulf of Finland ports for Finland. We assess vulnerabilities associated with the critical material flows of the critical industries, and possibilities for alternative routings in case either one or several of the ports in Finland would be closed. As a concrete example of a transport disruption we analyze the consequences of the Finnish stevedore strike at public ports (4.3.–19.3.2010). The strike stopped approximately 80% of the Finnish foreign trade. As a result of the strike Finnish companies could not export their products and/or import raw materials, components and spare parts, or other essential supplies. We carried out personal interviews with representatives of the companies in Finnish critical industries to find out about the problems caused by the strike, how companies carried out they transports and how they managed to continue their operations during the strike. Discussions with the representatives of the companies gave us very practical insights about companies’ preparedness towards transport disruptions in general.

Companies in the modern world are very vulnerable to transport disruptions because companies regardless of industries have tried to improve their performance by optimizing their resources and e.g. by reducing their inventory levels. At the same time they have become more and more dependent on continuous transports. Most companies involved in foreign trade have global operations and global supply chains, so any disruption anywhere in the world can have an impact on the operations of the company causing considerable financial loss. The volcanic eruption in Iceland in April 2010 stopping air traffic in the whole Northern Europe and most recently the earth quake causing a tsunami in Japan in March 2011 are examples of severe disruptions causing considerable negative impacts to companies’ supply chains. Even though the Finnish stevedore strike was a minor disruption compared to the natural catastrophes mentioned above, it showed the companies’ vulnerability to transport disruptions very concretely.

The Finnish stevedore strike gave a concrete learning experience of the importance of preventive planning for all Finnish companies: it made them re-think their practical preparedness towards transport risks and how they can continue with their daily operations despite the problems. Many companies realized they need to adapt their long-term coun-

termeasures against transport disruptions. During the strike companies did various actions to secure their supply chains. The companies raised their inventory levels before the strike began, they re-scheduled or postponed their deliveries, shifted customer orders between production plants among their company's production network or in the extreme case bought finished products from their competitor to fulfil their customers' order. Our results also show that possibilities to prepare against transport disruptions differ between industries.

The Finnish society as a whole is very dependent on imports of energy, various raw materials and other supplies needed by the different industries. For many of the Finnish companies in the export industries and e.g. in energy production maritime transport is the only transport mode the companies can use due to large volumes of materials transported or due to other characteristics of the goods. Therefore maritime transport cannot be replaced by any other transport mode. In addition, a significant amount of transports are concentrated in certain ports. From a security of supply perspective attention should be paid to finding ways to decrease import dependency and ensuring that companies in the critical industries can ensure the continuity of their operations.

TIIVISTELMÄ

Merikuljetuksilla on keskeinen merkitys Suomen kannalta, koska yli 80 % ulkomaankaupan kuljetuksista kulkee meritse ja mahdollisuudet hoitaa nämä kuljetukset maitse ovat hyvin rajalliset. Merikuljetuksia koskevat häiriöt voisivat tästä syystä vaikeuttaa monin eri tavoin taloudellista toimintaa maassamme. Merikuljetukset ovat siksi Suomen kriittisen infrastruktuurin keskeinen osa. Tässä raportissa tarkastellaan merikuljetusten merkitystä Suomen huoltovarmuudelle ja ns. huoltovarmuuskriittiselle tuotannolle. Raportti esittelee STOCA-hankkeen (Suomenlahden kuljetusvirrat poikkeusolosuhteissa) työpaketin 2 tulokset. Tutkimuksen tavoitteena oli analysoida huoltovarmuuden kannalta keskeiset lastivirrat ja kuljetusinfrastruktuuri sekä merikuljetuksessa tapahtuvien häiriöiden seuraukset yritysten ja yhteiskunnan toiminnan kannalta.

Raportissa esittelemme Suomen huoltovarmuuden kannalta keskeisen merikuljetusinfrastruktuurin ja kuljetusreitit. Tarkastelemme huoltovarmuuskriittisten toimialojen riippuvuutta tuonnista sekä erityisesti Suomenlahden satamien merkitystä huoltovarmuuden kannalta. Arvioimme yritysten kannalta keskeisiin tavaravirtoihin liittyviä haavoittuvuustekijöitä ja yritysten mahdollisuuksia käyttää vaihtoehtoisia kuljetusmuotoja ja -reittejä, mikäli yksi tai useampi Suomen satamista olisi suljettu. Käytännön esimerkkinä tarkastelemme kevään 2010 ahtaajien lakkoa (4.3.–19.3.2010) ja sen seurauksia yritysten toimintaan. Lakko pysäytti arviolta 80 % Suomen ulkomaankaupan kuljetuksista. Lakon seurauksena yritykset eivät voineet viedä tuotteitaan ulkomaille tai tuoda Suomeen tarvitsemiaan raaka-aineita, komponentteja, varaosia ja muita keskeisiä tarvikkeita. Selvitimme yrityshaastattelujen avulla, mitä ongelmia merikuljetusten pysähtyminen lakon vuoksi niille aiheutti, miten yritykset hoitivat kuljetuksensa ja miten ne pystyivät jatkamaan toimintaansa lakon ajan. Haastattelut antoivat paljon käytännöllistä tietoa siitä, miten yritykset ovat varautuneet kuljetuksia koskeviin häiriöihin.

Yritystoiminnan haavoittuvuus kuljetuksia koskeviin häiriöihin on kasvanut. Yritykset ovat pyrkineet tehostamaan toimintaansa ja resurssien käyttöään mm. pienentämällä varastojaan. Samalla ne ovat kuitenkin tulleet entistä riippuvaisemmiksi häiriöttömistä kuljetuksista. Useimmat ulkomaankauppaa käyvät yritykset toimivat maailmanlaajuisilla markkinoilla ja niiden hankinnat tapahtuvat globaalisti. Koska toimitusketjut ovat maailmanlaajuiset, mikä tahansa häiriö missä päin maailmaa tahansa voi kohdistua yritysten toimitusketjuihin vaikeuttaen yritysten toimintaa ja aiheuttaen huomattavia taloudellisia tappioita. Kevään 2010 tulivuorenpurkaus Islannissa ja sitä seurannut lentoliikenteen pysäyttäminen Pohjois-Euroopassa sekä maanjäristyksen aiheuttama tsunami Japanissa maaliskuussa 2011 ovat esimerkkejä vakavista, toimitusketjuihin merkittävästi vaikuttavista häiriötilanteista. Vaikka kevään 2010 ahtaajien lakko oli em. luonnonmullistuksiin verrattuna paljon pienempi häiriötilanne, lakko osoitti hyvin konkreettisesti yritysten miten riippuvaisia yritykset ovat keskeytymättömistä kuljetuksista.

Ahtaajien lakko toi yritysten kannalta esiin varautumisen tärkeyden: useat haastattelemamme yritysten edustajat havahtuivat lakon myötä huomaamaan, että yritysten tulisi varautua nykyistä paremmin kuljetushäiriöiden varalta ja että heidän tulisi tarkistaa toimintatapojaan tältä osin. Haastattelemamme yritykset pyrkivät varautumaan häiriöihin mm. täydentämällä varastojaan ennakkoon mahdollisuuksien mukaan, aikatauluttamalla

kuljetuksiaan uudelleen, toimittamalla tuotteet asiakkaille toisesta toimipaikasta ja ääritapauksessa jopa ostamalla asiakkailleen lupaamansa tuotteet kilpailijaltaan. Ahtaajien lakko osoitti myös käytännössä, että yritysten osalta varautumismahdollisuudet riippuvat hyvin paljon toimialasta ja toiminnan luonteesta.

Yhteiskunnan toiminta kokonaisuudessaan Suomessa on hyvin riippuvainen ulkomailta laivoilla tuotavista poltto- ja raaka-aineista sekä muista tarvikkeista. Monilla keskeisillä vientialoilla sekä mm. energiantuotannossa kuljetettavien raaka-aineiden ja muiden tarvikkeiden sekä asiakkaille toimitettavien tuotteiden määrät ovat niin suuret tai kuljetettavat tuotteet ovat ominaisuudeltaan sellaisia, että merikuljetusta ei voi korvata millään muulla kuljetusmuodolla. Merkittävä osa kuljetuksista on lisäksi keskittynyt tiettyihin satamiin. Huoltovarmuuden kannalta tuontiriippuvuuden vähentämiseen ja yritysten toiminnan jatkuvuuden turvaamiseen tulisi kiinnittää huomiota.

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1 INTRODUCTION

1.1 Background and key concepts

Transport infrastructure, and especially maritime transport, is critical for all Finnish industries, as over 80% of the Finnish foreign trade is transported by ships. Energy production, health care, food production and all main exporting industries are dependent on imported supplies transported by ships. Thus any failure in maritime transports can have very disruptive consequences not only to companies' supply chains but also to national security of supply and daily life of people in Finland.

Security of supply involves all the activities that are undertaken to secure a nations' functioning and the welfare of its citizens in case of major disturbances and emergency situations. Emphasis is on preventive measures (Valtioneuvoston päätös huoltovarmuuden tavoitteista 21.8.2008/539). Critical industries provide the necessary inputs and services a society is dependent on, including energy, food and health care, and they are an essential part of critical production. Critical infrastructure (CI) is a requirement for critical production. In this report we focus on selected critical industries, their material needs and dependency on maritime transport in Finland. We analyse the importance of each cargo flow for different actors: for the industries and companies therein that are the main users of the imported raw materials, critical value to other industries and users of the companies' finished products. We assess vulnerabilities associated with the critical material flows of the critical industries, both in terms of imported and exported materials that are transported through ports, and possibilities for alternative routings in cases of transport disruptions and emergencies. As a concrete example of a transport disruption we analyse the consequences of the Finnish longshoremen and stevedore strike at public ports (4.3.–19.3.2010). The strike stopped approximately 80% of the Finnish foreign trade. As a result of the strike Finnish companies could not export their products and/or import raw materials, components and spare parts. They had to find transport alternatives and ways to continue their operations. Discussions with the representatives of the companies on the subject how they managed to continue their operations during the strike and what problems they faced thus gave us very practical insights about companies' preparedness towards transport disruptions in general.

Critical infrastructure concept is helpful in analysing what infrastructure and assets are the most vital for society and its functions. The concept stresses interconnections and interdependencies within and across sectors in society, both between different industries as well as private and public users. This information helps to understand which industries and sectors in society would suffer the most if there is a breakdown, malfunction, lack of availability of certain materials or other assets or any other disturbance, and where (both geographical and organizational sense) the problems are likely to occur. While definitions of critical infrastructure vary, it is widely thought that a breakdown of one or more of these critical systems has the potential to cause very serious problems (Moteff 2005; Hagelstam 2005; Boin & McConnell 2007; Brunner & Suter 2008).

National Emergency Supply Agency (NESA) is responsible for coordinating measures for safeguarding continuity of critical infrastructure and critical production in Finland (figure 1.1). Critical infrastructure in Finland comprises of energy transmission and distribution networks, communication network, transport and logistics infrastructure and networks, water supply and other municipal services, as well as constructing and maintaining all these infrastructures. Ensuring the continuity of maritime transports, above all transports needed to secure energy and food supplies, are national priorities. This understanding underlines the importance of maritime transport for all industries, and therefore we have focused on how Finnish critical production industries are dependent on maritime transports. Critical production includes food supply, energy production, health care, production for national defense purposes and operational preconditions for export industry. All these activities are dependent on critical infrastructures (National Emergency Supply Agency 2009).

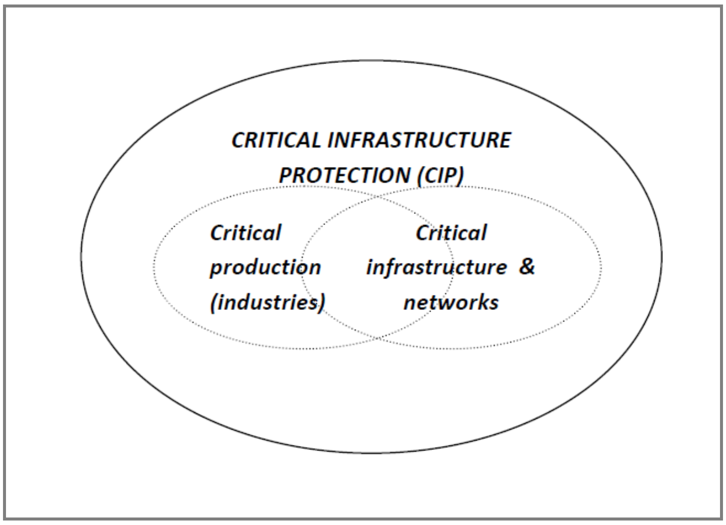

Figure 1.1. Critical infrastructure protection as a concept.

Hagelstam (2005) stresses that infrastructures are not critical for their own sake. Instead the societal functions, which are possible because of these infrastructures, are critical. In order to secure the critical infrastructure one needs to know, first, what functions are essential for society and its functioning and what infrastructures do they need. Then one can define the parts and components in different infrastructures that are critical for society solely and in connection with other infrastructures. Understanding the interconnections and interdependencies, and the geographic scale of the networks is important, because due to these linkages a disturbance in one sector can easily spread into other sectors and cross regional and national borders, causing cascading failures. It is also essential to build-up capacities to maintain resilience or capacities to recover from disruptions and emergencies (Rinaldi et al. 2001; Murray & Grubesic 2007; Grubesic & Matisziw 2008).

Critical infrastructure in our research has a double meaning. It refers firstly, to critical industries defined by NESA and the ports and the transport networks with goods flows these critical industries are using (table 1.1). Food supply, energy production and healthcare are critical because they provide the essential functions to society, whereas export industries are critical since they guarantee national income. None of these industries is self-sufficient in its material base, but the rate of export dependency varies between sectors, as we will show later in chapter 3. Since the critical industries are dependent on imported materials, the transport infrastructure represents a critical infrastructure for all these industries. Marine transport in particular is critical for Finland, as over 80% of foreign trade is dependent on it. Due to large volumes marine transport cannot be replaced by any other transport mode. Ports are an essential node in the transport network.

Table 1.1. Critical industry sectors and their imports. (NESA 2010)

Critical industry	***Main imported goods and materials***
Energy	Oil, gas, uranium, coal
Food sector	Pesticides, fertilisers and their raw materials, animal feed, agricultural machinery, chemicals, packaging materials
Health care	Pharmaceuticals, equipment, basic chemicals
Forestry industry	Timber, fillers, coating pigments
Chemical industry	Crude oil, basic chemicals, rubber
Technology industry	Metals, minerals, fuels

Secondly, we use the concept of critical infrastructure as an analytic tool to assess what should be protected *within* the critical industries. What are the imported critical supplies without these industries cannot function and how vulnerable the transport chains of these industries are? If there is a disturbance, for example a port is closed for some reason, what are the consequences to the industries that are dependent on foreign trade either in the form of imports or exports, and for the society?

In this report we are using the following definitions:

Critical infrastructure (CI): The EU definition for CI is the following: "critical infrastructure means an asset, system or part thereof located in Member States which is essential for the maintenance of vital societal functions, health, safety, security, economic or social well-being of people, and the disruption or destruction of which would have a significant impact in a Member State as a result of the failure to maintain those functions." Ocean and short-sea ports are classified as an essential part of the European critical infrastructure (European Council. Council Directive 2008/114EC)

Security of supply: National Emergency Supply Agency of Finland (NESA) defines the aim of the national security of supply policy the following way: "such a degree of preparation that the population's capacity to make a living, to carry out necessary economic activities, and to achieve the material preconditions for an effective national defence are not endangered." Security of supply includes ensuring functionality of society's critical systems and availability of critical materials. Concerning transports the aim is to ensure above all maritime transports and transports needed to secure energy and food supplies.

Transport system: a system which consists of different transport modes (sea, land and air), routes, nodes, and transport control systems for each of the modes.

Port infrastructure: in this report we use a broad definition of port infrastructure, which encompasses infrastructure and superstructure at the port area, maritime access infrastructure and land access infrastructures (figure 1.2). In addition, IT and waste management systems and systems used for management of safety and security at the ports are often included in the port infrastructure. Port area infrastructure includes berths, docks, basins, storage areas and internal connections within the port area. Port superstructure includes the equipment needed in loading and unloading operations of the cargo such as cranes and conveyors, stackers and forklifts, as well as areas for container stacking and storage of goods in the terminal areas. The port authority is usually responsible for construction and maintenance of the port infrastructure, whereas the state or a municipal government is responsible for the land access infrastructure, respectively. Responsibility for the maritime access infrastructure is usually divided between port and state or municipal authorities. Port superstructure assets are quite often privately owned (Nombela & Trujillo 2000).

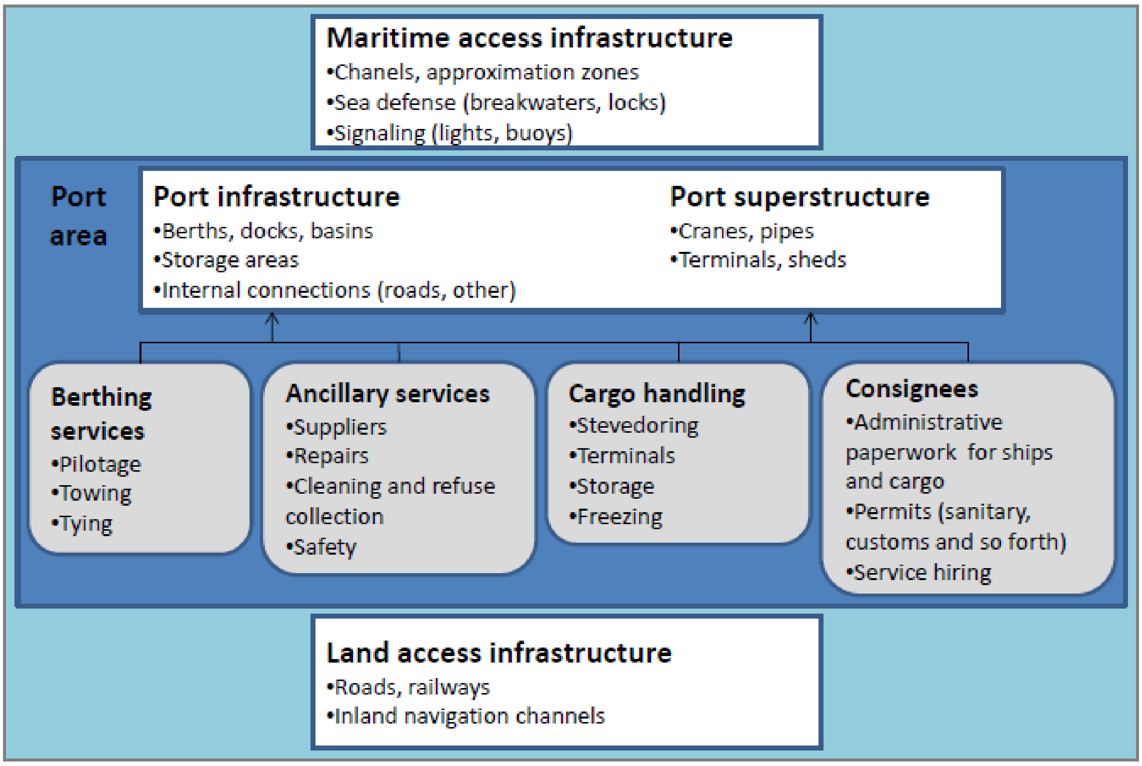

Figure 1.2. Port activities. (Estache & de Rus 2000; Nombela & Trujillo 2000, edited by authors)

Port capacity: port's maximum cargo handling capability (Fonteijn et al. 2006). The concept of the port capacity, although it might seem as self-explanatory, in reality is a rather complex one. The difficulty lies in calculating a realistic capacity. For instance, a port has a container terminal with the stated capacity of one million TEUs. Does this number represent the terminal's actual capacity with all the possible bottlenecks taken into account? Are there enough berths in the port? Is the draught of those berths deep enough? Is there adequate loading/unloading equipment? All of the above mentioned factors have an impact on port capacity. Consequently, in order for a port to achieve maximum potential capacity, all of its infrastructural elements have to be correspondently up-to-date (figure 1.3).

Loading capacity: can be measured in different ways: how many tonnes of goods can be handled in total in a certain terminal in a given measure of time (usually within a year), or how many tonnes of goods a certain loading equipment can handle e.g. within an hour. For goods in bulk form also storage capacity of silos is often given.

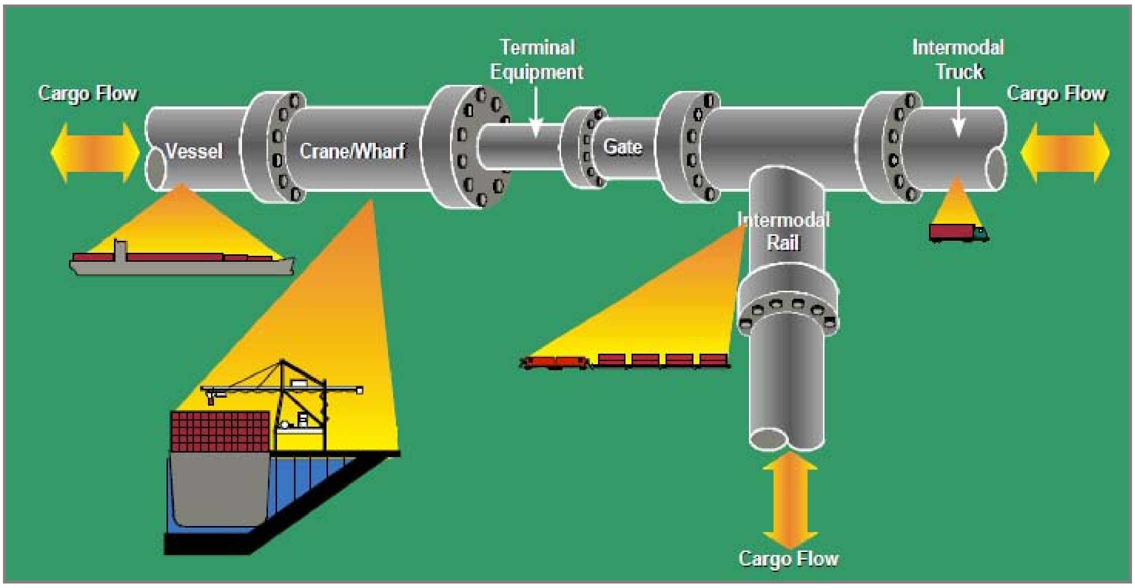

Figure 1.3. Container terminal throughput capacity. (Brennan 2011)

Alternative routing: is a measure of redirecting cargo traffic to another route in cases where the routing via regular channels is not possible. In our research, alternative routing is for the most part applied as redirecting traffic of specific cargo type from a primary port to an alternative port, if such alternative is present.

Operational pre-conditions for export industries: infrastructure and assets that are necessary for the export industries to function. Government can assist businesses by providing and or co-financing the infrastructure and assets, as well as having policies (e.g. financial, educational etc.) that ensure the industries stay competitive in the global markets (Prime Minister's Office 2008). In this report the preconditions refer above all to the maritime transport infrastructure the exporting companies are utilizing, and the distinct routes and nodes (e.g. a port) and physical infrastructure therein, but also to the way the logistics chains connected with exports are operating and their functionality.

Supply chain vulnerability: is "a susceptibility or predisposition to change or loss because of existing organisational or functional practices or conditions" in the operational environment of the supply chain (Barnes & Oloruntoba 2005; Wagner & Bode 2006). As a consequence, the operational performance of the system deteriorates (LOGHU 2008).

A disruption: is a sudden event that interrupts the material flows in the supply chain stopping movement of goods causing negative consequences (Svensson 2000; Kleindorfer & Saad 2005; Craighead et. al 2007; Wilson 2007).

An emergency: is a situation which poses an immediate risk to health, life, property or environment. Most emergencies require urgent intervention to prevent a worsening of the situation (into a crisis), however, usually the impacted area is fairly small and emergency services can train how to operate in these circumstances. An emergency situation could be e.g. an accident at a seaport, grounding or collision of a ship at sea causing oil spill (Boin & McConnell 2007).

Crisis: larger in magnitude and character compared to emergencies, requiring immediate actions. A crisis is an event or a failure with severe consequences that threaten the security of a whole nation or functioning of life sustaining systems (Boin & McConnell 2007). An example of crisis could be the humanitarian crisis caused by an earthquake in Haiti in the year 2010.

It should be noted that safeguarding critical infrastructure includes a paradox. While governments are usually legally responsible for safeguarding the vital societal functions and the critical infrastructure (CI) associated with them most of the critical infrastructure are owned, administered and operated by the private sector. Government authorities thus lack the authority, expertise and the means to control these critical operations (Pursiainen 2009; CRN Report 2009). This is the case in maritime transport, where private shipping companies, ship-owners, port and terminal operators, freight forwarders, and other private actors are responsible for the transport chain. Therefore it is vital to know the potential vulnerabilities of the private companies towards transport risks and their rate of preparedness. Government authorities do intervene in critical infrastructure operations in severe emergency or crisis situations, but these severe events are out of the scope of the STOCA project.

1.2 Aims of the research

The purpose of our research is to assess maritime transport dependency of the critical industries in Finland and describe, explain and understand how the companies in these industries have prepared for transport disruptions. In this report we answer the following research questions:

1. How vulnerable and prepared are the crucial sectors in Finland in terms of supply security when it comes to interruptions of cargo flows in ports? Are the supplies needed for these industries difficult to maintain or not?
2. What would be the possible alternative routes for critical supplies in cases of emergency? Which ports would have the adequate infrastructure, as well as capacities to handle traffic from another port? Are there many ports available or not for the crucial cargo streams in terms of port infrastructure and capacities?
3. How have the companies ensured they can continue operating despite disruptions? How do they inform their suppliers and clients?

1.3 Structure of the report

This report was written as a part of the research project STOCA – Study of cargo flows in the Gulf of Finland in emergency situations, financed by the Central Baltic INTERREG IV A Programme 2007–2013 of the European Union Regional Development Fund, Regional Council of Southwest Finland, Estonian Maritime Academy, and National Emergency Supply Agency (NESA). The STOCA project focuses on improved sustainable accessibility and transport of cargoes in the Baltic Sea region, with emphasis in particular on economical and environmentally sustainable cargo transportation in emergency situations. The publication reflects the views of the authors. The Managing Authority of the INTERREG Central Baltic IV A Programme cannot be held liable for the information published in this report.

The report focuses on the importance of maritime transports on security of supply in Finland and for the so called critical industries in particular. The report has five main chapters. In chapter 2 we present the data and methods we have used in this study. We conducted altogether 19 interviews with companies in the critical industries (chapter 2.1) and a phone/e-mail survey with port operators having operations in the Gulf of Finland ports (chapter 2.2). The interviews and the survey together with written documents and official statistics comprise the main data for this research. In addition, we collected data on the Gulf of Finland ports in order to assess possibilities to re-route cargo flows. Chapter 3 contains presentation of the infrastructure and transport routes which are critical for Finland and Finnish critical industries. We discuss import dependency of the critical industries (chapter 3.1), and the importance of the Gulf of Finland ports for Finland and the characteristics of these ports (chapter 3.2). In chapter 4 we discuss our empirical findings: possibilities for the port operators to redirect cargo (chapter 4.1), transport routes and main ports for the transports the main supplies the Finnish critical industries are using and their transport alternatives (chapter 4.2), and how transports are organized in the companies we interviewed, including routes and modes used in a normal situation and their alternatives (chapter 4.3). Based on interviews with the representatives of the critical industries we show vulnerabilities of critical industries towards maritime transport risks and discuss ways of coping during the stevedore strike in particular and preparedness to risks and resilience capacities in general (chapters 4.4 and 4.5), and societal implications for security of supply (chapter 4.6). Summary and conclusions is provided in chapter 5.

2 DATA AND METHODS

2.1 Interviews with representatives of the Finnish critical industries

The results discussed in this report are based on a qualitative study. Our main data are company interviews, and the results discussed later in this report are based on content analysis of the interviews of the representatives of the companies in critical industries as well as written documents to assess the dependency of the Finnish society on imported supplies. When selecting industries to be included to this study and company cases to be interviewed, we have followed NESA's definition of critical sectors, excluding national defense. National defense was excluded because of its specialized character. Information concerning defense related industries and operations is not publicly available, and in this report we rely on publicly available sources. Therefore, critical industries analyzed in this report include energy production, food sector, healthcare and export industries, of which forestry, technology and chemical industries form the main groups investigated. Within the technology industry we have chosen companies with large volumes and for which maritime transport is the only suitable transport mode. In the technology industry especially metal, mining and mechanical engineering have the type of cargo (e.g. weighty raw materials such as ores and metal concentrates and scrap, large and heavy project shipments including gantry cranes, large engines and turbines and other parts of machinery) that can only be transported by a ship. Critical supplies needed for food production analyzed here include rape seeds and soya used for animal feeds for their protein content, and imported grain needed for food industry. We have also included exports of meat and milk products into our analysis. Chemical industry has many subsectors, and when selecting companies to be interviewed we have tried to include at least one from every subgroup. It should be noted that supplies needed in electronics industry, biotechnology and also certain supplies needed in healthcare are mainly transported by air. One should keep in mind that as local markets in Finland are small, the whole Finnish economy is very export oriented, and all the companies included in our study export either their products or services.

We conducted 19 semi-structured personal interviews during the period 25.3.–11.6.2010, and we have also used written sources to complement and double check the information our interviewees gave us. Companies included in this study were selected the following way: we first identified 1–3 potential primary companies in each of the critical industries as well as secondary options, in case the representatives of the primary companies would refuse to be interviewed. Then we sent the list to NESA for comments. The interviewees received the list of questions by e-mail before interviews, along with a motivation letter describing the purpose of the research (appendix 2). We sent the message directly to logistics/transport managers of the companies if we had their contact information. Alternatively, we contacted the managing director and asked him/her to forward our message to a suitable person in the respective organisation. Thereafter we contacted each person by phone to ask his/her interest to participate our study, and the suitable date and time of the interview. Most of the companies were willing to participate, and only three companies refused.

The interviews were conducted at the premises of the companies and taped on the permission of the interviewees. Interviews lasted approximately an hour. Five interviews were group situations, where several persons from the same organization were present. The companies included in the research (table 2.1) are among the main users of ports in Finland, transporting considerable volumes. All of the companies have international sales and several production sites outside Finland, and with the exception of five companies they all are publicly listed. Eleven of the companies have their headquarters in Finland, 6 of the companies are affiliates of foreign-owned companies, 2 affiliates of Finnish-owned corporations.

Table 2.1. Industries included in the research. (annual reports of the companies 2009)

Industry	***Number of companies***	***Of which public***	***Number of employees***	***Turnover 2009***	***Number of sites outside Finland***
Energy production	2	2	5 000−14 000	5−10 billion €	10−20
Food supply & food exports	5	2	1 000−10 000	< 5 billion €	< 10
Chemicals (info on 1 company not available)	4	2	5 000−10 000	< 5 billion €	10−50
Pharmaceuticals & healthcare supplies	4	3	1 000−10 000	1−10 billion €	10−20
Logistics/ freight forwarding	1		> 15 000 (globally)	11−30 billion €	> 100
Forestry	1	1	> 15 000	5−10 billion €	> 10
Metals	1	1	5 000−14 000	< 5 billion €	> 20
Electronics (whole corp.)	1	1	> 100 000	> 30 billion	> 100

(Note: As the number of companies was small, their number of employees and annual turnover have been expressed as a class so that individual companies could not be recognized. Data on affiliates of multinational corporations was not available separately, and we have used figures for the whole corporation.)

Themes discussed during the interviews included (interview protocol, appendix 1):

- Transport routes and modes used, volumes of materials transported and most important ports
- Management of problems and disruptions: How did the companies prepare themselves to a situation where the transport mode or route they normally use cannot be used, and what alternatives they had during the strike? How did the companies ensure their continuous operation despite disruptions? How did they inform their suppliers and clients?
- Strategic position of the respective company in the markets and in its supply chain: how specialized is the production (e.g. each factory produces certain products only), how much flexibility does it have in its sourcing and is it e.g. the sole supplier to its clients?

Our analysis of the interview material is based on classifying the contents of the interviews according to above mentioned themes and finding similarities and differences between different company cases.

2.2 Survey with port operators

In addition to personal interviews carried out with representatives of the companies in the Finnish critical industries, a phone/e-mail survey with the port operators operating at the largest ports located on the Gulf of Finland (Hamina, Kotka, Port of Helsinki/Vuosaari, Hanko, Turku and Naantali) was conducted in December 2010 – January 2011. The main goal of the survey was to assess how the stevedoring companies would operate under the conditions, where a port's normal activity is partially or completely stopped due to a disruption such as a port workers' strike, or a more severe industrial accident of a greater magnitude. The magnitude of the disruption varied from affecting one particular port to creating disturbance of greater proportions, thus, affecting the operability of all major ports in the country. Examples of emergency situations could be a major chemical spill, natural catastrophe etc.

Twelve port operator companies were selected for interviewing and their chief operating officers (COOs) or representatives of similar positions were contacted via e-mail (appendix 3, contact message) and presented with the opportunity to answer our questions via telephone or via e-mail (appendix 4, survey questions). The criteria by which the companies were selected for the interview, was the extent of their activities in the main Finnish ports. Larger port operator companies as well as companies having operations in several ports at were particularly interesting to us, because of their capability of handling greater cargo volumes. Out of the twelve companies five agreed to provide answers, out of those, two operators preferred to answer via e-mail and the rest agreed to the telephone interview. All their answers were processed anonymously. Results of the survey are presented in chapter 3.5.

3 INFRASTRUCTURE AND TRANSPORT ROUTES OF FINNISH CRITICAL INDUSTRIES

3.1 Import dependency of the critical industries

Most of the critical industries in Finland are very dependent on imported raw materials or other supplies, but the rate of import dependency varies between sectors. For example 100% of the crude oil, coal, uranium and natural gas, 100% of the pesticides needed in agriculture, 70% of the raw materials for animal feed and 80% of the pharmaceuticals are imported. The health care sector is also dependent on imported equipment and basic chemicals (table 3.1). Many critical products for the health care, including infusion liquids, antibiotics and vaccines, are no longer produced in Finland at all (Sosiaali- ja terveysministeriö 2004.) Exporting industries import various raw materials, such as basic and other chemicals, products from mining and quarrying, components, and packing materials. Due to the import dependency, the transport infrastructure represents a critical infrastructure for all Finnish industries. Especially maritime transport is critical for Finland, as over 80% of foreign trade is dependent on it (Finnish Customs 2010a; Finnish Customs 2010b). Because of its large volumes, maritime transport cannot be replaced by any other transport mode. Rail traffic has a central role in trade with Russia, especially in raw material imports. In domestic transports road traffic dominates (Lumijärvi & Tapaninen 2009).

Table 3.1. Critical industry sectors in Finland and their main imports.

Critical industry	***Main imported goods and materials***	***Rate of import dependency (%)***
Energy	Oil, gas, uranium, coal	Crude oil, uranium, coal, natural gas 100 % - Share of imports in all energy production 65% - Electricity: 15–20%
Food sector	Pesticides, fertilisers and their raw materials, animal feed, agricultural machinery, chemicals, packaging materials Raw materials for the foodstuffs Packing materials	- Pesticides 100% - Fertilizers (surplus approx. 50%) - Ammonia & noble metal catalyst used in fertilizer production 100% - Animal feed (soya protein): 70% - Machinery 45 % - Raw materials for foodstuffs 20% - Food sold for consumers 30% - Packing materials
Health care	Pharmaceuticals, equipment, chemicals	- Raw materials for pharmaceutical production 90% - Pharmaceuticals 85% - Equipment 70% - Packing materials
Forestry industry	Timber, fillers, coating pigments	- Timber: 10–23 % - Fillers (kaolin): 70% - Pigments
Chemical industry	Crude oil, basic chemicals, rubber	- Crude oil 100% - Basic chemicals - Rubber 100%
Technology industry	Components and parts, metals, minerals, fuels	- Components & parts - Iron concentrate 100% - Copper, nickel & zinc concentrate - Components and other raw materials

Sources: Huoltovarmuuskeskus 2009; Manni & Riipinen 2002; Simola 2010; HE 151/2008; Sundberg 2009; Työ- ja elinkeinoministeriö 2008; Työ- ja elinkeinoministeriö & ELY-keskukset 2010

The general structure of Finnish imports and exports can be seen in table 3.2. Nearly half of Finnish imports are materials for manufacturing industries, consisting mainly of raw materials including chemicals and chemical industry products, products of mining and quarrying, electric and electronic industry products, and machinery. These same industries and forestry have also the largest share in exports. The share of high technology products in the year 2009 was 14% of both imports and exports (National Board of Customs 2010c). Next we give an overview of each of the critical industries in Finland, with an emphasis on industries with largest share of imports and exports.

Table 3.2. Finnish imports and exports 2009. (Finnish Customs 2010; EK 2011a & EK 2011b)

Imports	***€ million***	***%***
Chemical industry products	7 731	17.8
Electric and electronics industry products	7 170	16.5
Products from mining and quarrying	6 066	14.0
Machinery and equipment	3 892	9.0
Transport equipment	3 658	8.4
Other	14 922	34.3

Exports	***€ million***	***%***
Electric and electronics industry products	9 273	20.6
Forest industry products	8 673	19.3
Chemical industry products	7 775	17.3
Machinery and equipment	6 611	14.7
Metal and metal products	4 979	11.1
Other	7 678	17.1

Finnish forestry industry can be divided into two: production of pulp and paper and wood product industry. Both of these industries use domestic wood as a raw material, but pulp and paper industry also uses imported timber, mainly from Russia. The share of timber imports has varied between 12% and 23% (Maa- ja metsätalousministeriö 2008; Hetemäki 2009) In addition, pulp and paper industry is dependent on imports of fillers and coating pigments (table 3.1). The share of domestic minerals in paper production in Finland is approximately 30% (Työ- ja elinkeinoministeriö & ELY-keskukset 2010).

The Finnish chemical industry is very dependent on imported raw materials, of which crude oil comprises one of the most crucial (table 3.1, page 19). The largest commodity groups produced by the industry in Finland when measured by value are oil products, basic chemicals, plastic products, medicals and medicinal products, and rubber products (figure 3.1). Basic chemicals include ammonia, acids, bases, fertilizers and organic fine chemicals. The most important of them include sulphates, hydrochloric acid, sulphuric acid, nitric acid and phosphorus acid, chlorine and chlorine-alkali products, sodium hydroxide or caustic soda, and sodium bicarbonate. In addition, industrial gases form an important commodity group. For chemical industry nearly 3/4 of the production is exported either directly or the products are used as raw materials or semi-products by other industries which then export the finished products. Main products exported from

Finland in terms of value include titanium oxide used for pigments, pharmaceuticals, plastic materials such as polypropene and polyethene, phenols used as raw material for plastics, carboxymethyl cellulose used as thickener as well as in detergents and paper products, and enzymes (Finnish Chemical Industry; Sundberg 2009).

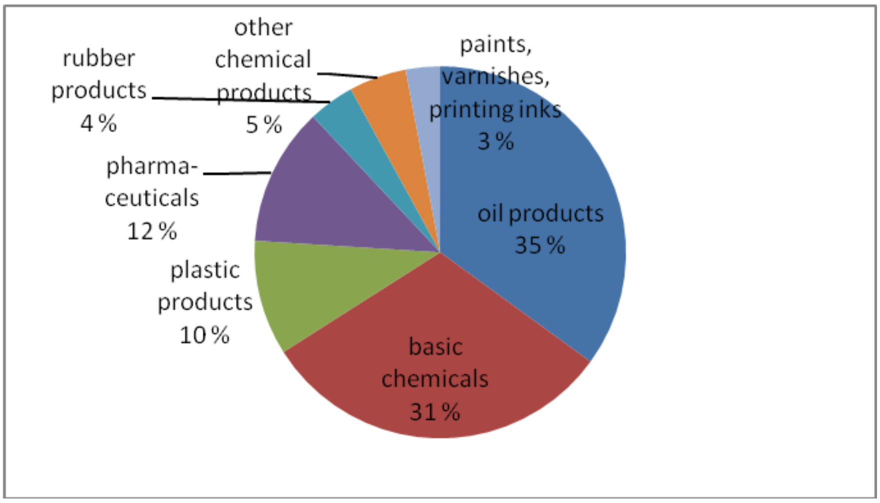

Figure 3.1. Main commodity groups exported by the Finnish chemical industry in the year 2009. (Finnish Chemical industry 2010)

Technology industry in Finland has four main branches: electronics and electrotechnical industry (including information technology), mechanical engineering, and metals industry (figure 3.2). Main products exported include electronics products and instruments (including telecommunications equipment, electromachinery and equipment, electric motors and generators), machines and equipment (including transport equipment, mining and construction machines, paper machines, lifting and handling equipment, engines and turbines, motor vehicles), and steel products and non-ferrous metals. In addition, Finnish companies in the health care technology sector export their products globally, and the companies have a strong position in their own branch. These branches include electric diagnostic (MRI) and patient monitoring devices, x-ray devices used in dentistry, surgical & dentistry instruments, devices and reagents used *in vitro* diagnostics, and ICT applications for the health care (Teknologiateollisuus 2007; The Federation of Finnish Technology Industries 2010). Components, parts, metals, minerals, concentrates, metal scrap and fuels are the most important raw material for the industry (table 3.1). Most of the metals and minerals are imported even though Finland has also own mineral deposits and production, both in metal minerals (mainly nickel, copper, cobalt, zinc and noble metals, also lithium and titanium), and industrial minerals such as limestone, quartz, feldspar, kaolin/illite and talc (tables 3.3, 3.4 & 3.5; Sundberg 2009; Työ- ja elinkeinomisteriö & ELY-keskukset 2010).

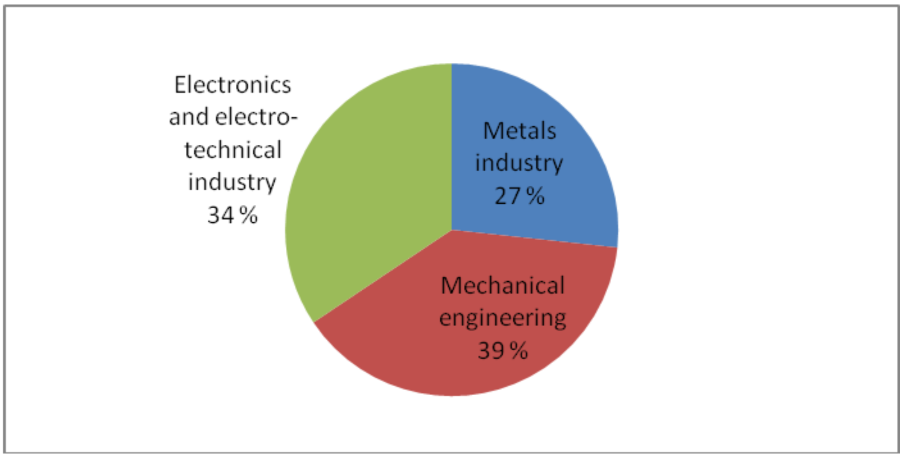

Figure 3.2. Main branches of the Finnish technology industry. (Finnish technology Industry 2010)

The Finnish mining industry has developed in recent years. The global prices for metals have been increasing and as a result new mines have been (table 3.3) and will be opened in Finland (table 3.4). The new mines will provide noble and metal minerals of which some are strategic for the whole EU. The following elements have been listed as strategic in the EU: antimony, beryllium, magnesium, fluor, gallium, germanium, graphite, rare alkali earth metals (scandium, yttrium & lanthanides), indium, cobalt, niobium, metals in the platinum group, tantalum and tungsten. Finnish bedrock contains some of them (TEM 2010; USGS 2002).

Table 3.3. Metal mines in operation in Finland in the year 2010. (TEM 2010)

The location of the mine	***Main corporation/ affiliated company***	***Main ores***
Suurikuusikko, Kittilä	Agnico-Eagle Mining Ltd/ Agnico-Eagle Finland Oy	Gold
Hitura, Nivala	Belvedere Resources Ltd/Belvedere Mining Oy	Nickel, copper, cobalt, platinum, palladium
Paahtavaara, Sodankylä	Lappland Golminers AB/Lappland Goldminers Oy	Gold
Keminmaa, Kemi	Outokumpu Oyj/Outokumpu Chrome Oy	Chrome
Jokisivu, Huittinen	Dragon Mining Ltd/Polar Mining Oy	Gold
Orivesi	Dragon Mining Ltd/Polar Mining Oy	Gold
Pyhäsalmi	Inmet Mining Corp./Pyhäsalmi Mine Oy	Copper, zinc, sodium, silver, gold
Talvivaara, Sotkamo	Talvivaara Kaivososakeyhtiö Oyj/Talvivaara Sotkamo Oy	Nickel, zinc (uranium)

Table 3.4. New mines starting construction in the year 2010. (TEM 2010)

The location of the mine	***Main corporation/affiliated company***	***Main ores***
Pampalo, Ilomantsi	Endomines AB/Endomines Oy	Gold
Keivitsa, Sodankylä	First Quantum Minerals Ltd/ Keivitsa Mining Oy	Copper, nickel, platinum group metals, gold
Kylylahti, Polvijärvi	Altona Mining Ltd/Kylylahti Copper Oy	Copper, cobalt, nickel, zinc
Laivakangas, Raahe	Nordic Mines AB/Nordic Mines Oy	Gold

Table 3.5. Industrial minerals imported to and exported from Finland in the year 2009. (TEM 2010)

Industrial mineral	***Imported to Finland (tonnes)***	***Exported from Finland (tonnes)***
Kaolin	729 132	13 830
Limestone used in smelting	1 264 737	2 154
Non-hydrated limestone	122 604	45 204
Hydrated limestone (calcium hydroxide)	10 568	477
Hydraulic limestone	2	0
Altogether	**2 127 042**	**61 665**

Table 3.6. Metal ores imported to Finland, and metals and metal products produced in Finland in the year 2009. (TEM 2010)

Ore	***Imported to Finland (tonnes)***
Iron ore and concentrate	2 204 018
Copper ore and concentrate	352 370
Nickel ore and concentrate	185 202
Cobalt ore and concentrate	15 173
Zink ore and concentrate	532 036
Other ores and concentrates	42 403
Altogether	**3 331 202**

Table 3.7. Metals and metal products produced in Finland in the year 2009. (TEM 2010)

Metal/metal product	***Amount of production***
Steel billets (tonnes)	3 066
Pig iron (2008) (tonnes)	2 943
Ferrocrome (tonnes)	123 000
Zink (tonnes)	295 049
Catode copper (tonnes)	105 411
Catode nickel (tonnes)	44 556
Cobalt products (tonnes)	8 970
Mercury (kg)	6 210
Selenium (kg)	57 040
Silver (kg)	70 062
Gold (kg)	5 749

Finnish manufacturing industries, especially metal refining and forestry, are very energy intensive. Therefore availability of energy is essential. Figure 3.3 shows the Finnish energy consumption by energy sources in the year 2009.

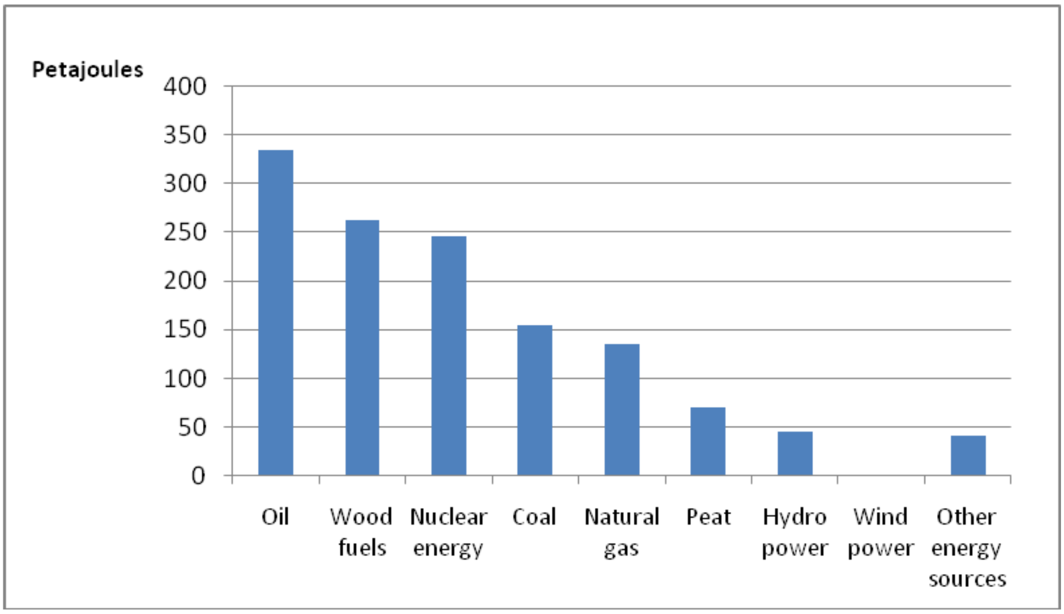

Figure 3.3. Finnish energy consumption by energy sources in the year 2009 (preliminary data). (Statistics Finland 2010a)

The main sources of energy in Finland are oil, wood fuels, nuclear energy, coal, and natural gas (figure 3.3). With the exception of wood, all of the other main sources of energy are based on imports, and over 2/3 of all energy consumed in Finland is imported. Finland is thus very dependent on energy imports (Työ- ja elinkeinoministeriö 2008). The share of domestic and renewable energy sources (peat, hydro power and wind) has increased over the years, but is still rather marginal.

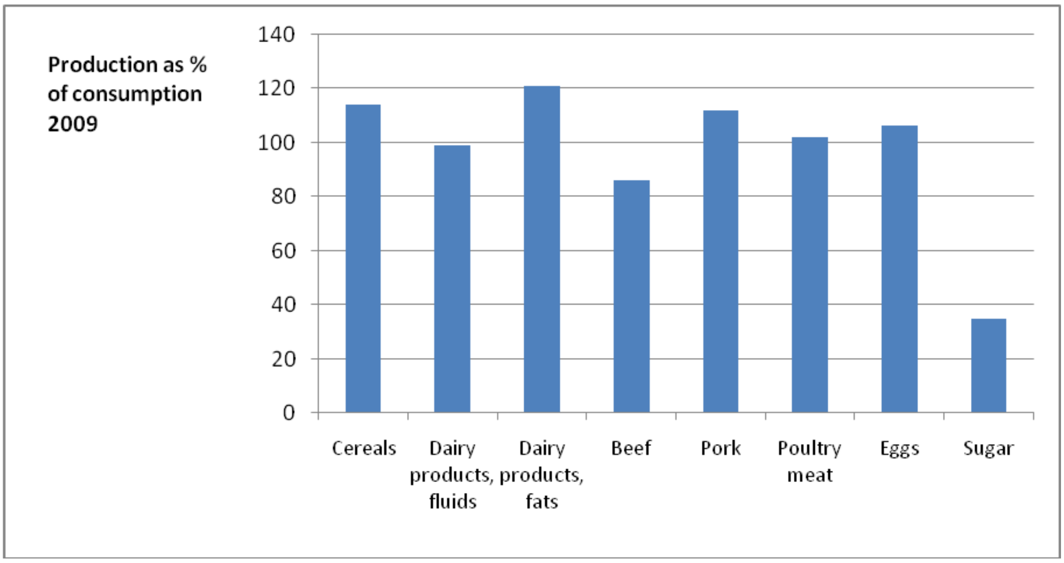

Figure 3.4. Self sufficiency in foodstuffs in Finland in the year 2009. (Statistics Finland 2010b)

Food production industry in Finland uses mainly (85%) domestic raw material, but as figure 3.4 shows, cereals (wheat, rye, oil crops) beef and sugar are the main groups with undersupply. Food industry is also dependent on imported chemicals, raw materials and materials for packaging. Approximately 30% of food supplies sold in Finland are imported and 20% raw materials of foodstuffs produced in Finland are imported. Food imports mainly consist of fruit and vegetables, beverages, coffee and cocoa products (Finnish Customs 2010b).

In conclusion, Finland society is very dependent on imports in many respects, as majority of the critical industries are dependent on imported supplies. The role of the Finnish port sector is particularly prominent in supplying the critical production industries. Based on table 3.1 (page 19), figure 3.5 depicts interconnections between the Finnish critical industries. Some of the critical assets, including chemicals, round wood, metals and minerals, human resources, crude oil and gas, and coal are depicted in the middle. For example, crude oil is used as a source of energy in transports, industrial processes and heating, and as a raw material in chemical industry e.g. in the production of plastic products, synthetic rubber and lubricants.

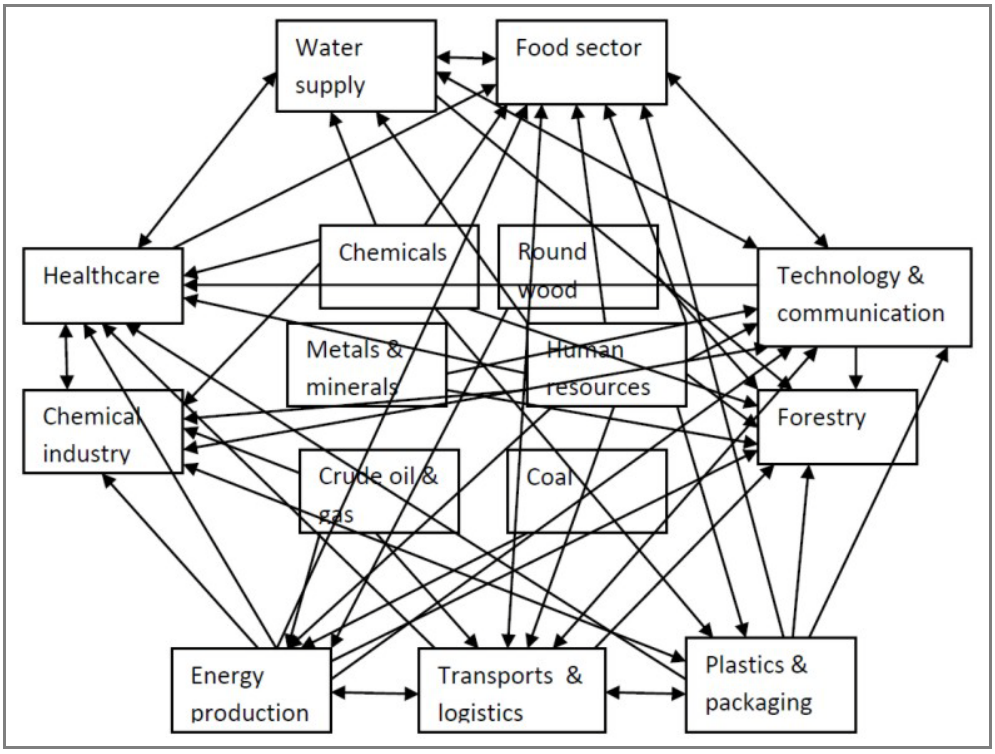

Figure 3.5. Interconnections with the critical industries.

The fact that all critical industries are tightly linked and thus depend on each other, furthermore stresses the importance of ports and maritime transports. Due to this dependency-based relationship any failure or disruption, like a breakdown in the supply chain in one industry might interrupt the continuity of a production in the other. Next we will assess the importance of the Gulf of Finland ports for the Finnish security of supply and possibilities to redirect the cargo flows.

3.2 Gulf of Finland Ports

Foreign trade in Finland is geographically concentrated in the largest ports and to certain logistics routes, which thus form the backbone of the transport infrastructure the critical industries are using. Both in exports and imports the five largest ports handle over half of the total foreign trade and the share of the 10 largest ports is 78% of the total volumes (Finnish Transport Agency 2010, figure 3.6). Three of these largest ports, Kilpilahti, Kotka and Helsinki are located on the Gulf of Finland, serving the most densely populated area of Southern Finland (figure 3.7). There are thus potential risks in terms of concentration of the largest volumes. The critical question thus is, are other ports capable of handling the traffic in case one of these main ports would be closed?

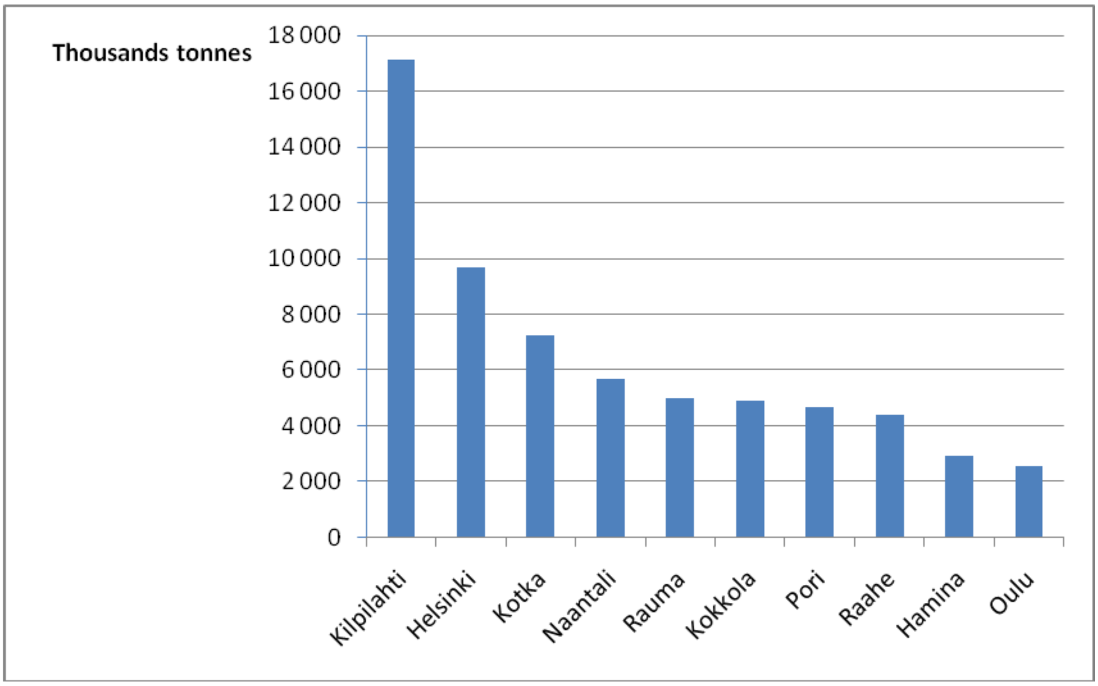

Figure 3.6. The largest ports in Finland 2009, total volumes imported & exported (millions of tonnes). (Finnish Transport Agency 2010)

Since the port sector plays a major role in supporting a continuous production within the critical industries, consequently affecting a country's whole economy and welfare of its citizens, the largest ports located on the Gulf of Finland (Sköldvik, Kotka, Hamina, Vuosaari Harbour at the Port of Helsinki, Hanko, Turku and Naantali) were selected for a closer study. The information presented below concerning each of these ports was gathered from the ports' official websites, port handbooks and by contacting port officials.

Figure 3.7. Ports of Finland. (Shell PSG 2011, edited by authors)

3.2.1 Port of Kilpilahti

The port of Sköldvik or Kilpilahti is located in the close proximity to the city of Porvoo in the Kilpilahti industrial area. It is the biggest Finnish port by cargo volumes and has Finland's deepest access channels of 15.3 m. Port's annual cargo turnover is approximately 20 million tonnes resulting in approximately 1 250 ship calls a year or up to four ships per day. These volumes consist almost solely of liquid bulk, chemicals and gases. The port has five oil berths, two berths for chemical products and gases, and one berth for dry bulk. Largest ships, which visit the port, can carry as much as 150 tonnes of crude oil. Tankers spend on average 16−18 hours in the port (Pietilä 2009; Neste Oil 2010a).

Port equipment at the Port of Kilpilahti are able to pump up to 10 000 m^3 of crude oil per hour during unloading procedure, while loading is significantly slower, only 2 500 m^3 per hour. Loading and unloading of raw materials for lubricants is notably slower, since a pipe's maximum throughput is approximately 400−500 m^3 per hour. Chemicals are transferred yet at an even slower rate, only 100 m^3 per hour. Products are transferred to ships via pipes by a land-based pump, while ship's own pumps are responsible for product unloading. The loading pipes are equipped with special joints, which allow the pipes to be flexible and to adjust to the ship's movement. Personnel of around 80 people take care of almost the whole facility (Pietilä 2009). Presumably port's capacity depends greatly on the refinery's own refining capacity, which is approximately 12 million tonnes of petroleum products a year (Neste oil 2010b).

Table 3.8. Cargo turnover at the port of Kilpilahti in the year 2009. (Finnish Transport Agency 2010; Särkijärvi et al. 2010)

Kilpilahti	
TOTAL TRAFFIC (t)	20 787 000
International traffic (t)	17 139 000
Import (t)	10 831 000
Export (t)	6 308 000
Transit traffic (t)	0
Dry bulk	0
Liquid bulk	16 970 000
Other dry cargo	169 000
Containers (TEU)	0
Domestic traffic (t)	3 648 000
Ship calls (total)	1 130

3.2.2 Port of Kotka

Port of Kotka is widely known as Finland's major export port serving Finland's and Russia's exporting needs. By volumes (measured in tonnes) handled it was the third largest port in Finland in the year 2009, after Kilpilahti and Helsinki (figure 3.7). In the year 2010 port of Kotka was the largest general port in Finland by annual cargo turnover. The total turnover of 2010 was 11.3 million tonnes, which is 0.4 million tonnes more than in the port of Helsinki and 50.5% more than the annual turnover of 2009 (table 3.9) (Häkkinen 2011). The port of Kotka is capable of handling vast variety of cargoes including coal, forest industry products, chemicals, ro-ro cargoes and containers. The port consists of the three major areas: Mussalo Harbour, which is a full-service harbour, ro-ro oriented Hietanen Harbour and the port's oldest area Kantasatama Harbour. The latter in its turn has been divided into two parts, where one part continues to serve as a commercial harbour and the other serves as a cultural area, which has the newly constructed Vellamo Maritime Centre–Maritime Museum of Finland, Kymenlaakso Provincial Museum and Information Centre under one roof (Maritime Centre Vellamo 2010; Port of Kotka 2010). Today most of the port's activities take place at the Mussalo and Hietanen harbour areas.

Table 3.9. Cargo turnover at the port of Kotka in the year 2009. (Finnish Transport Agency 2010; Särkijärvi et al. 2010)

Kotka	
TOTAL TRAFFIC (t)	7 532 000
International traffic (t)	7 251 000
Import (t)	2 170 000
Export (t)	5 081 000
Transit traffic (t)	2 010 000
Dry bulk	1 279 000
Liquid bulk	701 000
Other dry cargo	5 270 000
Containers (TEU)	340 700
Domestic traffic (t)	281 000
Ship calls (total)	1 760

Mussalo harbour at the Port of Kotka, as already mentioned above, is the full-service harbour. It consists of container, bulk and liquid terminals. Mussalo's container terminal's reported annual capacity is one million TEUs. In 2010 terminal has handled 397 275 TEUs, which is 14.8% more than in the year 2009. Bulk terminal is a major importer of the supplies for the Finnish paper industry. Besides that the terminal is also handling numerous other bulk cargoes, such as scrap metals, granite, cereals and project cargoes. Liquid terminal, in its turn, serves the needs of Russia's export of chemical products to the west (Port of Kotka 2010). Perhaps the most important ongoing project in Mussalo is the expansion of Kotolahti railway yard. In the past, accommodation of longer trains in the railway yard has been difficult. By its completion in 2011, the expanded railway yard is able to handle greater operational loads, which in turn improves the overall performance of the port of Kotka (Aro 2010).

Table 3.10.. Key features of the terminals at the Mussalo harbour. (Port of Kotka 2011)

	Containers	***Dry bulk***	***Liquid bulk***
Draught (m)	10.0–12.0	13.5–15.3	10.0–13.5
Quays (m)	1 792	600	
Number of berths	12	4	2
Cranes/Other	7 pcs 30–40 t, 1pcs mobile crane	3 pcs 40 t, 1 pcs 8 t	
Storage space	IMDG field 7 000 m^2	Covered 50 000 m^2	Storage tanks 241 500 m^3

Hietanen harbour at the Port of Kotka is responsible for handling ro-ro cargoes as well as transit traffic of cars exported to Russia. In the year 2010 approximately 100 000 cars went through the Hietanen harbour which was 25% more than in the year 2009. In the same year almost 15 000 ro-ro units were handled at the Hietanen harbour, which was 39% less than in the year 2009. Obviously those numbers are nowhere near the harbour's maximum capacity, since for instance in the year 2006 the port of Kotka handled over 200 000 cars (Port of Kotka, cargo statistics 2011).

Table 3.11. Key features of the terminals at Hietanen Harbour. (Port of Kotka 2011)

	Cars/Ro-ro	***Bulk (Hietanen South)***
Draught (m)	7.9−10.0	8.5
Quays (m)	1 081	360
Number of berths	6	4
Cranes/Other	1 pcs 40 t, 1 pcs 100 t (mobile)	
Storage space	Covered 150 000 m^2	12 000 m^2
Other	Ro-ro terminal 70 ha, car terminal 100 ha	9 ha

Table 3.12. Key features of the terminals at Kantasatama. (Port of Kotka 2011)

	Ro-ro/Sto-ro/Lo-lo
Draught (m)	7.7−10.0
Quays (m)	962
Number of berths	8
Cranes/Other	1 pcs 60 t
Storage space	covered 60 000m^2
Other	26 ha

3.2.3 Port of Hamina

Located only about 25 kilometres from port of Kotka and some 35 kilometres from the Finnish-Russian border, port of Hamina is the easternmost port in Finland. Today it is a rather prominent container handling port on the Baltic Sea, handling annually approximately 100 000 TEUs. There is an ongoing project for the development of a container terminal and after its completion the terminal should be able to handle up to a million TEUs annually. The terminal's capacity at the moment is half a million TEUs. Besides container cargo, the port also handles liquid bulk. As a liquid port, Hamina is the third largest in the country. Roughly half of the port's annual cargo turnover consists of liquid bulk. In 2010 port of Hamina has handled approximately 2 459 000 tonnes of liquid bulk which 57% more than in 2009 (table 3.13). (Port of Hamina 2011) Port has extensive railway system. "That Finland shares the same rail gauge with Russia and its CIS neighbours and Hamina has 43 kilometres of rail track connecting to almost all the warehousing and other facilities within the Port, offers the logistics industry significant opportunities and benefits, particularly with the increased talk of putting more transit between Finland and Russia onto rail" (Gran 2010).

The fairway bottom dredging project, which was launched in 2008, should increase draught from 10 to 12−12.5 meters. According to the port of Hamina homepage (2010) bottom dredging related works are to be finished in late 2010 − early 2011. Increased draught is especially important for the port's liquid terminal, since increased depth will make it possible for Panamax class vessels to enter the port. Ships' maximum deadweight will increase up to 50% (Port of Hamina 2010).

Table 3.13. Cargo turnover at the port of Hamina in the year 2009. (Finnish Transport Agency 2010; Särkijärvi et al. 2010)

Hamina	
TOTAL TRAFFIC (t)	3 557 000
International traffic (t)	2 913 000
Import (t)	1 209 000
Export (t)	1 704 000
Transit traffic (t)	1 138 000
Dry bulk	238 000
Liquid bulk	1 422 000
Other dry cargo	1 253 000
Containers (TEU)	105 100
Domestic traffic (t)	644 000
Ship calls (total)	1 010

Currently port of Hamina consists of the following areas: Hillo, Hiirenkari, Palokangas Liquid port and Gas terminal. Hillo harbour has four berths and somewhat shallow draught of 6.5 meters. Dry bulk and general cargo are handled in the harbour, yet their volumes represent only a small part of the port's annual cargo turnover (Port of Hamina 2006).

Lakulahti (table 3.14) and Hiirenkari (table 3.15) harbours share somewhat similar functions. Both harbours are capable of accepting conventional ships just as well as stern port vessels. Most typical cargo types for the two harbours are general cargo, ro-ro and large-sized unit cargo. Loading and unloading operations are performed with the assistance of the privately owned mobile cranes, terminal tractors and handling trucks. There is storage field available for the general cargo on the territory of the harbours (Port of Hamina 2006).

Table 3.14. Key features of the terminals at Lakulahti. (Port of Hamina 2011)

	General	***Ro-ro/ General/Containers***
Draught (m)	8.6	7.9
Quays (m)	216	351 + 240
Number of berths	2	8

Table 3.15. Key features of the terminals at Hiirenkari. (Port of Hamina 2011)

	General	***Ro-ro/General***
Draught (m)	7.9−8.6	8.4−8.6
Quays (m)	158 + 210	100 (Ro-ro/General)
Number of berths	4 + 1 Ro-ro/General	2

Palokangas harbour (table 3.16) handles containers, ro-ro cargo and large-sized unit cargo. Out of eight berths within the vicinity of Palokangas, five are located on the territory of the container freight station. Cargo in the harbour of Palokangas is handled with the array of port equipment similar to the one used in the Lakulahti and Hiirenkari harbours, with the addition of the container cranes (Port of Hamina 2006). Recent deepening of the fairway resulted in the increase of the draught in on one of the container berths (EU3-4) by 2.5 meters from 10 to 12.5meters (Vuorinen, personal communication, 1.2.2011).

Table 3.16. Key features of the terminals at Palokangas. (Port of Hamina 2011)

	Containers/Ro-ro/General cargo
Draught (m)	12.5
Quays (m)	1 291
Number of berths	8
Notes	*Current draught 10 m

The **oil port** has three berths of which one berths has the draught of 12.5 meters and the rest two berths' draught is 10 and 9 meters. As the name suggests, port handles liquid oil products and chemicals. There are more than 580 000 m^3 of liquid storing space in a form of liquid bulk canisters (table 3.17). Cargo transition between storage facilities and ship happens via pipe systems, most of which are privately owned. Additionally there is a **gas pier** in the vicinity.

Table 3.17. Key features of the oil terminals. (Port of Hamina 2011)

	Liquid bulk/Gas
Draught (m)	9.0−12.5*
Quays (m)	187+170 LPG pier
Number of berths	3 + 1LPG
Storage space	580 000 m3
Notes	*Current draught 10 m

Port HaminaKotka

The ports of Hamina and Kotka will proceed to operate as a single enterprise Hamina-Kotka Satama Oy since 1.5.2011. Due to the fusion of the two ports, the new port HaminaKotka will become Finland's largest export/general port and approximately 15th of all (250) ports on the Baltic Sea (Naski & Gran 2010). The fusion of the two large ports in Finland will improve the competitiveness of the port sector and may provide a bigger and a more flexible environment for the stevedoring companies.

3.2.4 Vuosaari Harbour at the Port of Helsinki

The Port of Helsinki is the largest container and passenger port in Finland (by volumes), and it was the second largest port in Finland in the year 2009 (by volumes). The value of the cargo traffic at the Port of Helsinki represents approximately one third of the value of the entire Finnish foreign trade and two-fifths of the Finnish foreign trade transported by sea. Cargo arriving at the goods ports of Helsinki consists mainly of consumer durables and foodstuffs, as well as raw materials and semi-finished goods for the industry. Export goods comprise products of forestry and metal industry, as well as foodstuffs, textile products and glassware (Port of Helsinki 2011). Vuosaari is the most recent addition to the Helsinki harbour portfolio– a result of the cooperation between port of Helsinki and the private port operators. The total amount of investments in the project is close to one billion Euros, of which construction costs were nearly 700 million Euros (Blomberg 2008). According to the Finnish Transport Agency report, investments in Finnish ports in 2006–2015, during the period from 2006 to 2010 Port of Helsinki has invested close to half a billion (476 millions) Euros in the Vuosaari Harbour, which is 58.8% of all investments in Finnish ports from the same time period (Karvonen 2010). The Vuosaari harbour was opened for traffic in the end of the year 2008 (Heikkonen 2008). Vuosaari is a substitute for the 145 years old Sörnäinen harbour in the eastern part of Helsinki and the West harbour, where containers were previously handled (Puintila 2008). The main reason for the construction of the new harbour was to improve the conditions for cargo handling, including connections to motorway and railway lines, close proximity to airport, updated equipment and general harbour infrastructure.

In 2010 the port's total cargo turnover was 10.9 million tonnes, which is 12% more than during the previous year (table 3.18; Port of Helsinki 2011).

Table 3.18. Cargo turnover at the port of Helsinki in the year 2009. (Finnish Transport Agency 2010; Särkijärvi et al. 2010)

Helsinki	
TOTAL TRAFFIC (t)	9 770 000
International traffic (t)	9 692 000
Import (t)	5 479 000
Export (t)	4 213 000
Transit traffic (t)	229 000
Dry bulk	809 000
Liquid bulk	830 000
Other dry cargo	8 053 000
Containers (TEU)	365 000
Domestic traffic (t)	78 000
Ship calls (total)	8 700

Vuosaari operates on the landlord port principle, where city of Helsinki is the practical owner of the harbour, yet superstructure objects are the property of the port operators (table 3.19; Blomberg 2008).

Table 3.19. Key features of the terminals at the Vuosaari Harbour. (Port of Helsinki 2011)

	Containers	***Ro-ro***
Draught (m)	12.5	
Quays (m)	1 500	
Number of berths		15
Cranes/Other	10 pcs (4 pcs 65/90 t, 4 pcs 40/50 t, 2 pcs 50/60t)	
Storage space	c. 200 000	
Other	122 ha	2 double ramps

According to the information provided by the official site of the port of Helsinki Vuosaari Harbour is capable of handling up to 1.2 million TEUs and approximately 800 000 trucks and trailers (Port of Helsinki 2010). If those numbers represent the actual harbour's capacity, then it is safe to say that at the moment Vuosaari is rather far from reaching its maximum handling capabilities. There are existing plans to further develop harbour's intermodal capabilities, through the construction of the intermodal terminal in Kerava–area close to Vuosaari. Hence those plans are yet to be realized, and specifics and schedules of the project are somewhat indistinct.

3.2.5 The Port of Hanko

Port of Hanko is Finland's southernmost port with a long history, which dates back to 1872 when the port was originated. Today Hanko is a modern port oriented on the import, export and transit traffic. Most typical cargoes for the port are paper (export), cars (import) and lately also fresh produce (import) (Port of Hanko 2011).

Cargo turnover in the port of Hanko during the 2010 was approximately 3.5 million tonnes, which is over million tonnes more when compared to the year 2009 (table 3.20) (Finnish Port Association 2011).

Table 3.20. Cargo turnover at the port of Hanko in the year 2009. (Finnish Transport Agency 2010; Särkijärvi et al. 2010)

Port of Hanko	
TOTAL TRAFFIC (t)	2 476 000
International traffic (t)	2 442 000
Import (t)	1 028 000
Export (t)	1 414 000
Transit traffic (t)	226 000
Dry bulk	0
Liquid bulk	144 000
Other dry cargo	2 297 000
Containers (TEU)	49 500
Domestic traffic (t)	33 600
Ship calls (total)	1 100

The port of Hanko is divided into two operational sites: **Outer Harbour** and **Western Harbour**. The first one specializes on car import, and is also handling small volumes of chemicals. Outer Harbour has two ro-ro berths (table 3.21). Some 250 vessels visit harbour yearly. Western Harbour on the other hand is oriented on processing ro-ro cargoes and export of paper products. Western Harbour has total of six berths, of which five are ro-ro oriented and one unspecified, presumably general purpose berth. Out of five ro-ro berths one is a deep-water berth, whose draught is of 13 metres, three berths have the draught of 9 metres and one of 7.8 metres (table 3.22). Around 1350 vessels visit harbour annually. Both harbours are capable of handling containers (Port of Hanko 2011).

Table 3.21. Key features of the terminals at Outer Harbour. (Port of Hanko 2011)

	Ro-ro
Draught (m)	7.2−7.3
Quays (m)	170+180
Number of berths	2
Cranes/Other	
Storage space	Covered 21 000 m^2, hard surface open 600 000 m^2

Table 3.22. Key features of the terminals at Western Harbour. (Port of Hanko 2011)

	Ro-ro
Draught (m)	9.0−13.0
Quays (m)	245+230+280+165+300
Number of berths	5
Cranes/Other	1pcs 45t
Storage space	Covered 54 500 m^2, Uncovered 128 000 m^2

According to Port of Hanko logistics survey (2007) that was commissioned by Uusimaa Regional Council, Port of Hanko and few other regional authorities, port is pushing the limits of its freight capacity. Due to a high utilization rate, storage space, both covered and open air, represents somewhat of a bottleneck in the port of Hanko. Another bottleneck–like factor is high utilization rate of the berths, especially in the Western Harbour, which causes ship-queues and need for additional ship manoeuvrings. Narrow fairway leading to the Outer Harbour is also somewhat of a problem. Fairway's dimensions make it difficult for larger ships to manoeuvre, especially during strong wind weather conditions. Under such circumstances ships are redirected to the Western Harbour, thus straining its capacity limits even further (Uudenmaan liitto & Hangon satama 2007). During the 2006−2010 time period Port of Hanko has invested 15.9 million Euros in development of its berths and storage areas (Karvonen 2010). However, there is very little comprehensive data on what effects those investments had on the ports functioning and capacity.

3.2.6 The Port of Turku

Port of Turku is one of the oldest Finnish ports, dating all the way back to the Middle Ages. Today port of Turku is a modern passenger and cargo port with a well developed and perhaps somewhat distinctive infrastructure. It is the only port in Finland with a train ferry harbour. Port has 41 kilometres of railways, connecting all of its major areas.
In comparison with 2009, in the year 2010 Port of Turku has managed to increase its annual cargo turnover by roughly 8% up to approximately 3 210 000 tonnes (Port of Turku 2011).

Table 3.23. Cargo turnover at the port of Turku in the year 2009. (Finnish Transport Agency 2010; Särkijärvi et al. 2010)

Turku	
TOTAL TRAFFIC (t)	2 721 000
International traffic (t)	2 518 000
Import (t)	1 358 000
Export (t)	1 160 000
Transit traffic (t)	57 000
Dry bulk	54 000
Liquid bulk	135 000
Other dry cargo	2 330 000
Containers (TEU)	17 700
Domestic traffic (t)	202 700
Ship calls (total)	2 380

Cargo port consists of three major harbour areas: **Linnanaukko**, **West Harbour** and **Pansio Harbour**. Linnanaukko is where many unit cargo traffic, steel, paper and timber and selected bulk transports serving terminal warehouses are located. Larger private lorry terminals are also situated in the area. The area has extensive railway network in both Finnish and European track gauge (table 3.24). Naturally wagons' load and unload operation services are also available in Linnanaukko (Port of Turku 2011).

Table 3.24. Key features of the terminals at Linnanaukko Harbour. (Port of Turku 2011)

	Unitized cargo/Train ferry
Draught (m)	7.5−10
Quays (m)	800
Number of berths	2 ro-ro ramps
Cranes/Other	1 pcs 6 t
Storage space (m^2)	37 000 (Port of Turku), 23 000 (private)
Other (railways)	European track gauge 7 km, Finnish track gauge 5.5 km

All container traffic and part of ro-ro traffic in the port of Turku go through the **West Harbour**. Existing container terminals, two CFSs (Container Freight Station) and four lightweight halls, provide a wide spectre of container handling related services (load/unload, heating/cooling, monitoring and registration) and make cargo handling possible without taking weather conditions into account (Port of Turku 2011).

Table 3.25. Key features of the terminals at West Harbour. (Port of Turku 2011)

	Containers
Draught (m)	8.5−10
Quays (m)	1 050
Number of berths	5 ro-ro
Cranes/Other	1 pcs 40–48 t container crane, 1 pcs 40 t multi-purpose crane, 1 pcs 60 t multi-purpose crane, 3 pcs 6 t
Storage space (m^2)	35 000 (Port of Turku), 8 500 (private)
Other (railways)	4 km

Main accent in **Pansio** is made on truck and trailer traffic. Car export and import is yet another important part of the port's activities profile. In this particular area Turku is the third largest port in the country, handling approximately 90 000 cars annually. Pansio harbour has 140 000 m^2 of asphalted field especially for car export/import operations. Besides ro-ro cargo Pansio is also capable of handling liquid bulk cargo. Over 170 000 m^3 of bunker space is located in Pansio oil harbour and owned by a number of Finnish oil and chemical companies (table 3.26). Oil harbour also provides wagons loading and unloading services. Storage area for dangerous materials (IMDG) is also available in Pansio. Furthermore Pansio is seen as the area for possible port expansion (Port of Turku 2011).

Table 3.26. Key features of the terminals at Pansio Harbour. (Port of Turku 2011)

	Oil/Ro-ro	
Draught (m)	7.5−9	
Quays (m)		
Number of berths	1 (+1ro-ro)	
Cranes/Other		
Storage space	Teboil 20 000 m^3, Baltic Tank 92 900 m^3, Altia 9 960 m^3, Suomen Petrooli 43 800 m^3, Eko-Port 6 000 m^3	10 100 m^2
Other (railways)	Finnish track gauge 4.3 km	

Additionally there are 25 ha **The Free Zone** and 37 ha **Ovako**−areas especially dedicated to provide warehousing services, including load and unload service, cool and warm storage, Pre-Delivery Inspection service for car import, railway connection, connection with the national road network. Two port's largest, private distribution/storage terminals are located in the Ovako area, offering to clients over 68 000 m^2 of covered space. Besides plenty of reserve capacity, terminals also provide value-added services (Port of Turku 2011).

It is somewhat difficult to speculate how close port of Turku to its maximum handling capacity. For the past eleven years (2000−2010) port's annual cargo turnover saw very little fluctuation. Foreign traffic's average was 3.5 million tonnes a year, with the peak in 2000 at almost 4 million tonnes and decade's lowest point in 2009–approximately 2.8 million tonnes. Since 2000 port's capacity has increased through various development projects, yet its cargo turnover in 2010 was 25% less than back 2000 (Finnish Port Association 2011). It is logical to assume that lesser annual volumes put smaller strain upon the port's capacity.

3.2.7 The Port of Naantali

The port of Naantali is located only 15 kilometres from the port of Turku. By annual cargo turnover the port of Naantali is holding third place amongst the largest general purpose ports in Finland. It is also the second largest port by domestic maritime traffic. 2/3 of the port's traffic volume consists of bulk cargo including crude oil, oil products, cereals and coal. The rest of the volume is ro-ro and ROPAX traffic, which is more than a half of the total lorry traffic between Finland and Sweden (Port of Naantali 2011).

The total annual cargo turnover in 2010 in the port of Naantali has reached 8.12 million tonnes, and has surpassed the result of the previous year by 12% (table 3.27; Port of Naantali 2011).

Table 3.27. Cargo turnover at the port of Naantali in the year 2009. (Finnish Transport Agency 2010; Särkijärvi et al. 2010)

Port of Naantali	
TOTAL TRAFFIC (t)	7 250 000
International traffic (t)	5 697 000
Import (t)	4 271 000
Export (t)	1 427 000
Transit traffic (t)	0
Dry bulk	815 000
Liquid bulk	3 021 000
Other dry cargo	1 861 000
Containers (TEU)	0
Domestic traffic (t)	1 553 000
Ship calls (total)	1 950

The port of Naantali consists of three areas: Kantasatama Harbour, Luonnonmaa Harbour and the Oil harbour. Kantasatama and Luonnonmaa have infrastructure and equipment suitable for processing dry bulk, small amounts of liquid bulk and ro-ro cargo (Port of Naantali 2011).

Table 3.28. Key features of the terminals at Kantasatama Harbour. (Port of Naantali 2011)

	Bulk	***Ro-ro***
Draught (m)	8.0–13.0	7.2–9.0
Quays (m)	400+150	178+175/145
Number of berths	1+1dry bulk/liquid	1+1double deck
Cranes/Other	4 pcs (private)	
Storage space	Dry bulk 80 000 m^3	

Table 3.29. Key features of the terminals at Luonnonmaa Harbour. (Port of Naantali 2011)

	Dry bulk
Draught (m)	7.5
Quays (m)	173
Number of berths	2
Storage space	14 000 m^2, liquid 5 000 m^3

The oil harbour of the Port of Naantali is a somewhat special case. Even though the oil harbour is administered by the Port Authority of Naantali, it is completely independent and separated from the other two harbours. The oil harbour is the shipping point for the Neste Oil Naantali oil refinery. More than 4 million tonnes of crude oil and different oil products go through the harbour annually, which is in retrospect more than half of the port's total annual cargo turnover (Neste Oil 2011).

Despite the fact that the port's cargo volumes are amongst the highest in the country, the actual capacity of the Port of Naantali is significantly smaller than in Finland's leading ports Helsinki (Vuosaari) and Kotka, or HaminaKotka soon to be. According to the port's webpage its capacity is limited to 10 million tonnes per year. Infrastructural aspects of the port are less developed compared to other ports in Finland are the port's land is also drastically smaller. The port's total area is only 24 ha, whereas the port of Kotka has 629 ha and Helsinki 302 ha, respectively (Finnish Port Association 2011; Port of Naantali 2011).

3.3 Summary

We have shown in this chapter that the ports situated in the Gulf of Finland are vital for Finland. These seaports are located relatively close to each other, which may contain both advantages and disadvantages in case there are disruptions having an impact on port operations. On the one hand, in case, where one port becomes inoperable alternative ports are nearby. On the other hand, a disturbance of a greater magnitude can affect multiple ports at once and thus causing difficulties for companies in the critical industries to maintain their supply chains, and ultimately harming security of supply at national level. Although, an emergency situation, which could radically affect ports' functionality, occurs rather rarely, the severity of the possible repercussions demand careful study of all the potential developments in order to be able to react instantly, would the situation ever require it. In case the maritime transports face a disruption or if there is an emergency situation because e.g. an oil spill, the prime objective is to guarantee the integrity of the supply chain through the continuity of the cargo flow either by redirecting the cargo flows to other ports in case only some ports are closed, or considering possibilities to transport suitable cargoes by other transport modes.

Based on our interview results, we will look at next possibilities for the port operators to re-route cargo and their preparedness towards transport disruptions (chapter 4.1), the transport routes and transport alternatives the critical industries are using (chapter 4.2, how transports are organized in the companies we interviewed (chapter 4.3), vulnerabilities of critical industries towards maritime transport risks and ways of coping during the stevedore strike (4.4).

4 RESULTS

4.1 Possibilities for the port operators to re-route cargo

For the redirecting of a certain cargo type to take place certain conditions must pre-exist. First of all, an alternative port is a rather speculative concept, since no one port is fully replaceable at least not on a short notice. Volume and type of the cargo and the port infrastructure required for the ships and loading/unloading operations of the cargoes the ships are carrying are the main limiting factors. An alternative port must have reserve capacity in order to be prepared to handle additional cargo load. Many dry and liquid bulk cargoes require specialized loading equipment and storage facilities. Consequently, relocating a certain ship or cargo type into another port with rather unfamiliar or different infrastructure may present certain difficulties. Several ports can handle ro-ro or containerised cargo, so redirecting these cargo types from one port into another should be easier. However, as described in chapter 3.2 above, the Port of Kotka and Vuosaari have so large volumes of containerised cargo that in case both these ports were closed, their volumes need to be redirected into several ports as no single port in Finland has reserve capacities to handle all their volumes. In addition, not all cargo types can be redirected from certain ports into other ports, and some ports are completely irreplaceable in this respect. As an example, the port of Kilpilahti would be almost certainly impossible to replace, since the port is directly linked to the refinery of the Neste Oil Corporation and its volumes are just too large to be transported with any transport other than a ship.

Reasonableness of redirecting certain cargo type also depends on the value of the cargo. It is more sensible to redirect high value products, since possible additional expenses, which might come from alternative routing, would not have significant impact on the final price of a cargo. The final price of a low value cargo might be affected greatly by the route diversion, therefore, making it more difficult to sell further on (R. Viljanen, personal communication, February 1, 2011).

Presumably cargo handling capability of a certain stevedoring company relies on specific infrastructural aspects of a port a company is operating in. In case of an emergency situation moving all of a stevedoring company’s cargo volumes into another port would be rather difficult if not totally impossible. It is especially obvious in cases with the larger companies, since their cargo handling volumes are just too large to relocate at once. It is also assumed that only in cases with companies, which operate in multiple ports simultaneously, it might be possible to redirect certain cargo types.

Our series of questions for the port operators were divided into two thematic parts. Primary set of questions was directly related to the topic of port and maritime transportation substitutability in cases of failure or emergency situation in the port. The questions in the latter part inquire after stevedoring companies’ readiness and possible proactive measures in case of disturbance in their normal operation procedures. Out of five companies three stated that in case of an emergency situation they would be able to move certain cargo types into other port or ports. Those companies represent the largest port operator companies in Finland, and they have activities in multiple ports. The unifying factor for all three companies was in their ability to relocate larger container volumes into other ports. In case Port of Helsinki was closed, Port of Kotka was the possible alternative destination for the container cargo in answers of the two companies. Representative of the third company stated that their company would be able to relocate all of their containers into the nearest ports with the container handling capabilities. Other possible cargo types suitable for relocation that came up during the interviews were dry bulk (one answer) and ro-ro cargo (one answer). Port of Turku was aroused as the possible candidate for ro-ro cargo. One interviewee underlined that the port has well developed infrastructure especially suitable for relocation of ro-ro cargo. Dry bulk, although was mentioned as cargo type suitable for alternative routing, ultimately is rather difficult to redirect into another port. The same interviewee added that liquid bulk would be even more difficult to move. A possible alternative port for bulk cargo would be Rauma.

Port operators universally agreed in their replies that the core factor affecting the possibilities to re-route of a certain cargo type from one port into another is port capacity. Even those operators, who stated that their company would not be able to relocate any of their cargo to another port, suggested that insufficient port capacity and incompatible infrastructure of the substitute port are the main obstacles for alternative routing. One of the answers revealed that relocation of the certain cargo types, like IMDG cargo, might require special supporting documentation and permissions, which might also prevent or slow down the moving of the cargo into another port. The topic of port capacity naturally lead to the question of volumes. According to some interviewees only a small fracture of some particular cargo type total volume can be relocated or redirected. Container cargo was the only exception to this rule.

Port operators were unanimous on the fact that in case transportation by the sea was not possible, only relatively small volumes could be transported via land. Majority of the interviewees underlined that between transportation via railways and on trailers, the latter is financially sounder alternative. One of the experts said that 90−95% of total trailer traffic at some point of its journey travels by the sea on ro-ro vessels, hence stressing the importance of maritime transportation. As said by the interviewees, containerised cargo and timber are most suitable for trailer transportation.

All interviewees admitted that relocation of cargo causes delays in delivering schedules. Two companies stated that delay would be significant and in one case delay would have been short. COO of the company with no capability for alternative routing, stated that any kind of emergency situation in the port causes delays in operating schedules. He also added that even anomalous weather conditions, such as heavy snowfalls can slow down unloading/loading operations at ports.

Alternative routing, according to all experts, causes extra expenses either to the port operator company, their client(s) or to both. Only one operator stated that all additional expenses would fall on the shoulders of their customers, whereas most interviewees acknowledged that alternative routing would cause expenses to both of the parties, the stevedoring company and the customer. Finally, one representative said that the question of who is to pay is resolved through negotiations. He also added that in case of a force major situation, where the stevedoring company is in no way responsible for a failure situation in the port, the customer is most likely to pay all additional expenses. All in all, two out three operators were concurring that the additional expenses from alternative routing is rather a case sensitive topic.

As another potential course of action one expert said that under very specific and rare conditions it might be possible to redirect certain cargo types into non-Finnish ports. Another port operator stated that currently there are no suitable alternative ports abroad for their company. Other operators were unable to provide comprehensive answer on the topic.

On the topic of proactive measures in cases of a failure situation, port operators stated that storage related operations happen in the ports on a daily basis and almost all of the cargo types are stored at some point. Cargo storage periods are short, since the cargo is only waiting to be handled forward. The storage areas are also refilled constantly. None of the interviewed companies had emergency or reserve storages. All of the experts unanimously agreed that storage related costs are very high.

In general, answers provided by the experts during the interviews support our initial assumptions. However, some of the answers shed new light on certain aspects related to the stevedoring activity in Finland. As the number of respondents was small, the validity of the results could be limited. Stevedoring companies' readiness to relocate their container volumes points toward the conclusion that ports of Finland have well developed container handling capabilities and possess the necessary reserve capacities for this specific cargo type. Difficulties related to the relocation of other cargo types could be linked to the cargo type dependency on the specific port and its infrastructural aspects, insufficient alternative port capacities for those cargo types and irreplaceability of the maritime transport. The latter statement was supported by particularly many evidences, and especially by the statement about cargo transported in trailers. The fact that operators are able to relocate only a small fracture of their volumes into another port supports our presumption about the difficulties related to the alternative routing.

Port operators were somewhat vague in their answers with rather little specific and precise information. This and especially their additional comments regarding the taking of actions according to the situation might be indicators of unpredictability of the environment they are operating in. It may also be the sign of their readiness to be flexible in a non-standard operation conditions. Another final comment in the form of positive review of the Hamina Kotka fusion is a rather clear marker of the idea that bigger ports, which profiles in handling many different cargo types, provide more flexible environment for the port operators.

4.2 Transport routes of the critical industries and transport alternatives

Finnish industries use six logistic networks that are essential for the whole country: 1) network for conventional cargo imports 2) delivery network for trade, 3) export network for containers, 4) export network for bulk cargo 5) import network for raw materials, and 6) network for transit traffic. Imports and exports are diverged in Finland and are using different ports as points of entry/exits for the country. At a port level this means that ports have specialized in handling certain goods and serving their customers in their natural hinterland (LOGHU 2008). Even though these routes are partly overlapping so that same ports can be critical nodes for transports of several different products, the existence of several routes means there is a lot of infrastructure that should be protected. As a whole the logistics core region for Finland is Southern part of the country.

Critical maritime routes for Finnish security of supply include: Tallinn-Helsinki, Travemünde-Helsinki, Stockholm-Helsinki, Stockholm-Turku and Kapellskär-Naantali. Majority of Finnish imports transported in trucks and trailers uses these routes. Main routes for incoming containers are Hamburg-Helsinki, Bremen-Helsinki and Rotterdam-Helsinki. Alternatively, ports in the Western Finland (Turku, Pori and Rauma), can complement Helsinki (Vuosaari) for transports of containers (figure 4.1.). In the national preparedness plans ensuring the functionality of Finnish main ports and their alternatives have been taken into account. However, functionality of the counter ports for Finnish main ports in regular liner traffic including Tallinn, Stockholm, Travemünde, Hamburg and Bremen, is also very crucial (Koskinen 2010). An emergency situation in one of these ports could have a direct impact for Finland.

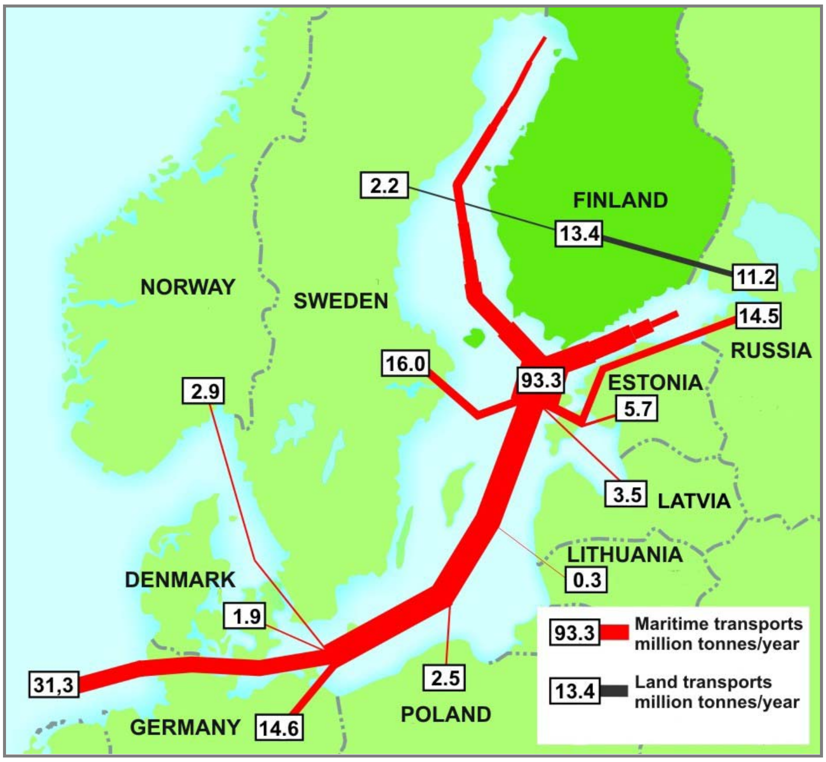

Figure 4.1. Main sea routes of the Finnish exports in the year 2010. (Ulkomaankaupan kuljetusten yhteistyöryhmä 2011, edited by authors)

Based on earlier research and company interviews we have identified the main ports the Finnish critical industries use, and some alternatives in case the main port are closed (table 4.1.). Table 4.1 shows that the critical industries' shipments are fairly concentrated at certain ports and these ports are thus critical nodes in the maritime transport system. If the ports mainly used are closed, there are no port alternatives for current oil, pulp & paper and meat exports in reefer containers. These industries would be suffering most from transport disruptions. Table 4.1 also shows that the ports used primarily are located at the Gulf of Finland. In case these ports were closed, transports would shift to ports at the Gulf of Bothnia.

Table 4.1. Critical industries, the imports, main ports and port alternatives. (Lumijärvi & Tapaninen 2009, Sundberg 2009, company interviews)

Industry	***Main imported goods and materials***	***Main ports***	***Port alternatives in case main port is closed***
Energy	Oil, gas, uranium, coal	Oil: Kilpilahti and Naantali Coal: Helsinki, Naantali, Inkoo, Koverhar, Loviisa, Kotka	Oil: No alternatives Coal: Hard to replace Naantali. Pori, Raahe, Kristiinankaupunki, Vaasa, Pietarsaari, Tornio, Oulu can cover partly
Food sector	Pesticides & fungicides, raw materials for fertilizers, animal feed (soya), grain, agricultural machinery chemicals, packaging materials, spices, Fruit, vegetables, jams & juices (used as raw materials in the food industry) food for consumer markets	Animal feed and grain: Naantali, Kotka, Loviisa Hanko Pesticides & fungisides: Vuosaari Fertilizers: Uusikaupunki Agricultural machinery: Kotka, Turku Fruit & vegetables: Vuosaari, Kotka Meat in reefer containers: Vuosaari	Animal feed & grain: Uusikaupunki, Turku, Pori, Rahja, Vaasa Fruit & vegetables: Hanko, Turku Meat in reefer containers: no alternatives to Vuosaari
Health care	Medicines, equipment, basic chemicals	Vuosaari	Kotka, Turku, Hanko
Forestry industry	Timber, fillers, coating pigments	Pulp & paper export: Kotka, Rauma Sawn wood exports: Kotka, Loviisa, Sawn wood imports: Rauma, Pietarsaari	No alternatives for pulp & paper
Chemical industry	Crude oil, basic chemicals, rubber	Hamina, Kotka, Rauma, Pori Mustola, Joutseno (in lake Saimaa)	Oulu, Pietarsaari, Kokkola Alternatives for Mustola & Joutseno: Kotka, Hamina, Vuosaari
Technology industry	Metals, minerals, fuels	Ores & metals: Raahe, Pori, Kokkola, Tornio Exports of metal products: Helsinki, Turku, Lappohja (a private port)	Use of industry-owned, private ports

4.3 Organising transports in the companies interviewed: routes and modes used in a normal situation, and their alternatives

Our company interviews started with a general question concerning raw materials and products these companies are either importing or exporting. We asked the companies, how they normally carry out these transports: which modes and transport routes they use and what ports are the most important for them in terms of loading/unloading operations, or transhipment points? In this context the interviewees often mentioned the terms of delivery they use, and how long it takes to ship the goods imported or exported. Secondly we asked, what the companies would do in case there are interruptions in their transports, e.g. if one or several of the ports they use in Finland would be closed. Critical issues concerning transports for all companies are capacity, reliability, scheduling and the cost of the transportation. Usually the seller is responsible for organizing the transport of the goods, so the Finnish exporting companies make contracts with transport companies (either with shipping companies or with freight forwarding companies), and ultimately these transport companies make decisions concerning the shipments. If an exporting company has very large volumes (100 000 tonnes or more) to be transported, it usually makes contracts directly with shipping companies. The largest exporters usually use time chartered vessels, and a typical feature e.g. for metal and mining industries are long chartering contracts with ship-owners (Venäläinen & Utriainen 2009.) An interviewed forestry company utilize three kinds of services concerning marine transports: liner services provided by shipping companies, long-term contracts with shipping companies, and ”system traffic”, which the company organizes by itself with vessels they have chartered for their own use. In addition, the exporters also determine the ports they use. Some of the companies also have their own, private ports they use for their imports and exports.

With imports to Finland usually the seller of the goods (located abroad at the origin of goods) is responsible for organizing transports and the buyer or receiver of the goods does not have any influence on decisions concerning transports. In addition, small and medium sized companies often have outsourced their transports to freight forwarding companies. The interviewees commented the terms of delivery usually used include DDP, DDU, or Ex Ship. An interviewed freight forwarder told the ocean lines and the feedering operators decide the ports they go in. His clients mostly use FOB for terms of delivery. As the transports are outsourced, the small and medium sized companies thus lack the means and authority to affect their transports, and often they do not have any interest how they are conducted either (Venäläinen & Utriainen 2009.) We got similar answers from some of our interviewees. These interviewees commented that for their organization it does not matter how the goods arrive and by which mode; most important is that the shipments come on time and that they can trust their partners. A representative of a wholesaler of consumer products describes their ordering process:

Interviewee: “The time from the order to actual arrival (to Finland) depends much on the contract between us and the supplier. Some goods have to be ordered six months before delivery, some goods are here within three days. So it varies. And of course we have quotas with the big suppliers, like tuna fish or pineapple conserves and so on, which we are buying from Far East. You have to order those (products) six month before. (…) We schedule the delivery so that our

warehouses are not full packed. From Europe most orders are done on two- or four-week basis. So, they are quite easy to manage. And we also book the transportation for those orders...
Interviewer: So you are responsible for organizing it from the origin...?
Interviewee: Yes. Well, the terms of delivery is so that we pay the freight then when we make the booking and arrange the transportation. And I guess it is something like 60% of our orders. Most of the orders come on our freight.
Interviewer: OK. And the rest is it...?
Interviewee: Supplier pays the freight. And they arrange and it is a little bit harder to manage because we are not responsible for the transportation. So the full responsibility is by the suppliers. But, of course, when you are a big buyer the contracts are good. So, they are quite manageable." (Import service manager, consumer products)

All the companies whose logistics/transport managers we interviewed had thought about different transport alternatives in cases of emergencies or disruptions. One of the informants said that being prepared for unexpected situations is an essential part of daily work in export business. The delivery times are quite long in overseas maritime transport with several re-loadings, so one needs to have flexibility in schedules. It takes approximately a week for the shipment from Europe to arrive in Finland, and it takes a month to ship goods from Finland to Far East and America. Thus one cannot build a delivery schedule based on estimated arrival time of the goods on a certain hour or even a day if the goods are coming by a ship, because for example weather conditions can cause delays. The longer the transport chain and the more transhipment points there are, the more possibilities there are for delays:

"But if the container is coming by train and does not make it to the train on time or if there is congestion at the port of Lübeck and the container does not arrive on time to be loaded on the ship, it takes an another week until the delivery gets to the factory in Finland. (...) One cannot think that (the goods arrive) by the next day even if the ship would come overnight. The ships do not leave all the time and there are not that many ships (sailing to Finland). A delay for a week at least is quite common for a shipment coming from Europe to Finland, if something goes wrong." (Logistics manager, a chemical company)

For most of the interviewees the Finnish stevedore strike (4.3.–19.3.2010) was the most recent and concrete example of a disruption at ports, causing delays and other negative impacts for their transports and thus for their production operations. For that reason majority of the interviewees talked about the strike when asked about problems at ports and maritime transport chain in general. Some interviewees also mentioned winter conditions could cause some delays for maritime transports even though icebreakers usually work well. The risk for accidents (e.g. a large oil spill at the Gulf of Finland) was mentioned a few times as well as the risk of diseases, mainly salmonella concerning the food industry. In case all Finnish ports are closed, the companies will try make their shipments via the closest ports available in neighbouring countries Sweden or Estonia. The interviewees comment that it is very unlikely all ports are closed at the same time. A strike is the only cause for such a situation they can think of. They also commented that permanent closures of ports occur rarely.

The strike of the stevedores at public ports stopped approximately 80% of the Finnish foreign trade. Only industry-owned private ports were operating normally during the strike. The causes for the strike were disputes between Finnish Transport Workers' Union (AKT) and Finnish Port Operators' Association (Satamaoperaattorit ry) on working hours and severance benefits. The workers' union was requesting a compensation equivalent to one year's salary for laid-off workers. The longshoremen's union gave a strike warning a month before and the representatives of the employers and employees negotiated to solve their disputes. As a result the strike was postponed for two weeks (Kuusela 2010). Because of the strike Finnish companies could not export their products and/or import raw materials, components and spare parts. They had to find transport alternatives and ways to continue operations. Our informants stressed that Finland is like an island: The Baltic Sea separates the country from continental Europe and land transport options are limited. Finland has land border with Russia, but strict border regimes makes passing it difficult. Borders with Sweden and Norway in the North are open, but the longer distance makes this land route uneconomical. However, companies did use the route via Sweden during the strike when they could not use their normal maritime transport route. Majority of the Finnish maritime traffic is feedering to and from ocean ports Antwerp, Rotterdam and Hamburg in the Continental Europe, where goods are either reloaded to/from inter-continental vessels or from where they continue by other transport modes to their final destination.

When shipping from the ports the Finnish companies normally use is not possible, land transport by truck, or *combined transport* (driving trucks with trailers into ferries) are alternatives to e.g. container transport in ships. During the stevedore strike the only option for the Finnish companies to deliver goods to ships was using driver + trailer combination instead of containers or semi-trailers. Shipments in bulk form were only possible via private, industry-owned ports. Also the feeder vessels delivering the containerized goods to and from the overseas ports (Hamburg, Rotterdam, Antwerp) stopped running, but companies could still use liner ferries running between Finland and Sweden, Finland and Estonia, or Finland and Germany, or transport goods by land via Sweden or using Swedish and Estonian ports for their shipments. Alternative routes the interviewed companies used include shipping material to/from Sweden by the ferries in a truck with a driver from the ports of Turku, Naantali or Vaasa, or alternatively from Helsinki to Estonia (via Baltica route from Estonia to Poland) (figure 4.2).

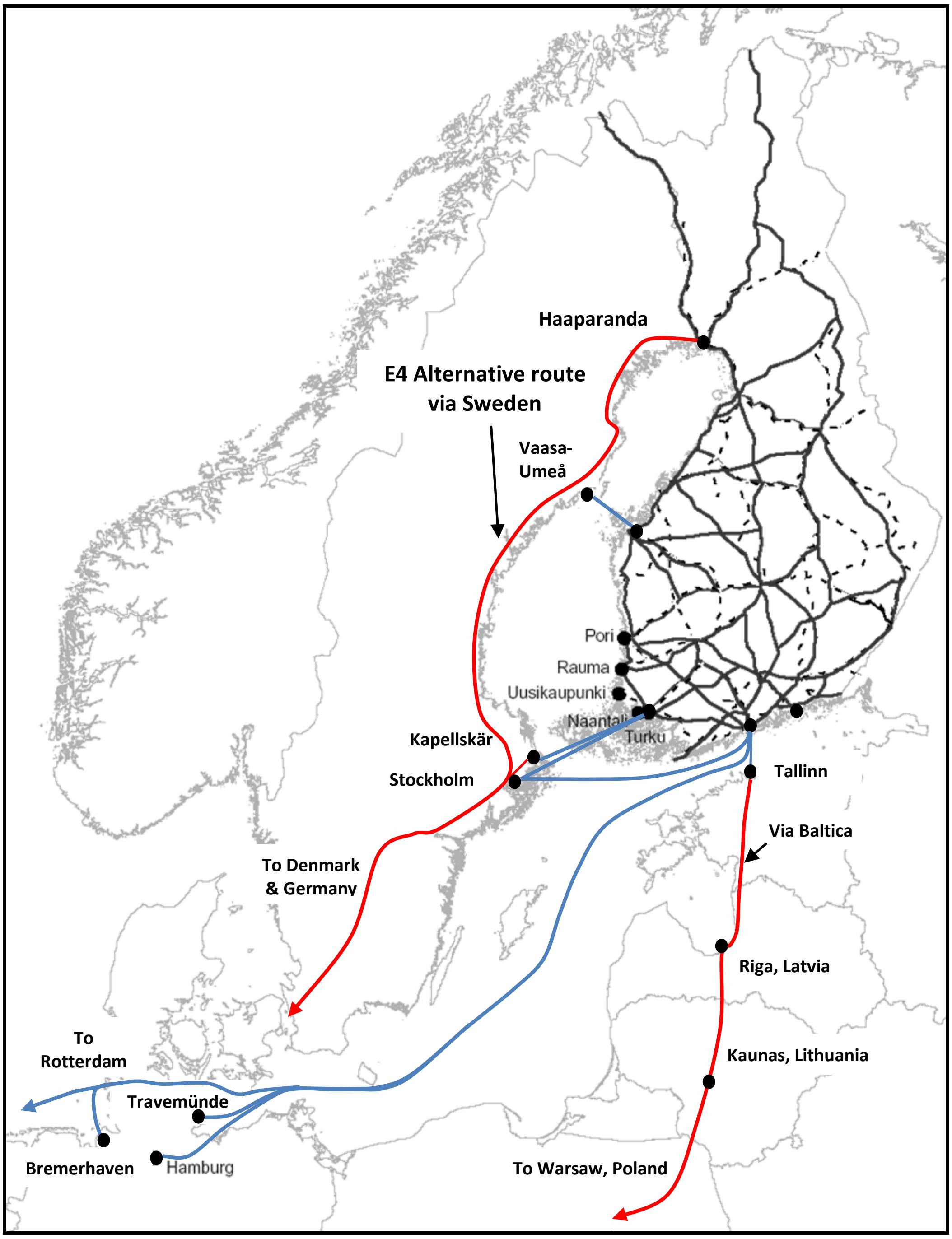

Figure 4.2. Main sea and land transport routes of the Finnish foreign trade and their alternatives.

The route to Sweden via ports of Turku or Naantali is the traditional route connecting Finland by road to Western Europe. In the extreme case transporting goods on land by truck via Tornio-Haaparanta to Sweden, then using the Swedish ports to transport the goods to their destination could be used. These special arrangements caused additional costs for the companies. The interviewees said these extra costs varied from 300 to 500€ per load, the highest being 1 500€, which is twice the normal price:

"So, during the strike we had to take units with drivers and pay those fees. We had to change European container load to trailers. It is always 500 or 1 000 Euros more, plus the driver. And we had to decide, which loads are important and which we can leave and just wait. A lot of special arrangements (were needed). Some (re-)routing, taking via Sweden, that we did, and of course Tallinn. And also shipping companies made their own changes and arrangements, which affected us quite a lot. But for example with Far East and Third country loads, which have a very long transport time, we did not have this kind of chance to make very many changes. So, then we just had to sit and wait. Some shipping companies took their vessels via Tallinn, and we took containers out in Tallinn, and (transported them) then by Tallinn ferries to Finland. (..). But it was quite stuck." (Import service manager, consumer products)

Theoretically rail or road transport via Russia could cover maritime transports via Baltic Sea: goods could be transported by rail or road via Finnish-Russian border and then e.g. to Estonia, and further to Central Europe. Rail transport via the Trans-Siberian Railway could also cover overseas shipments or flights from Far East. Despite being promoted as an environmentally friendly transport alternative in Finnish and EU transport policies, rail transport is not considered as an alternative at all due to its higher price compared to road transport and because the interviewees felt it would be difficult to use. Rail network does not cover all places that can be accessed by road in Finland and the route via Russia by road is considered unreliable and risky:

"We do not know how much time it (meaning land transport via Russia) is taking, for instance, because the borders are not very reliable. So, of course we have to calculate some additional days for the deliveries." (Customer care manager, a chemical company)

"The documents must be correct, with stamps and there is also some kind of "saattomies", it means that there is an extra person (following and securing the goods) from the border to the destination. There are some extra (costs). (...) And if goods are stuck to the customs they will be there long, long time, we speak about a month." (Supply chain manager, a pharmaceutical company)

Rail transport via Russia is thus not a feasible alternative even though the rail gauge between Finland and Russia is the same. Rail is normally used only for certain imports and exports with Russia (e.g. grain, chemicals, scrap metals, ores) as well as in domestics transports of forestry, metals and mining, and chemical industries. An alternative to overseas maritime transport is rail connection via Russia to the Far East, the Trans-Siberian Railway. However, the interviewees comment it is not working well and the prices are much higher compared to ocean carriers:

Senior purchase manager: "Also there is the option to import from China via Russia. And Japan. But think that is not working either. So, it is better to drive, you know, even from Beijing to the South to Singapore and go south of Africa and then to Antwerp and Helsinki rather than to go the straight line via Russia. Because to my understanding (the train connection) is not working."
Sourcing director: It works but it is very expensive.
Senior purchase manager: And I also have heard some goods to be lost. (…)
Interviewer: So, it is not really an option considered? Going through Russia by train?
Senior purchase manager: If something changes, then we might.
Interviewer: You have it in mind as an option?

Sourcing director: Yes, but this is just... This October-Railway Company, they really increased the prices. And now they lost almost all the business. This is totally bad for Finland. Because Finland is quite a natural place for loading ships. Because of this rail distances are the same." (Sourcing director and senior purchase manager, a wholesaler of pharmaceuticals & health care products)

For pharmaceutical products, some materials needed in health care, as well as electronics components the primarily mode of transport is by air. In cases of emergency these companies can use currier services (e.g. UPS):

"Most of this crucial pharmaceuticals they… the size is quite small, value is quite high and the weight is quite low. So, it makes sense to use airfreight in a case of emergency." (Sourcing director, a wholesaler of pharmaceuticals & health care products)

For many companies changing the transport mode or route is primarily an economic question. In case the transport mode or route they commonly use cannot be used they would have several alternatives but not all of them would be economically realistic to use. If for example one port would be closed, these companies could use another one:

"We are always using the cheapest way for the transportation. Then if you have to use some additional load or substitute transportation systems, of course that will always increase the price. Are all the ports closed or just one can make quite big difference." (Sourcing director, a wholesaler of pharmaceuticals & health care products)

However, in some cases the requirements of the goods restrict the available transport options, both the transport mode, the number of operators capable of carrying the transport, and the port. For example, only certain ports have the facilities needed to handle reefer containers. In addition, storage capacities, cargo handling equipment and their loading capacities also curtail the amount of suitable ports for certain types of bulk cargo including oil products and grain. Moreover, companies with dangerous cargo (IMDG classified goods, see IMO 2010) have difficulties finding a suitable transport company. A representative of chemical industry clarifies:

"Sometimes our requirements or our needs do not fully go together with the ship owners' capabilities. But then again, that is why we have also contracted that business. (...) With these products and with this geographical location (Baltic Sea) you need to have your ice class, your double hulls, and vessels that can heat your products and can segregate two products, one heated and the other one cannot even get close to heated products. (...) It is difficult to get an adequate number of ship owners to be interested in this. Because this is, I have been told, this is highly complicated shipping contract for a ship owner. You have two products (which are) very different in nature. You need to have a vessel in (the port the company uses) roughly every fifth day. So, you need to have a fleet enough to do that. You have the ice conditions. So, that is what the ship owners say, it is not an easy contract to run, from their point of view." (Logistics and customer service manager, a chemical company)

Companies are very dependent on transport services, and even though they organize their transports by themselves, they are still dependent on other companies such as ocean carriers or trucking companies who conduct the transport. Thus the preparedness of the transport companies in emergencies is very crucial for the whole society:

“Well, we are totally dependent on other companies. We are totally dependent on shipping companies and transport companies. How they work in crisis situations (...), their choices and chances to make changes. We have seen a lot of stretching during this strike that those shipping companies actually... they made changes. They unloaded in Tallinn and the helped us to make... to arrange transportation from Tallinn and so on, and helped a lot. But it was not so, how should I say, it was not easy and it was not fluent. Everybody had to work a lot for that. But their crisis plans and so on would be very interesting. And there are not so many Finnish shipping companies anymore (...). The ownership is not in Finland anymore. How it affects their ... what they do in this kind of situations. Are they interested in that there is enough food in Finnish stores? (Import service manager, a wholesaler of consumer products)

The interviewee quoted above stresses dependence on multiple actors in the transport chain, and the ability of these other companies to provide transport services despite disruptions, e.g. a strike. If companies providing transport services had difficulties it would reverberate directly to their clients’ operations. However, as many of these companies are foreign-owned, they may not be interested at all e.g. food security in a country. Due to foreign ownership it would be hard for their clients or authorities to influence the shipping and transport companies’ decisions in this respect.

Companies and the society should thus be prepared for threats coming from outside our borders. The risks can be market related, e.g. sudden increase of demand of certain products or raw materials, or lack of supply of which a global shortage of acetonitrile (CH3CN) is a recent example. Acetonitrile is used as a solvent in many chemical applications including manufacturing and synthesis of pharmaceuticals, as well as a solvent in various chemical analysis (both in research laboratories as well as in chemical industry) including Gas Chromatography (GC) analysis, Ultraviolet (UV) analysis, Thin Layer Chromatography (TLC) and high performance liquid chromatography (HPLC) (Rojas et.al 2009). The main cause for the shortage of supply of this chemical was Olympics in China: Chinese production was shut down because of Chinese authorities’ aim to improve air quality. Furthermore, a U.S. factory was damaged in Texas during Hurricane Ike. Owing to the global economic slowdown, the production of acrylonitrile that is used in acrylic fibres and acrylonitrile-butadiene-styrene (ABS) resins decreased. Because acetonitrile is a by-product in the production of acrylonitrile, its production has also decreased. As a consequence of these events, the prices for high-quality and HPLC-grade Acetonitrile have increased significantly throughout 2009, from $30/litre to $100/litre between July and September. As the major acetonitrile producers ration their supplies, they have started advising customers to develop alternative methods to eliminate or reduce the use of acetonitrile. The global shortage of acetonitrile has continued through early 2010 (Bonilla 2010). Other risks related to supply can be related to ownership of the natural resources. For example China’s share of rare alkali earth metals production was 97% in the year 2009. These metals are strategic because they are used in many high technology devices including lasers, computer memories, superconductors, as well as environmental applications (USGS 2002; TEM 2010).

In addition to global shortages of critical supplies, changing legislation or customs regulations, embargo on exports (of which exports of Finnish meat products to Russia in the year 2010 is a recent example), political instability in countries were raw materials are bought or the relationships between companies and their strategic position in the markets can cause difficulties for companies who are dependent on global trade. In many respects Finnish market represents just a tiny share of the total sales of many big suppliers. This is most clearly visible in food, consumer products and medicines where big, global producers dominate the markets. In case of emergencies companies usually prioritize which customers they supply, and according to the interviewees the biggest customers would be served first:

Interviewee: “Well, the big suppliers might not be interested in our little problems. Their volumes are so huge and ... our share is so small that they are not interested in our functions.
Interviewer: So, you are not in any way strategic to them as a customer?
Interviewee: Might be, might be. Even the total Finnish volumes (of the main consumer chains), if we all have the same suppliers, it is still just 1 percent of their volumes. They actually could not care less. But of course when we have good relationships with those suppliers they might just consider a little our feelings.“ (Import service manager, a wholesaler of consumer products)

Global shortages of certain supplies and raw materials could potentially harm Finnish society:

“Maybe if there is a global pandemic and then you have a global shortage of some products. Like now we had in the autumn, both in the pharma side but also in some, you know, face masks and stuff like this. So this kind of global shortages might have then some affect on the ability to get the products to the country at all. And this product might be used for something else than for the purpose that people are buying it. But maybe also for some other purposes, which is then supplemented because of the other issue. I would say if there is this kind of a problem, a serious problem with the freight or with the suppliers, then we also have some even bigger problems, like war or pandemic or something.” (Purchase manager, pharmaceutical & healthcare products)

4.4 Vulnerabilities of the critical industries towards maritime transport risks and ways of coping during the stevedore strike

As described above, all the interviewees said they and their companies had made plans for the unexpected as a part of their operations, and they had to utilize these plans in practice during the stevedore strike. In addition to transport adjustments discussed above, the companies did all they could to secure their supply chains. Most companies were able to supply at least their key customers with the most essential goods and materials during the strike. However, depending on the industry ways to cope with transport interruptions can be quite limited. Having goods in stock also ties capital so all the companies regardless of industry try to keep their stocks at a minimum. Reliability of the deliveries is thus the main concern for all companies:

“Almost all the companies are trying to keep the warehouses levels as low as possible and get the transportation working so well that they do not need to have those raw materials in the warehouses.” (Transport manager, a company in the food industry)

Interviewer: So, having smooth transports (...) without delays or without any interruptions whatsoever is very crucial for you?

Interviewee: It is, yes. And, as you very well know, we are reducing, or have been reducing, our working capital as much as possible. So, it is becoming more and more critical.
Interviewer: I think since many industries have minimized their warehousing and capital tied within those, I think that is one of the motivations for this whole project. How can then companies deal with interruptions within their transports of crucial materials that they are importing or exporting?
Interviewee: Yes, you are absolutely right. What we are asking from our suppliers is more and more. And what is happening in practice is, if we need a warehouse at the mill for raw material, we ask them to invest into it, and to guarantee the supply to our mill. So they are in charge of the total supply chain. We do not want to have our money in these warehouses or stocks. (Senior vice president of logistics, a forestry company)

The latter quote above shows companies are placing more responsibility to their suppliers, also in terms of risks. When experiencing uncertainties the companies usually raise inventory levels. Raising inventory levels at own and customers' sites was for many companies the first preparatory measure towards the strike:

Interviewee: "So, we loaded a few additional containers and kept those near the customers. That way we secured the deliveries during the strike."
Interviewer: On the road you say. So, how did you concretely manage this? Where were the extra materials or the stocks? (...)
Interviewee: Near the customers. (...) It is not new (for the company), we do have a buffer stock because these customers are taking huge volumes. So, it is basically a delivery each day. Now we were just building up the stock.
Interviewer: So, the infrastructure is at place?
Interviewee: Yes, because from Finland it is quite difficult to supply these huge volumes on a direct basis. Vessels are not leaving each day, so you have to also plan when you can get the trucks or containers out from Finland. And then on the other hand, if there are sudden peaks in the customers' consumption... we cannot react very fast. That is why we have to have something near the customers, just to be able to be flexible." (Customer care manager, a chemical company)

A representative of a health care supplier describes their stock situation:

"We keep safety stocks of the most important items. Then we have a lot of equipment that is not economical to keep in stock. (With those items) we wait for the customer's order and then we order for the customer. So, when it starts to be a problem is a difficult question because for the equipment it is a problem right away. So, if you sell an x-ray nobody expect that if we order today it would be there on Friday. So, it is ok to wait a couple of weeks or even longer. But then for the goods we need every day, consumables and stuff, we of course have our own stock. But, well, it depends, for the Asian imports we have larger stocks: two month, three month stock. For the European (imports), where we have short lead times, we only have maybe 4 or 6 weeks. So I would say after four weeks or six weeks or 8 weeks, we are seeing then running out of stock. And of course, at that point also the customer who had been ordering this equipment, which we do not have in stock, of course they would be a little bit disappointed to get so late delivery."

Preventive measures the interviewees used during the Finnish stevedore strike include:

- raising inventory levels at their own and customers' sites before the strike began
- changing the delivery schedule, e.g. making orders of incoming supplies earlier and/or postponing orders to customers if possible
- changing the transport mode and route if possible
- having spare capacity (e.g. in production or storage), using several transport companies
- buying finished or semi-products from a competitor to fulfil delivery contracts to customers in case the company's own production had to be stopped e.g. due to shortage of raw materials caused by the transport disruption.
- supplying the customer from another site (outside Finland) among the corporation's network producing the same or suitable products (so transferring customer orders between the plants). However, many companies have specialized production plants producing only certain products with no compensatory production elsewhere.

Having buffer stocks is necessary as distance from the supplier of the goods to the customers is long. However, stockpiling only makes sense if the product's holding costs are low and there is no danger of obsolescence. For products with high holding costs and/or high rate of obsolescence it is more recommendable to use multiple suppliers (Chopra & Sodhi 2004; Manuj & Mentzer). Our interviewees also pointed out, that for a global company with multiple production units in different countries the international network can help solve problems if there is e.g. lack of supply situation. It would be much harder for a smaller, non-global company to find solutions for logistics problems because they do not have alternatives available within their own organization:

"Normally if orders are exceeding the plants' capacity then there is the possibility that some orders are switched from plant to plant. But this is also an option in case there would be such a situation here in Finland that we just cannot get material out from here. Then we have also the flexibility to use our plant in Belgium or the US." (Customer care manager, chemical company a)

"Logistic problems can cause uncomfortable situations for us, and we raise inventory levels if we have uncertainties of supply. But our functions do not stop easily if something happens. (…) We know how to utilize the (company's global) network in such a way that we know from where can the shipments take place in various situations." (Logistics specialist, chemical company b)

In order to secure oneself from market risks one strategy is having a balanced pool of customers either in different industries, or in different regions. From a customer's perspective changing the supplier and buying from somewhere else is an option, but some cases it is impossible for the producers. Pharmaceutical companies are vertically integrated, have a very rigorous quality control with audit procedure for their suppliers. Therefore it is not easy for them e.g. to change suppliers. Many companies have plants that have specialized producing only certain products and there is no compensatory production elsewhere:

” There are some licensed products. You cannot change the raw material (unless) you have gone through some sort of an approval program. (...). But I think (...), it is always a question about the good planning because (with) dry bulk you can always build this buffer stock. And you can just calculate what you would like to have the safety stock on the road in case the strike is continuing longer than you maybe planned.” (Customer care manager, a chemical company)

“In the pharmaceutical business we have back-up suppliers. But of course deliver times are quite long: it can take like 3 months, you know, lead time. So, of course we have back-up suppliers but it is not easy to switch suppliers just like that. (...) Everybody knows that deliver time is quite long. (...) In our business we need quite heavy audit. And there is also the registration point of view. And there is a lot of bureaucracy when we say that this is the preferred supplier. So, in many cases there is not much possibility (to change the supplier). Usually there is more than one (supplier). But in some cases there might be only one. ” (Senior purchase manager, a pharmaceutical wholesale)

For critical products and raw materials there are according to legislation three different storing systems available: state owned reserve stockpiles, compulsory stockpiles owned by companies, and security stockpiles owned by companies on a voluntary base. These mainly concern energy (oil and oil products, coal, peat), health care products, supplies needed in agriculture (e.g. seed grain, pesticides, components needed in animal feed), and certain industrial raw materials considered critical. The body responsible for managing or controlling these stocks is NESA (Valtioneuvoston päätös huoltovarmuuden tavoitteista 2008/539). The producers and wholesalers of health care products and pharmaceuticals are responsible for keeping compulsory stocks of certain groups of their products, and hospitals, health centres and National Institute of Health and Welfare keep stocks of critical supplies and spare parts. National Compulsory Stockpiling system has three categories: goods with inventories equivalent to 10 months, 6 months or 3 months use. Either the wholesaler or the principal gets a small compensation from the government for keeping this compulsory stockpile (Laki lääkkeiden velvoitevarastoinnista 2008/979). Transports of some critical materials, including medicines, were ensured during the Finnish stevedore strike by co-operation between the workers’ unions and authorities.

Companies in the process industries (e.g. chemical, forestry and steel industry) simply have so large volumes of the raw materials they need or the products they are delivering to their customers there is no realistic alternative for a ship. Those companies suffer most if there is an interruption in transport services, and in the worst case they are forced to shut down their operations:

Interviewee: “We were not able to manage our logistics during the strike in practice at all.
Interviewer: So, you had to close down factories?
Interviewee: Yes, we closed most of the factories. In a strike situation our factory (at a location X), which is our biggest, can continue production for 12 hours. Then it has to be closed. Most of the production plants within 3 days. Some specialty factories like Y and Z and one machine in W, a couple of weeks. (...). But in practice it is an impossible situation for us. (...) We are producing some of our products only in Finland. (...). The other element is that for some customers we are the sole supplier. And actually that is something we are preparing now, how to tackle this question in future. It is not allowed to happen anymore. But in practice we were ... it was mission impossible for us. And also for X (the interviewee’s company’s main competitor). But

companies which have own industrial ports were able to operate normally." (Senior vice president of logistics, process industry)

Some companies, as the one whose representative is quoted above, found that none of their mitigation strategies worked when ports were closed. As the interviewee above says, his company was forced to shut down the first factories after two days the strike had begun. This quote shows clearly the risks of focused factories and lean production (Herod 2000; Jüttner et. al 2003; Peck 2005).

4.5 Preparedness to risks and resilience capacities

Our empirical results show there is variation between industries how long a disruption can cause harm and which risk mitigation strategies can be used (table 4.2). These strategies and measures refer to the ways how companies deal with disruptions in general and how they managed the strike in particular. Products with shortest times are marked red.

Table 4.2. Critical length of disruption by industries. (based on interviews)

Industry	***How long production can be carried out after a disruption***
Energy production	Coal: 3 months (reserves by law 3 months) Oil production: 2−3 days (production process is then forced to put down), reserve stocks of critical products (corresponding the amount of imports for 90 days)
Food supply & food exports	Grain imports & exports: several months (can be stored) Meat: 2−3 weeks (with special arrangements) Animal feeds: 2−3 weeks (with special arrangements; if there is a breakdown etc. at a factory, it will have an immediate impact) Malt: several months (can be stored) Milk products: 2−3 days Consumer products: from 2−3 days (perishable products) to 2−3 weeks (based on the products)
Chemical industry	Approximately 2 weeks (with special arrangements); 2−9 days
Pharmaceuticals & healthcare supplies	**Mandatory reserves by law industry & importers** (3, 6 & 10 months**)** **of critical supplies, hospitals** (3−6 month stocks) Other supplies*: 3 weeks to 2 months
Forestry	**12 hours−2 days**
Metals and miming	Depending on the product: from a few weeks to 2−3 months
Technology industry	**2−3 days**

*Note: This is based on information given by interviewees concerning products **that are not mandatory** to be kept in stocks by law.

Table 4.2 indicates that the critical times for perishable products (2−3 days) and process industry (12 hours to 2−3 days) are very short. Other sectors can manage 2−3 weeks. It should be noted also, that energy production, food supply and health care are protected by reserve and compulsory supplies. Essential pharmaceuticals and health care supplies are kept in reserves by industry and importers (lääkkeiden velvoitevarastointijärjestelmä), and hospitals as well as the National Institute for Health and Welfare, as mentioned above. However, planning for potential crisis in the health care sector is often rather difficult, as the measures need to be crisis specific. In case of pandemic the consumption of vaccines increases whereas if there is a large accident, the pressure is more on supplies needed in first aid and surgery. In addition, pharmaceutical products have expiration dates, and the inventory need to be rotated accordingly. Thus, there will be costs concerning products in the inventory that need to be destroyed due to the fact that they have expired (Juhola, personal communication 25.11.2010).

The stevedore strike lasted 16 days. Many interviewees commented that had the strike lasted longer, e.g. a month, it really would have caused major problems for their operations, forcing them to close down their production. In addition, if there would be a disturbance having an impact on several transport modes at the same time, the societal impacts would be significant:

"If it (delay etc.) is one week or more then it starts really problems. If 2−3 days, then it is manageable. And two weeks would be catastrophe."(Developer, electronics industry)

When hearing from the representatives of the companies we interviewed that the critical times are so short in many industries, we also asked the interviewees how their company informs its customers and other essential stakeholders if there are problems in their own production. Most of the companies said they have a communication strategy for such situations, they have priority lists of customers as well as products, and experienced people who know what to do and how if something happens. Knowledge sharing between people with different expertise and good internal relations between the different departments of the organization are vital especially in difficult/emergency situations:

"You have the sales, you have the logistics, and you have the production, sort of along this corridor. So, it is very easy to communicate and make the decision and change them on a hourly basis, as we sometimes do. (…) In every work of course you get the experience, but particularly in the problematic situations you need to be able to understand immediately if I will do this it has these impacts. You cannot sort of try and 'oh no, it did not work', you need to know what your option are and make the right choice between the options. (Logistics and Customer Service Manager, a chemical company)

Our informants stressed that having back-ups concerning transports and also concerning human resources (e.g. key personnel) is vital. We also discussed with some informants, whether companies can co-operate in preparedness:

"I think the key question here is that, is there something that we should do as ... under the Finnish industry umbrella? Or are these company specific solutions? And my thinking today is, whatever the plan is for the future, or what kind of readiness you want to build up or invest in, those are company specific solutions. Concerning companies of our size. I cannot find any

benefits to cooperate with our competitors in this respect. And we are and we will not be able to use others' industrial ports." (Vice President Logistics, a forestry company)
As the informant above stresses, different industries have differing transport needs, so even though companies can learn from each other's experiences, each and every company should make their own plans for their own needs.

4.6 Societal implications for security of supply

The stevedore strike clearly revealed Finnish industries' vulnerabilities towards transport disruptions. Industries suffering most during the strike were main export sectors forestry, chemicals, production of metals and machinery, and also food. Products requiring temperature controlled transport, including pharmaceuticals and food, do not bear interruptions at all in the transport chain and are thus very vulnerable. Some industries, such as chemical production, have constantly running processes which are dependent on continuous, daily delivery of raw materials as well as continuous transports carrying finished products. Any problems with the supply chain, both lack of availability of raw materials and/or difficulties delivering the finished product, can cause production reduction or even stoppage immediately, resulting considerable economic loss.

According to media, for example 70% of the paper production in Finland was stopped because of the stevedore strike, causing 2.5 – 3 million € losses per day to the companies. Timber production was not stopped as largely as in the pulp and paper production, but the industry suffered losses of export revenues. If the strike had continued longer, suppliers of the forestry production (including chemicals) would have been forced to diminish or shut down their production (Metsäteollisuuden tietopalvelu 2010; EK 2010b).

Interviewee from the chemical industry confirms:

"If the pulp factories had [been] closed, it would have been meaningless to bring in goods here since we would not have been able to forward [our products] to our customers."

Besides forestry, other industries reported economic losses. Finnish chemical industry products are used as supplies in other industries and impacts of the strike varied depending on the subsector. Companies supplying forestry industry and plastics industry were among the first to adjust their production. In other subsectors of the chemical industry the impacts of the strike were visible within 1−4 weeks. Technology sector estimated loss of exports as 70 million € per day. A nickel producing company had to close down its smelting plant due to lack of nickel concentrate. Wholesalers of technical products had also difficulties getting supplies. The strike caused some changes in the retail trade, too. Supermarkets run out of certain perishable products such as imported fruit and vegetables. However, the strike did not cause any severe lack of food, as the percentage of domestic products is rather high and the share of imported products rather marginal in Finland. Retail trade could use alternative ways of imports (Yle uutiset 22.2.2010; EK 2010b, Kaarenoja 2010; Kjellberg 2010).

With the exception of forestry industry, other industries did not face production stops due to lack of raw materials, but they were very close to it. The strike also caused process alternations. Food production companies suffered lack of imported raw materials which caused closures of some production lines and disruptions in production. Exports of meat, meat products and cheeses were first to suffer (EK 2010b.) In meat production the final products have to be shipped out right after packing, due to limited storage capacities and perishable nature of the products. Furthermore, meat production is dependent on animals of a certain age. When the production is interrupted due to interrupted export streams, the animals will grow too old and expensive production adjustment will be necessary.

In addition to strike and transport disruptions there are also other threats having an impact of security of supply. Concentration of the production to few companies can form considerable risks in case the companies have specialized production plants and something goes wrong in the production process. The case in point in this respect is agriculture. Two companies represent 80% of the Finnish feed production volumes. According to our interviewee, if both these companies are having problems in their feed production, the situation is so severe that can endanger the welfare of the animals. Animal farming is very vulnerable to changes in feeding and dependent on other industries. Production stops of the factories can cause much harm even if producers are prepared for such situations:

“We can produce certain more simplified products and we can reduce our product assortment. But the farms with domestic animal production, currently the requirements for efficiency are so widespread which means the production does not bear changes in animal feeding. If the feeding concept changes it immediately affects the output (of the animals). For example in a dairy farm with cows having a high lactation rate the change in feeding immediately reverberates to the milk production. So the changes are not desirable. (…) If there is a problem both with us and for example our main competitor, in that case we are talking about a major problem. Together (with the main competitor) we represent 80% of the Finnish feed production volumes. If (we) both are having problems in feed production, the situation is so severe that… it endangers the welfare of the animals. ” (Division director, a company producing animal feed)

Farms can also suffer a great deal (economically), in case there is production stop at factories. Farms have limited storage capacity for feeds:

“Not to speak of farms producing broiler chicken as these farms have so high feed consumption in the end of the production period that they require a truckload of feed delivered to the farm each day. These farms simply do not have extra storage capacity for broiler feed, and they have major problems if feed cannot be delivered within two days. (...) Physical storage space can really be a limiting factor, because the volumes of feed needed at the farms are so large. Every day the farms need altogether 4–5 million kilos of feedstuffs. Producing this amount of feed requires quite large amount of raw materials, taking all factories together.” (Division director, animal feed producing company)

In addition, considerable amounts of raw materials for animal feeds are imported to Finland. This dependency on imported materials as well as the fact that imported material can be contaminated can cause vulnerabilities. The self-sufficiency of protein for animal feed is quite low in Finland; less than 1/5 of the protein feed for the animals is of domestic origin in Finland and majority of the raw material for animal feeds needs to be imported. The most important components imported are crushed soybeans, crushed turnip rapeseeds, and fish meal. Also feed components containing roughage, such as molasses, are imported to certain extent. In most of the countries where crushed soya and rape seeds are imported, salmonella bacteria is very common, and as a result one in every ten samples taken from imported soya in Finland contains salmonella. In contrast, salmonella occurs only rarely in Finland. Therefore during accession negotiation with the EU Finland was given an exemption order that allows to, inter alia, test every batch of animal feed material imported for salmonella (Sektoritutkimuksen neuvottelukunta 2010).

Salmonella bacteria can cause severe problems in the food chain. Usually the source of the bacteria is contaminated feed raw material (e.g. soya) imported to Finland and it is here that the maritime transport comes into play, since often also port storage and cargo handling facilities abroad are contaminated with the bacteria. Ports have thus a crucial role in both spreading the bacteria but also preventing further contamination:

"Unfortunately we have quite often contaminated loads with salmonella, because elsewhere in Europe there is no comparable salmonella liberty status equal to Finland or Sweden. These two countries were given exemption orders during accession negotiation with the EU. In other countries the raw materials for feed can be taken directly to the factory and use, one does not have to care whether the raw material contains salmonella or not. For this reason the infrastructure at the port of origin where soya is imported is often very contaminated by salmonella and unfortunately we receive the disease, too. Salmonella is a big problem and one of the reasons why we should increase self sufficiency in protein feed for animals. In case salmonella bacteria is found in the official samples then the feed raw material imported needs to be decontaminated. The decontamination causes logistic problems in the port area, because the contaminated feed raw material need to be treated in the port and after the treatment it needs to be moved into a clean storage facility, and it needs to make sure no contamination occurs in between. It is quite a challenge. " (Head of a division, animal feed producing company)

Most recent case of salmonella was discovered in March 2009 when salmonella bacteria were found in the excrement samples of 27 egg producing farms and 9 piggeries in Finland. The source of the bacteria was traced back to the cooling system of one of the Raisio Group's production lines. Altogether 80 farms and production areas were contaminated by the tainted fodder from Raisio feed. According to Raisio Group the contamination was caused by imported soybean. As a measure of precaution Rehuraisio decontaminated its whole factory and changed some of the machines altogether as it was not possible to clean them sufficiently. The estimated costs for cleanup were around 20 million Euros (Anonymous 2009).

The problems concerning protein feedstuffs as well as dependency on energy have been taken into account in policies and strategies concerning these sectors. Import substitution and increasing domestic production in renewable energy sources, improving the domestic share of protein feedstuff, diminishing the dependency of imported energy sources at farms and protection of the water supply has been listed as a strategic targets in national energy, forestry and food strategies (MMM 2008 & 2010b; Työ- ja elinkeinoministeriö 2008; Huoltovarmuuskeskus 2009; Sektoritutkimuksen neuvottelukunta

2010). According to Government's energy and climate strategy fossil fuels will be replaced by renewable, domestic energy sources to decrease CO_2 emissions. The aim is to increase the share of renewable forms to 38% of final energy consumption by 2020. The government's energy package will promote the use of forest chips and other wood-based energy, alongside wind power, the use of transport bio-fuels, increasing utilization of heat pumps, and measures to enhance energy efficiency. The proposed measures are expected to facilitate a total saving of 37 TWh in energy consumption by 2020 (Työ- ja elinkeinoministeriö 2008 & 2010b). However, increasing the share of renewable in the form of bio-fuels would require investments at the power plants (e.g. new boilers) and more storage space at the ports. A representative of a energy company was in the opinion the forests in Finland would not cover the need, and bio-fuels would be imported from Russia in the future:

"If we are thinking of Finland, where are the forests and the targets we have for the use of the renewable energy sources, it is quite clear that it is quite attractive idea to start importing from Russia the bio-fuels. And that would need then infrastructure on the Russian side and also here in the ports if we would like to import. So that is one possible way of increasing the use of bio-fuels. That is of course, if one compares bio-fuels with the coal, the energy density is quite different, so it requires much, much more volumes, and that makes it different to handle the fuels in the ports." (Manager, a company producing energy)

In addition, production and wholesale of products have concentrated in pharmaceutical production and food wholesales. In the pharmaceutical industry several products are sold in worldwide markets and only few producers are responsible for the production. Thus the concentration on the production makes the industry vulnerable worldwide, and no country can have a complete self-sufficiency in pharmaceutical products. The concentration on the industry is significant also in Finland. Only three companies, Orion Pharma, Bayer Schering Pharma and Santen produce pharmaceuticals in Finland, and two companies Tamro Finland and Oriola are responsible for wholesale of the pharmaceuticals. The product range of the medicines produced in Finland has been narrowed down in recent years as a result of global structural changes in the pharmaceutical industry. For the Finnish society a notable threat is that medicinal products and other critical supplies for the health care sector cannot be acquired from abroad. Several reasons can cause such as situation: an international political situation and conflicts, disturbances in the global trade, natural catastrophes and environmental problems, epidemics or pandemic, real estate and fire damages, accidents, vandalism, crime and terrorism. Also a sudden increase in consumption and/or increased stockpiling in other countries, problems in production and producers' logistics, disturbances in information technology or energy production and delivery can cause problems for the health care sector (HE 151/2008). Being prepared for these risks is thus important.

5 SUMMARY AND CONCLUSIONS

Transport infrastructure, and especially maritime transport, is critical for all Finnish industries, as over 80% of the foreign trade is transported by ships. Moreover, Finnish society is very dependent on imports in many respects, as majority of the critical industries are dependent on imported raw materials or other supplies. For example 100 % of the crude oil, coal, uranium and natural gas, 100% of the pesticides needed in agriculture, 70% of the raw materials for animal feed and 80% of the pharmaceuticals are imported. The health care sector is also dependent on imported equipment and basic chemicals. The industries in Finland that are most dependent on imported supplies (energy, health care, food sectors) are protected by reserve supplies.

As the maritime transport has such a significant role for the Finnish society, it is important to assess whether there are vulnerabilities associated with it. Our research points out vulnerabilities that are related to concentration of traffic flows, specialization of ports and as a consequence, difficulties redirecting certain cargoes to other ports. The commodity flows of both imports and exports in Finland are concentrated in certain Finnis ports, as both in exports and imports the five largest ports handle over half of the total foreign trade. Three of these ports, Kilpilahti, Kotka and Helsinki are located on the Gulf of Finland, serving the most densely populated area of Southern Finland. Critical maritime routes for Finnish security of supply include: Tallinn-Helsinki, Travemünde-Helsinki, Stockholm-Helsinki, Stockholm-Turku and Kapellskär-Naantali. Majority of Finnish imports transported in trucks and trailers uses these routes. Main routes for incoming containers are Hamburg-Helsinki, Bremen-Helsinki and Rotterdam-Helsinki. Health care products, certain chemicals, pesticides used in agriculture, and spare parts and components are examples of supplies transported in containers that are vital for the critical industries. Transports of crude oil and oil products concentrate in ports of Sköldvik and Naantali, and there are no alternatives for them. Main ports for coal imports are Helsinki, Naantali, Inkoo, Koverhar, Loviisa and Kotka. Ports of Kotka and Rauma have specialized in pulp and paper exports. Exports of sawn wood are handled at Kotka and Loviisa, and the main ports for sawn wood imports are Rauma and Pietarsaari. Chemical industry products and raw materials are transported via ports of Hamina, Kotka, Rauma, Pori, Mustola, Joutseno (in lake Saimaa), and Oulu, Pietarsaari and Kokkola. Some companies also have their own, private ports.

Majority of the ports primarily used by the Finnish critical industries are located at the Gulf of Finland, and as the list of ports mentioned above shows, the same ports are critical for many of the critical industries transports but ports have also specialized. There are thus potential risks in terms of concentration of the largest volumes.

In case the ports at the Gulf of Finland would be closed, our research indicates transports would shift to ports at the Gulf of Bothnia. For example, ports in the Western Finland (Turku, Pori and Rauma), can complement Helsinki (Vuosaari) for transports of containers. However, imports and exports are diverged in Finland and are using different ports as points of entry or exit for the country. Finnish ports have specialized handling certain goods and serving their customers in their natural hinterland, as we already mentioned above. Ports have also specialized at the level of their infrastructure and layout: equipment for handling goods, land areas, depots and warehouses etc. depending on the types of cargo handled at the port e.g. bulk cargoes, containers or ro-ro. The specialization improves profitability of the ports, but it can also be a risk for a security of supply, as the port infrastructure is not replaceable because it is expensive to construct and maintain. As a result, it is hard to shift goods to alternative routes and from one port into another. The fact that there are several ports is important for ensuring national security of supply. Availability of several ports give flexibility, but as some goods need specialized equipment not available everywhere and/or if the volumes handled are large, the small ports simply cannot cope.

In addition, characteristics of the goods transported or production process restricts the available strategies narrowing suppliers to use and transport options, both the transport mode, the number of operators capable of carrying the transport, and location (e.g. port). This is the case with many chemical products. There are also no port alternatives for current oil, pulp and paper ports either, and only Vuosaari and Kotka have the facilities needed to handle reefer containers in Finland. Industries shipping these cargoes would be suffering most from transport disruptions. Furthermore, functionality of the counter ports for Finnish main ports in regular liner traffic including Tallinn, Stockholm, Travemünde, Hamburg and Bremen, is also very crucial. An emergency situation in one of these ports could have a direct impact for Finland. In addition, the trend is towards fewer but larger ports also in Finland, which could mean port closures. These matters should be taken into account in security of supply policies, both at a company and national policy level.

The Finnish stevedore strike in the spring 2010 made visible the Finnish society's dependency on maritime transports very concretely and we have used it as an example of a transport disruption in our research. The stevedore strike showed, that for many of the companies in the critical industries maritime transport is the only transport mode they can use. Rail or land transport cannot cover it. Despite being promoted as an environmentally friendly transport alternative in Finnish and EU transport policies, rail transport is not considered as an alternative at all due to its higher price compared to road transport and because the interviewees felt it would be difficult to use. Rail network does not cover all places that can be accessed by road in Finland and the route via Russia by road is considered unreliable and risky. However, for pharmaceutical products, some materials needed in health care, as well as electronics components the primarily mode of transport is by air. In cases of emergency companies in these industries can use currier services.

When shipping from the ports the Finnish companies normally use is not possible, as was the case during the strike, land transport by truck, or *combined transport* (driving trucks with trailers into ferries) are alternatives to e.g. container transport in ships. During the stevedore and longshoremen strike the only option for the Finnish companies to deliver goods to ships was using a driver + trailer combination instead of containers or semi-trailers. Shipments in bulk form were only possible via private, industry-owned ports. Also the feeder vessels delivering the containerized goods to and from the overseas ports (Hamburg, Rotterdam, Antwerp) stopped running, but companies could still use liner ferries running between Finland and Sweden, Finland and Estonia, or Finland

and Germany, or transport goods by land via Sweden or using Swedish and Estonian ports for their shipments. Alternative routes the interviewed companies used include ship material to/from Sweden by the ferries in a truck with a driver from the ports of Turku, Naantali or Vaasa, or alternatively from Helsinki to Estonia (via Baltica route from Estonia to Poland). The first mentioned route via Sweden is the traditional route connecting Finland by road to Western Europe. In the extreme case transporting goods on land by truck via Tornio-Haaparanta to Sweden, then using the Swedish ports to transport the goods to their destination could be used. These special arrangements caused additional costs for the companies. The interviewees said these extra costs varied from 300 to 500 € per load, the highest being 1 500 €, which is twice the normal price. In case none of these alternatives was possible for a company, the only options for a company would be either production stop in case materials and other supplies constantly needed in production could not be acquired, or with less critical products to wait until the disruption would be over and transports would be carried out again.

Any problems with the supply chain, both lack of availability of raw materials and/or difficulties delivering the finished product, can cause production reduction or even stoppage immediately, resulting considerable economic loss. Industries suffering most from maritime transport disruption during the Finnish stevedore strike were main export sectors forestry, chemicals, production of metals and machinery, and also food. Products requiring temperature controlled transport, including pharmaceuticals and food, do not bear interruptions at all in the transport chain and are thus very vulnerable. Some industries have constantly running processes (e.g. chemical or oil production) and they are dependent on continuous, daily delivery of raw materials as well as continuous transports carrying finished products. In addition companies in the process industries (e.g. chemical, forestry and steel industry) simply have so large volumes of the raw materials they need or the products they are delivering to their customers there is no realistic alternative for a ship. For many companies in other sectors changing the transport mode or route is primarily an economic question. In case the transport mode or route they commonly use cannot be used. As different industries have differing transport needs, each and every company should make their own plans, even though companies can learn from each other’s experiences.

The Finnish stevedore strike gave a concrete learning experience of the importance of preventive measures and operational/business continuity planning for all Finnish companies: it made them to re-think their practical preparedness towards transport risks and how they can continue with their daily operations despite the problems. Many companies realized they need to adapt their long-term countermeasures against transport disruptions. Most companies we interviewed for this research were able to supply at least their key customers with the most essential goods and materials during the strike. Preventive measures the interviewees used during the strike include:

- raising inventory levels at their own and customers’ sites before the strike began
- changing the delivery schedule, e.g. making orders of incoming supplies earlier and/or postponing orders to customers if possible
- changing the transport mode and route if possible

- having spare capacity (e.g. in production or storage), using several transport companies
- buying finished or semi-products from a competitor to fulfil delivery contracts to customers in case the company's own production had to be stopped e.g. due to shortage of raw materials caused by the transport disruption.
- supplying the customer from another site (outside Finland) among the corporation's network producing the same or suitable products (so transferring customer orders between the plants). However, many companies have specialized production plants producing only certain products with no compensatory production elsewhere.

In addition to the measures listed above, the interviewees stressed that knowledge sharing between people with different expertise and good internal relations between the different departments of the organization are vital especially in disturbancies or emergency situations. Companies should have back-ups concerning human resources such as their key personnel. However, depending on the industry ways to cope with transport interruptions can be quite limited. Having goods in stock also ties capital so all the companies regardless of industry try to keep their stocks at a minimum. Reliability of the deliveries is thus the main concern for all companies. Some companies found that none of their mitigation strategies worked when ports were closed. Forestry industry was one of the sectors which had to stop factories as a result of the strike. If the strike had continued longer, suppliers of the forestry production (including chemicals) would have been forced to diminish or shut down their production, too.

With the exception of forestry industry, other industries did not face production stops due to lack of raw materials during the stevedore strike, but they were very close to it. The strike also caused process alternations. Food production companies suffered lack of imported raw materials which caused closures of some production lines and disruptions in production. For example, in meat production the final products have to be shipped out right after packing, due to limited storage capacities and perishable nature of the products. Furthermore, meat production is dependent on animals of a certain age. When the production is interrupted due to interrupted export streams, the animals will grow too old and expensive production adjustment will be necessary.

Our results also indicate that there seems to be industry-specific mitigation strategies (appendix 5), but due to the small number of companies involved our research the existence of industry specific strategies should be investigated further. Our results show that the critical times for perishable products (2−3 days) and process industry (12 hours to 2−3 days) are very short. Other sectors can manage from 2−3 weeks to several months (appendix 5). It should be noted also, that energy production, food supply and health care are protected by reserve supplies. Essential pharmaceuticals and health care supplies are kept in reserves by industry and importers, and hospitals as well as the National Institute for Health and Welfare, as mentioned above. However, planning for potential crisis in the health care sector is often rather difficult, as the measures need to be crisis specific. In case of pandemic the consumption of vaccines increases whereas if there is a large accident, the pressure is more on supplies needed in first aid and surgery. In addition, pharmaceutical products have expiration dates, and the inventory need to be rotated accordingly. Thus, there will be costs concerning products in the inventory that need to be destroyed due to the fact that they have expired.

Compared with many other risks affecting transports (e.g. accidents) a strike is different as there usually is a warning given beforehand. As the Finnish stevedore strike was only 16 days long, ordinary people did not suffer and all the critical functions of the society could be carried out. The strike mainly caused short-term financial losses for the companies. Had there not been a warning about the strike, or had the strike lasted a longer period, e.g. a month, or involved also land transport, several companies would have faced serious trouble and companies in the process industries could have been forced to shut down production within a few days (appendix 5). The strike warning allowed companies to make preparations beforehand, enabling them to continue their operations.

Furthermore, companies are very dependent on transport services, and even though they organize their transports by themselves, they are still dependent on other companies such as ocean carriers or trucking companies who conduct the transport. Thus the preparedness of the transport companies in emergencies is very crucial for the whole society. In addition, many of the transport companies, shipping companies in particular, are foreign-owned and security of supply may not be among their priorities. Are they interested in that there is enough food in Finnish stores?, as one of the interviewees asked. Finding ways to substitute imports with domestic supplies and raw material sources in the critical sectors is thus vital for the national security of supply. Governmental authorities can also inform companies about the importance of business continuity planning. As transport needs between industries differ, each and every company should make their own plans even though companies can learn from each other’s experiences.

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APPENDICES

Appendix 1. Interview protocol (used interviewing representatives of the companies in the critical industries March 25 - June 11, 2010).

1. What products, materials or any other necessary supplies are either imported or exported to/from your company via Finnish ports, especially Gulf of Finland ports? Please name the most important commodities or commodity groups (if several)
2. What are the most critical of the commodities you listed? In other words, what are the materials, goods or other supplies whose lack of supply would harm the functionality of your company most severely?
3. What are the ports that your company mainly uses for incoming/outgoing shipments? Where are the supplies that you need (raw materials, spare parts etc.) currently arriving and how are your products transported? (If possible, tell us the whole transport route of the supplies, starting from the port from where goods are shipped to/from Finland)
4. What problems and risks have an impact on your shipments and logistics?

- Have you got many transport alternatives for your company's shipments?
- Where do you see the greater risks: in supply chain related matters or transports?
- What is the strategic position of your company in relation to other actors in the transport chain? To what extend are other companies and stakeholders dependent on you? How much can your company influence on the decisions made by other parties (shipping companies, logistic service providers, suppliers etc.)

5. How are you prepared to possible risks concerning availability of supplies and transport?

- What kind of impacts did the strike of the stevedores and longshoremen closing public ports have to your company's operations?
- How did your company manage to continue operating during the strike? What arrangements were needed before and during the strike? Do you e.g. have buffer stocks of raw materials, spare parts or other materials?
- Can you estimate the costs the strike caused you?
- How easy or difficult is it manage with risks in general? Can you e.g. change your suppliers, transport mode and ports you use? How about your clients, what can they do if something goes wrong in your company (e.g. an accident in a factory)?
- How do you ensure continuity of your company's functions during and after a possible disturbance?

6. How do you communicate about problems to your customers and suppliers? Do you have a communication strategy?
7. Can you recommend other persons to be interviewed?
8. Was there an important topic we did not ask? Anything you would like to say in conclusion?

Appendix 2. Contact message (in Finnish) sent to the interviewees.

Viite: Haastattelu logistiikan huoltovarmuuteen liittyen (STOCA)

Arvoisa (nimi),

Turun yliopiston Merenkulualan tutkimus- ja koulutuskeskus on mukana tutkimushankkeessa 'Study of cargo flows in the Gulf of Finland in emergency situations (STOCA)', jossa selvitetään Suomen ja Viron merenkulun logistista huoltovarmuutta häiriötilanteissa. Hankkeen tavoitteena on selvittää, mitä seurauksia yritysten ja yhteiskunnan kannalta on, mikäli joku Suomenlahden satamista on jostakin syystä suljettu sekä mitä vaihtoehtoja kuljetusten järjestämiseksi tällöin olisi. Kuten meneillään oleva satamalakko on osoittanut, Suomen viennin ja tuonnin kuljetusten vakaus ei aina ole itsestäänselvyys.

Hankkeeseen liittyen pyrimme tavoittamaan sellaisia yrityksiä, joiden tuonnin ja/tai viennin kuljetukset kulkevat Suomenlahden satamien kautta ja joiden toiminnan kannalta merikuljetukset ovat välttämättömyys. Pyrimme tekemään henkilökohtaisia haastatteluja näiden yritysten logistiikasta ja hankinnoista vastaavien henkilöiden kanssa. Toivomme, että voitte osallistua tutkimukseen. Otamme teihin uudelleen yhteyttä puhelimitse viikon kuluessa sopiaksemme teille sopivan haastatteluajan. Haastattelu vie aikaa noin tunnin. Haastattelussa antamianne tietoja käsitellään luottamuksellisesti. Haastattelukysymykset ovat tämän viestin liitteenä.

STOCA hankkeen rahoittajina ovat EU:n Central Baltic INTERREG IV A -ohjelma, Varsinais-Suomen liitto, Viron Meriakatemia ja Huoltovarmuuskeskus. Lisätietoa hankkeesta ja merenkulun logistiikan tutkimuksesta voitte saada http://www.merikotka.fi/stoca/ ja http://mkk.utu.fi/tutkimus/merenkulun_logistiikka/.

Toivomme myötämielistä suhtautumistanne hanketta kohtaan. Annamme tarvittaessa mielellämme lisätietoja hankkeeseen liittyen.

Ystävällisin terveisin,

Johanna Yliskylä-Peuralahti & Mattias Spies

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Appendix 3. Contact message sent to the port operators contacted for the phone/e-mail survey (December 2010).

Turun yliopiston Merenkulkualan tutkimus- ja koulutuskeskus on mukana tutkimushankkeessa ‘Study of cargo flows in the Gulf of Finland in emergency situations (STOCA)’, jossa selvitetään Suomen ja Viron merenkulun logistista huoltovarmuutta häiriötilanteissa. Hankkeen tavoitteena on selvittää, mitä seurauksia yritysten ja yhteiskunnan kannalta on, mikäli joku Suomenlahden satamista on jostakin syystä suljettu sekä mitä vaihtoehtoja kuljetusten järjestämiseksi tällöin olisi. Osana tutkimusta selvitämme erityisesti, mitä lastityyppejä olisi mahdollista siirtää satamista toiseen.

Toivomme, että voitte osallistua tutkimukseen yrityksenne edustajana. Otamme teihin uudelleen yhteyttä puhelimitse viikon kuluessa sopiaksemme teille sopivan puhelinhaastatteluajan. Haastattelu vie aikaa noin 30–40 minuuttia. Haastattelussa antamianne tietoja käsitellään luottamuksellisesti. Haastattelukysymykset ovat tämän viestin liitteenä.

Mikäli haastattelu puhelimitse ei sovi teille, pyydämme teitä vastamaan liitteenä oleviin kysymyksiin kirjallisesti ja lähettämään vastauksenne meille sähköpostitse.

STOCA hankkeen rahoittajina ovat EU:n Central Baltic INTERREG IV A -ohjelma, Varsinais-Suomen liitto, Viron Meriakatemia ja Huoltovarmuuskeskus. Lisätietoa hankkeesta ja merenkulun logistiikan tutkimuksesta voitte saada http://www.merikotka.fi/stoca/ ja http://mkk.utu.fi/tutkimus/merenkulun_logistiikka/.

Toivomme myötämielistä suhtautumistanne hanketta kohtaan. Annamme tarvittaessa mielellämme lisätietoja hankkeeseen liittyen.

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Appendix 4. Port operator survey.

Finnish ports and their capacities for alternative routing – on lyhyt englanninkielinen selvitys, joka toteutetaan osana STOCA -projektia. Tavoitteena on selvittää, kuinka satamaoperaattorit toimivat häiriötilanteessa varmistaakseen lastien käsittelyn. Pyrimme lisäksi selvittämään, mitä mahdollisuuksia on siirtää joitakin lasteja (kuiva- ja nestemäiset irtolastit, kontit, perävaunut, kappaletavara) kokonaan tai osittain muihin satamiin, mikäli yksi tai useampi Suomenlahden pääsatamista (lähinnä Vuosaari, Hamina, Kotka, Hanko tai Turku) olisi häiriön vuoksi suljettu. Häiriötilanteella tarkoitetaan tässä tutkimuksessa esimerkiksi lakkoa tai suuronnettomuutta, joka voi hidastaa tai lamauttaa kokonaan yhden tai useamman sataman normaalin toiminnan.

Vastatkaa alla oleviin kysymyksiin joko alleviivaamalla sopiva vaihtoehto tai vastaamalla vapaamuotoisesti. Puhelinhaastattelussa käymme nämä kysymykset läpi, joten olisi hyvä jos kysymykset ovat myös teillä itsellänne esillä haastattelutilanteessa.

Sataman ja kuljetusmuodon korvattavuus

1. Mikäli häiriötilanteen vuoksi sen sataman, jossa toimitte, normaali toiminta keskeytyy, pystyttekö satamaoperaattorina ohjamaan tiettyjä lastityyppejä (kuiva- ja nestemäiset irtolastit, kontit, perävaunut, kappaletavara) toiseen satamaan tai toisiin satamiin, joissa yrityksellänne on toimintaa?

Kyllä kaikki/ Kyllä jotain / Ei lainkaan. Täsmentäkää, mitä lasteja ei voi siirtää:

1.1. Mitä lastityyppejä voidaan siirtää toiseen satamaan (jossa teillä on toimintaa)? Mihin satamiin lasteja on tällöin mahdollista siirtää?

1.2. Mitkä tekijät voivat vaikeuttaa tai tehdä mahdottomaksi lastien siirron toiseen satamaan? Esimerkiksi:

-Ei sopivaa laivapaikkaa
-Kyseiselle lastille ei ole sopivia tai riittävän tehokkaita lastinkäsittelylaitteita muissa satamissa
-Varastotilan/satamakentän pienuus
-Muut mahdolliset syyt, mitkä?

1.3. Hidastuuko tavaran toimittaminen asiakkaille, jos lasteja siirretään satamasta toiseen?
Ei ollenkaan / Vähän / Merkittävästi

1.4. Aiheutuuko lastien siirtämisestä muihin satamiin teille (operaattorina) lisäkustannuksia?
Ei lisäkustannuksia / Pienet lisäkustannukset / Suuret lisäkustannukset

1.5. Aiheutuuko lisäkustannuksia asiakkaillenne?

2. Jos häiriötilanteen vuoksi lastin kuljetus meritse on mahdotonta, onko teidän asiakkaidenne mahdollista käyttää muita kuljetusmuotoja? Jos on, mitä?

Vaihtoehtoinen kuljetusmuoto____________________ ja mille käsittelemillenne lastityypeille (kuiva- ja nestemäiset irtolastit, kontit, perävaunut, kappaletavara) se sopii:

3. Muut mahdolliset toimintavaihtoehdot häiriötilanteessa:

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(Appendix 4 continues)

Ennakoivat toimenpiteet

4. Mitä käsittelemistänne lasteista voidaan tarvittaessa varastoida sen sataman/niiden satamien alueelle, jossa toimitte operaattorina?

4.1. Varastoinnin kustannukset: Pienet / Suuret / Erittäin suuret

4.2. Miten muuten olette varautuneet mahdollisten häiriötilanteiden varalle?

Kommentit:

Appendix 5. Preparedness strategies of the case companies.

Industry	***Risk mitigation strategies***	***How long production can be carried out after a disruption***
Energy production	**Company 1** (**coal imports**): **control and flexibility** - **control:** several month's stocks + backup - **flexibility**: multiple sourcing (contracts 80–90%, buying from spot markets 10–20%), widening the energy base (biofuels & domestic energy sources) **Company 2: (oil) flexibility** use of several raw materials sourced from different locations - several production sites in different countries - flexibility in terms of vessels (own + chartered vessels) - contracts concerning sales : term agreements used mostly, but some products sold also on spot markets - emergency stocks exist	3 months 2–3 days
Food supply & food exports	**Company 3:** (**grain imports & exports) flexibility** - multiple ports can be used - flexibility in schedules: postponing shipments or taking incoming deliveries earlier (before the strike) - product can be stored, multiple sites used (farms also keep stocks). During the strike extra storage capacity was organised **Company 4:** (**meat & meat products) mainly control** - contracts, making sure transport partners have adequate & suitable equipment - joint ventures in production (in emerging markets e.g. Baltic, Russia) - increasing inventory levels of incoming supplies, emptying storage of outgoing products - importance of direct communication **Company 5 (animal feed & malt): control & co-operation** - reserve stocks - some excess capacity (+ capacity to change production in emergencies) - co-operation in energy - localised sourcing & contracts with farmers (to reduce dependency on imports). **Company 6 (wholesaler of food & consumer products): flexibility** - lead times between products vary - changing schedules and transport modes	several months 2–3 weeks Animal feed: 2–3 weeks Malt: can be stored, several months 2–3 days to 2–3 weeks (varies between products)
Food supply & food exports	**Company 7 (milk products): co-operation & flexibility** - co-operation with transport companies - multiple suppliers - changing the transport route	2–3 days

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(Appendix 5 continues)

Industry	***Risk mitigation strategies***	***How long production can be carried out after a disruption***
Chemicals	**Company 8 (basic & specialty chemicals): control** - increased inventory - changing the transport route - continuity plans	2 weeks
	Company 9 (basic & specialty chemicals): control &co-operation - continuity plans - raising inventories - changing the transport route & mode - using other ports - supplying customers from other sites - global sourcing, alternative suppliers (but for some materials only 1 supplier)	2 weeks
	Company 10 (basic chemicals, raw materials for plastics): control & co-operation - supply contracts - integration - continuity plans, communication (internally & with suppliers & customers)	2 to 9 days
	Company 11 (pigments & chemicals): control & co-operation - increased inventory - VMI with suppliers -continuity plan: alternative routing & changing transport mode, back-up carriers	2 weeks
Pharmaceuticals & healthcare supplies	**Company 12 (pharmaceuticals): control** - buffers and safety stocks - alternative routing, changing transport mode - back-up suppliers	2 months
	Company 13 (wholesaler of health care products): co-operation & flexibility - co-operation with principals & contractors - several suppliers (with several factory locations) - several transport modes used - safety stocks	2 to 8 weeks
	Company 14 (wholesaler of pharmaceuticals): control & flexibility - safety stocks by law (3 & 6 months) - several transport modes used - safety stocks	3−4 weeks
	Company 15 (wholesaler of pharmaceuticals): control - co-operation with principals & contractors - safety stocks by law (3 & 6 months) - alternative routing, changing transport modes	3 months

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(Appendix 5 continues)

Industry	***Risk mitigation strategies***	***How long production can be carried out after a disruption***
Logistics/freight forwarding	**Company 16: co-operation & flexibility** - communication - flexibility in terms of scheduling, re-routing	No info
Forestry	**Company 17 (pulp & paper, sawn wood): co-operation** - VMI - communication - continuity plans will be made	12 hours to 2 days
Metals	**Company 18 (metal products): flexibility** - several suppliers of raw materials - some spare capacities	depending on the product from weeks to several months
Electronics	**Company 19 (products for power & automation technologies): postponement &flexibility** - different product categories: products produced to stock, engineered to order and configured to order - changing delivery schedules in case of problems - balanced pool of customers in different industries	2–3 days

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