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Eessõna

Käesolev Eesti Mereakadeemia Toimetiste üheksas number on välja antud akadeemia juubeliks, 90. aastapäevaks.

Number on valminud koostöös Soome ülikoolidega, Lappeenranta Tehnikaülikooli ja Turu Ülikooliga, partneritega, kellega on läbi viidud mitmed rakendusteadusuuringud merenduslogistika vallas.

Seekord käsitletakse Toimetiste üheksas artiklis kaubatransporti merel, teedel ja raudteel mitmest küljest.

Tõnis Hundi artikkel käsitleb riske nafta ja kemikaalide transpordil läbi Eesti ja Soome sadamate süsteemsest käsitlusest lähtudes.

Jyri Vilko artikkel vaatleb riske rohkem süvitsi ning toob põhjalikumalt välja riskid, mis puudutavad kaubavoogusid Soome lahes.

Lauri Lättila ja Juha Saraneni artiklis kasutatakse süsteemidünaamika simulatsioone hindamaks tagamaa ressursside piisavust ja sadamate toimimist kriisisituatsioonides, kasutades hüpoteetilist juhtumit, kui Kotka ja Hamina sadamad on suletud ja konteinerivood suunatakse Helsingi sadamasse.

Juha Saraneni ja Jouko Karttuneni artikkel käsitleb intermodaalse transpordi infrastruktuuri ja tarneahelate toimimise kindlust.

Tyyra Lumijärvi ja Ulla Tapaneni artikkel analüüsib Soome Soome lahe sadamaid läbivaid kaubavoogusid.

Olli-Pekka Hilmola artikkel peaks huvi pakkuma investoritele. Autor toob välja raudtee transpordisektori investeerimisportfrellide parema soorituse olulisemate turuindeksitega võrreldes viimase kümnendi mõlema kriisi ajal.

Eesti Mereakadeemia Teadus- ja Arenduskeskus soovib tänada meie koostööpartnereid Lappeenranta Tehnikaülikooli Kouvola uurimisüksust ja NORDI keskust ning Turu Ülikooli Merendusuuringute keskuse Kotka Merendusuuringutekeskust.

Preface

Present Proceedings of the Estonian Maritime Academy is published for the 90th year jubilee of the Academy.

Current issue is made in cooperation with Finnish universities – Lappeenranta Unversity of Technology and University of Turku – partners with whom we have made several applied science researches in maritime logistics field.

Main theme of this Proceedings is cargo transport on sea, road and railroad. The last is handled from many aspects maintaining nine articles.

Tõnis Hunt's article describes risks for oil and chemicals cargo flows through Estonian and Finnish ports from the system approach perspective.

Jyri Vilko's article observes risks more deeply and thoroughly analyzes risks concerning cargo flows in the Gulf of Finland.

The article made by Lauri Lättila and Juha Saranen introduces systemdynamics simulations for evaulating hinterland capacity and seaport performance in crisis situations. It is based on hypothetical case, if ports of Kotka and Hamina would be closed and container traffic would be transferred to Helsinki.

Security of supply and infrastructure of intermodal transport are analyzed in the article written by Juha Saranen and Jouko Karttunen.

Tyyra Lumijärvi and Ulla Tapaninen have analyzed traffic flows shipped through Finnish ports in the Gulf of Finland.

Olli-Pekka Hilmola's article should interest investors by showing that established railway company portfolios have outperformed leading market indexes in both recessions of this decade.

Estonian Maritime Academy Research and Development Centre would like to thank our long-term partners from Lappeenranta Unversity of Technology Kouvola Research Unit and NORDI and University of Turku Centre of Maritime Studies Kotka Maritime Research Centre.

Risks Causing Use of Alternative Routes in Handling Oil and Chemical Cargo Flows in Finnish and Estonian Ports in The Gulf of Finland

Tõnis Hunt *M. Eng*

Estonian Maritime Academy

1. Abstract

Emergency situations may cause serious problems in a supply chain. If not prepared it can cause loss of time, money, material and human resources. It is important to acknowledge the risks that can cause emergency situations and to be prepared for making emergency plans beforehand. To name the few, such risks may be strikes, riots, different natural phenomena, accidents or political relations.

During the last fifteen years cargo flows have grown fast in the Gulf of Finland. Especially oil and chemicals flows and containers. As oil and chemicals are dangerous cargoes, it is important to understand the risks associated with them. Moreover, it is of great importance to know the most efficient alternative routes in emergency situations.

Keyword: Oil and Oil Products, Chemicals, Ports, Risk, alternative routes, System Approach

2. Introduction

Taking into account basic principles of logistics, fluent movement of cargo is essential. There are many risks involved while transporting cargo. This can jeopardize arrival of cargo to the destination at the right time and in the right quantity with optimal price. The longer the distance, the greater is the chance that something could happen and conventional cargo routes could not be used. Therefore, backup routes should be also considered in the planning of cargo routes, because in case of emergency, readiness to change the route and planned action can considerably reduce extra use of different resources (human, financial, material etc.), and insures fluent movement of cargo flows.

There are different reasons why usual route cannot be used anymore, risks that can paralyze one or more links in supply chain. Those risks can be environmental, political, social and economical. There should be kept in mind that changes in one link of the chain usually cause changes in the next ones. Furthermore, there are risks which are not directly connected to supply chain but may have a certain impact on it. Therefore, it is necessary to make in-depth analysis of the supply chain, including possible risks and their affection on it.

Amount of cargo transported through the Baltic Sea has grown fast. Chemicals, oil and oil products have played important role in this growth. Big part of the mentioned cargo flows is transported through the Gulf of Finland.

Firstly, this article analyzes oil and chemicals cargo flows through Finnish and Estonian ports in the Gulf of Finland. In addition, it gives an overview of the risks, which can cause use of alternative routes. Lastly, it gives an overview of alternative routes that can be used in emergency situations.

3. Overview of cargo flows through estonian and finnish ports

3.1. Overview of cargo flows of oil and chemicals through Estonian ports

Since early 1990's, after regained independence, when the structure of economy needed dramatic changes, also the ports had to change their plans of action. This meant that new cargo flows were introduced, that has kept its dominance up to present-day. While old cargo flows were mainly general cargoes, the new ones were mainly liquid and dry bulk cargoes. This brought up the need for new specialized terminals for handling these flows. Keeping in mind that simultaneously one major trend in logistics is specialization, the terminals that we have in major Estonian ports at present day are highly specialized, and there are modern terminals for handling oil and oil products, coal, fertilizer, containers, cars, chemicals etc.

Main commodities within oil and chemicals cargo flows are oil and oil products as liquid cargoes and fertilizers as solid bulk cargoes (figure 1). Port of Sillamäe, which started operating in 2005, has introduced new cargo flows – liquid chemicals (Port of Sillamäe 2009). At the moment the share of this cargo is not very big. Altogether oil and chemicals form big share of total cargo flows, making 64,5% (23,4 mln t) in 2008. In past nine years the share of oil and chemicals has been between 61% and 70%.

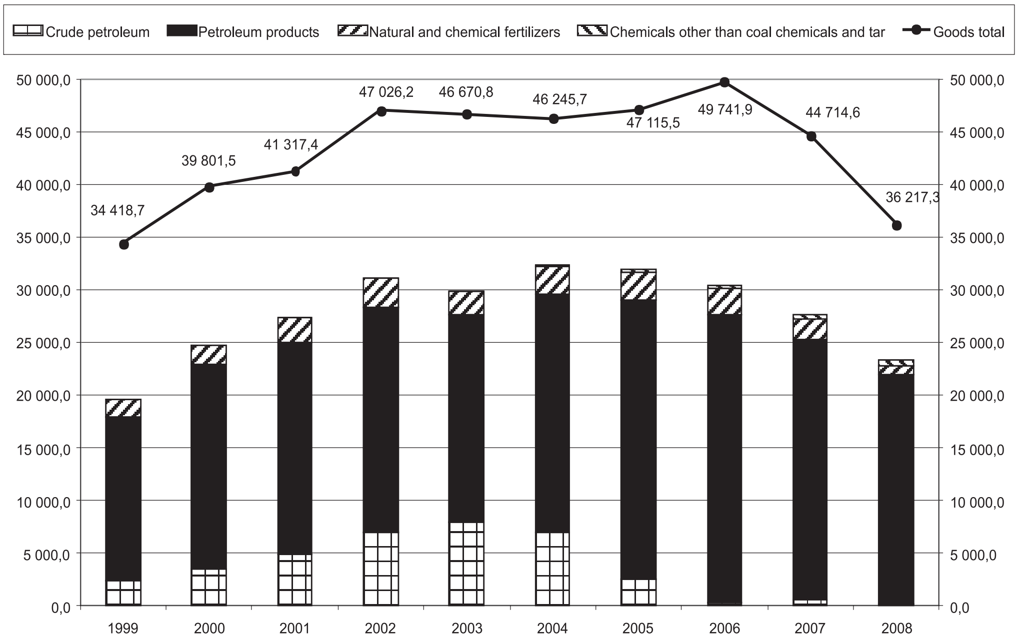

Figure 1. Transport of oil and chemicals (thousand tons) through Estonian ports 1999-2008, (Source: Statistics Estonia 2009).

Transit cargo share amongst oil and chemicals cargo flows is considerably higher compared to other cargo flows (figure 2). If chemicals, oil and oil products have transit cargo share averagely 81%, 99% and 100% respectively, then containerized goods, goods on trailers and wood transit share is averagely 24%, 1% and 1,3% respectively making total goods transit share 74%. As seen on the figure below, transit cargo share has dropped from 78% in 2006 to 68% in 2008. The reason for that is mainly political, not economical.

Though there have been different developments on economical and political level, in recent years oil products have been playing most important role in ports cargo throughput during the whole period of research. With harsh economical decline oil products share rose from 42% in 2003 up to 60% in 2008, although throughput fell from 27,3 mln tons in 2006 to 21,7 mln tons in 2008. Throughput of crude oil reached its peak in 2005 when 7,96 mln tons of cargo were handled. In 2008 only 0,23 mln tons were handled. Last two years

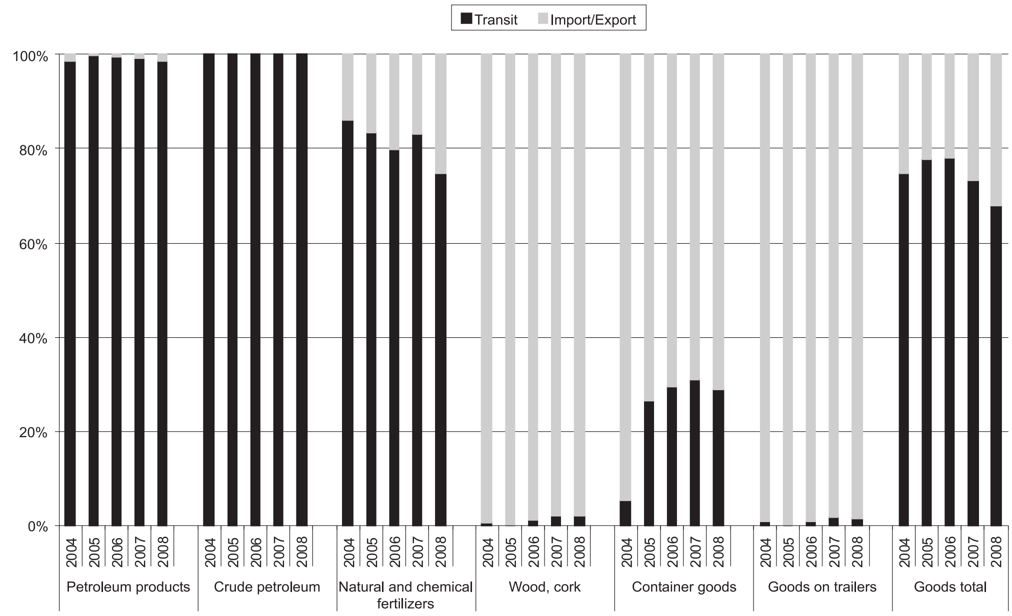

Figure 2. Transit cargo share of different cargo flows handled in Estonian ports 2004-2008 (Source: Statistics Estonia 2009).

have shown a big decline amongst companies while handling fertilizers, dropping from 2,75 mln tons in 2006 to 0,86 mln tons in 2008. Before that amount of fertilizers varied from 2,2 to 2,75 mln tons between 2001 and 2006. (Statistics Estonia 2009). Looking at the statistics from the Port of Tallinn for current year then the numbers are looking surprisingly good. For the first 9 months cargo traffic is up by 6,8%, from that liquid cargo is up by over 14% and fertilizers are up by almost 30%. Port of Tallinn (consists from 5 ports – Muuga, Old City, Paljassaare, Paldiski South and Saaremaa) is the biggest port in Estonia handling over 80% of total cargo handled by Estonian ports. Other cargo ports are Sillamäe, Kunda, Pärnu, Paldiski North port, Bekkeri/Meeruse, Vene-Balti and Miiduranna. From those Kunda, Pärnu and Bekkeri/Meeruse are oriented on import/export cargo flows. Other ports are also handling transit flows. Port of Tallinn's Muuga, Paljassaare and Pladiski South, Sillamäe and Vene-Balti are able to handle oil and chemicals. Miiduranna is also able to handle oil but future development plans are connected with other activities than oil handling.

3.2. Overview of cargo flows of oil and chemicals through Finnish ports in the Gulf of Finland

In Finland, due to its geographical location, lots cargo movements both for domestic and foreign traffic are made by water transport. Therefore, the ports are evenly spread over the coast of Finland.

Cargo flows through Finnish ports have steadily grown reaching 102,4 mln tons in 2008 (Figure 3).

Finnish ports focus more on serving domestic industry whereas Estonian ports' throughput mainly consists of transit traffic (Figure 4). The share of transit traffics is rather small, but its importance has grown in the last couple of years.

From the foreign traffic side main ports in the Gulf of Finland are Sköldvik, Helsinki, Kotka and Hamina. Sköldvik is so called oil port importing crude oil and exporting oil products, Helsinki's main import and export article is general cargo (including containers), Kotka's exports are timber products, paper and paperboard, chemicals, imports timber, metals, crude minerals and cement and general cargo (including containers), Hamina imports general cargo

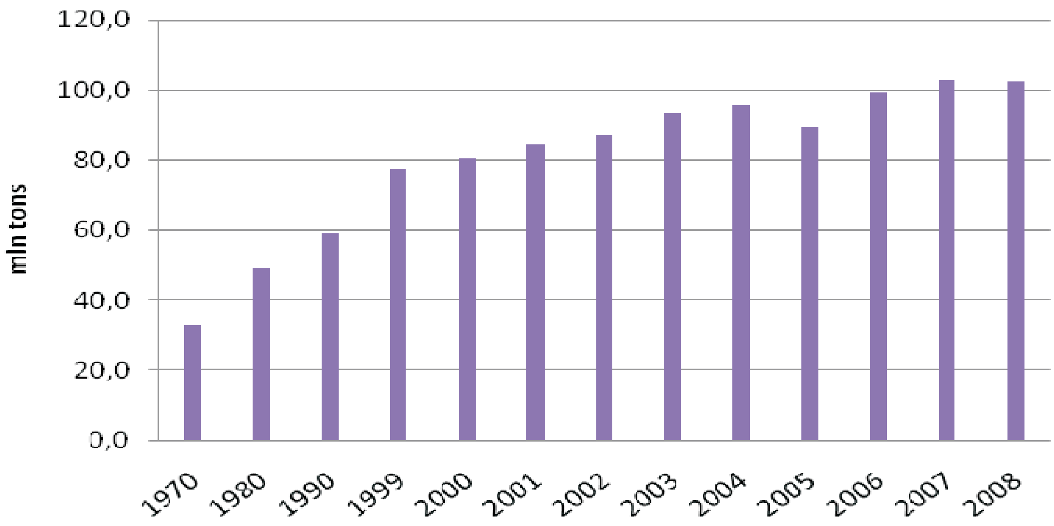

Figure 3. Total throughput of Finnish ports over the years. (Finnish Maritime Administration 2009).

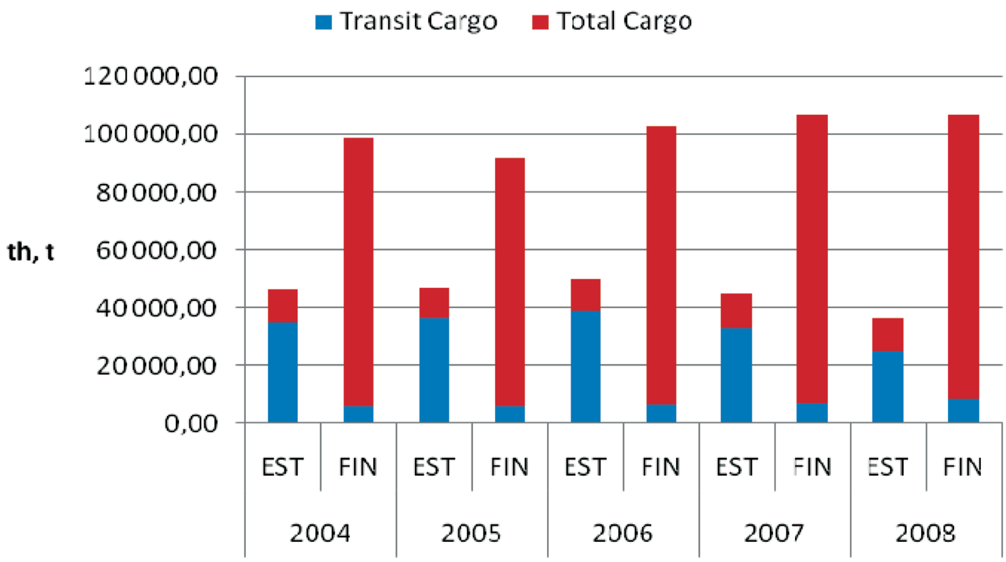

Figure 4. Share of transit cargo of Finnish and Estonian ports. (Statistics Estonia 2009, Finnish Maritime Administration 2009).

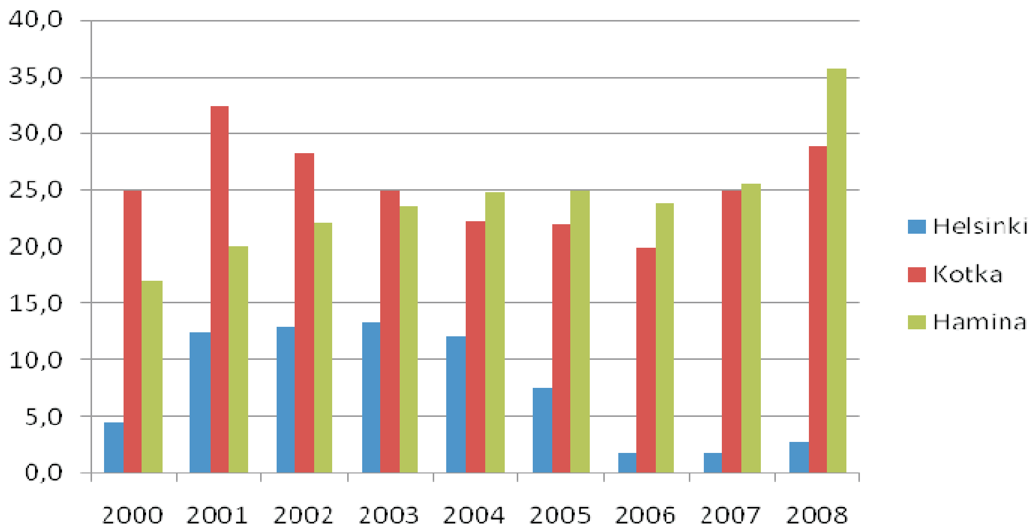

Figure 5. Share of transit cargo in ports of Helsinki, Kotka and Hamina, 2000-2008. (Finnish Maritime Administration 2009, Finnish Port Association 2009).

(including containers) and chemicals, exports chemicals, paper and paperboard. While Helsinki is more focusing on import-export cargo flows, Kotka and Hamina are more focusing on transit traffic than Helsinki (Figure 5).

4. Possible risks as a cause of using alternative routes

4.1. Systems Approach – Port as a Subsystem

Port as a subsystem is a part of the logistics system and, therefore, is tightly linked to another subsystems in logistics like water transport, rail transport, road transport, warehousing etc. It must be kept in mind, that logistics system as open system interacts with its surroundings, which consist of other systems like manufacturing, politics, finance etc (figure 6). Therefore, analyzing risks or threats that can cause use of alternative routes, we must look further than logistics system and also deal with other systems. It should be also taken into account that some of the risks can be result of concurrence of at least two different systems or subsystems. For example, how would the cargo flows through Estonian ports be affected, if due to cold winter the ice conditions would be harsh and there would be lack of ice breaking power in the south side of Gulf of Finland?

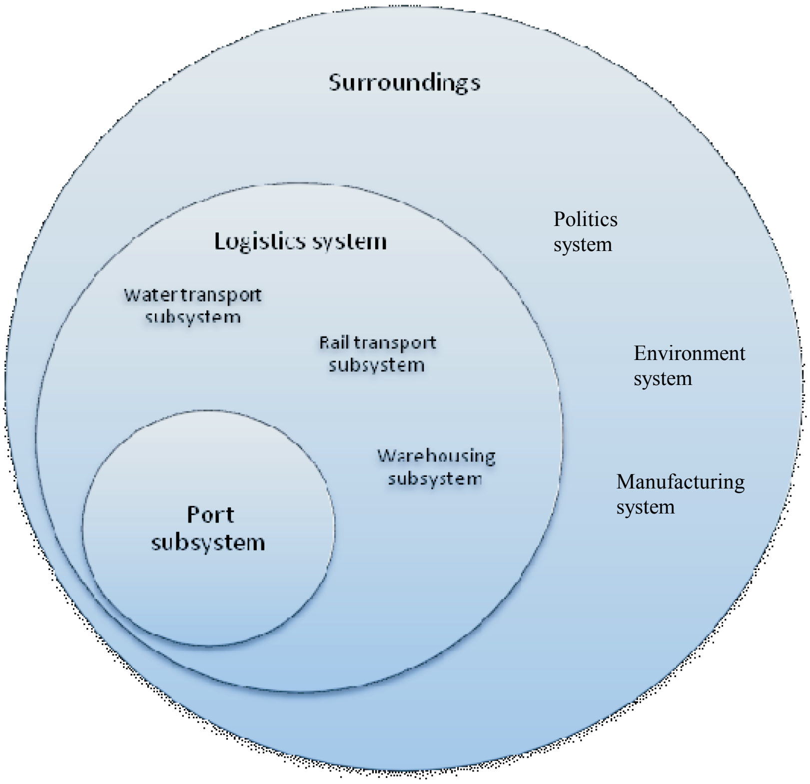

Figure 6. Relation of port subsystems to logistics system, surroundings and to other systems and subsystems.

There are many different risks that can cause use of alternative routes. Some of them are risks within port subsystem, others affect the port subsystem from outside. Though, sometimes the border between system and surroundings can be vague - depending on the risk being internal or external. More important is to understand, whether the risk can be neutralized within port subsystem and/or in cooperation with other (sub)systems; or the problem is solvable by application of other systems only, and that port subsystem has no influence on that.

It is also time factor to be considered while defining risks, as it depends whether the risk affects the system in short or long time. The longer is negative influence of some certain risk, the more outside help is going to be needed. For example, when relations between two countries are bad and additional constraints (like higher taxes or higher service charges etc) for cargo traffic are introduced. This kind of problem must be solved on governmental levels.

4.2. Strike

Strong unions is a precondition for successful strike. Strike can cause very serious problems in logistics and different parties in supply chain such as big loss of resources. Probably, the biggest problem with strike is the uncertainty of its duration. Especially, when negotiating parties cannot find a compromise. For example, on 13th of March 2009 stevedores from company Finnsteve have been striking in Vuosaari Harbour for 24 hours (YLE 2009).

However, such situation is uncommon as unions usually warn beforehand about the possibility of strike and its duration. The longer the strike lasts, the bigger is the chance that the cargo will be rerouted. In longer perspective cargo flows can move to other ports and big efforts must be made to get them back.

Fluent cargo flow is not interrupted by port workers strike only. As ports is only one of many links in the supply chain, strikes in other links (railroad, road transport, warehousing etc) can also paralyze the cargo flow through ports. Work in port can be heavily influenced by strikes from other systems that have not such kind of direct connection to port. For example, somebody could strike and block roads or public transport, so that people could not get to work.

Lastly, comparing Finnish and Estonian situation, it is worth mentioning that Estonian ports have upper hand on this cause due to the lack of strong unions. So, risk for strikes is much smaller than in Finland.

4.3. Riot

Riot is a form of civil disorder, "strike" on another level. In larger scale riots can be predicted. Still, their beginning as duration, extent and aftereffect might be unpredictable. Riots are indicators that there is some kind of instability/problems in society.

In April 2007 there was a riot in Tallinn and other places of Estonia due to removal of the statue of Unknown Soldier. While one part of the Estonian population saw in this statue the symbol of the Soviet occupation (and there is no place for it in the center of the capital), for others it is a symbol of liberation and victory over Nazism. The riot itself started on the 26th of April (Postimees 2007), and the statue was removed on 27th of April. Unrest of mostly youngsters paralyzed the life in the city, as well as the cargo transport through Tallinn. After the riot there were numerous cyber attacks against different Estonian websites and information systems of governmental institutions, banks etc which totally interfered normal business process. In longer term, this event was very negative for Estonian transit sector, as Russia reacted very vigorously and almost every cargo flow originated from Russia was redirected to other countries (especially to Latvia).

The beginning of 2007 was probably the best for Estonian Railway, when during the first four months averagely 40 trains were handled. In May 2007, after the riot, Estonian Railway handled only 25 trains, and in June its amount decreased to 16 trains (Terk et al 2007).

4.4. Natural Phenomena

Nature's influence has always played important role in transport – choosing routes, building transport infrastructure, planning journeys etc. The exact moment of natural phenomenon is unpredictable. So, precautionary measures must be prepared. Being unprepared could cause loss of human, material and financial resources. Natural phenomena that could seriously affect fluent cargo flow are earthquakes, ice, winds (e.g. hurricanes), waves (e.g. tsunamis), rise of water level etc.

Kobe earthquake on the 17th of January 1995 caused heavy damages to the city including port and other transport infrastructure. Port of Kobe was only a prior to earthquake in Japan's principal shipping port. After the earthquake port lost its cargo flows and still has not regained the former status. Destruction meant that lots cargo flows had to reroute through other ports. (Somerville 1995, Kinki Regional Development Bureau, 2006)

Natural phenomena with the same devastations can be tsunamis, hurricanes etc. Hurricane Katrinas impact to the Port of New Orleans and Gulfport where many port and navigational facilities got damaged. As a result 2 years later these ports didn't fully recover the cargo flows, other ports handled them. (Port of New Orleans 2008)

In the Gulf of Finland there is no such kind of natural phenomena. It does not mean that nature can be overlooked. Probably the most serious phenomenon in the Gulf of Finland for shipping is ice. Ice conditions can cause serious obstacles for transportation, if proper instances are not prepared.

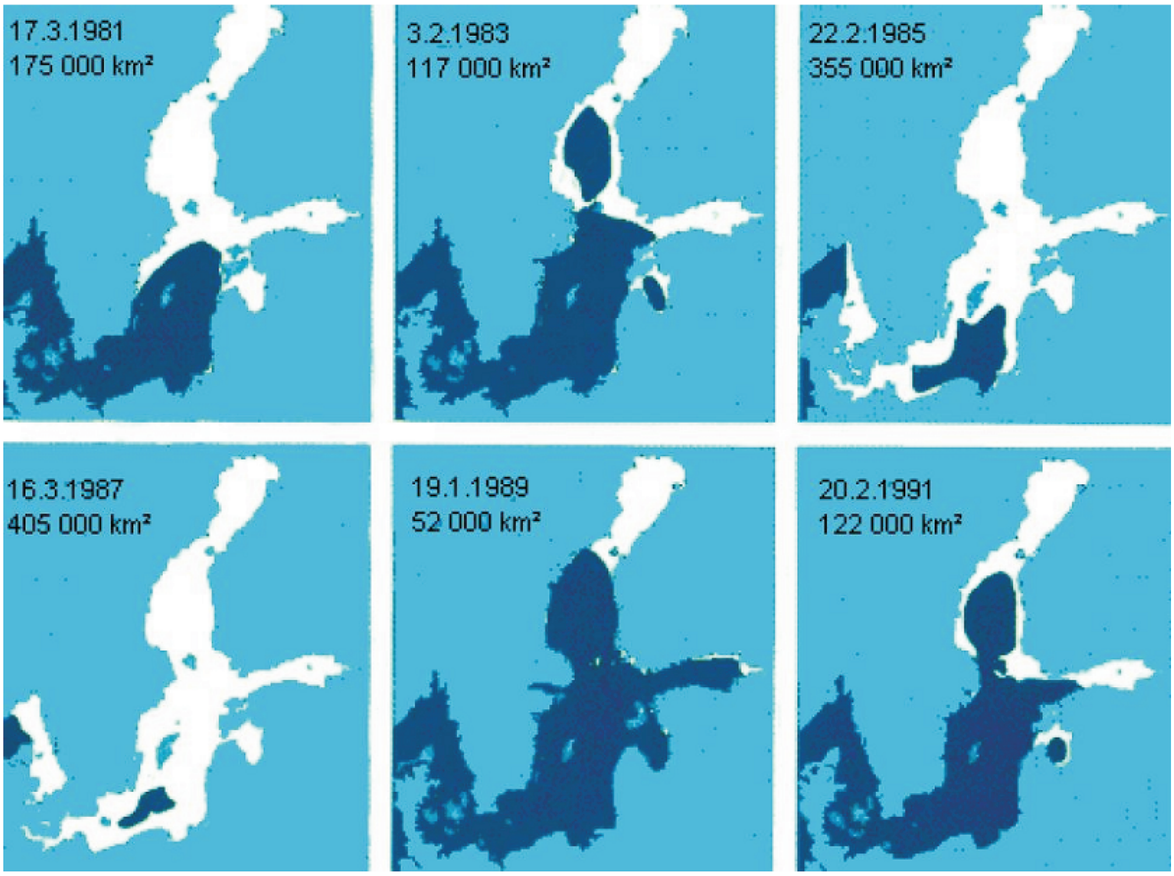

Figure 7. Ice conditions in the Baltic Sea in selected dates. (Lampela 2007).

4.5. Accidents

Accidents may cause serious obstacles for cargo transportation because some parts of the chosen route are unusable. It depends on the area the accident happens, whether it causes only one route to close down or some more. For example, if some kind of accident happens in Kopli railway station, it means that ports in Kopli peninsula as well as ports in Paldiski can not be served by rail anymore.

There can be traffic accidents, fire, explosion etc. Such kinds of accidents are often caused by someone's fault. More attention must be paid to quality system to prevent such accidents. Proper implementation of quality system should ensure that provided logistic service would be first-rate and safe. Safety factor is extremely important, otherwise because its avoidance could lead to serious consequences for humans, facilities, nature. The last one can be especially devastating, e.g. "Exxon Valdez" accident in Alaska in March 1989 (Cleveland 2006) or "Erika" by the coast of France (IMO 2009). Cargoes like oil and chemicals need special attention in handling. Therefore, stricter rules must be applied for them. Cargoes, which are dangerous according to IMDG Code, should be handled in safe distances from each other preventing domino effect.

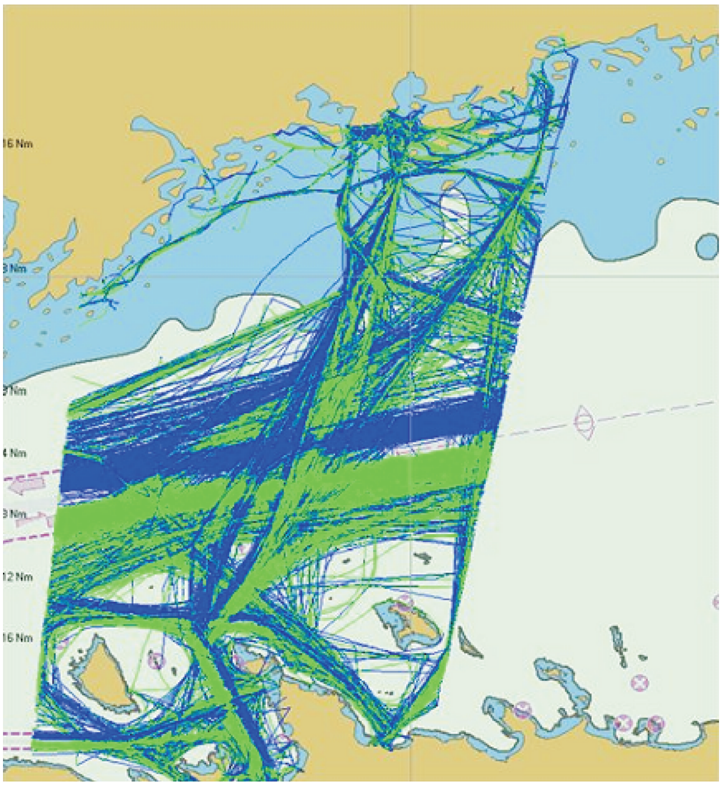

Figure 8. Traffic density in the Gulf (Tallinn – Helsinki) of Finland in July 2009 (Estonian Maritime Administration 2009).

Another important side in accident prevention is traffic management. World trade has grown and has globalized, and therefore, traffic has increased tremendously as in land as in sea. Air and traffic management has become more important than ever. In some regions vessel traffic has grown in such extent, that additional measures have to be implemented. In the Gulf of Finland vessel traffic has increased in big extent. Situation is more critical in region, where ships sailing east-west direction cross with the vessel routes moving in north-south direction i.e. in Tallinn-Helsinki direction (Figure 8). Therein lies a problem - passenger ships (north-south direction) meet a large number of tankers (east-west direction). Further research is needed in order to clarify what kind of risks this situation involves and what would be further consequences in case of an accident.

4.6. Political relations

Political arguments often prevail over all other arguments like economical, logistical, environmental etc. They prevail so much, that sometimes other routes should be used instead of one transport route. Good example is the aforementioned riot in Estonia in 2007 and decisions from Russian side on governmental level after that. But that event was not the only reason for bad relations between Estonia and Russia on governmental level. Unfortunately, bad relations have resulted in restrictions in doing business with Russia through Estonia.

Political relations have caused also trade wars between countries - so called “banana war” between EU and Latin-America, USA (EUBusiness 2007) or “beef war” between EU and USA (BBC News 1999) – just to name a few.

Political risks are the hardest to manage, as they exist on another level than logistics system. Political problems take also long time to resolve.

5. Alternative routes of cargo flows of oil and chemicals transported through Finnish and Estonian ports in the Gulf of Finland

Finding an alternative route for a cargo flow in emergency situations is a complex problem. Sometimes, it is complicated to find answers to some questions like: How long will the emergency situation last? What alternative routes might be available? Are these routes able to handle extra cargo flows? Is there enough resources? What are the extra costs? What about all the documents and contracts, i.e. commercial and juridical side?

This chapter analyzes only theoretical side of rerouting and offers alternative routes for oil and chemicals cargo flows in the Gulf of Finland in theory. In-depth analyze and simulations must be made to find out exact answers to other questions.

Analyzing cargo flows of oil and oil products in ports of Finland and Estonia in the Gulf of Finland, a big difference between the countries can be spotted. While Estonian ports handle transit cargo, Finnish ports handle import-export cargo. Recent developments in Estonian ports have shown that if earlier the cargo was handled as fast as possible, then now cargo usually stays longer in oil terminal’s tanks. It means that, despite the recession, need for storage capacity has stayed the same or even has risen. In Estonia oil and oil products handling ports are Muuga, Vene-Balti, Sillamäe, Paldiski South and Miiduranna. Oil is taken to ports mainly by rail, so if something happens from the land side with the railroad, then all or some of the mentioned ports are going to stay without oil supply on land. It would be possible to handle cargo flows from seaside – cargo would be brought to port by smaller ships and then loaded to bigger ships. Such scheme has been used recently, but not in emergency situations.

One of the Finnish ports that would be able to handle oil cargo flows is Sköldvik. In other ports (Hamina, Kotka, Helsinki) the statistics shows that the ports have handled mainly oil products, but in small amounts. However, will they be able to handle big amounts of oil transit flows? This is doubtable. On the other hand, Sköldvik is specialized oil (refinery) port and is able to handle big volumes of oil and oil products.

In addition, it is uncertain whether Estonian ports are able to handle Finnish oil cargo flows. It is probably doable on condition that the cargo would only be loaded and unloaded. However, in this case oil refining would be out of question. In Paldiski South harbour different cargoes are blended in Alexela Terminal, but they are not refined.

There is also possible to use Russian, Latvian and Lithuanian ports for oil transshipment.

Alternative routes for liquid chemicals are more limited than routes for oil cargo flows, as they need more specific facilities. Different chemicals need different pipes for transporting in ports. Estonian ports handling liquid chemicals are Sillamäe, Kunda and Muuga, and in Finland - Sköldvik, Hamina, Kotka and Helsinki.

Fertilizers are handled in Muuga, Kunda (small amounts) and in Paljassaare (current status is unknown). In Finland Kotka is the main port handling fertilizers. Other ports in Finnish Gulf handle fertilizers in very small amounts.

One of the issues concerning these cargo flows is whether the cargo is transit cargo, or it is meant for import/export cargo. In case it is import/export cargo, then due to geographical peculiarity other alternative routes are also possible both for Finland and Estonia. The situation is different with transit cargo. (In this case there are important issues to be solved.) Everything depends on the fact, whether the ports can handle rerouted cargo flows, and where the link of the caused blockage is.

6. Summary

Firstly, analyzing the use of alternative routes in emergency situations, we must observe a port as a subsystem to logistics system. Port system is influenced by other subsystems in logistics. As logistics is an open system itself, it is also influenced by surroundings with other systems. When it comes to research of possible risks, reasons of rerouting of cargo flows must be also kept in mind. In this article some of the risks were brought forward. Such risks include strike, riot, natural phenomena (earthquake, hurricane, ice), accidents, politics. They can be handled on different levels – port level, logistics level, governmental level etc. Often the key word is cooperation between subsystems and systems.

Secondly, oil and chemicals cargo flows, which are handled by Finnish and Estonian ports in the Gulf of Finland, can be characterized very differently. While Finnish ports are more focusing on domestic market, cargo flows through Estonia are more transit-based. It is essential factor, when we are talking about using alternative routes in emergency situations.

Lastly, further analyzes and simulations must be made in order to understand and handle the risks better, and to be ready for optimal alternative route in emergency situations.

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Risks affecting the Gulf of Finland cargo flows

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1. Abstract

Cargo flows in the Gulf of Finland have grown substantially since the fall of the Soviet Union. The high growth of traffic density in the narrow and shallow shipping lanes has been the center of attention for some time, and researchers have produced numerous reports warning about the risks involved. Many of these reports have not, however, considered the viewpoint of the practitioners of business life. Therefore, this paper is contributing to this gap by presenting the risks identified affecting the supply chains from their perspective. The study was conducted by interviewing organizations acting as part of a focal supply chain. The main risks identified by the interviewees were the port functions and the sea lanes and land routes near the port. The risks recognized varied significantly between the companies and persons depending on their position in the supply chain.

Keywords: Supply chain risk assessment; Identification; Cargo Flows; Gulf of Finland

2. Introduction

Cargo flows have grown substantially in the Gulf of Finland during the last decade. The financial crisis has calmed it down somewhat, but given that the economic growth will continue in the EU and especially in Russia, the traffic will also continue to rise in the future. So far in the Gulf of Finland there have been fewer accidents compared to traffic density than in the world on average (VVT 2004; FMA 2009). However, taking into account the shallow, narrow and curvy waterways of the Gulf of Finland with ice in the winter season, the risks are substantial compared to many other seas.

The Gulf of Finland is geographically situated between Finland, Estonia and Russia. It is approximately 400 km long and its width varies from 60 to 135 km with an average depth of only 37 m. The depth of the Gulf varies greatly, and for example the depth of the Neva Bay is only 5 to 10 m. (FMA 2004) Sea transports form 85% of the cargo flows of Finland and the Gulf of Finland has a special position in it as the three biggest ports Helsinki, Sköldvik and Kotka are on its shores.

After the unfortunate sinking of M/S Estonia there have been active studies about the risks and accidents in the Gulf of Finland. New systems for maritime safety have been introduced and new technology has continuously been taken into use. The fragile state of the Gulf of Finland and the environmental questions have lately been in the heart of research. The possible accidents and disasters have been studied from the point of view of the insurance companies as well (e.g. Järvenpää 2006; Nevalainen 2002). The viewpoint of the companies acting as part of the supply chains has however been somewhat neglected.

In the modern world supply chains have become very long and complex. This is caused by many drivers including globalization and the development of communications and other technologies, e-business and more agile logistics. Previously supply chains were thought to be purely operational problems and thus they were ignored and trivialized by many managers. Many recent events have, however, signaled how vulnerable the long and complex supply chains are. This has drawn the attention of many academics, which has resulted in guidance efforts in the form of research reports and publications. In recent articles and books the focus has been in the need for a systematical analysis of the supply chain vulnerability (Peck et al. 2003; Waters 2007).

Typically the risks affecting supply chains in the Gulf have been studied through accident reports and the consequences from the environmental perspective. The consequences, however, extend downstream in the supply chain affecting business life and the supply security of many goods.

According to Jüttner (2005), a disruption affecting an entity anywhere in the supply chain can have a direct effect on a corporation's ability to continue operations, get finished goods to the market and provide critical services to customers. In the US a ten-day shutdown of 29 ports costs 1 billion dollars per day to the US economy which illustrates the effects that disruptions in a supply chain can have. Finland as a northern country with small markets and great distances is particularly vulnerable, and here the ports on the Gulf of Finland are in a unique position. If a port was unable to receive cargo, the supply chain disruptions or at least delays would be likely.

The cargo flows in the Gulf of Finland are part of a longer supply chain which is to be studied from a wider perspective. Risks from the Finnish mainland can have an effect on the flows quite rapidly. The vulnerability of the cargo flows in these risks should therefore be studied. This paper is concentrating on representing the risks affecting the supply chains in the Gulf of Finland. The study is based on both the literature concerning the risks in the Gulf of Finland maritime transportations and supply chain risk management and the findings from interviews conducted. The paper begins by describing the methodology used. Next the supply chain risk management (SCRM) will be introduced by describing risks and vulnerability concepts. The identification and assessment of the risks is thereafter presented following with the risks found from the current literature concerning the Gulf. After that the risks identified in the interviews are presented with a framework for assessing them. Finally, conclusions will be presented.

3. Methodology

The study was done as part of a larger study, STOCA, which aims to study the cargo flows in the Gulf of Finland in emergency situations. As part of this study the interviews were conducted with a cross-section of companies acting as part of the supply chain from the Gulf of Finland to the Finnish mainland.

In order to tap into the supply chain professionals' experience and knowledge, a discovery-oriented approach was applied with semi-structured interviews as the primary method of data collection (Zaltman et al. 1982; Yin 1989). The interviewees were selected from the companies best representing their field and with high significance to the area of operations. The interviews were conducted with persons from a range of supply chain manager related duties. The position of the interviewed persons varied by the company, but all had a broad view of their company's operations. The interviews were conducted by researchers of different specialization backgrounds to get as broad a view of the subject as possible and to ensure the reliability of the study and its viability as the basis for further work. In the beginning of each interview, the interviewees were promised anonymity and their permission to use a recorder was solicited. Afterwards the recorded interviews were transcribed and sent to the interviewed parties for proof-reading and acceptance.

4. SCRM and concepts

Supply chains in the modern world are more efficient than ever, stretching over longer distances with complicated networks, which makes them vulnerable to a variety of risks. Global supply chains require highly coordinated flows of goods, services, information, and money within and across national boundaries (Mentzer 2001). Events affecting one supply chain entity or process may interrupt the operations of other supply chain members. Hence, it is important to investigate supply chains across borders when selecting and implementing supply chain risk management strategies (Manuj & Mentzer 2008).

Although the awareness of supply chain vulnerability and risk management is increasing among practitioners, the concepts are still in their infancy and there is a lack of conceptual frameworks and empirical findings to provide a clear meaning of the phenomenon of global supply chain risk management (Jüttner 2005; Manuj & Mentzer 2008). In the literature concerning supply chain management, risk is defined as purely negative and seen leading to undesired results or consequences (Harland et al. 2003; Manuj & Mentzer 2008). A standard formula for the quantitative definition of supply chain risk is:

$$Risk = P(Loss) * I(Loss)$$

where *risk* is defined as the probability (P) of loss and the significance of its consequences (I). (Mentzer et al. 2001).

Risks in the supply chain can come in many forms: Firstly, they can be operational, which are considered to be minor by their consequences but occurring regularly. These risks can cause disturbances in the supply chain that are not considered to be serious. However, when occurring simultaneously or when causing a snowball effect, these risks can have serious effects. Secondly and more commonly considered, disruptive risks are described by Tang (2006) and Zinn et al. (2009) as low probability–high consequences (LP–HC) events. These events can unexpectedly disrupt the flow of material in the supply chains at any time.

Jüttner (2003) describes vulnerability as an exposure to serious disturbance, arising from risks within the supply chain as well as risks external to the supply chain. According to Waters (2007), supply chain vulnerability reflects the susceptibility of a supply chain to disruption and is a consequence of the risks to the chain. Furthermore, Jüttner (2003) describes supply chain vulnerability as the propensity of risk sources and risk drivers to outweigh risk mitigating strategies, thus causing adverse supply chain consequences and jeopardizing the supply chain's ability to effectively serve the end customer market. How sensitive a supply chain is to these disturbances is measured by its vulnerability. How vulnerable a supply chain is to disturbances depends on its structural agility and resilience, where supply chain (risk) management plays a crucial role.

5. Identifying and assessing supply chain risks

Identifying supply chain risks is a key activity that forms the foundation for all other aspects of supply chain risk management (SCRM). In reality it is virtually impossible to list every conceivable risk, and identification gives a list of the most significant risks that have an effect on the supply chain. Inter-organizational people have usually the most intimate knowledge of the organization and its conditions, but not necessarily the capability to identify risks. Organizations cannot rely on personal knowledge and informal procedures, but need some formal arrangements to identify risks (Waters 2007).

Increasing risks in the supply chain are a current trend in logistics (Minahan 2005). According to Singhal et al. (2009), supply chain disruptions have become a critical issue for many companies. The categorization of the supply chain risks has many variations. Modern literature offers many possibilities for categorizing risks and they should be considered according to the supply chain in question. Blackhurst et al. (2008), argue that the most important step during the process of risk assessment is the selection and definition of categories of risks, which can be weighted, compared and quantified. The state-of-the-art literature offers many ways to categorize risks; some are industry specific and others general. In this case the risks were chosen to be classified by the case.

6. Risks in the Gulf of Finland

The risks in the Gulf of Finland found from the literature mostly concerned maritime transportation from the perspective of either environmental effects or the insurance company. These studies are usually based on statistical data where the occurred events and their probabilities can be calculated. Accidents occurred are those risks that have realized. Kujala et al. (2009) have produced one of the most recent studies about the Gulf of Finland's maritime safety and in their report some statistics about the accidents reported in the Gulf can be seen (Figure 1).

According to the shipping experts, the highest risks in the Gulf of Finland involve winter traffic, sailing in ice, large ships, lack of clear route division and the traffic culture (Kujala et al. 2009). Also, the crossing traffic is seen as a big risk with the most affecting factors being the qualities of the ships and the wind, ice and visibility conditions (Finnish Maritime Administration 2004).

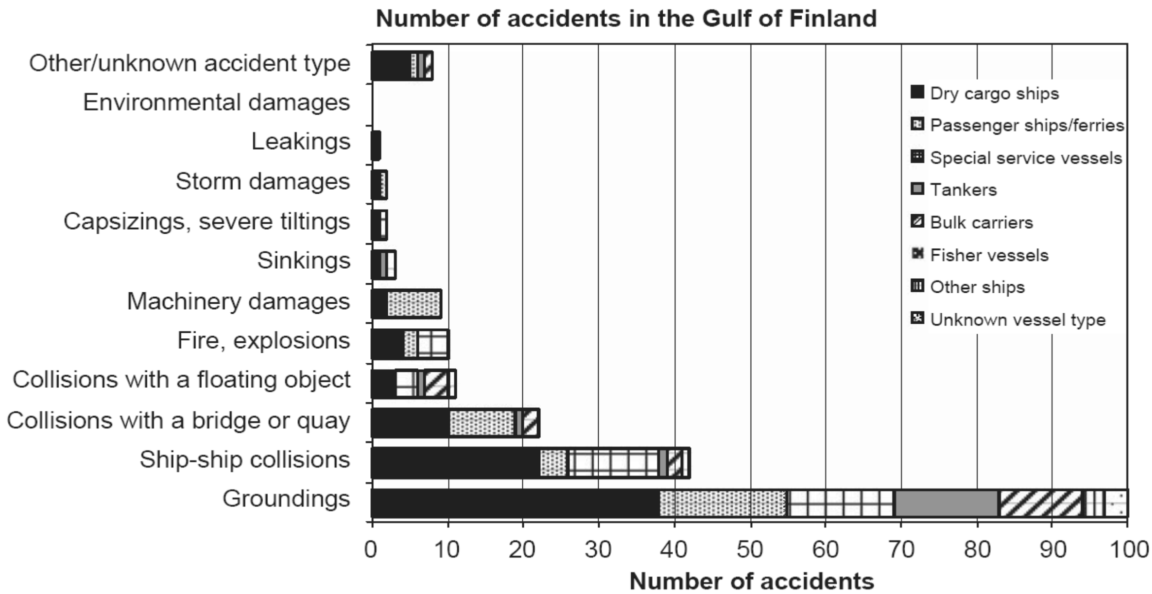

Figure 1. Number of marine accidents by accident and ship type in the Gulf of Finland. (Kujala et al. 2009).

As the transport volumes continue to rise in the Gulf of Finland, so do the risk involved. Especially the crossing traffic has received a lot of attention in the last few years. One of the best describing fact about the risen risk levels is the volume of oil transport traffic in the Gulf of Finland: at the beginning of the millennium, there were 50 million tons of oil shipped through the Gulf when the current figure is approximately 150 million (Kujala et al. 2009). In her report Pelto (2003) summarizes the risk factors of oil transportations in the Gulf of Finland as follows: increasing traffic density, growing oil transportation, risk of winter navigation, single hull tankers, illegal oil discharges and insufficient oil combating capability in the surrounding states.

According to Finnish Maritime Administration, the number of accidents recorded has decreased in the last 40 years. For example, in 1991–1995 there were 355 accidents recorded, whereas in 2001–2005 there were only 203.

However, in the pressure of global competition, local shipping companies find it hard to compete with cheap foreign labor. This can cause the ship crews to have poor knowledge of local conditions and great variation in their shipping skills, working hour regulations and legal obedience.

Language differences should also not be undermined. Modern technology helps to overcome these difficulties but is still far from perfect. Trusting blindly in the equipment on board can be a fatal mistake (Rytkönen 2003).

The current financial crisis and its effects on the Gulf of Finland's risks can be diverse. On the one hand it has reduced some of the traffic, but other effects can also be predicted. The economic slowdown will most likely delay the renewal of the ships and their systems which will increase risks in the long run. Furthermore, when the crews of these ships sail in the Gulf of Finland's icy conditions only rarely, their skills may rust which again increases the risks substantially.

The ice conditions vary from winter to winter in the Gulf of Finland. Winter traffic usually starts from January and continues until April. Ice appears first in the eastern part of the Gulf and spreads from there towards west along the shores. According to the statistics, the human factor is at least partially the cause in 60–80% of the accidents occurred in the Gulf of Finland (Kujala et al. 2009).

7. Risks identified in the interviews

Supply chain risks from the Gulf of Finland to the Finnish mainland were the focus of the interviews, which were conducted with 14 managerial practitioners in the focal supply chain. Focal companies are companies that typically rule or govern the supply chain, provide a direct contact to the customer and design the product or service offered (Skj¸tt-Larsen et al. 2007). The risk seen by the practitioners varied between the companies, but some of the same risks were also mentioned in every interview.

The identification of the supply chain risk and overall risk management were on a lower level in the smaller companies (e.g. trucking) than in those operating with a wider perspective in the supply chain. Also, the personal differences between managers and their interpretations were significant.

The interviews were conducted in the most important ports of Finland on the Gulf of Finland with global and local logistics operators and with some logistics companies operating from cargo transportations to distribution. One of the most obvious matters that was noticed from the interviews was the perspective that the different level operators have in a supply chain; the global logistics operator networking in many countries had the widest perspective on supply chain management. The benefits of co-operation were clearly understood at this level as were its inhibitors – fierce competition – which was also seen as a risk in the logistics field.

The port operators interviewed recognized the financial crisis and human factors (e.g. irresponsibility, poor motivation, alcohol) to be the most severe risks. The port managers had also their own view to the risk, and the responses varied according to the persons' position and background. The managers responsible for security did not typically see the market risk to be relevant, whereas the development or traffic manager saw them higher compared, for example, to terrorism. The 9/11 disaster still affected the business from every interviewee's point of a view.

Given the background of the interviewees, the conceptual clarity of the risk, risk sources and risk drivers were not taken into consideration; the interviewees rather responded with tales of cause and effect. In this respect the findings concur with Peck (2005) and Zsidisin (2003) who noticed that practitioners perceived risk as a multi-dimensional construct. The low-hierarchy trucking companies seemed to have only some idea about the functions they were conducting in the supply chain and how the disruption would affect the chain. Typically their perspectives were narrow, single-functioned and logistics based (Larson et al. 2007).

A surprising point found from the interviews was the poor state of preparedness that the companies had for any disruptions, no matter how insignificant they were considered and how little co-operation there was between the organizations operating in the same supply chain. The co-operation and communication between the parties was usually only at a level that was compulsory or necessary to conduct business.

According to Barratt (2004), supply chain collaboration requires a lot of resources. This would imply that the intense competition and financial crisis will have a negative effect on the collaboration on a vertical as well as horizontal level. The lack of collaboration typically causes overlapping in the supply chain and therefore increases costs and further decreases the low resources (Hertz 2006). In the interviews conducted, it was found that co-operation with the organizations importing or exporting goods in the Gulf of Finland is still at its infancy. A lot of suspicion still remains in the logistics and transportation field. One of the reasons for this is the intense competition which especially in the times of economic crises seems to take a strong hold of the managers.

Besides the risk of electricity or IT blackout, one of the main findings in the interviews was also the routes to and from the ports. Not only the narrow shipping lanes but also the land routes; in every major port there was either a bottle neck or a critical risk in the road or tracks. These were all noticed in the ports but only few of the identified risks had been assessed properly. If the usage of these vital routes was prevented, the capacity of the port would be significantly lower or even disrupted. This would have an instant effect on the cargo flows in the Gulf of Finland. Because of the specialization of the biggest ports in Finland the transferring of cargo that requires special handling equipment would be difficult.

From the export industry's point of a view the available containers are a clear risk. Currently Finnish companies depend on the Russian transit containers that become available after being unloaded. The rates have therefore been typically lower comparing to the rest of Europe, but the effects of the financial crisis have decreased the transit traffic. Less containers have become available and the rates have risen. Some companies have even had to order empty containers from Europe to ensure their supply.

Among the most significant risks was also the power that the labor union (of stevedores and truck drivers) has with strikes, which came up in every interview. The actions of the trade union had even prevented interfunctional co-operation between the companies of the supply chain, which illustrates the complexity of the relationships and risks and the operational environment's attitude towards developments in the supply chain (Jackson 1997).

The risks mentioned by the interviewees can be seen in Table 1. The risks are categorized in four different groups according to their sources (security, environmental, supply and transport, and business). The risks were also categorized by their effect, whether they were related to time (as in delay or disruption), cost or quality of the cargo. A descriptive, not explicit, rating of the risks is shown that illustrates the tool and its feasibility in assessing risk effects.

Table 1. Risks and their effects identified in the interviews.

	Time		Financial	Quality	
SECURITY	Delay	Disruption	Costs	Damage	**SUM**
Organized Crime (infiltrating into the SC)	1	1	1	1	4
Smuggling of people	1	0	0	0	1
Information systems	9	9	3	1	22
Drunken drivers	3	1	1	1	6
Traffic law negligence	1	1	1	1	4
Electricity	9	9	3	0	21
Outside interference to the SC	1	1	1	3	6
Spying and espionage	0	0	1	1	2
The ownership of the Finnish merchant fleet (supply security)	1	3	3	1	8
The applications of the transported good	0	0	1	3	4
Invoice inspection in transit traffic	1	1	1	0	3
Energy supply	3	3	0	0	6
Demonstration (Eco-terrorism)	1	0	0	0	1
Water deliveries	0	0	1	0	1
Problems in telephone connections (transformer breaks down)	3	0	1	0	4
Military situation	9	9	9	3	30
Breakdown of a critical railway bridge or railway yard	3	1	1	0	5
Commercial and administrative linkage (foreign ownership)	1	0	3	1	5
	2,6	2,2	1,7	0,9	**7,4**
ENVIRONMENT					
Nuclear disaster in nearby plants	3	9	1	0	13
Wide oil catastrophe in the Gulf of Finland or on the shipping lane	9	3	1	0	13
Ice conditions in wintertime	3	3	0	1	7
Narrow and slow shipping lanes	1	3	0	1	5
Intersecting rail and road traffic	1	0	0	0	1
Fire	3	3	9	9	24
Regional infectious diseases	9	3	1	0	13
Climate change	3	1	1	9	14
Natural forces (weather changes, storms, floods etc.)	3	1	1	9	14
Operating in heavy traffic area (GoF shipping lanes, straits of Denmark)	1	3	0	0	4
Finlands geographical position and dependence on sea traffic	0	0	3	0	3
Routes from the harbors (Tunnels, intersections etc vulnerable spots)	9	3	1	0	13
Fault in cargo/traffic control systems	9	3	3	9	24
Long distances	9	3	1	1	14
Documents, contracts and permits Interpretation problems	9	1	9	0	19
Toxic waste in the bottom of the lane (dredging)	0	1	0	0	1
Fog in the shipping lane	3	1	0	0	4
Wide spread pandemia	9	3	1	0	13
Slipperiness in wintertime	9	3	1	3	16
Flood	9	3	3	9	24
	5,4	2,6	1,9	2,7	**12,6**
SUPPLY AND TRANSPORTATION					
Hazardous materials	9	3	0	1	13
Stoppage made with cargo onboard	1	3	1	1	6
Ship Collision	3	9	1	9	22
Bottlenecks in the transportation routes	9	1	1	0	11
Capacity problems in railroad traffic	9	3	1	0	13
Lack of intermodal equipment and to multimodal transportations	9	3	1	3	16
Employee strikes in harbors	9	3	3	0	15
Cargo handling equipments condition	9	9	0	3	21
The permits of the transportation company	9	1	1	0	11
Oil accident in the harbor	9	1	0	0	10
Ship collicion or sunk in the lane to harbor	9	9	0	1	19
Bottlenecks in the Ro-Ro/Ropaxs-capacity	9	1	0	0	10
Lack of workforce	9	1	0	0	10
Customs unclarities	9	1	1	0	11
Workers' accuracy and motivation (carelessness)	3	1	0	9	13
Russian customs	9	3	9	0	21
	7,8	3,3	1,2	1,7	**13,9**
MARKET					
Fierce competition in the transportation sector	1	0	1	3	5
Economic situation (crisis)	3	0	9	3	15
Railway operators' attitude towards free markets	0	0	1	0	1
Finland's small and unatteractive markets	1	0	3	0	4
Orderers' financial problems (unable to pay for order)	9	9	3	0	21
	2,8	1,8	3,4	1,2	**9,2**

8. Conclusions

The Gulf of Finland has a unique position between Finland, Estonia and Russia. The traffic density in the area is high, and the narrow and shallow shipping lanes pose a serious risk to the cargo flows going through it. The risks affecting the cargo flows in the Gulf are reflected in the inland transportations as well as downstream in the supply chain. Disruptions in the downstream supply chain can also affect the Gulf's maritime transportation in the case of a disaster in or near the ports.

The main objective of this study was to identify the risks affecting the Gulf of Finland cargo flows from the business point of view. The study was done by interviewing organizations acting as part of a supply chain originating from the Gulf of Finland and ending up in the Finnish mainland. The interviews were semi-structured and exploratory by nature. To get a holistic understanding of the field, state-of-the-art literature was reviewed concerning the Gulf of Finland and supply chain risk management. The risks gathered from the literature presented typically the statistical analysis from the accidents in the Gulf of Finland. This study broadens the view by also taking into consideration the downstream parts of the supply chain.

Supply chains are usually extremely complex and vulnerable to various risks. A complete understanding of the consequences of the risks is impossible to achieve. In their studies Harland et al. (2003) came to the conclusion that in the supply chains examined, less than 50% of the risk was visible to the focal company. This study concurs with that but adds that there are significant differences between the companies and persons behind them. The risks were seen differently in each company even if there were many same concerns.

The most vital part of the supply chains from the Gulf of Finland in the eyes of the interviewed companies were the ports' infrastructure and the land routes near the ports. Typically, ports are specialized to handle only some transportation modes and therefore are not easily replaced if they are disrupted. The routes in and out of the ports were seen as the most vulnerable part of the infrastructure after the electricity and IT outage. From the export industry's viewpoint also the available containers are a risk, because it is depending from those received from the transit traffic.

Risks affecting the supply chains from the Gulf of Finland are numerous and, even though from different parts of the chain and of varying relevance, the consequences can have devastating effects throughout the chain. Some of the risks are hidden until they occur, some may emerge by passing time, some may only appear when a certain a mount of progress have been made or when another risk is been responded. Nevertheless further studies to reveal these should be conducted and more empirical evidence presented. For analysis of this the presented risk table could be developed by adding a probability column and an expert valued explicit rating.

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Infrastructure in intermodal transportation in the Baltic Sea region

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1. Abstract

During the last decade globalization has involved larger volumes in foreign trade. As a result maritime transportation and cauterization have increased. In Finland over 75 percent of trade volumes flows through seaports. Thus the functionality of the ports and supporting infrastructure plays an important role in the national economy.

This research is to evaluate security of supply and infrastructure and handling capacity of the ports in the shores of the Gulf of Finland as well as related railway infrastructure in railway yards of Kouvola and Tampere. The methodology is based on case study research. Finnish ports, such as Kotka and Vuosaari, have quite modern infrastructure with warehouses and logistics technology to handle container and ro-ro cargo. As the ports of Estonia have specialized to handle Russian oil, Finnish and Estonian ports have a limited capability to compensate for each others in operations as need arises.

Keywords: Infrastructure, transportation, capacity, seaport, railway

2. Introduction

The dominant mode of transport in the Gulf of Finland is sea with about 76 % of trade, while other means of transport cover only 24 % (Finnish Port Association 2008). In addition to their own import and export; the ports of Finland and Estonia handle a major share of the Russian transit traffic. In transit Finnish ports have mainly concentrated on container and consumer commodities import to Russia, whereas Estonian ports carry a great share of the oil export from Russia (Hilmola et al., 2007) (Terk et al., 2007).

From the biggest container ports of the world, which are located in Asia, America and Europe are imported commodities to the countries lies in Baltic Sea Region. With own import and export the ports of BSR handle a great deal of the Russian import and export. The ports of the Baltic Sea region have several potential transportation routes to Russia: The most northerly route goes from the ports of Turku, Hanko, Kotka and Hamina with railway connection to St Petersburg and Moscow. Southern routes go trough the ports of Lithuania, Latvia and Estonia. In the Baltic Sea region (BSR) the Russia has also own ports in mainly near St Petersburg region. Russia has also new ports that are under construction, which will have an important structural effect transit routes in the BSR. Nowadays containerized transit transportation goes mainly via the ports of Finland, but Estonia has a remarkable role in oil transit. The Finnish route constitutes about 13 % of transit value of Russian import in 2008 (Märkälä and

Jumpponen, 2009) Finnish route is considered as a reliable and safe alternative compared to routes in Central-Eastern Europe and the Baltic countries (Posti et al., 2009; Inkinen and Tapaninen, 2009).

The case-studies evaluate infrastructure of the ports in the shores Gulf of Finland in terms of identified risks. The case studies are supported by a literature review. The dominant mode of transport in the GOF is sea about 76% of trade, and other means of transport cover only 24% (Finnish Port Association 2008).

In addition to their own import and export, the ports of Finland and Estonia handle a major share of the Russian transit traffic. In transit Finnish ports have mainly concentrated on container and consumer commodities import to Russia, whereas Estonian ports carry a great share of the oil export from Russia. There is no study on how the very large maritime volumes could be handled if the operational environment changes unexpected. Such changes could occur, for example, if ports or sea routes would be closed down due to an economic crisis, an environmental hazard or disaster.

This paper is structured as follows: In the following section 2 is considered research methodology and in section 3 is the literature review. Case examples are illustrated in section 4. Section 5 provides discussion and conclusions.

3. The literature review

This literature work is made as a part of the project "Study of cargo flows in the Gulf of Finland in emergency situations" (STOCA) working package 5 to depict previous scientific publications in relation to efficiency of intermodal rail transport and port systems to secure supply of crucial flows of goods.

The articles handle infractructure of intermodal transportation: Its vulnerabilities, risks and possibilities International port centers evolve through an environment blessed with increasing containerization, concentration, collaboration and competition. The performance of containerized shipping is affected by external reasons: weather, security events, labor availability, stakeholder decisions, technology and accidents.

In overall it can be suggested that containerization despite being one of the major driving forces of launching intermodal transportation systems, it leads to growing uncertainty in supply of critical resources in meeting demand at hub ports. This might lead to suboptimal practices that create uncertainty in demand in supply chains (Lorentz et al., 2007). In the current state of global economic recession this process in turn may decrease the service capability of intermodal transport corridors (see De Borger, 2009; Brooks, 2009; Koskinen, 2009).

Below in Table 1 the core findings of the dissertations are summarized.

Table 1. Summary on findings of the scientific studies.

Author/Title	Purpose	Findings	Risk perspective
1	2	3	4
Duan (2006)	The main objective of this work was to elaborate an integrated framework for intermodal freight transport to show that by better coordination policies efficiency of the system can be increased.	The framework shows that by integrated decisions of the system players, empty container movements can be decreased and travel & waiting time inefficiencies in the transport network can be shortened.	Lack of collaboration can increase the effect of disturbances.

1	2	3	4
Newmann (1998)	The objective of this work is to show that by certain operational strategies, costs related to intermodal rail operations can be cut and still meet the deadlines for delivery requests.	Decisions on scheduling and allocating containers should be made first at the origins, only after at the hubs for outbound cargo. Direct connections should be preferred. At the hubs only the information whether the containers need special treatment is needed and they can be loaded in any order to the trains.	Disruptions in information exchange lead to decreased performance in container transportation.
Terahara (1999)	The main objective of this work is to shed a light on the efficiency bottlenecks of the coal transportation by rail from an economic and planning viewpoints.	From the planning perspective the bottleneck for efficiency is that costs incurred by the system do not reflect actual market conditions as a result of predefined centrally set government objective numbers. 20 percent of coal transfers could be eliminated if coal price gaps between regions would be settled out and some specific investment could be accomplished to ease capacity constraints.	Emphasizes investing on bottleneck resources in the transportation network and promotes market mechanism as a tool to achieve this.
Direnzo (2007)	The main objective of this work was to elaborate a new data-based tool to evaluate maritime risk from the point of view of homeland security indicators of vulnerability (attackability) and consequence (impact).	The created tool used risk definition of threat X vulnerability X consequence. The tool applied the CARVER method in determining the maritime risk for regions of the U.S. According to the results the region of Northwest and Northeast parts of that country are at most risk to be attacked.	In the United States number of foreign containers and recreational vessels contribute to maritime risk.
Vandiver (2006)	The aim of this dissertation was settling U.S. Critical infrastructure and its interdependencies by studying 16 imported commodities, which are very important to the U.S. Critical infrastructure (these commodities are common and valuable to U.S. economy).	With system engineering model and simulation in several scenarios it was found out that only a little fault in transportation system caused problems if it takes several days. Also the total stop in the port operations will cause an enormous economic loss. The most critical commodities were computers, telecommunication equipments and pharmaceutical preparations.	Interruptions are typically caused by labor or weather.
Fung (1998)	The aim of this dissertation was settling how many, when container terminals the port of Hong Kong should be construction. The other point was settling which will be the optimal value of Terminal Handling Capacity THC.	VECM, BVAR and ARIMA give quite same result as PDP planned on its own plans. "Trigger point mechanism" gives the optimal number handling operator. The optimal value of THC was 53 % from the existing level.	Concentrates on scheduling investments to ensure suitable capacity.

According to Table 1, the functionality of a maritime transportation system is affected by the form cooperation and information exchange between the parties involved in the system. If the information exchange is disrupted for some reason, the overall efficiency of the system is reduced. Special risks identified for international ports include foreign containers and recreational vessels. Interruptions have typically been caused by labor or weather conditions. Especially delivery reliability might suffer in the face of inadequate infrastructure investments and pressures to cut costs.

In order to prepare for emergency situations, scheduling activities and allocation of resources should focus on reduction of empty container moves, waiting times in ports and travel distances (times) on the network. The development of risk management tools might be beneficial to direct onto examining containers that are loaded to ships and onto recreational vessels.

4. Methodology

Case study methodology was chosen for a number of reasons: each port description is a case and at the end the data provided by the individual cases form the "system – model" case. In this manner the emphasis is on the integration of accumulated knowledge into a new robust model, where the interaction of each entity (ports and cargo flows) can be investigated in case of "what – if" emergency situations. So, in this way the case study context allows a deep understanding of each port and cargo flow while the system model case makes it possible to compare the effects of individual components.

By combining methods of system dynamics- and agent-based simulation greater accuracy can be gained on investments need of infrastructure and transport corridors located around the Gulf of Finland. In so case study opens a way for multidimensional experiments by facilitating the employment of broad spectrum of research methods and data sources. Furthermore, in this manner it is possible to integrate the most powerful sides of quantitative and qualitative research approaches.

Glaser and Strauss (1967) have detailed comparative method for developing the case theory. Yin (1984) described the design of the case study. Case studies is a research strategy that involves using one or more cases to create theoretical constructs, propositions or midrange theory from case-based, empirical evidence (Eisenhardt, 1989). Case studies are rich, empirical descriptions of particular instances of a phenomenon that are typically based on variety of data sources (Yin 1994). In case research each case serves as a distinct experiment that stands on its own as an analytic unit (Eisenhardt, 1989).

5. Research environment

The research was made in the ports of Finland: Naantali, Helsinki, Kotka, Hamina and Lappeenranta. Each port of Finland has its own infrastructure and way to operate, but ports of Hamina, Kotka and Hanko have more transit transportation than the other ports of Finland. In these ports are also handled raw materials, industrial products and customer commodities. The ports of Finland are mostly communally owned and there are some private owned ports mainly on industrial use.

5.1 Case: The port of Kotka

The commonly owned port of Kotka, which lies in the scores of Gulf of Finland, is the biggest container and car transit port in Finland. Over a third of freight transportation was delivered in containers. Kotka is also an important export and transit port: Kotka offersport offering direct connections to Germany, Great Britain, Netherlands, Belgium and Estonia as well as other European oceanic ports. The port of Kotka is developed during the latest years to the modern, pro-environmental and safe port of the Gulf of Finland. Nearly 3000 people are working in the port of Kotka.

ISPS (International Ship and Port Facility Security Code) includes port security regulations to shippers and ports in all maritime infrastructures. Safe and good environment is object in all operating systems (planning, construction, implementation and daily use) in the port of Kotka by fulfilling ISO 14001 and ISO 9001 Quality as well as Green office system standards. Quality and safety systems are checked in daily operations and with extra audit. Safety operation methods are inspected by internal and external auditing. The Finnish Maritime Administration makes several inspections in the port annually. Also U.S. Coast Guard and U.S. Marine and Port Organization have made informal inspections. Learning from best practice in port operating safety and security systems is a common way in port security in the port of Kotka.

Access control system in the port is based on automatic camera identification of vehicles entering and leaving entrance point of the port area. Information systems including access control (port lies in large area) and accidents in the transportation system are substantive risks in Kotka. Co-operation with other safety and security authorities has increased including ISPS rehearsals with fire and rescue department as well as a new contingency plan with national defense. Furthermore, information is exchanged with other ports in the Finnish Port Associations' security group.

In developing the infrastructure the aim is to enable effective and safe port operation. Transformability is emphasized developing the port, because maritime transportation and operation environment is considered vulnerable to quick changes. In the year 2009 a new quay and a concrete department for gas pipes is built. A new area (150 ha) has been reserved for a new logistics area with warehouse, railway access.

The objective in planning, construction, implementation and daily use of all operating systems in the port of Kotka is safe environment. As a tool to achieve this the port has qualified the ISO 14001 and ISO 9001 Quality as well as Green quality and environment systems in the middle of 1990's. Flaws and weaknesses that are noticed in daily operation or audit are corrected to prevent accidents and interruptions in the port operation.

5.2 The port of Hamina

The commonly owned port of Hamina is located 35 km from the Russian border and handles nearly 20 % of the Russian transit transport (The port of Hamina 2008). During year 2009 transit transportation has decreased about 39 % because of worldwide depression (The port of Hamina 2009). The port of Hamina has a general responsibility of infrastructure and security while the cargo is handled by the operators. Hamina is specialized to handling containers, liquid bulk (mostly gas) and oil. Up to 70.000 DWT vessels can arrive to the harbor when dredging work of shipping channel and dock to 12 meter is ready at the end of year 2010.

The biggest risk in the port of Hamina is a large accident in harbor, at sea, in the road or railway. Leaky oil wagons from Russia are a risk although there is a chemical leak indicator (over loaded tankers) along railway from Russia. Also discontinuation in the gas or electricity supply can cause damages to the goods that are stored in warehouses in harbour.

5.3 Case: The port of Helsinki

The commonly owned port of Helsinki is an important ro-ro and container port in Finland. In Vuosaari about a third of value of Finnish import and export is handled. The terminal is planned to serve flexibly ro-ro and container shipping. There are two 750 meter container quays and 15 ro-ro berths with minimum depth of 12,5 metres. The motorway and railway connection starts from the harbour and there are eight tracks in the terminal area and some terminal houses have railway connection. The port is brand new and it hasn't any investment plans to the future. Vuosaari harbour is specialized in handling of unitized cargo and it has regular ferry connection to the ports of Germany, Estonia, Netherlands and Great Britain.

The ISO 14001 Quality system and ISO 9001/2000 environment system are used in the port. In emergency situations port operations are tried to keep as effective as possible. In case of breakdowns all entrances are open and transportation is controlled by spot checks. Also the port operators have own quality and security systems. Risk management systems are limited to the area owned by the city of Helsinki. In the port of Vuosaari the contingency plan includes a risk management plan. If a part of port is closed due to breakdown, the rest of port can be operated as normally. The risk management system is based on information and electric systems and ISPS system codes. Ships arrive to the port with pilot. An old dock channel to Vuosaari serves as a reserve route for the ships, reserve ports are located nearby. There are several liquid and debris collecting are several to avoid environmental risks. Also labor strikes are considered a risk.

Information and electric systems are the most important systems in the port of Vuosaari. The port operations are commonly based on electric power techniques. Because uninterrupted electric distribution is required, the port has its own electric plant in port area that makes all needed electric power.

The land traffic to the port runs through a road and railway tunnel, where the traffic is automatically directed: reliable information systems are necessary for undisturbed port operation. Information systems including access control and closures of way or railway connection are characteristic risks of Vuosaari.

5.4 Case: The port of Naantali

The commonly owned port of Naantali was founded in 1943, when the country of Finland had to build its reserve stocks of oil and oil refinery. The most important reason was the ports good sheltered location and waterways. Under the last ten years it has become a nationally significant unitized cargo traffic port. The port of Naantali is specialized in ro-ro and ropax maritime traffic; in 2008 Naantali was the second biggest truck and trailers port in Finland with 2.844.143 tons and 163.815 trucks or trailers (Finnports 2009). Oil transportation is nowadays limited because of oil refinery capacity of Naantali, ca. 4 million tons oil and oil products are transported through the port. The raw oil is transported to the oil refinery from Primorsk. 40 % of oil products are transported to the customers by ships and the rest by trucks or railway (Port of Naantali 2009).

The investments to the port infrastructure in Naantali will be large in the near future: The quays' repairing investments will take 6-9 million euros and oil shipping needed deep-waterway (15.3 meter) investment will take 4-5 million euro. Besides that the port of Naantali is in long-term co-operation with the ports of Southern-Western Finlad (SW Ports) and centre of Maritime Studies (CMS) in the education and development.

5.5 Case: Kouvola railway yard

Kouvola is as a major marshalling yard in which railway traffic from the ports of Turku, Helsinki, Hanko, Hamina and Kotka is divided to the other places in Finland and to Russia and Asia via the rails of corridor 9.In railway transportation and railway yard operations are separated several dissect areas: railway yards, creation of train, operation and management, wagons or containers, raw wood transportation (freight cars or combination cars for raw wood and containers and separate raw wood loading places) and track capacity. Kouvola railway yards' rebuilding work in 2008-2010 makes railway infrastructure to react for the future requirements. All surface structures will be replaced so that all tracks allow 25 ton transportation, creation of long trains, good loading and unloading platforms. The knot railway yard of Kouvola is made creation of trains in an automatic downward slope. The trains that bypass Kouvola have its own tracks separated from other tracks. These trains are generally freight trains from the port of Kotka to Russia. Risks in Kouvola railway yard can be separated to environmental and occupational security. Chemical or oil tankers' spillage is typical accident in Kouvola railway yard that caused annually several times. Because chemical tanker traffic is busy with Russia, it is made an automatic spillage identification point in Utti that gauges concentration of hydrocarbon. This system alarm when needed in Kouvola central railway control room. In Kouvola railway yard there is a refuge pool for spillage tankers (Kouvolan Rataympäristö selvitys 2007, 2008), because it is the most significant spillage risk soil area. Noise and vibration are the most significant risks to workers in railway yard, tracks and these neighborhoods. The noise is detrimental to health if it is loader than 50 dB at night and 55 dB in daytime (22-07). Noise area at night time varies from 20 to 650 meters on both sides of track and day time from 20 to 360 meters. Noise and vibration damages to the environment can be avoited by building noise barriers and plant vegetation and trees round tracks. However, noise barriers protect only in track level situated settlement, but not situated above that. In consequence noise and vibration disadvantages can be avoited best by land use planning: depopulating and locating working places and industry near railway yards.

5.6 Case: Tampere railway yard

Tampere serves as a major marshalling yard in which railway traffic from Helsinki brand off to directions of Pori, Seinäjoki and Jyväskylä. Tampere railway yard has been rebuilt under last years: In the marshalling yard around 40 trains a day consisting altogether of 700 - 800 wagons are reordered to make new trains. The cargo consists mainly of forestry products and raw materials, industrial products, chemicals and oil products to or from the Finnish ports. VR-Cargo has made security plan railway yard with the emergency centre, a joint security exercise is run annually. A security plan is provided for disaster, Pollution of soil can be caused from spillages of wagons or locomotives.

The main risk is handling chlorine, ammonia and sulphur dioxide tankers (in Viinikka is handled about 40 tankers daily), because in accident these gases spread in large area in wind direction and then a big amount of people can run in to danger. However, in Viinikka serious accidents have not happened.

Noise and vibration are concurred together harmful to the people and environment. Viinikka rail yard is not located close to residential area, for that reason noise and vibration aren't very harmful.

5.7 Summary of the identified risks

Table 2 provides a summary of the main risks in the transportation nodes.

According to the table different ports and railway yards have differing risk profiles depending on the infrastructure and cargo handled. The critical infrastructure is different in the ports and in the major railway yards: The ports are depending on information and energy systems whereas major railway yards are depending on transport equipment and railway infrastructure such as tracks, switches and brakes.

Table 2. Risk table.

Object / port	Risk	Description	Duration
Port of Hamina	Energy: electric power and gas	Port uses gas and does not have own power plant	Hours, day, week
Port of Helsinki	Tunnel closure, quay closure	Port is beyond way and railway tunnels, weather/ ice	Hours, day
Port of Kotka	Information system, accident	Port lies in large area, port handle a lot of transit goods	Hours, day
Port of Naantali	Accident	Port lies in compact small area	Hours, days, weeks
Kouvola railway station	Spillage	Handle a great deal of Russian liquid and chemical tankers	Hours, days
Tampere railway station	Derailment	Derailment in building new trains in railway yard	Hours, days

6. Discussion and Conclusions

The infrastructure of the intermodal transportation is an ever-evolving system- of system with complex dependences. Oceanic maritime transportation infrastructure promotes large-scale units in containers (up to 11.000 TEU) and port infrastructure. Justly limits of (narrow and low water) boat routes, the ports of Baltic region are served by smaller feeder container-ships (200-1000 TEU) and ro-ro ropax ships from the big European oceanic ports. Besides we have a lot of small ports in Baltic Sea region. The case-studies evaluate infrastructure of the ports in the shores Gulf of Finland (GOF). The dominant mode of transport in the GOF is sea about 76% of trade, and other means of transport cover only 24 % (Finnish Port Association, 2008) In addition to their own import and export, the ports of Finland and Estonia handle a major share of the Russian transit traffic.

In transit Finnish ports have concentrated on container and consumer commodities import to Russia in containers, whereas Estonian ports carry a great share of the oil export from Russia. For these facts Finnish and Estonian ports have a limited capability to compensate for each others in operations as need arises. The Finnish route constitutes about 13 % of transit value of Russian import in 2008.

According to the literature review conducted the functionality of a maritime transportation system is affected by the form cooperation and information exchange between the parties involved in the system. If the information exchange is disrupted for some reason, the overall efficiency of the system is reduced. Special risks identified for international ports include foreign containers and recreational vessels. Interruptions have typically been caused by labor or weather conditions. Based on the case analyses different ports and railway yards have differing risk profiles depending on the infrastructure and cargo handled. Sources of risk include energy supply, information systems, weather conditions and labor.

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Import of vital industries to the Finnish ports in the Gulf of Finland

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1. Abstract

Finland is very dependent on import of most raw materials needed in several industries, since there is no self-sufficiency within any important sector. Because of the location of Finland, Finnish import and export by maritime transport is by far the most important transport mode. Finland is very dependent on maritime transport: 75% of import was transported by ship in 2008. In export the share of ship transports was even higher, 89%. 14% of import was carried in trains and 6% by road. Rail traffic is important especially in trade with Russia and truck traffic is used in industry's transports but particularly in distributing consumer goods. From the security of supply point of view, the essential industries are technology, forest and chemical industries, food supply and domestic trade. Important raw materials needed in Finland are raw timber, metals and minerals, chemicals and energy products, and they are to a great extent imported. This study is a part of STOCA-project that concentrates on traffic flows in Gulf of Finland and includes 12 ports, 3 inland ports (Lake Saimaa) and 3 check points to Russia. This study shows that ports in the Gulf of Finland have a major role especially importing consumer goods that is part of general cargo import network. Technology industry transports have been concentrated in the Gulf of Bothnia area, and in forest industry transports for example in Kotka, Loviisa and Hanko. In crude oil imports only ports used in Finland are Porvoo and Naantali. Porvoo and Hamina are also important chemical ports that serve for example plastics and other chemical industries. There are also questions of ownership and its impact on security of supply within different sectors. For example, vessels and mines are increasingly foreign-owned, and in 2008 only 31% of foreign trade transports was carried in Finnish vessels.

2. Aim and research question

The aim of this study is to analyse the present traffic flows and their contents (the main focus is on dry cargo) shipped in/to Finnish ports in the Gulf of Finland, i.e. harbours and transportation through the Saimaa Canal. In addition, Imatra, Nuijamaa and Vaalimaa check points (border crossing stations to Russia) will be included. After the analysis of present traffic flows the importance of each cargo flow for different actors will be evaluated. The actors included in this study are national security, business actors and maintaining functioning society. The Finnish ports included are Naantali, Turku, Hanko, Koverhar, Inkoo, Taalintehdas, Kantvik, Helsinki, Porvoo, Loviisa, Kotka, Hamina, Imatra, Joutseno and Lappeenranta. Ports of Imatra, Joutseno and Lappeenranta are inland ports that are accessed via the Saimaa Canal. The other ports are located in the coast of the Gulf of Finland.

This scientific paper has been written as a part (University of Turku, Centre for Maritime Studies, Work Package 2) of the research project STOCA (Study of cargo flows in the Gulf of Finland in emergency situations) managed by the Kotka Maritime Research Centre. The STOCA-project is funded by the European Union and the financing comes from the European Regional Development Fund, The Central Baltic INTERREG IV A Programme 2007–2013, the Regional Council of Southwest Finland, the Estonian Maritime Academy and the National Emergency Supply Agency.

In this study, the research questions are: 1) What are the most important industrial sectors in Finland from the point of view of security of supply? 2) What raw materials do these sectors need? 3) What are the shares of different transport modes in transport, especially in import? 4) Through which ports are raw materials imported?

3. Import by industries

In 2008, the value of import to Finland was 62.4 billion euros; export was 65.6 billion euros (National Board of Customs 2009a). Measured in tons, the amount of import was 69.4 million tons and of export 42.3 million tons. Totally of 45% of imported cargo was of Russian origin, which is 31.0 million tons (National Board of Customs 2009b). The biggest trade partners were Germany, Russia and Sweden. In 2008, the biggest trade partner both in export and import was Russia.

In export Russia's share was 11.6%, Sweden's 10.1% and Germany's 10.0%. In import Russia had a share of 16.3%, Germany 14.1% and Sweden 10.1%. (National Board of Customs 2009c).

Around a half of the import goes to manufacturing industries' requirements and over 40% to wholesale and retail trade (Table 1). The import inputs are significant especially in technology industry and chemical industry. The import of forest industry is big when measured in tons, but small in value.

Table 1. Imports by Finnish industries (TOL2008). (National Board of Customs 2009a).

	Million €	(%)
Agriculture, forestry and fishing	54	0,1
Mining and quarrying	101	0,2
Manufacturing	**30 805**	**49,4**
Manufacture of food products, beverages and tobacco	1 401	2,2
Manufacture of textiles, clothes, leather and leather products	429	0,7
Forest industry	2 157	3,5
Chemical industry	10 956	17,6
Manufacture of other non-metallic mineral products	507	0,8
Manufacture of metal and metal products	5 230	8,4
Electric and electronics industry	6 007	9,6
Manufacture of machinery and equipment	2 690	4,3
Manufacture of transport equipment	1 075	1,7
Other manufacturing	354	0,6
Wholesale and retail trade	**26 456**	**42,4**
Other industries, incl. Industry unknown	4 985	8,0
Total imports	**62 402**	
Trade balance	+3 178	

4. Transport modes

According to Sundberg (2009) the main logistical network of Finland consists of six parts that are general cargo import, domestic trade collection and distribution network, container export network, bulk export network, raw material import network and transit traffic network. Maritime transport is the most important transport mode measured in volumes both in the import and export. Other important transport modes in Finland are rail and road transport, mostly to and from Russia.

4.1. Sea transport

More than 80% of the foreign trade of Finland is transported by sea and Finland is very dependent on maritime transport. Both in 2007 and 2008, foreign sea transport exceeded 100 million tons. In 2008, foreign maritime transports were 102.4 tons of which 94 million tons were foreign trade transport. Only 31% of foreign trade transport was carried in Finnish ships. In export the share of Finnish ships was only 20% and in import 39% (Finnish Maritime Administration 2009a). In 2008, 89% of Finnish export was transported by sea and in the import share was 75% (Figure 1).

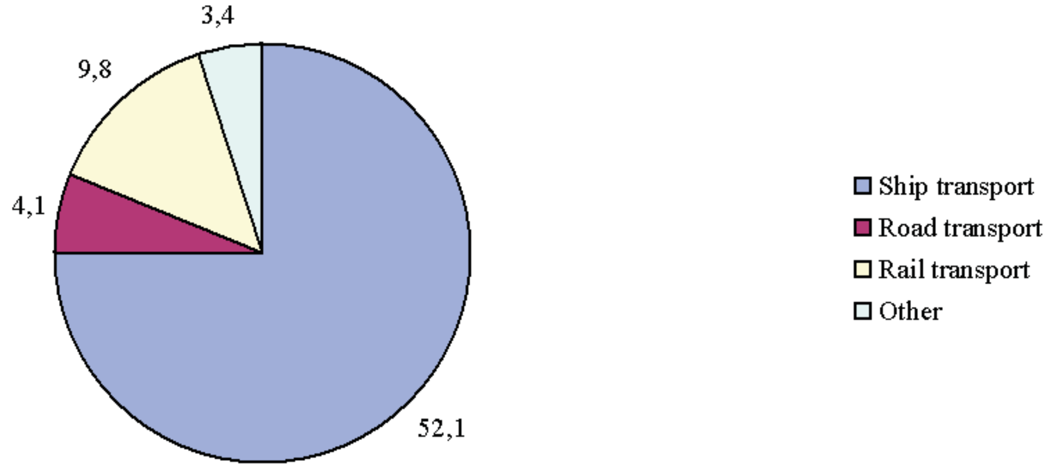

Figure 1. Import of Finnish trade by transport mode in 2008 (million tons). (National Board of Customs 2009b).

4.2. Rail transport

The share of rail transport in Finnish import was almost 10 million tons (14%) in 2008 (Figure 1) and 80% of import transported by rail was of Russian origin (National Board of Customs 2009b).

Over 60% of the total volume of rail transports consists of transports of forest industry raw materials or of transports of finished forestry products. Chemical industry and technology industry have both a share of about 20% of rail transports. (Sundberg 2009)

In Finland the rail gauge is the same as in Russia. Because of that, the Finnish railway network has a straight connection to Russian and Eastern European railways as well as to Far East through the Trans Siberian railway. There is four border crossing checkpoints at the Russian border: Vainikkala in Lappeenranta, Imatrankoski, Niirala in Tohmajärvi and Vartius in Kuhmo. The main shunting yards are located in Kouvola and Tampere (Viinikka). General cargo, for example consumer goods, is transported to Russia mainly through the logistic centre of Kouvola and the checkpoint in Vainikkala. The other cargoes are transported mainly through Niirala. In Turku there is the only train ferry port in Finland. The products that are carried by rail are mostly forestry exports like paper and sawn timber, and raw materials for forestry industry, like pulp and raw timber. (Sundberg 2009)

Measured in tons, the heaviest traffic is found in the main line (Helsinki–Tampere–Oulu), in Eastern traffic via Vainikkala, Imatrankoski, Niirala and Vartius border crossing points and also tracks used by forest industry export transports to the ports of Kymenlaakso and Rauma (Iikkanen 2007).

4.3. Road transport

The share of road transport in Finnish import was 4.1 million tons (6 %) in 2008 (Figure 1) and 81% of cargo was transported from Russia (National Board of Customs 2009b). In Finland road transport by trucks and trailers is a common transport mode because of the extent of the country and the flexibility of road traffic. The transit traffic to Russia leaves Finnish ports by road and it consists mainly of consumer goods. Road transit uses mostly Vaalimaa and Nuijamaa checkpoints for border crossing. In the domestic road traffic containers have not been very common. In the Baltic Sea area ro-ro traffic is commonly used and trucks and trailers are carried by ferries e.g. to EU countries. (Sundberg 2009)

The most important truck traffic freighter in Finland is industry. Traffic includes both raw materials and finished products transports. Other important freighters in road traffic are trade and construction. Truck traffic is used especially in transporting daily consumer goods. (Sundberg 2009)

4.4. The Saimaa Canal transport

Mostly forestry products are exported and timber and minerals imported through the Saimaa Canal. The freight traffic through the canal has exceeded 2 million tons every year in the 2000's. The maximum load for a ship is 2 500 tons. The small ship size has its constraints: for example containerization will be restricted. The Saimaa Canal has growth potential e.g. in biofuel transports and raw mineral transports depending on possible mining plans. Inland waterway traffic is competitive especially in low-priced bulk and raw timber transports. (Sikiö & Salanne 2008) In this study the following Finnish inland ports are included: Imatra, Lappeenranta and Joutseno.

5. Security of supply and traffic flows through the Finnish ports in the Gulf of Finland

According to the National Emergency Supply Agency (NESA) of Finland, "security of supply means the capacity to maintain the basic social activities and infrastructures that are indispensable for safeguarding the population's living conditions, maintaining a functioning society, and sustaining the material preconditions for upholding national defence in case of serious disturbances and in emergency situations." Therefore security of supply means not only access to raw materials, but also the reliable functioning of essential technical and logistical systems in the society. (National Emergency Supply Agency 2009a)

The objectives of NESA are safeguarding critical infrastructure and critical production. Critical infrastructure includes the following: energy transmission and distribution, communication network, transport and logistics, water supply and other municipal services and constructing and maintenance. As critical production the following are mentioned: food supply, energy production, healthcare, production for national defence purposes and operational preconditions of export industry. (National Emergency Supply Agency 2009b)

From the security of supply point of view critical industrial production includes food production, technology industry, forest industry, chemical industry, plastic and rubber industry, construction industry and clothing industry. Also health care and water supply and sewerage are included in Department of critical production. (National Emergency Supply Agency 2009c)

Sectors included in this study are critical industrial production sectors classified by NESA complemented with the domestic trade (consumer goods) and mining industry. Therefore, the chosen sectors are: energy sources, food production, technology industry, forest industry, chemical industry, mining industry, constructing and maintenance, trade and national defence. The emphasis is on trade and food supply, energy and important export industries (technology, forest and chemical industry). The analysis of present traffic flows will later be a basis for evaluating the importance of different cargo flows for these sectors, business actors, national security and functioning society.

5.1. Energy

5.1.1. *Crude oil and oil products*

Crude oil imports to Finland were almost 12 million tons in 2008. Crude oil and oil products were imported altogether almost 17 million tons. The most important country of origin of oil and oil products is Russia: almost 10 million tons of crude oil and 2 million tons gas oil was imported from there in 2008. From Norway, 1,2 million tons of crude oil was imported in 2008. (Öljy- ja kaasualan keskusliitto)

Oil products are used in Finland in traffic (47%), as raw materials and lubricants (20%), as energy source for industry (14%), in heating (10%) and in agriculture, forestry and constructing (9%) (Figure 2).

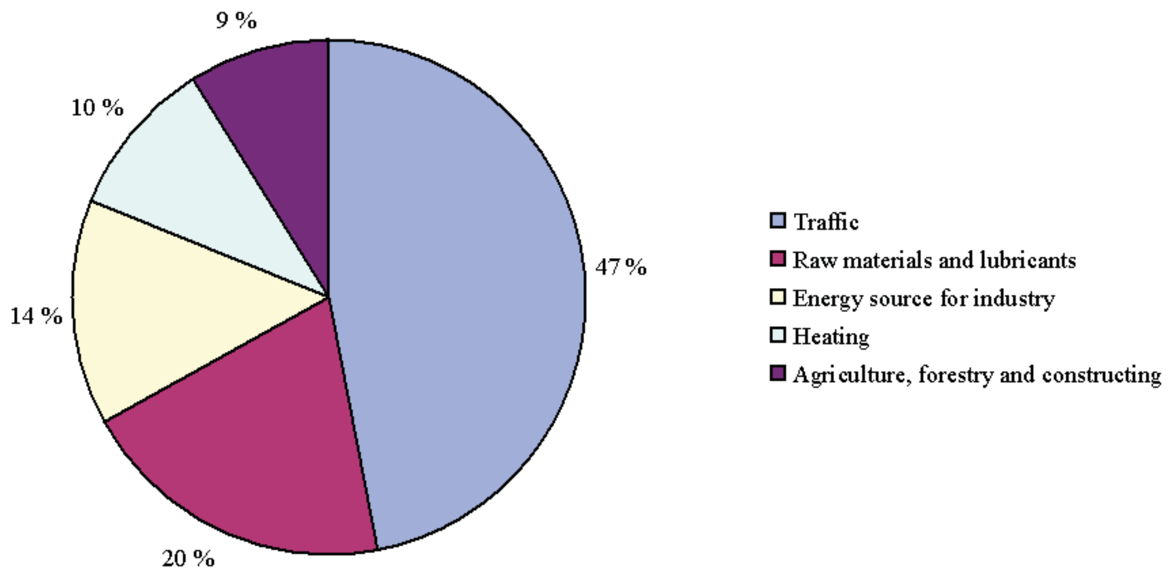

Figure 2. Consumption of oil products in Finland in 2008. (Öljy- ja kaasualan keskusliitto).

Crude oil imports are concentrated in the ports of Porvoo and Naantali (Table 2). Oil products are imported especially to Porvoo (69%), but also to port of Hamina (6%), Naantali, Helsinki and Turku.

Table 2. Imports of crude oil to Finnish ports in 2008 (Finnish Maritime Administration 2009b).

Port	Import (1000t)	Share of imports (%)
Porvoo	7 943	75
Naantali	2 651	25
Total (Finland)	10 594	100

5.1.2. *Coal*

Approximately half of coal used in Finland is imported from Russia, by sea and train. In steel production quality requirements are higher than in energy production, and coal needed in steel industry is mainly of Australian and American origin. Other significant countries of origin are South Africa, Indonesia, China, Colombia and Poland. (Hiilitieto.fi) In Gulf of Finland area, coal and coke is imported through the ports of Helsinki, Naantali, Inkoo, Koverhar, Loviisa, Kotka and Lappeenranta (Figure 3). Other significant coal ports include Pori, Raahe, Kristiinankaupunki, Vaasa, Pietarsaari, Tornio and Oulu, and these ports are located in the Gulf of Bothnia area.

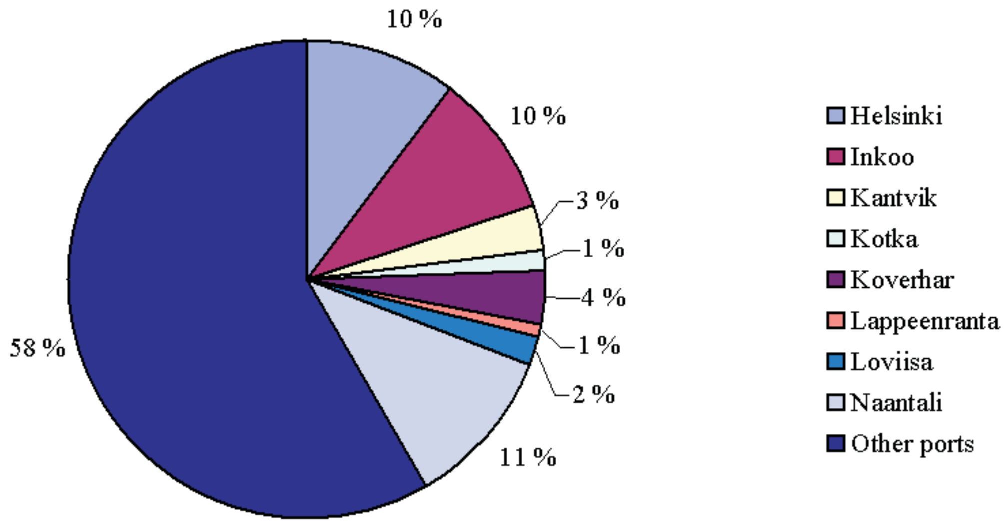

Figure 3. Import of coal and coke in Finland in 2008 (Finnish Maritime Administration 2009b).

5.1.3. *Metals and minerals*

Raw materials needed in technology industry include metals, minerals, concentrates, metal scrap and fuels. Most of these are imported even though Finland has also own mineral deposits and production, both in metal minerals and industrial minerals. There are several mining projects underway, and it is estimated that 2–4 new mines will be started during the next ten years, depending on world economy and minerals' price developments (Sundberg 2009).

From the 1980's quarrying of metallic ores started to decrease significantly in Finland. In the 2000's, the amount of metallic ores extracted every year has been around 3.5 million tons. At the same time quarrying of industrial minerals has increased considerably, and in 2007, 11.9

Table 3. Import of ores and concentrates in 2008 (Finnish Maritime Administration 2009b).

Port	Ores and concentrates (1000t)	Share of imports (%)
Helsinki	20	0
Kotka	147	3
Koverhar	786	13
Lappeenranta	5	0
GoF*	958	16
Other ports	4868	84
Total (Finland)	5826	100

* GoF: The Gulf of Finland

million tons of industrial minerals were extracted. The amount of metallic ores is going to increase again after the opening of Talvivaara nickel mine in Sotkamo. Production of concentrates is quite small except in nickel and chromium. (Sundberg 2009)

In import of ores and concentrates to the ports of Gulf of Finland have minor importance; only 16% of ores and concentrates were transported through these ports in 2008. The port of Koverhar had the largest share of import of ores and concentrates (Table 3). Other important ores and concentrates import ports in Finland are Raahe, Pori, Kokkola and Tornio, and Raahe has the share of 52% of imports. Also crude minerals and cement imports are transported mainly through other ports, the most important Gulf of Finland (GoF) ports being Kotka (9% of imports), Inkoo (8%) and Kantvik (5%). Significant crude minerals and cement import ports not located in the GoF area are Rauma, Raahe, Kokkola, Parainen, Pori and Tornio.

The most important ports importing metals and metal manufactures were Hanko, Kotka, Helsinki and Turku. Import was concentrated to GoF ports (Table 4). Other ports included for example Pohjankuru and Rauma. In export Helsinki (11%), Koverhar (10%) and Taalintehdas (8%) were the biggest GoF ports, and the share of GoF ports was 40%. Raahe (20% of all imports) and Tornio were the biggest import ports outside the GoF area, and also Pori, Kokkola and Rauma were significant ports in import.

Table 4. Import of metals and metal manufactures in 2008 (Finnish Maritime Administration 2009b).

Port	Metals and metal manufactures (1000t)	Share of imports (%)
Hamina	180	6
Hanko	831	27
Helsinki	452	14
Inkoo	2	0
Kantvik	9	0
Kotka	652	20
Koverhar	5	0
Loviisa	36	1
Turku	429	13
GoF	2596	81
Other ports	591	19
Total (Finland)	3187	100

5.1.4. *Forest industry*

In the Finnish export the biggest and most important products are paper and sawn wood. Import consists mainly of raw materials like timber (Table 5), fillers and coating pigments. Fillers include for example calcium carbonate (lime), kaolinite, and talc. Kaolinite and talc are also used as coating pigments. Especially talc but also some of calcium carbonate is extracted in Finland, but kaolinite has to be imported.

The most important ports both in export and import for forest industry in Finland are Kotka and Rauma. Another important group of ports consists of Hamina, Kemi, and Oulu. Helsinki and Hanko are also significant ports in export (Halla 2008). Kotka and Loviisa were the most important export ports in Finland for sawn wood (Table 6). Of these ports, Kotka, Hamina, Helsinki and Hanko are situated along the coast of the Gulf of Finland. In the Gulf of Bothnia area significant sawn wood export ports in 2008 were Kaskinen, Pietarsaari, Pori and Rahja.

Table 5. Import of timber to Finnish ports (Finnish Maritime Administration 2009b).

Port	Timber (1000t)	Share of imports (%)
Hamina	28	0
Helsinki	1	0
Imatra	275	4
Inkoo	1	0
Joutseno	168	3
Kotka	1557	26
Lappeenranta	212	3
Turku	1	0
GoF	2243	36
Other ports	3893	64
Total (Finland)	6136	100

The Saimaa Canal has also been an important timber import area for Russian timber. For raw timber imports, the most important port in the Gulf of Finland area is Kotka (Table 5). In Finland the second biggest timber import port in 2008 was Rauma (24%), others were Kaskinen and Pietarsaari. In the port of Kaskinen import of timber has nevertheless decreased after the closing of pulp factory.

Table 6. Sawn wood exports in 2008 (Finnish Maritime Administration 2009b).

Port	Sawn wood (1000t)	Share of exports (%)
Hamina	208	6
Hanko	248	8
Helsinki	287	9
Kotka	628	19
Loviisa	463	14
Turku	106	3
GoF	1940	59
Other ports	1344	41
Total Finland	3284	100

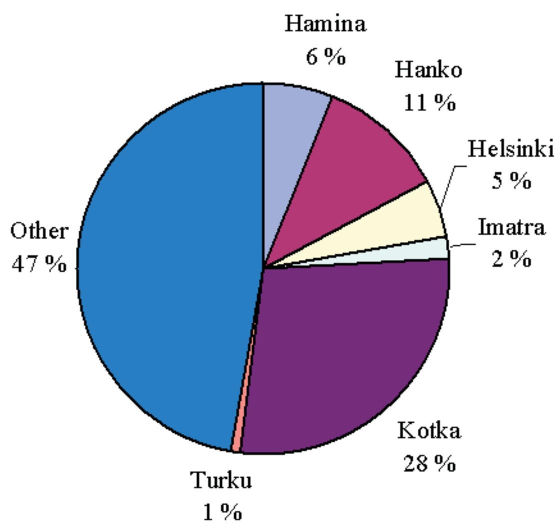

Figure 4. Export of paper and paperboard in 2008 (Finnish Maritime Administration 2009b).

Different companies have concentrated their export in certain ports. Stora Enso Oyj exports paper produced in Eastern Finland through the port of Kotka, and paper produced in Northern Finland to Oulu and Kemi. UPM-Kymmene Oyj uses the port of Rauma in exporting paper from Western and Northern factories and the port of Hamina in Eastern Finland transport. M-Real Oyj uses mainly the ports of Hanko and Helsinki. (Iikkanen 2007) The port of Kotka had a substantial share in paper and paperboard exports in 2008 (Figure 4), and other important ports in the GoF area are Hanko, Hamina and Helsinki. Other ports include Rauma (31%), Oulu (8%) and Kemi (7%).

5.1.5. *Chemical industry*

Chemical industry is one of the three biggest industries in Finland (others are forest and technology industries). It is a wide-ranging industry that includes so-called basic chemical industry as well as different specialized branches. In Finland the most important clients of chemical industry are forest industry, traffic, and electronics and electrotechnical industry, but products are made also directly for consumers. A substantial part of production is exported (44% of production) or used in the production of export goods (with direct export almost ¾ of production). Import consists of raw materials and special products. The most important branches are linked to forest industry, agriculture, constructing, electronics industry, food production, environmental products and biotechnology. Products include for instance pulp and paper industry chemicals, oil products, fuels and lubricants, plastic raw materials, packaging materials, paints, plastic pipe systems and insulating materials. (Chemind.fi – ala numeroin) Production is based for the most part on imported raw materials but domestic forest and mineral resources are also used. (Sundberg 2009) The most important raw material is crude oil. Hamina and Naantali were the most important chemical ports in GoF area in 2008 (Table 7) and their import consists for example of raw materials for local producers of plastics and forest industry chemicals. The ports located in the Gulf of Bothnia area had a substantial share in chemical imports, the most important ports being Oulu (25%), Pori, Kokkola and Rauma.

Table 7. Import of chemicals in 2008 (Finnish Maritime Administration 2009b).

Port	Chemicals (1000t)	Share of imports (%)
Porvoo	369	13
Naantali	34	1
Hamina	410	14
Hanko	74	3
Helsinki	20	1
Inkoo	13	0
Kotka	97	3
Turku	66	2
GoF	1083	37
Other ports	1866	63
Total (Finland)	2949	100

The most important countries of origin in chemical industry imports are Russia (2 162 million € in 2008), Germany (1 418 million €) and Sweden (1 066 million €). (Chemind.fi) From the point of view of security of supply, important branches of chemical industry include in addition to basic chemical industry and petrochemical industry also plastics and rubber industry and pharmaceutical industry. Especially, when medicines are considered, Finland is very dependent on import.

5.1.6. *Consumer goods*

The biggest general cargo import ports in Finland are Helsinki, Kotka, Naantali, Turku, Hanko, Rauma and Hamina. Large logistical centres serving retail trade are situated in Helsinki and Turku region, near the leading import ports and significant population centres. The ports of these regions have also good liner traffic connections, which is essential for trade. (Sundberg 2009; Loghu2 – Työryhmäraportti 2008) In land transport the importance of Kouvola as a logistic centre is expected to grow (Halla 2008).

Import of consumer goods is part of general cargo import network. The most important port is the port of Helsinki that had the share of 41% of all general cargo imported to Finnish ports in 2008 (Figure 5). Gulf of Finland ports' share was altogether 94%, which means that Finland is supplied from the South. Other significant ports were Kotka, Naantali, Turku, Hamina and Hanko.

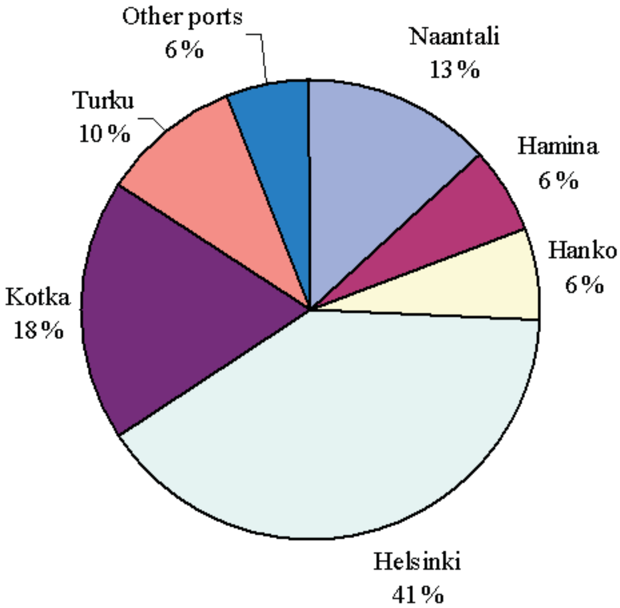

Figure 5. The most important general cargo import ports (Finnish Maritime Administration 2009b).

In food production industry, 85% of used raw materials are domestically produced. Its production covers 81% of Finnish food market and it has a dominating market position. (Elintarviketeollisuusliitto) Nevertheless, the primary production and food industry in Finland suffers from profitability problems. Recent price fluctuations and changes in agricultural policies and farming subsidies in European Union have further increased uncertainty about the future. (National Emergency Supply Agency 2009d)

Food supply is one of the branches of critical production defined by the National Emergency Supply Agency. It shares interdependencies with other "basic sectors", like energy, health care, critical industry, logistics and infrastructure. Food supply system consists of input industry, primary production, secondary production and functions of trade. The production chain is long, interdependent and vulnerable. Even though raw materials used in secondary production are mostly domestic, the importance of certain critical imported inputs is fundamental for the whole chain. (Kananen et al. 2009) These inputs include for example pesticides, fertilizers and their raw materials and protein for animal feed.

6. Conclusions

Finland is very dependent on import of most raw materials needed in several industries, since there is no self-sufficiency within any important sector. Because of the location of Finland, Finnish import and export by maritime transport is by far the most important transport mode. Rail traffic has a central role especially in trade with Russia, for example in raw material imports. Road traffic is significant in consumer goods transports and distribution. In land traffic and in Eastern traffic Kouvola is an important logistical centre and its importance is expected to grow in the future. The main sectors from the security of supply point of view are trade and food supply, energy, technology industry, forest industry and chemical industry. In food production raw materials are mostly domestically produced but primary and secondary production are still depending on imported inputs, for example pesticides and chemicals needed in food production industry. In mining industry there are plans of opening new mines, which could enhance supply of ores. Mining plans are nevertheless depending on world economy and minerals' price developments. In addition, there are questions of ownership and its impact on security of supply within different sectors. For example, vessels and mines are increasingly foreign-owned. Most industries have also interdependencies with each other, and for example chemical industry is essential for forest and technology industries.

The ports in the Gulf of Finland have a considerable importance in general cargo imports. Consumer goods are part of general goods import network, and the most important ports handling general cargo are Helsinki, Kotka, Naantali and Turku. Large logistical centres serving retail trade have been concentrated in Helsinki and Turku region, near the leading import ports and significant population centres. The ports of these regions have also good liner traffic connections with the Continent of Europe and Sweden, which is essential for trade. In Finland the three biggest retailing conglomerates have together the share of 85% in daily consumer goods retail markets. In import container traffic is increasing, but ro-ro -traffic has still an important position in Baltic Sea Region's internal trade and in trade with Central Europe.

The ports of Hamina and Porvoo are essential chemical ports and they are serving to a great extent local plastics and other chemical industries. Oil transports have been concentrated to Porvoo and Naantali, and no other Finnish port is importing crude oil. In technology industry, the Gulf of Bothnia is considered to be more important than the Gulf of Finland. Forest industry transports have also been concentrated to certain ports, for example to Kotka, and have local importance for example in smaller inland ports of Saimaa.

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Railway Transport Portfolio Outperforms Index Investor

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1. Abstract

Investors have shown interest in allocating their assets in privatized railway companies (mostly freight) – leading companies in this respect are located in North America and Asia. In this research work we show that established railway company portfolios have outperformed leading market indexes in both recessions of this decade, IT bubble and global credit crunch. As index investor of SP500 and FTSE100 is not showing any yield for the investment made in early 2002 (actually slight decrease), railway portfolio is on the other hand indicating 150 % yield. Hang-Seng index in comparison shows similar, but one third lower gains. For investors this research work provides ideas to diversify their large-scale investment portfolios, for long-term investing ordinary people it gives idea, why "the hottest hot" is not necessarily the right venue for hard earned dimes, and for European governments it gives motivation, why railway sector deregulation should be continued.

Keywords: Investment yields, railway sector, indexes, recession, long-term

2. Introduction

Evolution from boom to bust is very hard for people, companies and governments to remember as growth is showing its most positive outcomes. During IT boom investors were eager to finance their way into recession, and venture capital was plentiful for young high tech companies showing neither revenues nor profits (Perkins & Perkins 1999; Chu & Ip, 2002). In long-term observation Messica & Agmon (2009) concluded that venture finance (key reason for IT bubble) is too short-sighted, and overshoots in both directions (in boom too much, in recession too scarce). However, high technology investments could still today characterized as "one shot growth" miracles, and as success appears, they provide extremely nice returns (Hilmola et al., 2003; Wang & Tseng, 2005). After IT bubble world experienced one of the most significant periods of strong economic growth all over, and this was basically enabled by fiscal stimulus of Europe and USA to have lowest possible interest rates. Increased amount of money at the circulation created situation, where countries having growing trade deficits (imports much more than exports, typically deficits were most significant for Asian economies, and particularly to China; Ivanova et al, 2006; Turner, 2008) were having extremely low unemployment and boom in real-estate market (Cooper, 2008; Turner, 2008). New economic order (based on outsourcing of production, service industry and real-estate) in this case did not sustain either (earlier one was based on outsourcing of production, programming and Internet) – as real-estate market started to show small decreases in price development, and lowest income class started to lose their working places, enforced domino effects travelled through critical structures of modern societies (firstly banks and insurance companies, thereafter service sector was affected). We are currently experiencing the advent of larger change, where contractors (production and product development) become owners and/or competitors of old west brands (Hilmola et al. 2005; Arrunada & Vazquez 2006; Slob 2006).

Motivation in this research work is to show that contrarian investment strategies in old and restructured sectors are the safest investments. As Siegel (2005) have concluded, railway sector in USA has provided one of the best returns over long-term (from early 1980's, when restructuring and privatization started in this sector). However, in this study we include most recent recession, credit crunch, into analysis, and are able to show that rather small sized portfolio of railway companies has provided very significant returns after year 2002, and basically has bounced back to early 2008 valuation levels after severe global economy crash in autumn 2008. It should be remembered that our research work only concentrates in the share price development over time, but railway companies are known to have been distributing constantly, from year to year, increasing dividends.

This manuscript is structured as follows: In the Section 2 we review briefly the restructuring process of railways in different countries, and show how lower transportation prices and productivity has improved over time. Thereafter, in Section 3 we introduce research methodology, hypothetical railway portfolio, and data used in this study. Section 4 analyses two different recessions, IT bubble and credit crunch through the performance of railway portfolio and leading stock market indexes. Finally Section 5 concludes our research, and some new avenues are being proposed for further research in this area.

3. Railway Sector Restructuring

Typically railway sector restructuring is exemplified with USA freight sector – during 1950's European railway sector and USA held similar high market share from transportation (60 %), but during year 2005 European share was only 10 %, while in USA it was 44.2 % (Vassallo, 2005). These differences arise not only from restructuring, but also from higher bulk transports in USA, and from larger amount of sea harbours in Europe (Vassallo, 2005; see discussion from European sea ports, e.g. Roe, 2009). In USA railway sector restructuring started during 1980 with Stagger's act, and resulted in the large-scale layoffs of people, removal of network as well as mergers and acquisitions between market actors (Miljkovic, 2001; Spy-

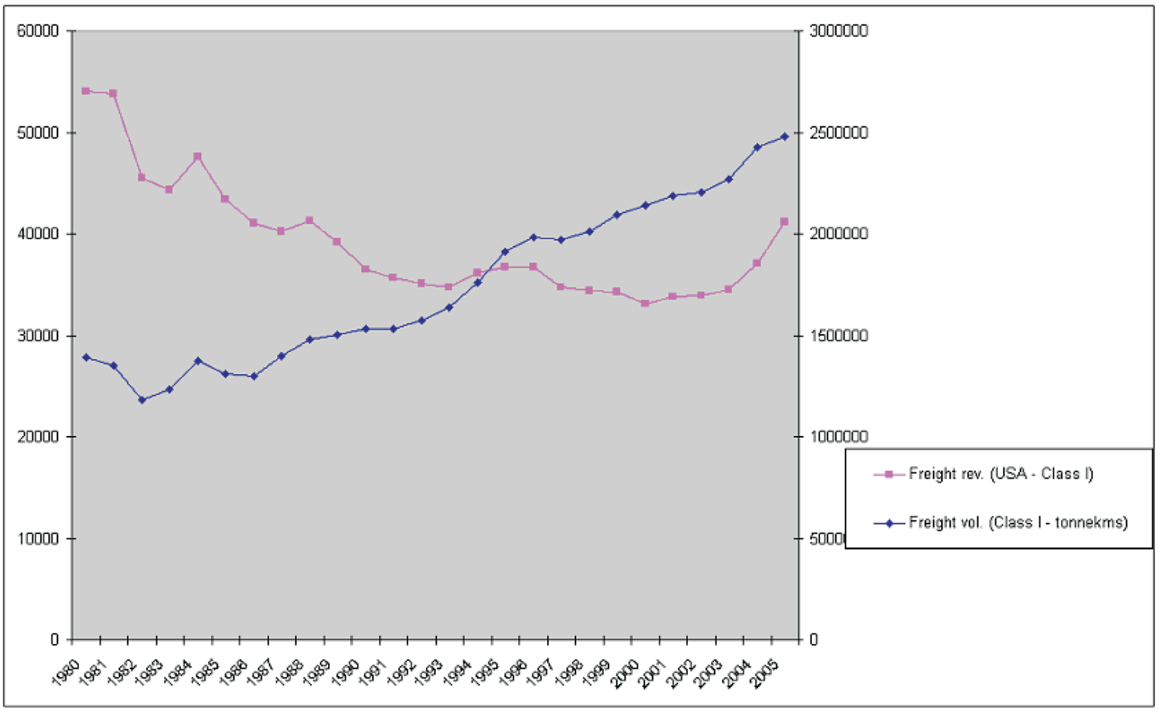

Figure 1. Freight volumes and revenues in Class 1 railway companies in USA during period of 1980 to 2005 (year 2000 US dollars). Source: World Bank (2007)

chalski and Swan, 2004; Hilmola et al., 2007). In the railway context it has been generally found that private undertakings, and increased competition, creates more demand (e.g., Hilmola et al. 2007) for this sector and cost structure (e.g., Jensen & Stelling, 2007) and prices (e.g., Vogt, 2008) generally go through a declining development. In those countries, where infrastructure ownership is in the hands of railway operators (e.g. USA, Mexico, Japan and China), restructuring could lead into local monopolies and oligopolies; however, these are not undesired effects for long-term investor, only on sector inefficiency.

Siegel (2005) named US railways as one of the best investments over the longer period of time, and even well recognized investment fund Berkshire Hathaway has invested billions of US dollars in the largest operator (BH, 2008; CNBC, 2009). So, a priori we could assume that US railways have strong basis to sustain over recession, as is known that volumes have grown considerably after 1980's, and customer charged prices have considerably decreased. Development is shown in Figure 1 – only in very recent years of observation period, revenues of class 1 railway operators increased with volume increase (actually increased a bit prices of volume being transported).

Chinese railways development from USA do not differ that much, due to the reason that this country is using coal extensively as a source of energy, which is being mined from the northern inland parts of the country, and transported on a large scale to the largest coal sea port, Qinhuangdao (one main sea harbour). This should favor the efficiency of freight operations in China. Support for this argumentation could be found from Kwan & Knutsen (2006), who concluded that railways in China serve coal transport and passengers – under developed terminal infrastructure as well as railway line related renewal need prohibits the growth of container based transports. Highest population concentration exist in Asian mega-cities, and e.g. in Hong-Kong there exist one of the few examples out of profitable railway passenger transportation system.

Earlier technical efficiency studies from global railway sector indicate that North America, Israel, Russia, China and Baltic States are strong in freight transports (Hilmola, 2007; Savolainen & Hilmola 2009; Hilmola, 2009a) as in passenger transports Japan and South Korea are setting the benchmark for the others (Hilmola, 2009b). Based on Yu's (2008) research work it was argued that the most efficient countries in railway transportation (both passengers and freight) originated in Western Europe, followed by Asian, East European and African countries.

4. Research Methodology

The basic set of data about the stock market listed railway companies was gathered from the online databases of Thomson One Banker (for IT bubble evaluation – years 2002 to 2007), and from Yahoo Finance (for recent recession caused by credit crunch – years 2008 to Sept. 12th of 2009). Our portfolio allocation was completed with weights of revenue and total assets of year 2002. Share price development was followed in this study weekly, which aided us to avoid problem of stock market closure during holidays in different countries and continents.

As could be noted from Table 1, our portfolio consist largest North American companies called Burlington Northern Santa Fe Corporation (BNSF), CSX Corporation, Kansas City Southern (KCS), Norfolk Southern Corporation (NS), Union Pacific (UP), Canadian National Railway Company (CN), and Canadian Pacific Railway Limited (CPRL). Among these we chose longest (as a listed company) history owning Chinese passenger operator, Guangshen Railway Company (of course in recent years initial public offering in generally in China have boomed, and e.g. mid 2006 Daqin railway company was listed in the stock exchange). All of these chosen companies have long history of existence, and tradition to be a part of stock market regulations and investor yield requirements.

Table 1. Portfolios formed from railway sector companies with respect of revenues and total assets during year 2002 (in million USD).

Income St	12/31/2002 USD, mill.	
Burling	8,979.00	21.0 %
CSX	8,152.00	19.0 %
Kansas	566.00	1.3 %
Norfolk	6,270.00	14.6 %
Union P	12,491.00	29.2 %
CanNatR	3,876.00	9.0 %
CanPacR	2,203.00	5.1 %
Guangsh	305.00	0.7 %
Total	42,842.00	100.0 %

BalSheet	12/31/2002 USD, mill.	
Burling	25,767.00	21.0 %
CSX	20,951.00	17.1 %
Kansas	2,009.00	1.6 %
Norfolk	19,956.00	16.3 %
Union P	32,764.00	26.7 %
CanNatR	12,005.00	9.8 %
CanPacR	6,129.00	5.0 %
Guangsh	2,925.00	2.4 %
Total	122,506.00	100.0 %

Two railway portfolios do not differ that much from each other, in revenue based portfolio representation of four largest US railway freight operators is more significant as compared to total asset established portfolio. In the latter portfolio Chinese passenger operator will have a bit more weight, but in the end differences between these two portfolios are small.

5. Empirical Data Analysis of Two Recessions

5.1. IT Bubble

Rather interestingly, railway operator portfolios (mostly freight and from North America) show remarkable yield during years 2002-2007. Basically recession effect of IT bubble during 2002 was nearly non-existent (although, bubble started to burst in 2000-2001), and yield growth continued from early 2003 until the mid 2007. In the end of the observation period invested amount in these two portfolios resulted on yield of approx. 130-140 %. During the

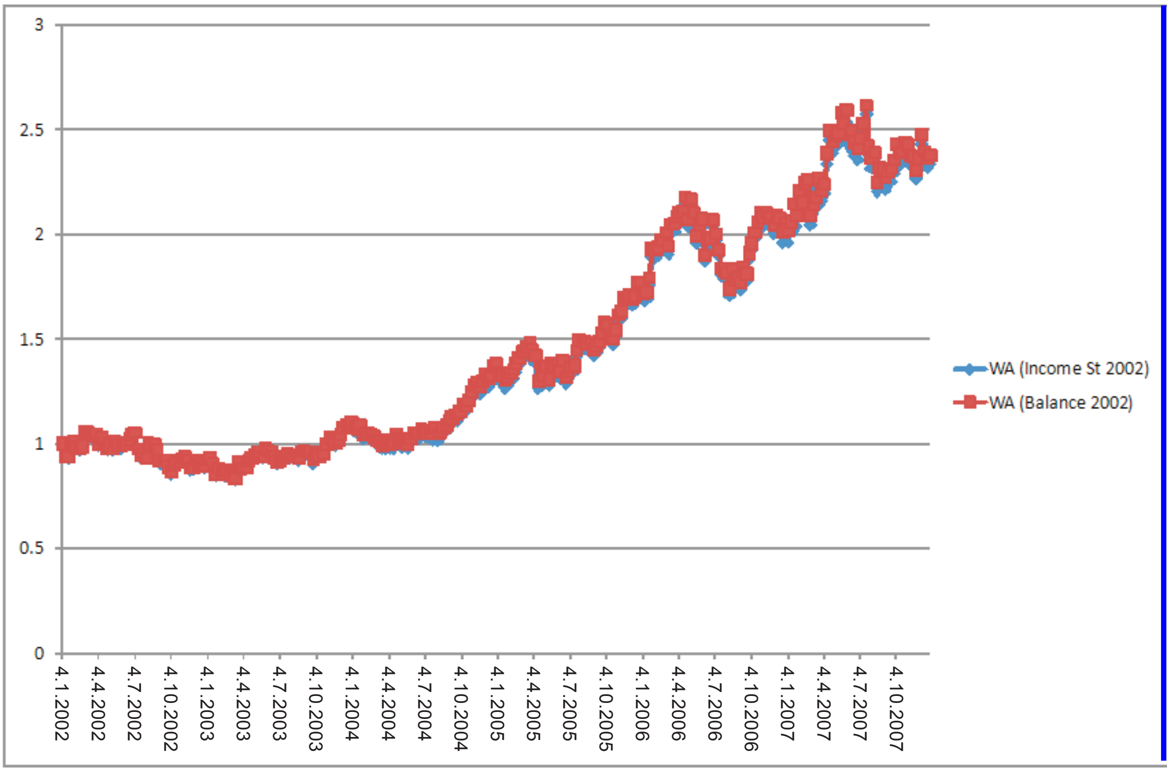

Figure 2. Portfolio index development in two hypothetical railway proposals during years 2002-2007.

observation period balance sheet portfolio is constantly very slightly above income based portfolio – indicating well developed passenger transport business between Hong Kong and mainland China.

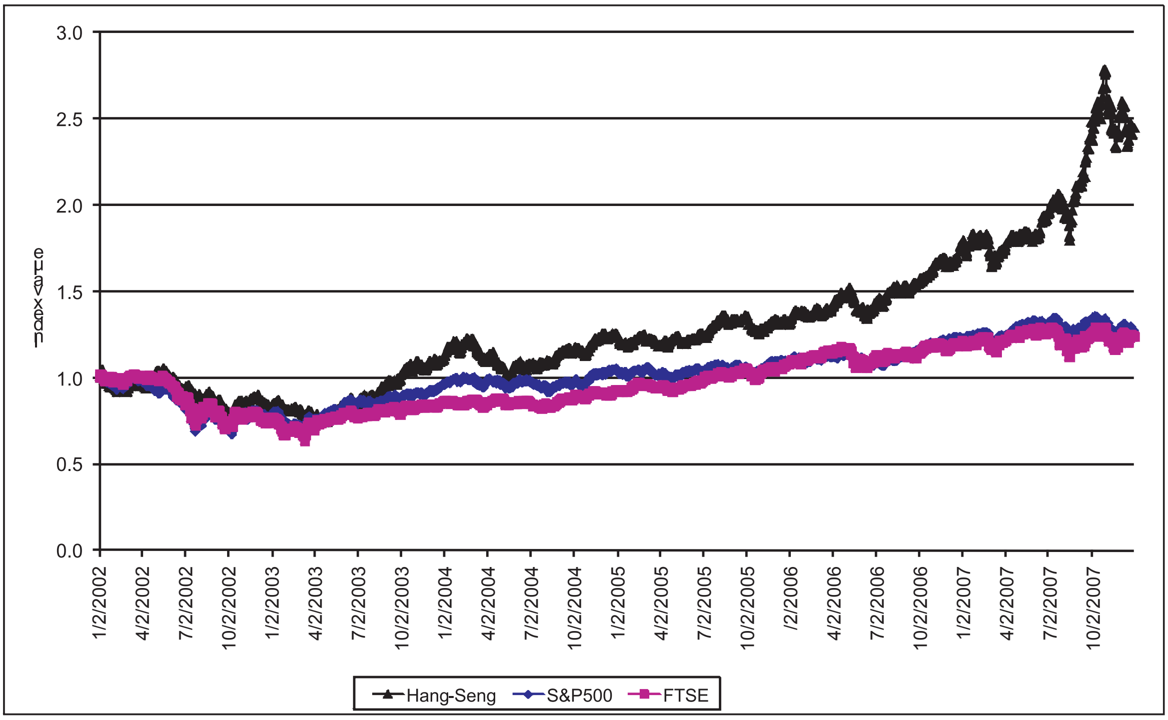

Figure 3. Major stock market index development during period of 2002-2007.

Interestingly, stock market index of USA (S&P500) and London (FTSE) have both serious problems until the first quarter of 2003, and thereafter they showed very conservative increase towards the end of the observation period (year 2007). Overall, investing on these west indexes did not result on success, only approx. 25 % gain during the six year time period. However, due to Chinese economic miracle development, Hang-Seng index (of Hong Kong) have considerably improved during the observation period, and shows similar high gains with two railway portfolios.

5.2. Credit Crunch

During summer 2008 onwards there were great doubts whether US and European banking system could sustain in long-term, this was reflected on the stock market valuations in general, and on decreasing index values as is shown in Figure 4. Interestingly, railway portfolio was able to resist this economic downturn for very long period of time (10 months) – only large default wave of US, and UK banks was affected on railway companies during October of 2008, and thereafter their valuations decreased heavily until the current known local bottom of March 2009.

After March 2009 all the stock markets around the world have recovered, but as could noted, three followed main indexes have not even reached the level of early 2008. However, railway portfolios have outperformed markets (once again), and show even slight 10 % gain during observation period (in a period, when world faced one of the most severe economic crises in known history). It could be interpreted that railways are not unaffected by economic forces, but they have much longer resistance over economic downswing, and do show to recover much quicker than on the average.

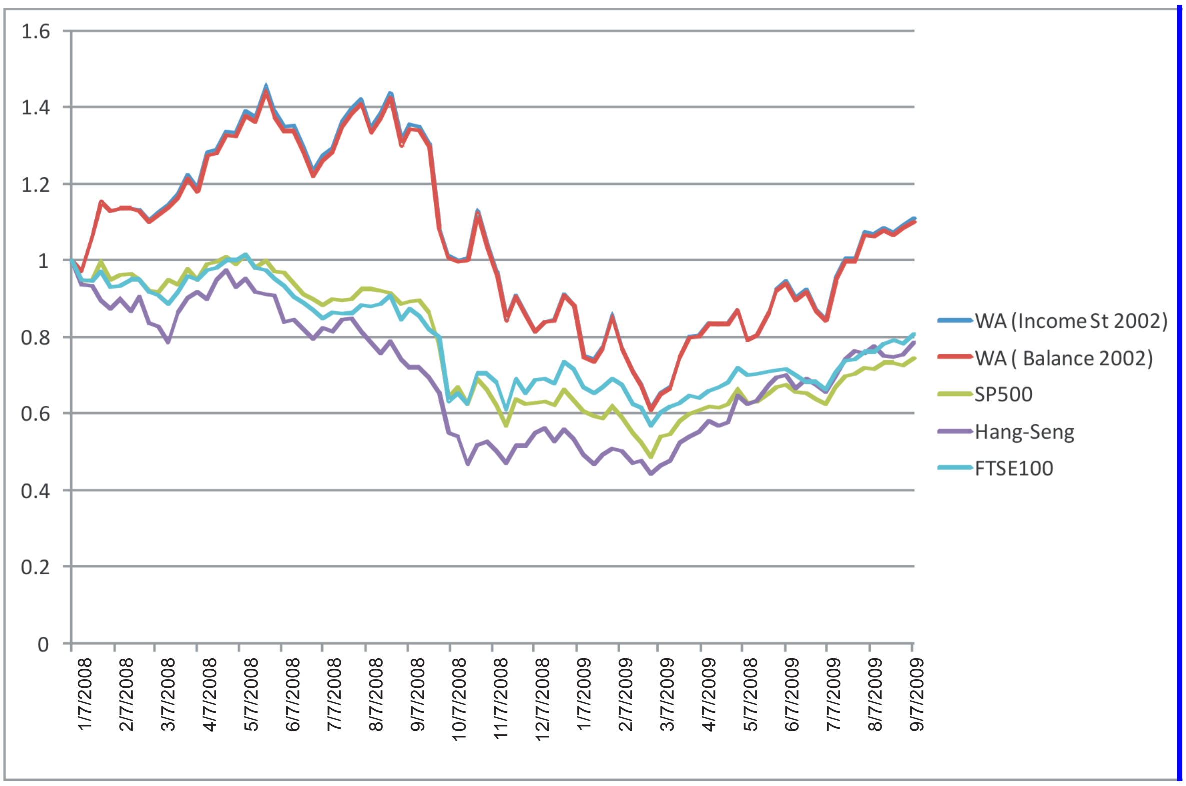

Figure 4. Effect of credit crunch during period of 2008 to Sept.2009 on railway portfolios and three selected indexes.

5.3. After Two Recessions – What Is Investment Worth?

So, if gains from early 2002 would be calculated until Sept. 2009 for railway market portfolios, they would have resulted on 150 % gains – in a same period these companies have continuously (all the others than Kansas City Southern) sharing increasing dividends for their shareholders (we have not taken these into account, these would have had also time value). As Siegel (2005) presented, investing these monetary gains back to the same share purchases, it would lead into even more significant gains (actually boosting yields). However, even without taking divided yields, and investment back option into account, railways seem to perform much better than compared stock market indexes from USA, Europe and Asia.

Based on our research work only Hang-Seng index is able to have similar magnitude performance with railways, but basically a bit lower, due to reason of credit crunch based economy collapse, and slow recovery process; index performance over this longer period of time is approx. 100 %. World's mega-trend of China led growth was, and partially still is, the major factor in the world economy, but this research work leaves further speculation whether this "fashion" will hold in the future. In comparison, index investor of S&P500 and FTSE in this stated longer-term have lost 5-10 % out of the investment value. After IT bubble index investing was rather popular policy suggestion among investment advisors, but basically in retrospect seems to have no further significance today as examined in period of 2002-Sept.2009 (think about, what is the situation with the index level of year 2000 – really value destroying approach!).

So, basically old, uninteresting and unattractive railway transportation sector has been the best shield for investor during the two most recent downturns. Buy, invest dividends back and never sell approach seems to still hold as appropriate strategy for gains in the long-term. Actually it is not only appropriate, but gives really high return, if historical price development from year 1980 onwards is to believe.

6. Conclusions

Railway sector has experienced large-scale restructuring in North America as well as in other selected countries, if development is portrayed within longer-term (after deregulation and privatization initiatives actually started). In the short-term this restructuring resulted into considerable amount of job-loss, and disinvestments, but after consolidation wave, this sector is one of the healthiest e.g. in North America. As was shown in the literature review part, transportation prices have decreased a lot in USA during the first quarter of century, after deregulation process took off. This have without a doubt created the value for customers, and also competitive advantage over other rival transportation modes (like road). Among this, railways are able to show really nice gains for investors too – if development is followed through sales development, nothing radical is happening, but constantly improving. In USA and Canada, of course, raw material transports have affected greatly the development – Asian economies are starved for commodities, and therefore competitive advantage of North America in recent years has been the old commodity based manufacturing, and related distribution structures. It is known that railways are superior in commodity transportation – the same purpose where they were built in the first place during the mid 19^{th} century. However, without being able to transport efficiently containers, North American railways would not prosper in scale as they do. This is mostly due to privatization and deregulation process effects. So, railway success in USA could be considered to have been end result of these two major movements – Asian starvation for commodities and successful deregulation process. However, this earlier explanation does not cover Guangshen Railway co., passenger transporter between Hong-Kong and mainland China. However, this company has benefitted from the integration of this mega-city under Chinese governmental control, and because of Chinese economic miracle, also travelling with rails has attracted increasingly more people.

In the future we would like to follow, what is the effect of environmental issues on railway sector demand, profitability and shareholder value. Several completed global environmental agreements will push governments to reduce their CO_2 emissions, and this will end in the situation, where freight is more beneficial to be transported by railways than with trucks. However, it is still questionable whether environmental issues are alone enough to make passenger transports profitable. For example, in USA passenger transport has constantly produced one third out of gathered revenues as deficits, without any end in sights (Rhoades et al., 2006).

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Hinterland Capacity And Seaport Performance In Crisis Situation

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1. Abstract

Seaports are an important part of international supply chains. The use of standardized containers has allowed seaports to thrive. In order to have a robust supply chains, security becomes an important factor. Simulations are a good way to analyze transportation systems as they tend to be too complex for analytical model. In this paper we build a system dynamics model which is used to analyze the shifting of demand from one seaport to another. Several scenarios are used in the simulation model to study the impact of hinterland capacity on the performance of seaport. The simulation model clearly shows that an adequate amount of hinterland capacity is needed to keep the seaport operational, especially if the storage space is not large enough.

Keywords: Simulation, Seaports, Emergency situations

2. Introduction

Seaports are an important part of logistical supply networks as they integrated the inland logistics to international trade through the oceans. One very important part in the global supply chains are the containers. Containers allow the standardized operations in individual seaports and the amount of containers has increased dramatically during the last 20 years (United Nations, 2007). According to IMF (IMF, 2007), globalization will only increase this trend and the amount of container traffic will increase.

Security is an important is in maritime supply chain. It is not only an issue to individual companies, but overall to international trade as well (Barnes & Oloruntoba, 2005). According to Salter (2008) more critical studies are required to analyze the impact of key infrastructure nodes (includes airports, seaports, and border crossings) in both national and international context. One way to conduct these critical studies is to use simulations to study, how the system interacts in a crisis situation. System dynamics has been used in supply chain risk management (Kara & Kayis, 2008) and in this paper we analyze a national level crisis.

Transportation systems are a typical example of complex real-world systems, which cannot accurately be described by analytic methods. Ujvari and Hilmola (2006) show in Automated Guided Vehicle context explicitly that minor system details, which can be incorporated in to a simulation model, but typically cannot be dealt with using other tools, can have major impact on system performance. According to Ujvari and Hilmola (2006) such features include e.g. the control and loading logic applied as well as physical properties of the transportation system.

This paper is structured as follows: The second section gives a brief overview about maritime logistics and the Gulf of Finland. We discuss the different definitions of seaports and the impact of seaports for nations. The third section gives information regarding simulations. We present both general information and more specific information about system dynamics, the methodology used in this paper. The fourth section provides the information regarding our simulation model while the fifth section provides the results. We are interested in few key variables and present their development in different scenarios. The final section contains both the discussion about the simulation model and concludes this paper. We also provide further research objectives in this section.

3. Maritime logistics and the Gulf of Finland

Seaports play an important part in the Finnish foreign trade flows as over 75 percent of trade (in tons) happens through seaports (National Board of Customs, Statistics Unit 2007). On a global scale the amount of trade through sea is enormous and trade using containers has increased to 142.9 million TEU a year (Drewry Shipping Consultants 2007). As the world becomes even more connected through globalization, this trend will most likely continue to grow (IMF 2007).

Seaports also play an important part in the competitiveness of the national infrastructure and thus have an indirect impact on the competitiveness of companies. Seaports should be able to offer quick service for the ships in order to remain competitive. In addition to competitiveness of a nation, seaports play an important part in the overall wellbeing of a nation as most countries are heavily dependent on trade (for instance, in Finland the amount of exports and imports are 44.5 percent and 39.3 percent, respectively, from the Finnish GDP) (SF, Economic Statistics: National Accounts, 2007).

Winkelmans (2002) has summarized some definitions for ports from numerous sources. One definition for a seaport is: an area of land and water, where reception, loading, and unloading of ships is possible in conjunction with storage of goods, and there is a connection to inland transportation. Other definitions see seaport as a logistical and industrial center which plays an active role in global transport system. Winkelmans (Winkelmans, 2002) continues by stating that it is difficult to give a definition to seaports as these include different transport chains, equipment required to conduct these logistical operations, and there is a large diversity of different terminals.

As logistics plays an important part in these definitions, it also needs to be defined. According to the Council of Logistics Management, logistics management is *"part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements"* (Council of Logistics Management 2008). According to this definition, logistics also include the flow of information and services, not merely goods. Also, logistics is part of supply chain management. Vafidis (2007) has summarized definitions for supply chain management. According to Vafidis (2007) the definitions for supply chain management differ greatly between different researchers. It can either be a minor activity or a complex relationship chain. Thus, the definition of logistics would mean a large area of possibilities.

In this study, a port is defined as follows: "A facility, which can receive ships and transfer cargo. The facility includes the container terminal, which is required to conduct the transshipment between ships and land vehicles." This definition is chosen as this study is concerned about the actual seaports and the container terminals in their immediate vicinity. Also, only the flow of actual goods is in the area of interest, not the flow of information.

The Gulf of Finland contains many large seaports. These include Helsinki, Sköldvik, Kotka, Primorsk, St-Petersburg, Tallinn and Vysotsk. The amount of oil transportation will increase heavily in the future (Kuronen et al. 2008) and thus, an oil spillage might happen in the near future. This will have a large impact on the local economies and nature as the ecosystem in Golf of Finland is relatively sensitive (Hänninen & Rytkönen, 2004).

This study is part of a larger study, where the cargo flows in the Gulf of Finland in emergency situations is studied (STOCA-project). The larger study relies on a simulation model so this study will only include simulation models. Before this simulation model some interview were conducted with some key logistical operators in the Gulf of Finland. In one interview it was concluded, that the main road next to Helsinki seaport has insufficient capacity to handle much excess capacity. In the simulation model we study different amounts of capacity leading out of Helsinki. We do not specify the type of hinterland capacity available and use an aggregate value to represent the maximum outflow capacity.

4. Simulation

Naylor et al. (1966) define simulation as the process of designing a mathematical or logical model of a real system and then conducting computer-based experiments with the model to describe, explain, and predict the behavior of the real system. Simulation analysis is a descriptive modeling technique. It does not provide explicit problem formulation and solution steps like linear programming.

Borschev and Filippov (2004) distinguish between discrete-event system simulation, agent based simulation and system dynamics modeling. In agent-based modeling individual actors behavior is modeled; the dynamics of the system is derived from the interaction between the actors. Furthermore, in discrete-event simulation discrete units flow inside a system, while resources offer services to the units.

Simulation has been widely used in transport system analysis. Applications range from elevator planning and airport baggage handling system design (Tervonen et al., 2008; Rijsenbrij & Ottjes, 2007) to evaluating segregation strategies of genetic manipulated grain (Coleno, 2008) and modeling of national freight systems (de Jong & Ben-Akiva, 2007). Godwin et al. (2008) use simulation for tactical locomotive fleet sizing for freight trains. Simulation has also been used for assessing different regulatory methods in congested transport systems (Kidokoro, 2006). Although simulation is often seen as an alternative to other analysis tools, it can also be used in combination with them.

The Canadian Pacific Railway has used an optimal block-sequencing algorithm, a heuristic algorithm for block design, simulation, and time-space network algorithms for planning locomotive use and distributing empty cars when changing their service concept (Ireland et al., 2004). Cheng and Duran (2004) report a decision support system for managing transportation and inventory in a world-wide crude oil supply chain. The tool is based on a discrete-event simulation model and dynamic programming.

Recently simulation has been used also in analyzing sea transportation. For example Engelen et al. (2006) have used system dynamics for a strategic and tactical decision making model for ship owners in the dry bulk sector. Ottjes et al. (2006) have investigated the future capacity needs of the Rotterdam port area. Their results include the requirements for deep-sea quay lengths, storage capacities, and equipment for interterminal transport.

Further traffic flows on the terminal infrastructure are determined, and the consequences of applying security scanning of containers are evaluated. Douma et al. (2009) have evaluated effect of information exchange in the Rotterdam port area on the waiting profiles. Tu and Chang (2006) have analyzes operations of ditch wharfs and container yards in future megacontainer terminals by using simulation. Grunow et al. (2006) have analysed strategies for dispatching AGVs at automated seaport container terminals in single and dual-carrier mode.

SD was developed by Jay Forrester in the late 1950s. The first published work was "Industrial Dynamics" (Forrester 1958) and the simulation model consisted of a supply chain. SD is part of a larger school of thought, Systems thinking. Systems thinking studies dynamic complexity. In dynamic complexity is seen to arise from the non-linear and multi-loop feedbacks, while in detailed complexity the complexity derives from a wide array of possibilities (Maani & Maharaj, 2004).

SD uses only a couple of different kinds of elements to construct complex models. Nowadays almost all SD programs use a graphical interface where the model can be build by connecting different elements together and writing the actual equations inside the individual elements. The used elements are shown in Figure 1.

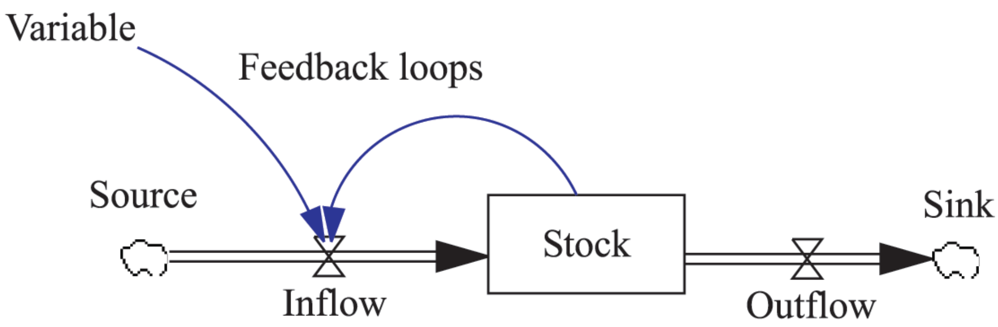

Figure 1. The basic elements in a system dynamic model.

Among the most important elements in a SD model are the stock and flows. The stocks are accumulations which are defined by the in- and out-flows of the model. Mathematically speaking the equations are simply integrals. The stocks play an important part as the model reaches equilibrium as the stocks regulate the feedbacks in the system. For instance, in the example of Figure 1, the stock impacts the values of the in- and outflows so the system reaches equilibrium in time. As the model needs to have fixed boundaries, sinks and sources are used to represent stocks with an infinite capacity. Final parts in SD are variables / parameters and feedbacks. Variables simply store information and / or conduct different calculations during the simulation. The feedbacks represent either a positive or negative feedback, e.g. it will either have a positive correlation between the elements or a negative one. (Sterman, 2000)

SD has been used in a wide area of applications. These include ecology, economics, supply chain management, urban development, and even world development. SD has also been used earlier in studying seaports. Munitic et al. (2003) created a SD model where they studied the material flows in a whole port cargo system. The model was constructed on a micro-level and it contained individual fork-lift trucks, wagons, wharfs, etc. Sanders et al. (2007), on the other hand, studied the investment dynamics in larger port systems including hinterland capacity. The model also contained the competition between the different seaports. Lättilä (2009) constructed a macro-level SD model where the focus was on the development of demand in different seaports. The simulation model did not include competition between the different seaports and the demand was imposed on individual seaports using the historical values. Even thought the amount of publications regarding system dynamic simulations of seaports are low, there should be no reasons why SD could not be a valid method in studying the development of seaports.

5. Simulation model

As it was stated in the previous chapter, we are interested in studying the impact of insufficient hinterland capacity on the performance of seaports in crisis situations. In the hypothetical case the Hamina and Kotka seaport are going to be closed due to an oil spillage in the Gulf of Finland. The container traffic from Kotka is transferred to Helsinki seaport and we analyze what happens with different amounts of hinterland capacity. Hamina's demand is transferred to another seaport so there is no need to study it in the simulation model.

In the simulation model both of the seaports have an estimated daily demand and capacity. As soon as the Kotka seaport malfunctions, the seaports start shifting some of the capacity from Kotka (for instance mobile cranes) to Helsinki. There is also a limit to the amount of additional capacity which Helsinki can absorb, which will also impact the potential movable capacity. In this paper we assume that the seaport cannot take much additional capacity from other seaports so the potential for additional capacity is small. The shifting operation will require some time (loading at the Kotka seaport, transporting, and finally installing at Helsinki) and in the simulation model all movable capacity has been moved after 15 working days. Also, 15 days before Kotka seaport can start serving ships again the capacity is going to be transferred back to Kotka in a similar fashion.

Helsinki also has a fixed amount of containers which it can store at the seaport. In the simulation model the containers stay in the seaport for about 2 days on average (during the crisis situation the containers will only spend a very short amount of time in the seaport and this way the average time at the seaport remains low) and this is taken into account with the storage module.

There are two constraining factors in the maximum capacity of the seaport: available flow through the seaport (calculated with the help of hinterland capacity) and the actual cargo handling equipment. If the hinterland capacity is not large enough, the available warehouses

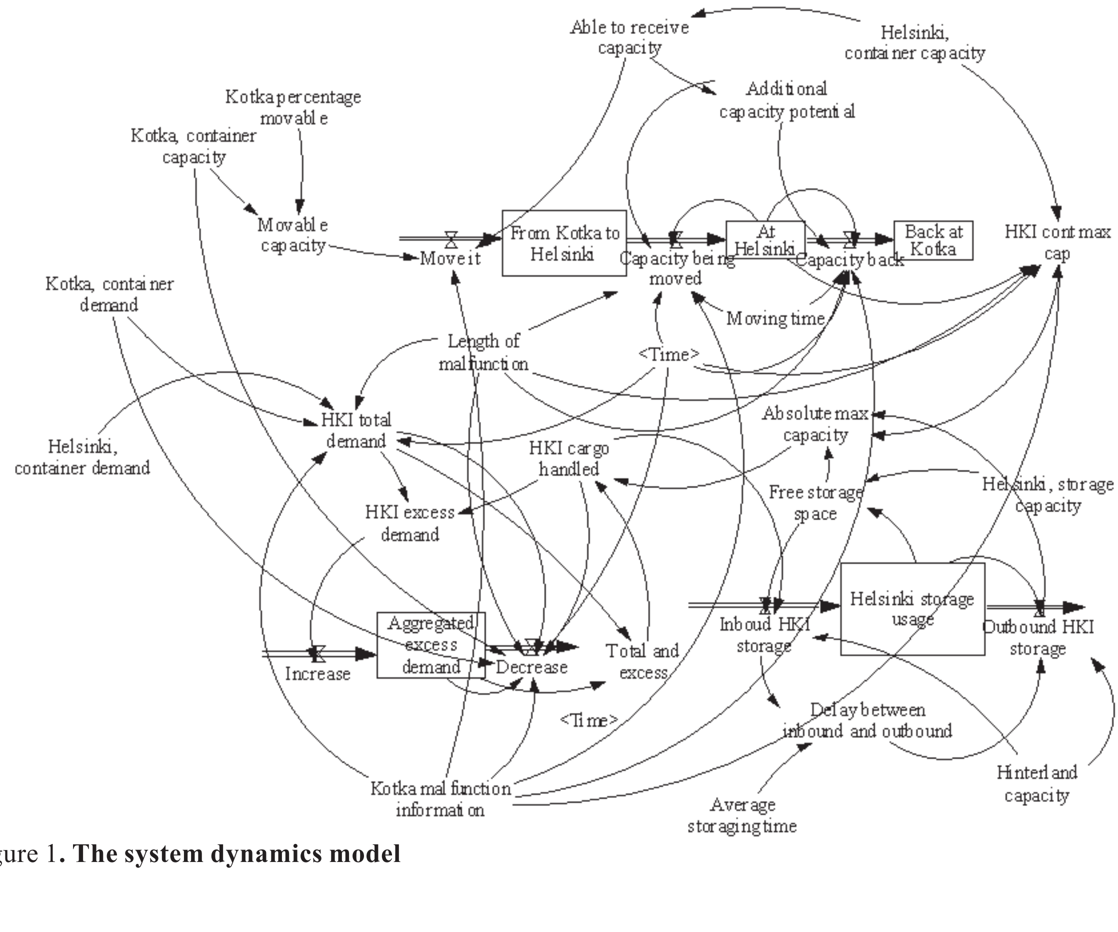

Figure 1**. The system dynamics model**

for containers start to fill up. When the practical maximum capacity is reached, the seaport cannot handle any more ships as there is not enough space to store the goods. In this situation hinterland capacity creates the maximum capacity for the seaport. Overall the simulation model contains a lot of interactions and the whole model is presented in Figure 1.

In this paper we are interested in the impact of hinterland capacity on the functionality of seaports in crisis situations. We run nine different scenarios with the simulation model. Hinterland capacity will differ between 1500 (a little bit over Helsinki seaports current demand) and 3500 containers (the demand of Kotka and Helsinki combined) per day. We will study the free size of storage, the maximum capacity of the seaport, and the excess demand which cannot be handled by the seaport.

6. Simulation Results

We will first analyze the amount of aggregated excess demand, which the seaport cannot handle during the crisis. All of the scenarios are presented in Figure 2.

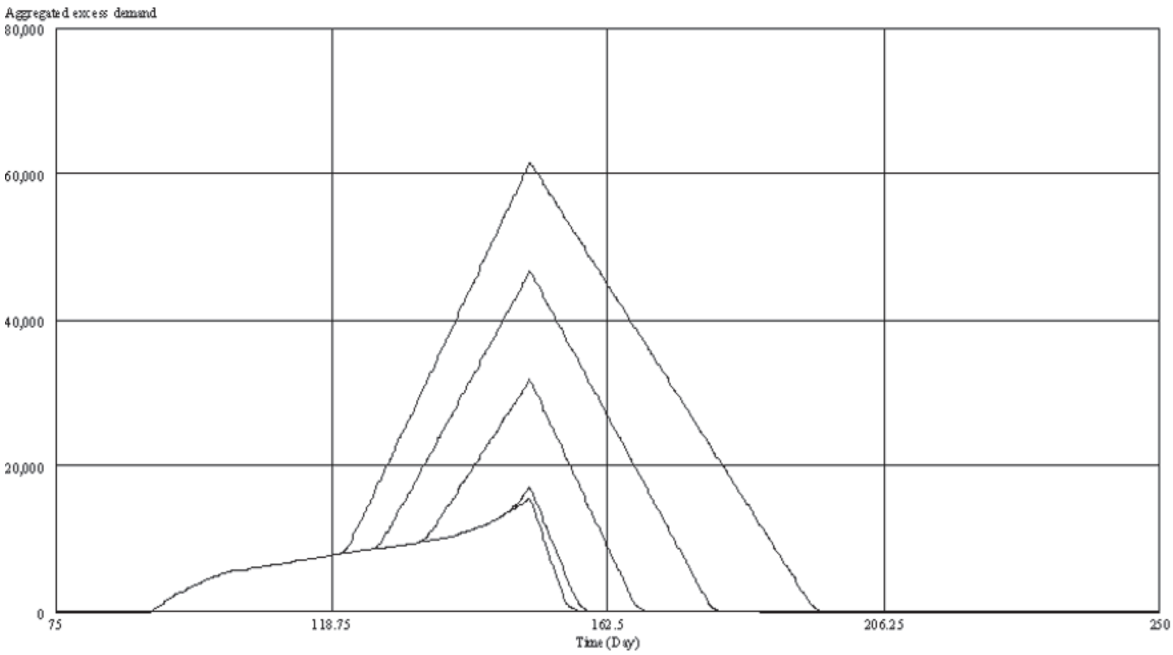

Figure 2. Aggregated excess demand in different scenarios.

As it is possible to notice from Figure 2, all scenarios have the same amount of excess capacity for the first 30 days of the crisis (The crisis start at day 90 of the simulation model and end after 60 days). At about time 120 the scenario with the lowest amount of hinterland capacity starts to differ from the rest of the scenarios. The scenarios with a hinterland capacity of at least 2500 do not differ between each other. In these cases the additional amount of hinterland capacity will not make a difference as free storage space does not run out during these simulation runs. We can verify this by studying the available capacity in different scenarios. These are presented in Figure 3.

Figure 3 confirms the expectation: Available capacity does not differ between the scenarios with a larger amount of hinterland capacity. From the figure it is clearly seen how the capacity increases in the beginning of the crisis. When the free storage space starts to run out, the available capacity decreases rapidly towards the amount of hinterland capacity available. Figure 4 shows the amount of free storage space in different scenarios.

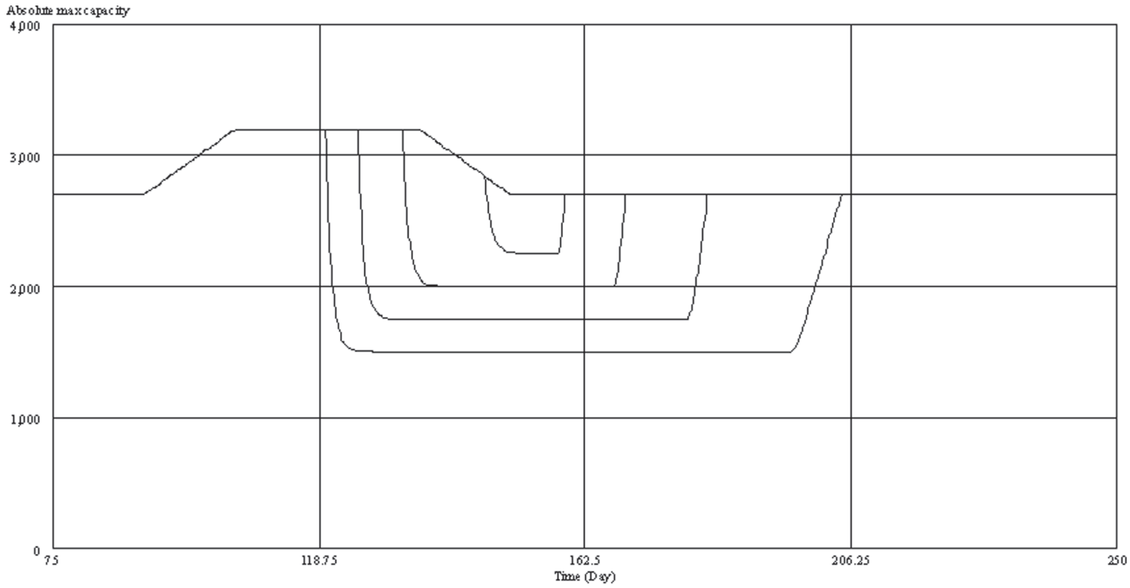

Figure 3. Available capacity in different scenarios

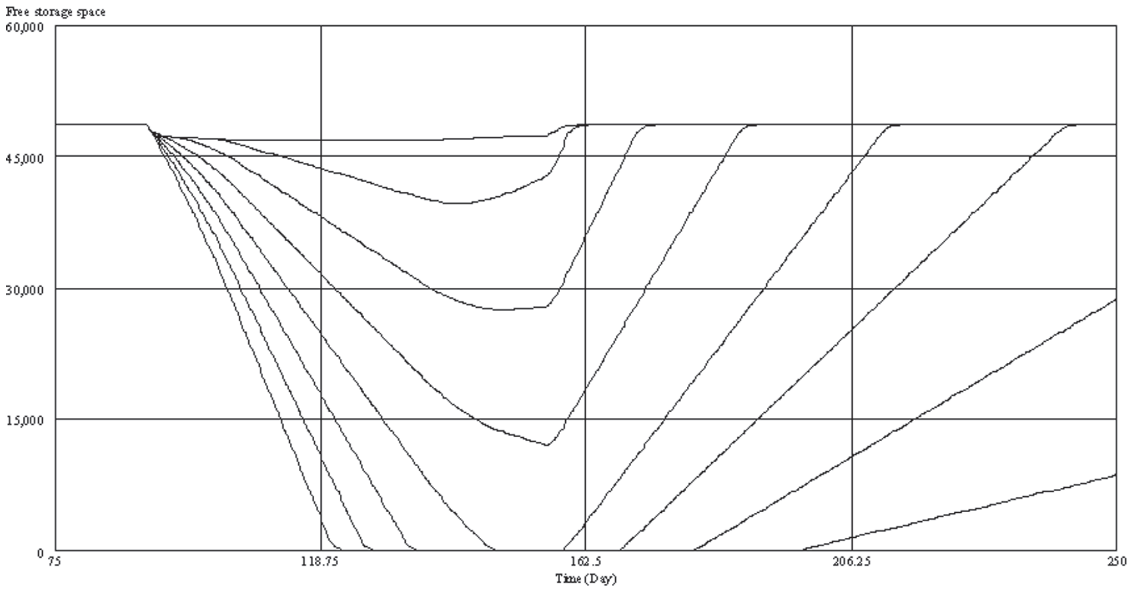

Figure 4. Amount of free storage space in different scenarios.

The free storage space runs out in four scenarios. When there is no more excess demand in the seaport, the amount of free storage space starts to increase. Even though the crisis ends at day 150, many of the scenarios are working on full storage capacity for a long time. Even at day 210 there is still a large amount of material in storage in three scenarios.

7. Discussion and conclusions

In this research work a simulation model was build to analyze the impact of hinterland capacity on the performance of a seaport in crisis situation. We studied the situation where the container demand for Kotka seaport was transferred to Helsinki. From the simulation model it was possible to notice that hinterland capacity also plays a vital role in crisis situations. As long as there is adequate storage for containers, the seaport can handle a large amount of vessels. When all of the storages are full, the handling capacity drops dramatically. Even when the crisis is over it takes a long time to return to normal situation.

The proposed simulation model is an initial model. It has some limitations which offer avenues for further research. Firstly the hinterland capacity could be simulated more accurately. Trucks and railways have different constraints and the capacity might not remain the same during the whole simulation period. Secondly the simulation model does not differentiate between imports, exports, and transition. In crisis situations imports are the most important goods, followed by exports, transition being the least important category. If the storage area is full, more capacity can be allocated to exports, which will increase the speed at which the storage is emptied. Thirdly, the simulation model does not take into account the impact of having the right amount of empty and full containers. These are the next steps in order to improve the simulation model.

System dynamics works relatively well when crisis situations are analyzed. As long as the goods can be aggregated to categories, it is easy to construct the simulation model. In this model only one category was analyzed (containers) but it would be possible to include other categories as well as it might be necessary to use one seaport to handle more than one type of additional goods in crisis situations. This could be done using arrays in a SD-model and could be achieved relatively easy.

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