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# TRANSSHIPMENT HUB CONCEPT, MULTIMODAL TRANSPORTATION, INTERNATIONAL BENCHMARK

## Finnish-Russian Transshipment Hub - The optimal model for the future IWT

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**Thesis title**

Transshipment hub concept, multimodal transportation, international benchmark – Finnish-Russian Transshipment Hub – The optimal model for the future IWT

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**Commissioned by**

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**Supervisor**

Suvi Johansson

**Abstract**

The objective of the thesis was to examine the demands of the transshipment hub which would serve the inland waterway traffic in Finland and at the Saimaa Canal. The objective was to determine the most efficient ways of handling cargo. The thesis was made as a commission from INFUTURE- The Future potential of Inland Waterways project. The research questions aimed to search answers to what the optimal model for a transshipment hub in an inland waterway traffic would be and which kind of factors had an influence on the operation of that kind of a hub.

The research methods were international benchmarking and semi-structured interviews. The benchmark was made by researching five different ports that were related to the inland waterway traffic. The purpose was to find out the best practices of port activities. The purpose of the semi-structured interviews was to get a deeper understanding about the topic. The interviews were conducted with three representatives from the ports of London, HaminaKotka and Oy Saimaa Terminals Ab.

As a result, it appears that the potential of the inland waterway transportations when trying to decrease congestions on roads is known and it is used as an optional route for large cargo volumes across the Europe. The central location of the transshipment hub near the market area with good connections to all onward transport modes is attractive also from the customer's point of view. The main conclusions were that the inland waterway transport has potential in Finland, and the benefits achieved with the implementation of it are good for the environment as well as for the people in the nearby areas.

**Keywords**

Inland waterway transportation, transshipment hub concept, multimodal transportation

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**Tiivistelmä**

Opinnäytetyön tarkoituksena oli tutkia Suomessa, Saimaan kanavalla, sisävesiliikennettä palvelevan transshipment hub: in vaatimuksia ja tavoitteena oli määrittää tehokkaimpia lastinkäsittelymenetelmiä. Opinnäytetyö tehtiin INFUTURE – The Future potential of Inland Waterways -projektin toimeksiantona. Tutkimuskysymysten avulla pyrittiin löytämään vastauksia siihen, millainen olisi optimaalinen sisävesiliikenteen transshipment hub -malli ja millaiset tekijät sen toimintaan vaikuttavat.

Tutkimusmenetelminä käytettiin kansainvälistä benchmarkkausta ja teemahaastattelua. Benchmarkkaus toteutettiin keräämällä tietoja viidestä erilaisesta satamasta ympäri Eurooppaa, joilla oli kytköksiä sisävesikuljetuksiin. Benchmarkin tavoitteena oli selvittää satamatoimintojen parhaita käytäntöjä. Teemahaastattelun tarkoituksena oli saada syvällisempi ymmärrys aihealueesta. Teemahaastattelut toteutettiin kolmen eri organisaation edustajan kanssa, jotka olivat Port of London Authority, HaminaKotkan satama Oy ja Oy Saimaa Terminals Ab.

Sisävesikuljetusten potentiaali maanteiden liikenneruuhkien vähentämisessä on tunnistettu ja sisävesiväyliä käytetään vaihtoehtoisina reitteinä suuria lastivolyymeja kuljetettaessa ympäri Eurooppaa. Transshipment hub: in keskeinen sijainti lähellä markkina aluetta ja hyvien jatkokuljetusyhteyksien äärellä on houkutteleva myös asiakkaan näkökulmasta. Keskeisimmät johtopäätökset olivat, että sisävesikuljetuksilla on potentiaalia Suomessa ja sen käyttöönotosta on hyötyä lähiympäristölle sekä lähialueiden ihmisille.



**Asiasanat**

Sisävesikuljetukset, transshipment hub -konsepti, multimodaali kuljetukset

**CONTENTS**

## VOCABULARY

**IMO** International Maritime Organization

**INFUTURE** The Future potential of Inland Waterways project

**IWT** Inland waterway transportations

**TEN-T** Trans-European Transport Network

**TEU** 20” standard container

**tkm** ton kilometre, metric for transportation performance

**Väylä** Finnish Transport Infrastructure Agency

# 1 INTRODUCTION

The topic of the thesis was commissioned by INFUTURE, The Future potential of Inland Waterways project. The main purpose was to survey the demands of a transshipment hub which would serve the inland waterway traffic in Finland and at the Saimaa Canal. The objective was to determine the most efficient ways of handling cargo.

The INFUTURE project aims to find solutions for sustainable and cost-efficient inland waterway traffic. This project aims to recognize the most efficient ways of handling cargo and study the legislation concerning the traffic of goods between two countries, Finland and Russia. In this thesis, the information collected by the project team is utilized, and the objective is to supplement the project database especially in the field of multimodal transport and of the transshipment hub concept in the inland waterway traffic. (INFUTURE no date.)

In Finland international cargo is mostly transported by road. As a result, the amount of pollution and the number of traffic accidents increases, and the road network becomes overloaded. All this can be seen especially on the route between Finland and St. Petersburg. (INFUTURE no date.)

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At the moment, 20% of Finland's greenhouse gas emissions is caused by traffic. Of total traffic emissions, 90% is caused by the road traffic while the shares of rail, air and water traffic are 1%, 2% and 4% respectively. (Mannola 2019, 36 – 37.) The most significant greenhouse gases are methane ($CH_4$), carbon dioxide ($CO_2$) and nitrous oxide ($N_2O$). The greatest source of emissions is the use of fossil fuels, such as oil, coal and natural gas. The share of the sea transport in $CO_2$ emissions is globally only 2.7% even though its share of the world trade is 90%. (Björkendahl no date.)

The purpose of this thesis is to define the most important objectives of the transshipment hub operations and the main services it should be able to offer to its customers. The main objective of this thesis is to perform an international

benchmark between similar transshipment hub centres and conduct semi-structured interviews in order to collect information about the topic. As a result, the collected information forms a summary of the most important preconditions for efficient operations of these hubs. The research questions in this thesis are the following:

- What would be the optimal model for a transshipment hub in the inland waterway traffic?
- What kind of factors have an influence on the operations of the transshipment hub?

The research method chosen in this thesis was qualitative research and the information collecting methods were semi-structured interview and benchmarking. The qualitative research method was chosen because the objective of the research is to achieve a good understanding of the phenomenon that it is investigating. The material is collected from several sources such as literature, Internet, figures and interviews, for the study. (Kananen 2014, 18 – 19.)

At the beginning of the thesis there is a small vocabulary of the keywords of this study. The first four chapters are constructing the theoretical part of the thesis, it includes the theory about green logistics in Europe, inland waterway transportations in Finland, and introduces the transshipment hub concept and multimodal transportations. After the theoretical part, there is an international benchmark, in which five different ports related to the inland waterway transportation are introduced. At the end there can be found the research methods, and the results and conclusions of the study.

## 2 GREEN LOGISTICS IN EUROPE

If logistics and supply chains are to be made greener, all operations related to them should be as environmentally friendly as possible, and no resources should be wasted, at the same time focusing on decreasing carbon dioxide emissions in the whole supply chain. Logistics and transport companies should increase the use of new technologies and improve the operations of their networks by increasing cooperation between separate parties. Decision makers should promote the implementation of green logistics by creating opportunities to use

also other transport modes than road traffic. The congestions caused by road traffic can be decreased by transferring transports to rails, inland waterways and sea. (Grant et al. 2017, 28-29.)

Freight transport is in the most visible role in the discussion about separate logistics operations on developing and converting supply chains more environmentally friendly. The amount and magnitude of environmental effects varies a lot between different supply chains. The World Economic Forum (2009) has estimated that the main part of the carbon emissions of logistics operations comes from the freight transport. Other environmental effects that have a wide impact caused by freight transport are noise, vibration and accidents. (Grant et al. 2017, 65.)

Exposure to traffic noise has a negative effect on the health of the human population. The traffic noise is now familiar to the majority of the population, as early as 2000, more than 44% of the European population thought that the road traffic noise was annoying and 7% were exposed to the same level of rail noise. The aim is to reduce noise pollution by developing better tires and making restrictions on, among other thing operating hours. (Grant et al. 2017, 66.)

Accidents are commonly forgotten as an environmental effect. Freight traffic uses the same roads as other traffic, cyclists and pedestrians, and is therefore more likely involved in the accidents than railway or waterway transportations that have their own specific tracks and waterways. Because of the big size and heavy weight of the conveyance of the freight traffic, the probability of more serious accidents is higher than with normal cars. In Europe, the number of traffic accident casualties varies by country due to many factors, such as the level of road safety, vehicle maintenance standards, and the age of cars in traffic. A new topic of discussion about the road safety is whether sound generating devices should be added to electric cars, as there is a fear that other traffic will not notice them due to their quiet sound. (Grant et al. 2017, 67.)

Even though the other transport modes are more harmful to the environment than the others, companies have different logistical and commercial reasons that affect the choice of the transport mode. The external factors vary according to the country. The availability and the quality of the existing infrastructure as well as the amount and quality of logistic service providers and the means of transport can be highly different between countries. Accessibility of the targeted area along waterways or railways determines whether those modes can be considered as an option. Water and rail transportations often require a small part of the road transport to the beginning and to the end of the journey. In addition, local laws and regulations related to transports and the price, of course, affect the choices made by companies. Many of the developed countries are trying to add the use of transport modes that have smaller environmental effects, among other things, through the taxation. (Grant et al. 2017, 70.)

The utilization factor is an important factor in the assessment of the environmental effects of transport. If there is cargo loaded on board in both directions and as full as possible, it will decrease the costs as well as the emission load of one shipment per tkm. The profitability and the kindness to the environment can be increased by transporting the shipments included in an already planned trip that would be operated in any case or by utilizing already existing systems. A good example of this kind action is air cargo shipments that are transported along the passenger traffic. The carbon emissions of the transport modes are depending of which kind of a fuel and an engine is used, often the comparison relates to engines which are electricity-operated and which use fossil fuels. (Grant et al. 2017, 71.)

The strategic alternatives to reduce the environmental effects of transports are the reducing of the emissions of the transport form in use, transporting of the freight with totally other less polluting transport forms or in overall, reducing the amount of the freight to be transported. (Grant et al. 2017, 73.)

## 2.1 Climate change

Climate change is most commonly discussed in the framework of the global warming. According to some estimates, the world has been warming up in cycles for the past million years. This is called the natural warming cycle and it happens again and again in 100,000-year intervals, 80-90,000 years of ice age, and 10-20,000 years of warm period. The natural warming cycle is called Milankovitch cycles. The Milankovich cycles are caused by three things: change in shape of the Earth's orbit around the sun, change in tilt of the Earth's ration axis, and the wobble of Earth's axis. The current warming is not natural warming, it is the consequence of the huge amount of $CO_2$ emissions. (OSS foundation no date.)

The climate is warming first of all because of greenhouse gases. They allow the sun's thermal radiation pass from space to the earth, but when the radiation is reflected back to the space, greenhouse gases absorb some of the heat into themselves and this is why the earth is warming. The most significant greenhouse gas is carbon dioxide ($CO_2$) which is produced by the use of fossil fuels. (Mannola 2019.)

Control of the climate change contains a wide group of regulations which are used in restricting emissions caused by different transportation modes and in supporting the environmentally friendly technology, energy sources and transportation forms. The regulations can be connected to the planning standards of the transportation equipment and machinery, for example. In addition to regulations, the European Union's traffic politics is supporting environmentally friendly transportation modes, such as rail transportation. (Etelä-Suomen keskitetyn logistiikkajärjestemän visio 2018.)

The magnitude of the effects of the climate change control to the international supply chains depends on the contents of regulations and restrictions that come into force in practice. Emission reduction targets as well as tightening and expansion of emissions restrictions can cause the fact that in companies more observations than before are paid to the environment matters. One's attempt to consolidate deliveries and transportations more and effectively as well as

transporting bigger batches at one time has become more and more common in companies' policies. This can increase the storage need at some branches even though, for a long time, the trend has been the tend to avoid massive storage levels which ties up capital and causes the extra costs. Although, the development is all about balancing between different costs while one's reaching the optimal solutions to one's business. The storage need depends highly on the business area and the product itself among several other things. All in all, the regulations are increasing the implementation of the environmentally friendly technology. (Etelä-Suomen keskitetyn logistiikkajärjestemän visio 2018.)

## 2.2 EU strategy

The European strategy is based on White Paper 2011 of Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system. In 2011, the European Commission accepted a transport system plan that included 40 concrete initiatives that would increase growth and employment, and at same time remove major barriers between the transport modes and national systems, and increase the mobility. Also, the purpose is to cut carbon emissions from transportation by 60% by 2050. (European strategies 2020.)

White Paper 2011 key objectives for sustainable transport by 2050 include:

- Remove cars with combustion engines from the cities
- Reduce of road freight by 50% if the destiny is over 300 km and shift it to other modes such as water or rail transport
- In aviation, use of sustainable low carbon fuels 40% of total. Shipping emissions reduce by 40 %

If all goals were realized, it would cut transport emissions by 60% by the year 2050. (European strategies 2020.)

## 2.3 Inland waterway transportations in Europe

Inland waterway traffic is, in addition to the road and railway traffic, one of the three main traffic modes used in the inland transportations in Europe. Cargo is

transported by vessels between inland ports and loading docks through inland waterways, for example canals, rivers and lakes. One of the EU´s targets is to switch over road traffic into more environmentally friendly transportation modes like inland waterway traffic, among others. By this way one could be able to achieve cost savings, reduce pollution and increase road safety. (Euroopan tilintarkastustuomioistuin 2015.)

About half of the population of Europe lives at the coast areas or near inland waters, and most industrial centres can be reached by using inland waterways. The most important international inland waterway traffic network is the Rhine – Danube network which is 14 360 km long. Its share of internationally remarkable inland waterways is nearly half. The most important areas of the Rhine – Danube network are the Rhine river area and the Danube river area. (Euroopan tilintarkastustuomioistuin 2015.)

The Rhine river area, which is the most developed, maintained and used waterway for transporting goods, has the greatest density of population and waterways. About 80 % of inland waters' freight traffic is operated at the Rhine river. The Danube river area enables to secure inland waterway traffic between The North Sea and The Black Sea. About 9 % of all inland waterway traffic is operated in Danube and Rhine – Main – Danube canal. (Euroopan tilintarkastustuomioistuin 2015.)

Freight traffic at inland waters can be profitable, with barge convoys one can transport more freight per tkm than one could by any other transportation mode used at dry land, in addition one could decrease road traffic. The loading capacity of vessels used in inland waters corresponds to hundreds of trucks. Thanks to the great capasities one could save transportation costs and reduce emissions as well as traffic congestions. Also, the safety of inland water vessels is at the high level. (Euroopan tilintarkastustuomioistuin 2015.)

# 3 INLAND WATERWAY TRANSPORTATIONS IN FINLAND

Indicated as a transport performance, in 2018 the total amount of cargo transported on Finland's inland waterways was 580 tons and 120 million ton kilometres (tkm). Of the waterway transport of goods, of the domestic waterway transport, the share of the inland water traffic was 8%, while by the sea the share was 88%. The corresponding shares as tkm were 4% on the inland waters indicated as a transport performance and on the coast 93%. In the harbors of Lake Saimaa, the only commodity group in the domestic transport of goods was bulk cargo in both the import and export traffic. (Traficom 2019.)

In Finland, the inland waterway network is almost as wide as, for example, in Germany or the Netherlands, although the utilization of the potential is quite far from the maximum. (Developing Saimaa inland waterways 2018).

## 3.1 The Saimaa Canal

The Saimaa Canal is Finland's most significant canal. It leads from the Lake Saimaa through the city of Vyborg into the Gulf of Finland. The Saimaa Canal is 43 km long and consists of eight locks. Three of the locks are located on Finland´s side, and the remaining five locks are located on the Russian side. Half of the canal has been rented from Russia by Finland for the next 50 years. (Saimaan kanavan kehittäminen 2019.)

Potentially, as much as 5 million tons of cargo could be transported in a year through The Saimaa Canal, but at the moment the amount is only 1.3 million tons. This means that the full potential of the infrastructure is not in use, and the current level cargo transport is not as effective as it could be. (Developing Saimaa inland waterways 2018.)

The main problem is the size of the canal's locks because they are too small for modern vessels, but the production of the fleet designed for the current size of the locks has been discontinued. The vessels that are currently in use in the Saimaa Canal have been built in the late 1980´s. As the fleet in use is already

quite old, the traffic in the Saimaa Canal is in danger to be permanently stopped if the locks are not enlarged. By enlarging the locks of the canal, new vessels that are larger than the current ones can be used. The length of the vessels could be risen from 82.5 metres to 93 metres, and they could carry 3.2 tons instead of the current 2.2 tons of cargo. (Saimaan kanavan kehittäminen 2019.)

By lengthening the locks, the capacity of the fleet can be increased, which would bring cost savings for both the entrepreneurs and companies. The impact could also be seen in the environment as the road traffic would decrease. This would result in lower road wear, dust and noise caused by transportation vehicles, as the same amount of cargo would be silently moved by waterways. In addition, the number of traffic accidents would decrease. (Saimaan kanavan sulkujen pidennystä kiirehditään 2019.)

The plan is to extend the locks of the Saimaa Canal to 11 metres, and the costs are estimated to be approximately 85 million euros. By building new locks, it would be possible to operate through the canal around the clock. That would remove approximately 500 truckloads from the road. (Knaappila 2019.)

Lengthening of the locks would not only increase the capacity of the vessels but also create opportunities to increase the cargo traffic between the Lake Saimaa and the Gulf of Finland. (Hannus 2019).

**History**

The first time the Saimaa Canal was completed for use in 1856, it was opened on the same day when new Russian Tsar was crowned on 7 September. At that time, Aleksander II become the Tsar after Nikolai. (Vesterinen 2014, 14-15.)

The Saimaa Canal was completed in 1856. Its length was 58.25 kilometres, from that length 33.6 kilometres were excavated. The canal stretched from the shore of the Lauritsala beer factory to the Vyborg Castle and the Castle Bridge. The canal had 28 locks. (Vesterinen 2014, 16-17.)

The use of the canal exceeded expectations. As a result, the whole economy of Eastern Finland recovered. (Vesterinen, 2014, 20-21.)

In the 1890s, the volume of goods began to increase, and by the next century more than 300,000 tons of goods were transported. In 1912 it was decided to expand the canal, because the volume of the transported goods increased to over 800,000 tons. In 1923, the canal reached its limit when goods were transported over one million tons. (Vesterinen 2014, 22-23.)

The renovation of locks was started in 1927, but the renovation was stopped in 1939 because the Winter War started. At that time, about 40 percent of the canal was completed. The old channel locks had been replaced by eleven new locks.

The renovation increased the capacity of the canal, but its tons stayed at the same level that they were in the 1920s. This happened because the transports were shifted to the rail and road. (Vesterinen 2014, 86-87.)

The Continuation War destroyed the Saimaa Canal. The Paris peace treaties ended the war. With that peace, Finland lost Karelia and half of the Saimaa Canal. (Vesterinen 2014, 96-97.)

In May 1963 Finland signed an agreement with Russia that concerns the rental of the Saimaa Canal. Russia rented its half of the Canal to Finland for 50 years. In 1963, Finland started to build a new canal and it was completed in 1968. This canal is in use nowadays but it has been renewed. (Vesterinen 2014, 105-107.)

### 3.2 The future of the Saimaa Canal

Due to the economic recession that began in 2008, the traffic in the Saimaa Canal has decreased to an annual level of 1.3 million tons and the internal traffic to an annual level of 670 tons, of which 260 tons were floating. In 2004 traffic was 2.4 million tons of which the share of the float were 710 tons. (Itä-Suomen neuvottelukunnan kannanotto Saimaan kanavan kehittämiseen 2018.)

In 2018, the Finnish Transport Agency prepared a plan for measures to support the development of the freight transport in the Saimaa region. The aim is to increase the cargo carrying capacity of vessels operating at the Saimaa Canal by extending the canal locks and raising the canal's water level. The traffic season was to be extended with the renewal of the lower gates and new ice-breaking equipment. (Itä-Suomen neuvottelukunnan kannanotto Saimaan kanavan kehittämiseen 2018.)

According to the Eastern Finland Advisory Board, the closures of the Saimaa Canal should be extended, and the water level raised. This would enable larger ships to sail to the Lake Saimaa, which in turn would improve the profitability of traffic. (Kinnunen 2018.)

**Extension of the traffic season**

New lock gates were completed in 2019 and they enable almost year-round traffic. The gate locks were built during three winters, during which time the canal was closed from the traffic earlier than usual. Thanks to the new gates, the traffic season can be continued to February, when the previous traffic seasons ended in January at the latest. (Tanskanen 2018.)

The traffic season will also be extended by the new ice-breaking equipment that arrive at the Lake Saimaa. Thanks to the new equipment, the waterway will be able to be kept open across their entire for the first time. (Tanskanen 2018.)

The new ice-breaking equipment is a motorized ice-breaking removable-bow. It has been produced with the help of the WINMOS II project for the Saimaa Canal. The removable-bow is connected to the tugboat by a three-point hitch. The bow itself is equipped with a transport mechanism. The bow tug is operated by Alfons Håkans AS's Calypso. To make it suitable for a tug, it is modified. Currently, the bow is in test drive in the Naantali area. (Maailman ensimmäinen moottoroitu jäätä murtava irtokeula laskettiin vesille 2019.)

WINMOS II (Winter Navigation Motorways of the Sea II) project aims to develop and improve winter traffic and its safety, as well as ensure sufficient icebreaking resources. Part of the project was to develop and build a motorized removable-bow concept in the Saimaa area. The project is funded by the EU CEF. (Maailman ensimmäinen moottoroitu jäätä murtava irtokeula laskettiin vesille 2019.)

The traffic season can also be extended by raising the water level, which would allow the water mass in the canal to freeze more slowly in the wintertime. (Tanskanen 2018.)

**Extension of the locks**

The NaviSaimaa project, which aims to develop the inland waterway traffic on the Saimaa Canal, is currently being implemented. The project is implemented by four provinces, South Savo, North Savo, North Karelia and South Karelia. The project supports the goals of Prime Minister Sanna Marin's government program goals, which are: slow down climate change by reducing emissions, increase the employment rate to 75 percent, and increase the vitality by developing transport networks. (Saimaan kanavan sulkujen pidennys on sekä ilmasto- että työllisyysteko 2020.)

The Saimaa Canal is connected to the Baltic Sea, so it is part of international maritime traffic. It is also part of the EU-wide TENT-T network. For this reason, the canal is an important part of the entire eastern Finnish transport network. (Saimaan kanavan sulkujen pidennys on sekä ilmasto- että työllisyysteko 2020.)

The current locks are more than 50 years old. The project would allow larger vessels to operate in the canal. As the size of the vessels increases, the amount of cargo can be increased, which would have a positive effect e.g. on the competitiveness of the forest and paper industries. (FCG no date.)

The renovation has already started by renewing the lower gates in 2018-2019. The upper gate renewal has not yet been done. It is therefore planned that in connection with their renewal, it would make sense to extend the channel closures. The Finnish transport infrastructure agency has made a plan and estimated that its benefits would be as follows:

• The vessel selection reserve increases as the vessel size increases
• The vessel is able to take 30 - 40% more goods
• In wintertime, ships are more able to move in the locks
• New passenger cruise equipment may come. (Saimaan kanavan sulkujen pidennys on sekä ilmasto- että työllisyysteko 2020.)

The Finnish Transport Infrastructure Agency has estimated that the project would employ about 2,000 person-years. For the most part, the labor force would come only from Finland, as according to the regulations on the rental area one can work only with a Finnish passport. There is an urgent need to extend the closures, as the IMO ballast water agreement enters into force in the autumn 2024. The agreement requires that all the vessels which operate in the international traffic must have a ballast water removal equipment. It is estimated that such equipment will cost around € 160,000 to € 200,000. (Saimaan kanavan sulkujen pidennys on sekä ilmasto- että työllisyysteko 2020.)

At this moment shipping companies operating at Lake Saimaa are using vessels that are nearly at the removal age and the new vessels are not fitting in the canal. It is not profitable to install ballast water removal equipment to retiring fleet and it is highly unlikely that shipping companies would start to build vessels which would fit the current size of the locks. It would be profitable to install the ballast water removal equipment into new fleet that would fit the new extended locks. (Saimaan kanavan sulkujen pidennys on sekä ilmasto- että työllisyysteko 2020.)

The cargo amount of the old fleet is about 2 300 tons and in the new fleet it would be 3 200 tons. By correspondingly it would replace 80 railway carriage and 128 truckloads. Then the carbon dioxide emissions from the heavy traffic of Eastern

Finland would decrease by 60 000 tons, which is about 10 – 15%, at the same time the stress of the road network would decrease. The new fleet enables the usage of new and more ecological power sources, such as LNG- or electric motors. If the locks remain as they are now it would lead to the decline in the waterway transportation in the Lake Saimaa area, which in turn would increase the use of heavy trucks by 23% from the current level. (Saimaan kanavan sulkujen pidennys on sekä ilmasto- että työllisyysteko 2020.)

**Water level optimation**

Finnish Transport Infrastructure Agency is preparing to raise the water level in the Saimaa Canal so that vessels could be loaded with higher amounts of cargo and because bigger water mass would freeze slower during the wintertime. According to the calculations water levels should be raised by about ten centimetres. The raising water level allows cargo vessels to take 50 to 100 tons more cargo on board. This would transfer two truckloads away from the road traffic. Raising the water level is technically easy, because it can be done with the Saimaa Canal´s locks. The operation wouldn’t have any effect on the water level of the Lake Saimaa but the water level of Lake Nuijamaanjärvi would raise permanently. (Tanskanen 2018.)

### 3.3 Port of Mustola

Port of Mustola is the most important freight port at the Lake Saimaa District. It is located by the Saimaa Canal, ten kilometres away from the centre of the city of Lappeenranta and only 20 kilometres from the Russian border. The port area is bordered by the highway 13, which leads to the Nuijamaa border station. There is also a railway connection to the other parts of Finland and Europe, and through Russia to the Far East from Mustola. The Saimaa Canal is the only connection from the inland waters to the Gulf of Finland. When headed to the east, the waterway joins the river network of Russia and offers a route to River Volga. The Port of Mustola is also a logistics centre for road and rail freight. (Port of Lappeenranta no date.)

The logistics centre at Port of Mustola and Raippo areas are together offering facilities for effective and safe operations for Russian logistics. These areas are having the so called “free zone” - status, which means that the area is not covered by the EU customs charges. The status allows the handling and storing of the European Community goods and duty-unpaid goods from outside the EU. Mustola and Raippo have wide warehousing spaces that can be rented by companies, there are various companies that are providing logistics and forwarding services. (Free zone – two location options no date.)

### 3.4 Other areas

In addition to the Saimaa Canal with eight locks, the Finnish Transport Infrastructure Agency (later called Väylä) maintains overall 31 canal with locks. The canals are located at Vuoksi, Kymijoki and Kokemäenjoki water systems. (Väylä 2019.)

The figure 1 from Väylä is presenting the locations of the canals and locks of the inland waterways of Finland. From there it can also be seen that the Saimaa Canal is just a small part of the inland waterways here in Finland, and the potential for the waterway transports is quite enormous. Still, the freight traffic is concentrated on the Lake Saimaa and other areas are mainly used for the passenger traffic and pleasure boating. (Autio 2014.)

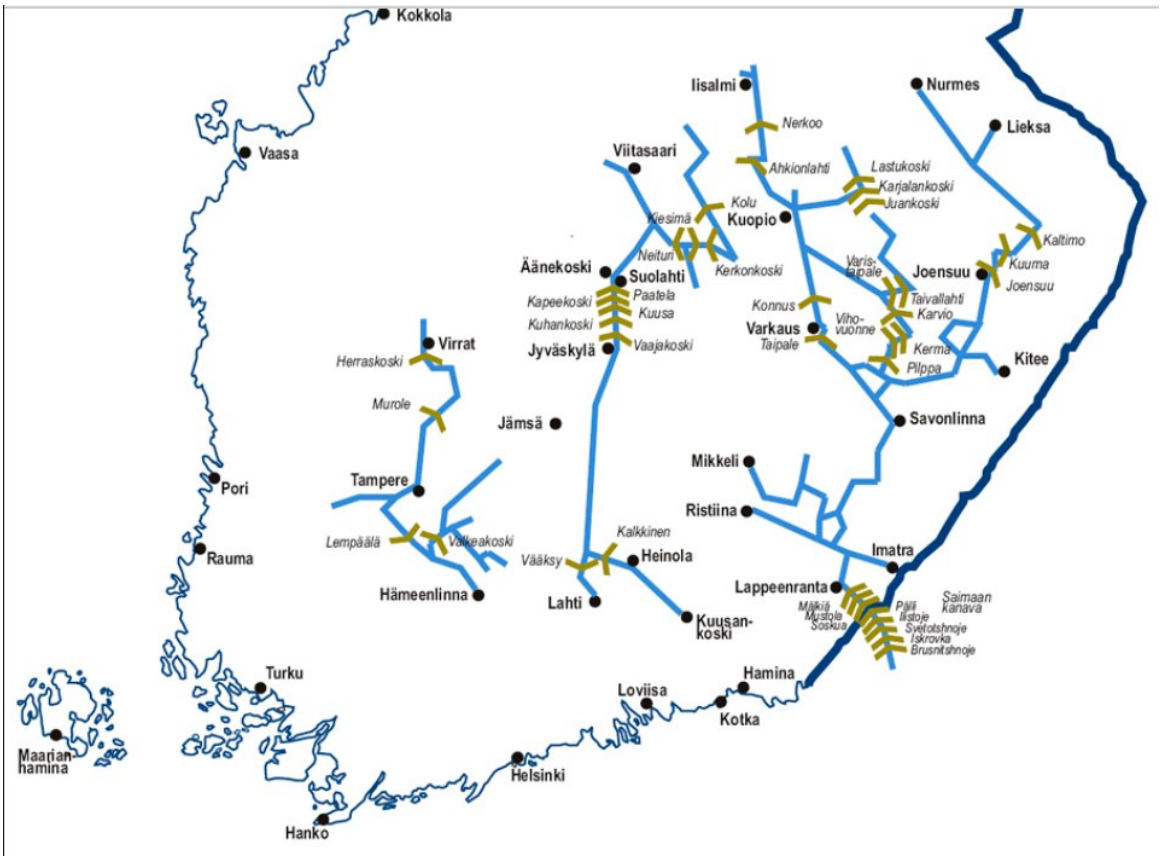


Figure 1. Locations of canals and locks of inland wateways of Finland (Väylävirasto 2019).

The main reason to the lack of the cargo traffic at the other areas of inland waterways is that there aren´t connections to the sea. (Autio 2014.)

## 4 TRANSSHIPMENT HUB CONCEPT

The terminal that goods or containers reach before the final terminal is called as a transshipment hub. When goods arrive at the transshipment hub, they are unloaded from the original vessel and reloaded onto the new vessel. (Dolgansky 2016.)

The main object of the transshipment hub is to improve the efficiency and geopolitical coverage of sea container loading networks. The transshipment hub enables ports to be linked more effectively to the global maritime transport system. There are three major forms for the transshipment hub, the figure (2) below describes those models. (The geography of transport systems 2020.)

1. Hub-and-Spoke. This form of the transshipment hub provides connections between short distance feeder lines and long-distance deep-sea lines. It links global and regional shipping networks together.

2. Intersection. In the second form transshipment hub is a point of interchange between long distance shipping routes.

3. Relay. Transshipment hub connects the same region shipping routes, but service different port calls. (The geography of transport systems 2020.)

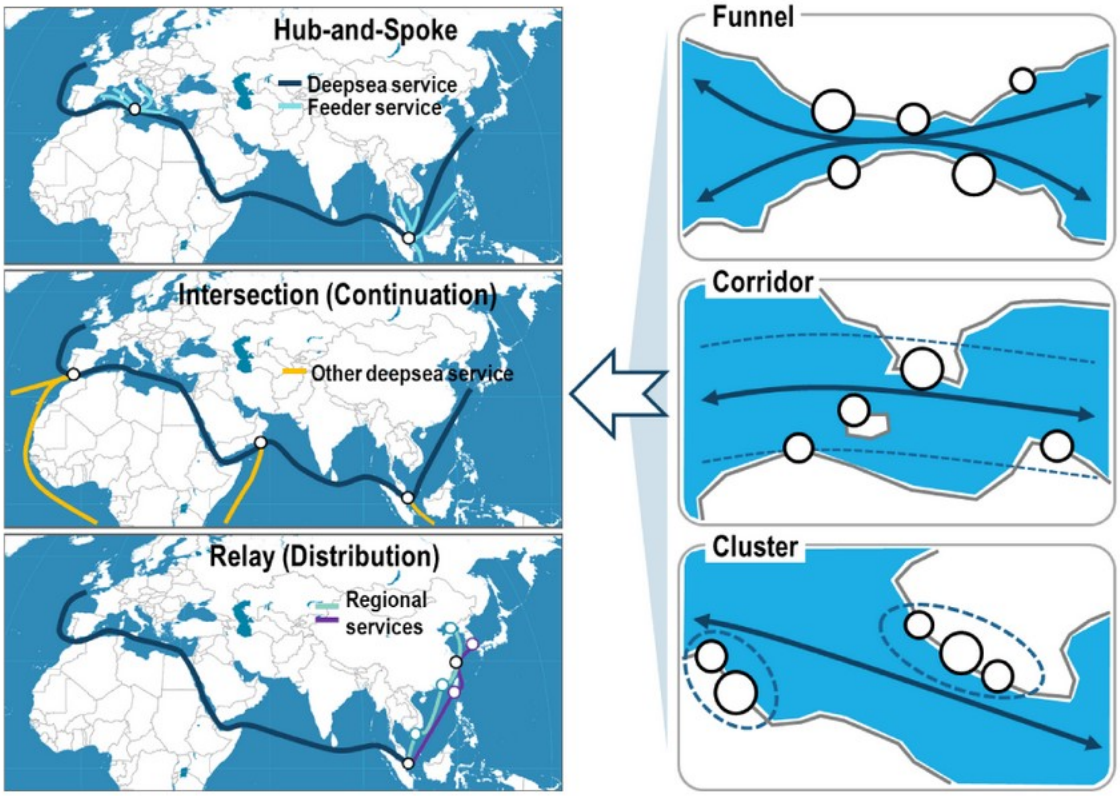


Figure 2. Three forms of transshipment hub (Port Economics, Management and Policy. 2020).

Of all the transshipment activities about 85% account for the Hub-and-Spoke function, the last 15% are intersection and Relay. The Hub-and-Spoke form of transshipment hub was the first developed form of the transshipment, it was developed to service small ports that had poor accessibility. Later other forms of transshipment hub were taken into use. They were taken into use for better connectivity between ports. The transshipment hubs have three dominant locations:

1. Funnel. Strategic passages locations create funnel shipping lines.

2. Corridor. Hubs are located in important shipping lanes that offer the hub to have a low deviation to emerge.
3. Cluster. Hubs are making groups and compete with each other. (The geography of transport systems 2020.)

There are several logistics centres in the region of Southern Finland which are serving the whole country in addition to the closest areas. The central warehouses of retail stores are in Southern Finland and especially located near the Helsinki metropolitan area. Industrial transportations are also handled by those southern centres. The largest ports and Helsinki-Vantaa Airport are also major logistics centres. (Etelä-Suomen keskitetyn logistiikkajärjestemän visio 2018.)

The objective of the INFUTURE project is to develop this kind of a hub to serve the international inland waterway traffic at the Saimaa Canal, while reducing the road traffic in order to decrease emissions and congestions. Practically this means building up an inland port to a place where already exists or where it would be easy to build a rail connection and where there are good connections for the road traffic. In addition, it is good to be able to handle containers in the port. Since the main purpose is to serve international trade, it is the easiest to use containers as a transport unit if the nature of the cargo allows it. (INFUTURE no date.)

Also, the potential of the digitalization should be taken into account. Like Ahonen (2019) states, “Increasing level of digitalization at port operations, usually reduces carbon dioxide emissions at the whole supply chain and improves both occupational safety and the protection of passengers and property”. By utilizing digitalization it is possible to improve the reduction of emissions more comprehensively.

**Gateway**

Gateway acts as a point where freight is interchanged between transport modes. It is also used as a place where the cargo clearance is made. (Cogopoer no

date.) The following figure (3) illustrates the difference between the Gateway and the Hub.

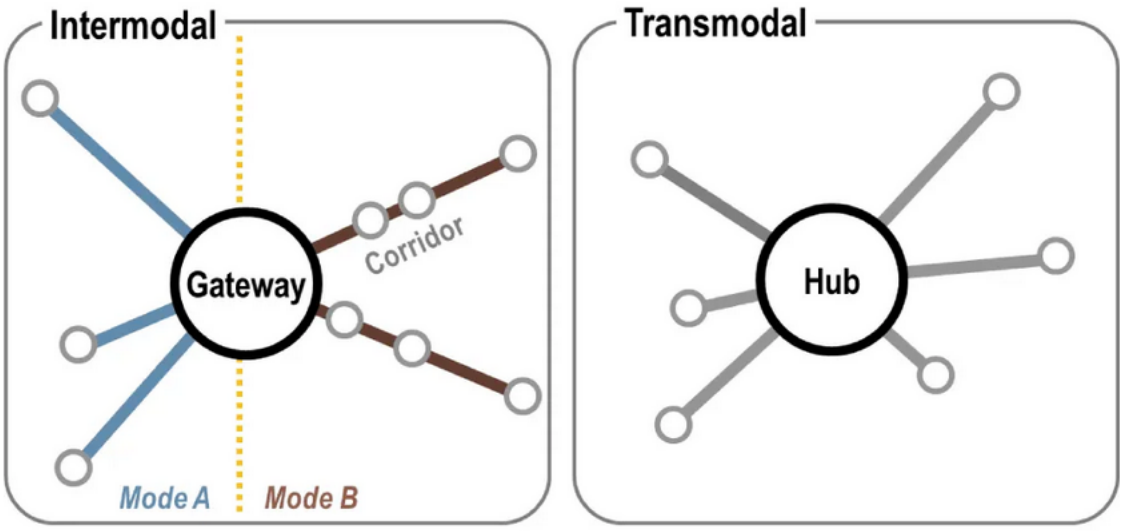


Figure 3. Gateway & Hub (The Geography of Transport Systems. 2020).

The difference between hubs and gateways is the change in the modes of transport. Gateway is the place where different modes meets, called as intermodal. The hub is the place where goods are shifted between the same transport modes, called as transmodal. (The Geography of transport system no date.)

### 4.1 Digitalization

In logistics, the target is to control the material flows from the source of raw material all the way to the end customer in a way that the product is available at the right place at the right time. Logistics answers to the customer needs aiming to minimize costs, quality and safety risks as well as the negative environmental effects of the process. Since the logistics is serving companies´ supply chains and needs, the implementation and development of logistics in the future will be affected by all the factors related to companies´ services and supply chains. Digitalization is a mega trend that affects all industries and people´s lives in many ways. The revolution of digitalization creates huge opportunities for the development and improvement of the effectiveness of logistics. Each transport mode and transporting itself are changing towards of automatization. The costs of

technology investments are decreasing, which is the reason why the use of automation is beginning to be more common than an exception at the logistic centres and even in the smaller terminals and warehouses than earlier. (Pöyskö et al. 2016.)

Digitalization has no simple explanation, instead the concept is quite extensive. Generally digitalization means the integration of technology and intelligent solutions into different business fields as well as people´s everyday lives. (Pöyskö et al. 2016.)

Thanks to the digitalization, in future, all systems can be developed towards self-steering fully autonomic systems where every transport equipment and machines are communicating with each other without human or computer guidance. This allows deleting distractions and with the same time avoiding the wasting of resources. (Stts. No date.)

TS Finland has determined the digitalization in logistics as follows: ”Digitalization of transport means the unravelling the information into bits which allows the saving, organizing and transforming of the information. When this is combined for example mobile technology (i.e. tabloids, social networks, cloud services), it changes the whole industries.” (Pöyskö et al. 2016.)

In the future the digitalization will make logistics more intensive so that becomes more efficient, reliable and information will be in real time. Because of that shipping information will be seen all the time in real time which would make it easy to track shipping. Thanks to this, there will be fewer delays in transportation. If information were in real time the whole time, it would be easy to combine transports into the multimodal transportation. Then transportation would produce less emissions and they would be safer. (Pöyskö et al. 2016.)

### Internet of Things, IoT

The Internet of Things is a system where all the objects and parts of infrastructure are connected to each other via the Internet. In this network, physical objects collect information around them and share it with each other. The collected information can be utilized in various processes. However, IoT requires a lot of time because the current 4G LTE (Long Term Evolution) network does not support the IoT traffic. The objects that would collect information still need to be developed, they must be energy efficient, and they must be able to process the information. (Pöyskö et al. 2016.)

### 5G

5G is the fifth generation mobile network. The first-generation mobile network was 1G, it was just the voice. People could call to each other. 2G allowed to send messages and call. 3G allowed the first time to use data on the phone. 4G was the same as 3G but faster, and 5G is even faster. 5G is not just faster, it also has a very low latency and high-speed connectivity. It is designed to handle very large growth in the connectivity and data. Because 5G can connect billions of devices, it will create IoT ecosystem. (Collela 2017.)

### Sensor networks

The sensors monitor various functions and operating modes, these form a sensor network. The sensor can be used to monitor various activities such as heat, humidity or even speed. The sensors are monitored via the Internet. The information that is collected by sensors is huge, it is called Big Data. (Pöyskö et al. 2016.)

### Big Data

The concept of Big Data usually refers to large amounts of data, which have no systematic nature. The collected data is processed into statistics, using different

methods. Information is obtained from the sensor network and digital devices, companies are also collecting information about customers, its operations and processes. (Pöyskö et al. 2016.)

Big Data – analytics processes a large amount of data into a useful form for the users. It learns from past information and makes predictions based on it. (Pöyskö et al. 2016.)

### 4.2 Port automation and robotization

Digitalization has a strong impact on automation. Because of the development of digital tools, the development and deployment of robots will be faster. (Pöyskö et al. 2016.)

Automation in the waterborne transport is seen for example in remote monitoring and management of ships, and in the automation of engine powers and steering. As automation develops, ships can be automated more. The challenge for the development of automation is a data transmission network in the marine environment. A remote controlled ship equipped with robotics has been estimated to reduce human errors, which will improve the ship safety. Automation can be built on existing vessels or assembled at the ship construction stage. (Pöyskö et al. 2016.)

Automation is increasing fast in the maritime transport and ports. Digitalization in the port environment is seen in various information transmission networks that are used to anticipate ship maintenance and repair activities. A digital infrastructure for the maritime transport is currently being developed to improve the transparency of information. (Pöyskö et al. 2016.)

There is already technology that allows the full automation and remote control of ships. There are ships under development that could move without a crew, those are called unmanned ships. It is estimated that the first unmanned vessels can be put to the test in the next few years. It is estimated that they may become available in the next decade. (Pöyskö et al. 2016.)

Unmanned ships achieve significant savings when crew space is not needed. The new technology may not even cost more than the old, but because it needs control centers, it can increase the costs. (Pöyskö et al. 2016.)

Automation in ports and warehouses is seen in various autonomous transport devices, transfer devices and work machines. At the terminals, containers are unloaded, and loaded with autonomous locks and robotic wagons. Pallets and cages can be handled by various transport robots. Their demand has increased due to the growing e-commerce. Automation aims to the efficient use of space, especially in warehouses, and in ports, it aims to increase the working hours and minimize the labor costs. (Pöyskö et al. 2016.)

At this moment, there are no ports in Finland where fully automation is used. The Finnish ports have small fragmented cargo flows, because of that the automation can be too expensive investment in relation to the profits it would make. It is estimated that as the technology develops, the costs of automation will potentially decrease, and this would make it possible to implement it even in the hubs or ports that have small cargo volumes. (Pöyskö et al. 2016.)

Benefits of automation:
• better for the environment because it is locally carbon emission free
• doesn’t need light, it works with sensors.
• works faster than human, so efficiency is higher
• process-led
• makes work safer by removing people from dangerous areas
• reliable
• creates new jobs. (DP World London Gateway no date.)

In ports, automation can be seen as the use of integrated systems to develop intelligent solutions for the better control of traffic, which increases port capacity and efficiency. Automated ports are called smart ports and they use cloud-based solutions for managing operations flows smoothly. (SHM Shipcare 2018.)

In general, robotization means replacing human physical work with robots. With the help of various industrial, service, care, military or entertainment robots, tasks and services can be automated and produced more flawlessly than with human labor. (Mitä on robotisaatio 2018.)

Robots are machines that are programmed to do some tasks. They are able to do tasks autonomously or semi autonomously. They connect with the physical world via sensors. Their tasks can be changed by programming them. (Owen-Hill 2017.)

### 4.3 Safety

Safety aspects are important in every workplace, and a company is responsible for arranging safe working conditions to its employees whose responsibility is to operate according to the safety instructions. First of all, reasons why one should take care of the safety in a workplace is to operate according to the law. At the logistics centre as well as the transshipment hub, it is related mostly to the work, environment, and fire safety sectors. Safety aspects are also a good motivator, only a few will want to get convicted of a crime because of their work. (Mitä hyötyä organisaatiolle on hyvästä turvallisuuden hallinnasta? 2011.)

Organization’s reputation and image have clear impacts on its business. When those are fine, a company can ask a higher price than its competitors. For example, deficiencies in information security or the rejection of crime costs except money but also in the worst case can destroy a customer relationship. Undelivered shipment can be critical to a customer’s own business and that way also to the supplier. A good reputation is useful when it comes to the competition of the best employees, as no one will want to work in a company where working conditions are poorly. In addition, a great citizen of society often gets free advertising. (Mitä hyötyä organisaatiolle on hyvästä turvallisuuden hallinnasta? 2011.)

Decreasing accidents, sick leaves and property damages creates cost savings and growth, not to mention reducing the number of disability pensioners or avoiding major accidents. Only a small part of the total costs of those can be covered by insurances, so it is more profitable to put efforts at overall safety in a company than to ignore it completely. The importance of work welfare is nowadays understood also by the top management, and it is seen as a key element of profitability and innovatively, and a remarkable factor in the pursuit of the lengthening of careers. (Mitä hyötyä organisaatiolle on hyvästä turvallisuuden hallinnasta? 2011.)

# 5 MULTIMODAL TRANSPORTATIONS

Transport can be called multimodal when more than one transport mode is used under the same transport contract in order to deliver the shipment to its receiver, also the transport unit can be changed if needed. The use of several transport modes increases the cargo handling times when the same shipment is moved from one transport mode to another. By using standardized pallets and containers, the shipment can be packed in the same unit, for example in a container, for the whole journey, and one can decrease the redundant times of cargo handling. When the shipment is packed in the same transport unit during the whole journey and the unit is transferred from one transport mode to another, it is called intermodal transport. Both, the multimodal and intermodal transport require appropriate equipment and machines in addition to an environment that allows the encounter of different transport modes. (Grant et al. 2017, 73 – 74.)

Tapaninen (2019, 44) says it clearly, multimodal transportations are creating extra costs and making the tracking of the transport process more difficult. Also the time of the year where the change of the transport mode is placing may cause extra costs. She notices that especially winters are a challenge for the development of the Finnish inland waterway transportations when our inland waters freeze over. To avoid these extra costs, the transportations are aimed to complete with the same transport mode as much as possible. The third objective affecting the development, according to Tapaninen, is the limits to the maximum sizes for the vessels used in the inland waterway transport caused by the existing

infrastructure. That makes the ship costs relatively high. In the sea traffic the advance compared with the other transportation modes is achieved with the economy of scale, the great total amount of cargo decreases the costs of the transport for the load unit or load ton per every travelled kilometre. (Tapaninen 2019, 72). When developing the inland waterway transportations, the economy of scale is recommended to be taken into consideration.

**The places for multimodal transportation connections**

The Saimaa Canal is part of the traffic network which is about to be developed to cover the whole Europe according to the European Parliament´s and Council's regulations. This traffic network is called a TEN-T network and it will consist of a core network that will be completed by 2030, and a comprehensive network completed by 2050 according to the plans. The objective of the network is to promote the fluent movement of people and goods in Europe. The TEN-T network comprises all modes of traffic as well as the platforms, which make combining of them possible. (Väylä 2019.)

There are nine multimodal core network corridors, of which the Scandinavian – Mediterranean Sea and North Sea – Baltic Sea core corridors are going through the southern Finland, in the TEN-T core network. An Europe level main connection to Russia goes by road through Vaalimaa and by rail through Vainikkala. The water system of the Lake Saimaa, the most significant inland waterway corridor in Finland, is part of the TEN-T core network. By location, the current ports at the Lake Saimaa are at the optimal place, near the TEN-T network that is under development and with a straight waterway to Russia. (Väylä 2019.)

# 6 BENCHMARK

Benchmark is a method where one compares a company´s processes and operations with other companies and their processes. In addition, the company´s own processes can be compared between separate departments. Usually the company or department, where one is supposed to be compared, is working effectively or does something differently and is having a competitive advance

because of that. The main purpose of the benchmark is to collect information about how one could develop one´s own business. (Richards 2011, 243-244.)

For this thesis, we compared different hubs serving inland waterway transport around Europe and collected the best practices and operation models that could be utilized for the transshipment hub serving the future inland waterway transport between Finland and Russia. The hubs that were chosen for the comparison were Port of HaminaKotka, Port of Duisburg, Port of Hamburg, Ports of Stockholm and Port of London.

### 6.1 Port of HaminaKotka

Port of HaminaKotka is located in South-Eastern Finland. It covers six separate harbour parts in the area of Hamina and Kotka cities at the coast of the Gulf of Finland. It is the most eastern port of all Finnish ports, only 70 kilometres from the Russian border. As the largest general port of Finland, it is serving Finland's own import and export businesses, transit traffic and international projects, in addition, Port of HaminaKotka can be seen as an asset also for St Petersburg and Moscow regions. (Satamanosat no date.)

Port of HaminaKotka is Finland's greatest full-service general harbour. It can handle each cargo types such as containers, RoRo, liquid and dry bulk, LoLo, gas, project cargo, international passenger traffic as well as diverse additional services. (Satamanosat no date.)

Into port's 1100 hectares, wide area developed logistics, industry and stevedoring are making Port of HaminaKotka a unique harbour on the Baltic Sea. Connections to the important economic zones of Finland and Russia as well as 15 metre draft are enabling great connections from Port of HaminaKotka to the rest of the world. (Satamanosat no date.)

Port of HaminaKotka in numbers:
Land area: 1 100 ha
Water area: 1 400 ha

Maximum draft: 15,3 metres
Docks: 9 kilometres
Places for vessels: 76
Railway tracks: 80 kilometres
(Satamanosat no date.)

| *Traffic statistics* 10.1.2019 | *December TONS 2019* | *January – December 2019* | *January – December 2018* | *Change %* |
|---|---|---|---|---|
| *Export** | 1 255 412 | 14 253 860 | 11 231 799 | 26,9 % |
| *Import*** | 298 826 | 3 838 352 | 4 935 774 | -22,2% |
| *Total* | 1 554 238 | 18 092 212 | 16 167 573 | 11,9% |
| *Shares of freight transport* | | | | |
| *Transit**** | 338 212 | 4 126 542 | 3 914 585 | 5,4% |
| *Domestic* | 12 349 | 555 015 | 792 317 | -30,0% |
| *Containers (TEU)* | 50 000 | 677 621 | 653 443 | 3,7% |
| *Vessels* | 215 | 3 181 | 2 836 | 12,2% |

* *includes export transit*
** *includes import transit*
*** *includes import & export transit*

Table 1. Traffic statistics 2019 Port of HaminaKotka. (Port of HaminaKotka 2020).

The table 1 includes Port of HaminaKotka's traffic statistics from the year 2019. As one can see from the table, the share of transit transportations is over quarter of the total transportations. In Finland, the transit is mainly freight that is either coming from Russia or going to Russia by truck from a harbour. In August 2020 transit transportations were even higher level than previous year, transit is at high

level, 2 995 721 tons between January 2020 and August 2020, which is 4.9 % growth. (Naski 2020.)

## 6.2 Port of Duisburg

Port of Duisburg is located in Western Germany in the city of Duisburg by the Rhine, which offers a direct connection to the large North Sea ports. There is Europe's largest consumer market in the area, over 30 million consumers over a radius of 150 kilometres. Port of Duisburg, known as well as Duisport, is the world's greatest inland port and Central Europe's leading logistics hub. In a year approximately 20 000 ships and 25 00 trains are handled. The following figure (4) lays an overview of Port of Duisburg. (The logport concept 2020.)

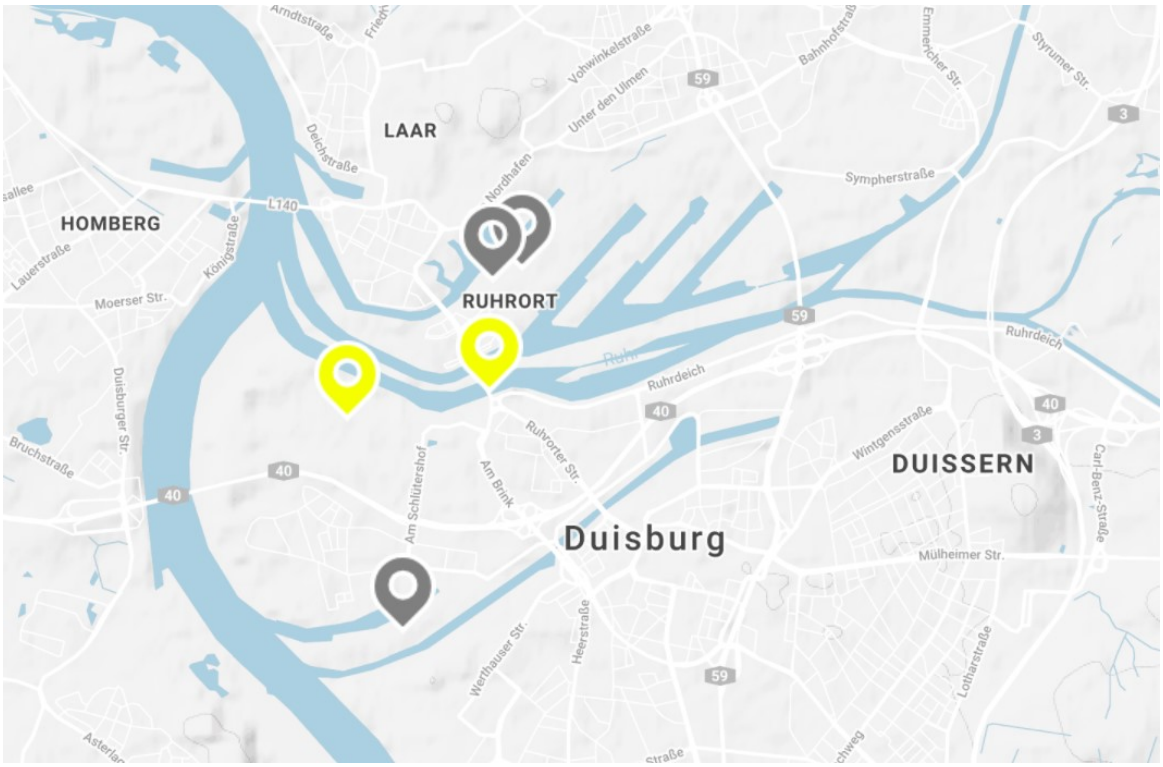


Figure 4. The Port of Duisburg 2020 (Port of Hamburg 2020).

Duisburg – Rheinhausen area had earlier coal and steel industry, the sites were already then, a size of 371 football fields. In 1998, the area of 265 hectares got a makeover when the idea of redeveloping spaces and establishing multimodal logistics centers came in action and the concept of Logport I was getting its shape. The concept brought international logistics providers there and raised Duisport to one of Europe's the most important logistics hubs. The Duisburg

Intermodal Terminal (DIT), the Duisburg Trimodal Terminal (D3T), Duisburg Multi-Purpose Terminal (DKT) and the secondary railway station, which were built up, created the base for Duisport. Those available transport connections and port facilities with high quality were on a key role in convincing logistic companies. Logport has a huge advantage when it comes to location, two rivers Rhein and Ruhr are crossing which offers inland waterway connections across the whole country and all the way to the North Sea. (The logport concept 2020.)

Nowadays about 50 companies have their operations at Logport I, also some of the big players of the logistics field have based their operations in the area. On top of the three intermodal terminals, Logport I covers around 650,000 $m^2$ of warehouse space, which is one reason why Logport I is also a home for several European distribution centres for companies such as Danone Waters, Hewlett Packard, Johnson & Johnson and Siemens. (The logport concept 2020.) In total, there is access to more than 2 million $m^2$ of covered warehouse space, which is used by about 300 companies that have their operations based in the Port of Duisburg. (We are the network 2020.)

Port of Duisburg in numbers:
Port area: 1 500 ha
Warehouse space: 2 million $m^2$
Tank room for liquid goods: 0,6 million $m^3$
Maximum draft: 17,05 m
Port basins: 21
Gantry cranes: 21
Container terminals: 8
Railway tracks: 200 km
(Duisport: Facts and figures 2020).

| | *2019* | *2018* |
|---|---|---|
| *Total cargo handled by all Duisburg ports* | 123.7 Mio. t | 127.5 Mio. t |
| *Total cargo handled by duisport Group* | 61.1 Mio. t | 65.3 Mio. t |
| *Containers* | 4.0 Mio. TEU | 4.1 Mio TEU |

Table 2. Cargo volumes at Port of Duisburg 2019 & 2018. (Duisport 2020).

In the table 2, one can find volumes that were handled at Duisport in 2019 and for the comparison same statistics from 2018. (Duisport: Facts and figures 2020).

Duisburg has a remarkable role in the European river and canal system, from Duisport, there dispatches more than 20 000 inland waterway vessels and about 2 000 shallow draft maritime vessels and its container hub is handling more than 4.1 million TEUs in a year. Duisport offers services for all freight types and it is possible to handle both short sea and inland water vessels there. (Intermodal transport concepts 2020.)

By keeping truck transportations at the minimum, one has a target in sustainability and efficiency, for long distances and high transport capacities rail and ship transportations are mostly used to cover the journey as much as possible. Intermodal transport concepts are providing wide connections from Duisburg to almost every European country and industrial centres. (Intermodal transport concepts 2020.)

The Port of Duisburg connects water, rail and road transport carriers and provides infrastructure for efficient, resource friendly and cost-effective transport chains. Duisport is a trimodal logistics hub and the largest hinterland hub in Europe, it combines a specific location, exquisite site conditions and high level of professional skills. Duisport can be seen as a promoter of innovative logistics, it

was involved in founding “startport” innovation platform together with the partners from industry, with a mission to develop the logistics solutions of tomorrow. Startport helps small start-up companies to start co-operation with bigger companies in order to develop new solutions for logistics operations. Parties that are gaining most benefit from this connected logistics concept are the customers and partners of Duisport. (Company 2020.)

Duisport is putting effort at customer service, market and customer-focused services are related to over 400 weekly combination transport connections to more than 100 direct destinations in Europe and Asia from eight multimodal container terminals in addition to wide range warehousing and storage capacities. The facilities enable the arrangement of different packing services which are offered specially for the machine and equipment builders as a part of integrated freight products and contract logistics solutions. Duisport also offers consultation services regarding port infrastructure and superstructure building and development of logistics centres and hinterland connections. (Company 2020.)

### 6.3 Port of Hamburg

Port of Hamburg is located in the city of Hamburg in Northern Germany, by the Elbe River. It is Germany’s largest seaport and the third largest container port in Europe. In a worldwide comparison of the largest container ports, the Port of Hamburg is reaching 17$^{th}$ place. In 2019 there were handled 136.6 million tons of cargo, including 9.3 million TEU, there is around 8 000 ship calls in a year. Port of Hamburg offers facilities to 290 berths and in total of 43 kilometres of quay for vessels and four container terminals, three cruise terminals and about 50 prospects that are specialized in handling roro and breakbulk and all kinds of bulk cargoes in cooperation with 7 300 logistics companies in the city area. In the following figure (5) one can see the overview of the Port of Hamburg. (Hafen Hamburg Marketing e.V. 2020.)

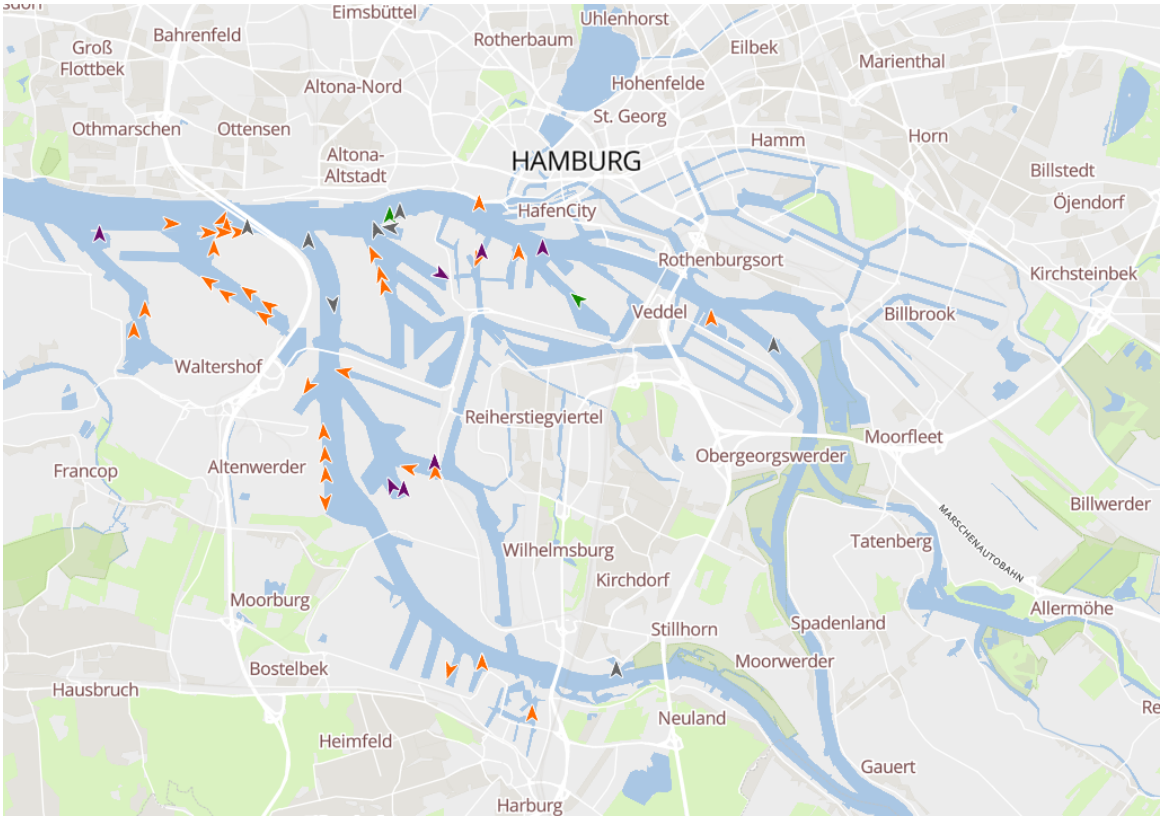


Figure 5. The Port of Hamburg (Port of Hamburg 2020).

As a universal port, the Port of Hamburg offers facilities for handling of each cargo type, even for the reusable waste products and recyclable materials are having their own special terminals. Operations are submitted at the area of 71 $km^2$ with more than 50 handling facilities with state-of-the-art technology and highly qualified personnel in action. The port is able to handle vessels from all size categories, from large containerships and bulk cargo freighters to oil and chemical tankers, ro-ro & break bulk carriers and feeders and inland waterway vessels. (Handling facilities to meet every need 2020.)

Nowadays over 70 percent of all bulk cargoes transported around the world are packed into containers. The Port of Hamburg has an important role of ensuring distribution and cargo flow around the world as Germany's largest and Europe's third largest container port. There are four container terminals that are together enabling handling capacity of 12 million TEU in a year. The real capacity is even higher, because there are several multi-purpose terminals where also are handled container cargo alongside conventional general cargo. Into each

container terminal there are integrated rail terminals, which are strengthening Hamburg's leading position among rail ports in Europe. (Germany's largest container port 2020.)

Cargo types that cannot be transported in containers, e.g. heavy goods, over – sized packing units and cargo on wheels, are handled in a multipurpose terminals, which there are in total seven at the whole port. One of those is specialized for heavy cargo and there it is possible to load and discharge single units of project and plant cargo that are weighing several hundred tons. Several facilities there are specialized to handle different product groups, vehicles, fruit, cocoa and other foodstuffs, for example. (Special equipment at the multi-purpose terminals 2020.)

For the trade, the bulk cargo handling is extremely important, there is handled over 40 million tons of bulk cargo every year in the Port of Hamburg. Most common bulk cargoes are building materials, fertilizer, suction cargo like grain and animal feed, grab cargo like iron ore and coal and liquid goods like mineral oil and chemicals. Bulk cargo handling is performed under roof that ensure safe handling for moisture sensitive goods. Port of Hamburg is a leader in Europe with its silo capacity of a million tons for a suction cargo. For mineral oil and other liquid materials there are numerous companies that are equipped to handle and store them safely. (Bulk cargo terminals ensure supply of raw materials 2020.)

Port of Hamburg is also a remarkable central for cruise shipping. First cruises were despatched on the voyage by Albert Ballin, HAPAG's Director-General, back in the late 19$^{th}$ century. World's first officially classified cruise ship was called the "Prinzessin Victoria Luise", Ballin ordered it from the Hamburg shipyard Blohm & Voss in 1899. Nowadays cruise industry adds value almost 270 million euros per year. (Cradle of cruise shipping 2020.)

### 6.4 Ports of Stockholm

The Ports of Stockholm include ports in Stockholm, Nynäshamn and Kapellskär.

The city of Stockholm and Stockholms Hamn AB are the port authority for the Port of Stockholm. The following figure (6) shows the locations and connections from Stockholm ports to other ports of the Baltic Sea. (Ports of Stockholm no date.)

Figure 6. Location and connections from Stockholm ports (Ports of Stockholm 2020).

Ports of Stockholm have a total 14 km of quays and 1,100,000 $m^2$ of land at its three ports. They also have around 80 buildings that are located close to the ports. (Ports of Stockholm 2017.)

Ports of Stockholm handles RoRo (Ferry traffic), Container, Bulk, International cruises and Archipelago traffic. The central ports are for goods and passengers travelling they are located in Stockholm area which are Stadsgården, Frihamnen and Värtahamnen. Transporting from and to Finland, the Baltic States and Russia. (Business areas 2020.)

Port of Nynäshamn is located 60 km south from Stockholm city. It takes RoRo services to and from Gotland, Poland and Latvia. Ports have for each destination own berth. (About Port of Nynäsham 2020.)

Port of Kapellskär is located 90 km north from Stockholm. It is used to transport goods and passengers to and from Stockholm, Finland, Norway, Russia, Continental Europe and the Baltic States. The port has 5 berths. (About Port of Kapellskär 2020.)

Stockholm Norvik Port is new port that is designed to handle RoRo and containers. It is operated by Hutchison Ports. It was opened in May 2020. It is located 60 km south from Stockholm. Location of container terminal is the nearest to Sweden's largest markets. It is also close to the fairway and because of that it has short steaming time for all important ports in the Baltic Sea. It also has intermodal connections to the rest of Sweden. Container terminal has its own rail connection. (About Stockholm Norvik Port 2020.)

Stockholm Norvik Port in numbers:
Port area: 44 ha (total)
Container terminal: 32 ha
RoRo terminal: 12 ha
Maximum draft: 16,5m
Straddle carriers: 8
Wide cranes: 22
(About Stockholm Norvik Port 2020.)


Figure 7. Partnership between ports (Ports of Stockholm 2020).

Stockholm Norvik Port created a partnership with Mälarhamnar ports of Västerås and Köping. The goods come by sea to Stockholm Norvik Port, and from there they are transported via Lake Mälaren to Mälarhamnar ports. In figure 7 can be seen the waterway connection between ports. This connection offloads the roads and rail networks that are currently heavily congested. (A unique and sustainable transport partnership – inland water ways in the Stockholm region. 2020.)

### 6.5 Port of London

The Port of London is one of the oldest ports in Europe, it has been very important for national and international markets since the Roman Empire. It has enabled trade and the growth of the British economy for centuries. (Berti 2019.)

The Port of London is located along the Thames from Wandsworth in South-West London to the mount of the river. It contains different port operators and processors that are located 95 miles along the River Themes. The Port of London carries 60 % of all goods that are transported in UK's inland waterways. It is the second largest port in the UK. (Port Of London Economic Impact Study 2020.)

The Port of London contains over 70 private terminals and port facilities. In all port handles over 50 million tons of cargo every year that makes it one of the top three ports in the UK.

- The port gives over 35,000 full time jobs
- it adds value to the London and South East economy each year by £3.4 billion
- It takes over 400,000 lorries off the roads each year

In 2019 port handled 18 % more tons than five years earlier in 2014, so the increase was 18%. In 2019, the port handled 54m tons that were 11% of total traffic at UK's ports. Freight traffic from EU has been the largest source of traffic in the port, almost half of the traffic comes from EU. (Port Of London Economic Impact Study 2020.)

**Table 2-1: Composition of freight traffic in the Port of London (2019, million tonnes)**

| | Inwards traffic | | | | Outwards traffic | | | |
|---|---|---|---|---|---|---|---|---|
| | 2014 | 2019 | Change | % change | 2014 | 2019 | Change | % change |
| Liquid bulk | 12.5 | 14.4 | 1.9 | 15% | 0.3 | 0.2 | -0.1 | -46% |
| Dry bulk | 11.1 | 13.6 | 2.5 | 22% | 1.6 | 1.6 | -0.0 | -3% |
| Lo-Lo | 6.4 | 9.4 | 3.0 | 47% | 2.7 | 5.6 | 2.9 | 107% |
| Ro-Ro | 5.8 | 5.7 | -0.1 | -1% | 2 | 1.9 | -0.1 | -4% |
| Other general cargo | 1.7 | 1.4 | -0.3 | -21% | 0.4 | 0.4 | -0.0 | -9% |
| Total | 37.5 | 44.5 | 7.0 | 19% | 7 | 9.6 | 2.6 | 37% |

*Source: PLA*

Figure 8. The Port of London statistics 2020 (SQW 2020).

The figure (8) includes Port of London traffic statistics from the years 2019 and 2014. As one can see there has been increased in inwards Lo-Lo (Lift-on Lift-off) traffic by 47%. This is explained by berth capacity at London Gateway. (Port Of London Economic Impact Study 2020).

In 2014 London Gateway handled 271, 00 TEU, it was its first full year of operations. In 2015 it handled 469,000 TEU, in 2016 TEU was 708,000 TEU and in 2017 TEU was 954,000. In 2018, London Gateway broke through 1 million

TEU when they reached 1.3 million TEU. Right now, the port capacity of handling is 2.4 million TEU. In the future it is planned to expand port facility that would increase port capacity to 3.5 million TEU. (UK Port – The comprehensive guide to the UK's Ports 2020.)

Port of London handles many different units: containers, unit loads, dry and liquid bulk, hazardous cargoes, oil products, project cargo, forest products and passenger's traffic. (London 2020.)

The largest single category of cargo that is handled at the Port of London is oil products. But the cargo is not the only thing that is transported in The Thames. There is also passenger traffic. Every year around 10 million journeys are made in The Thames. (Port Of London Economic Impact Study 2020.)

## Port of London Authority

The Port of London Authority (PLA) was created because of the chaos and congestion. There was chaos because of Rival wharfs, river and docs users battled for business. PLA mission was to bring order. (A Brief History of the PLA 2020.)

The Port of London Authority (PLA) is self-funding public trust that was established by the Port of London Act of 1908 to govern the Port of London. Which result was that all the separate dock companies come under the organization of the PLA. Before that, all docs were controlled by separate companies. (Port of London Authority 2018.)

The Port of London usage is largely governed by The Port of London Authority (PLA). It works to keep commercial and leisure users safe and protect. PLA also enhance the environment and promote the use of the river for trade and travel. The Port of London Authority (PLA) provides pilotage, navigational and many other services for ships that use the Port of London. (Port of London Authority 2020.)

## London Gateway

London Gateway Port is one part of Port of London. It is automated deep-sea container port, which has been developed by DP Word. It is located on the north bank of the River Thames in Essex. Construction of the Port was started in 2010 and Port started operating in 2013. (ShipTechnology no date.)

The Port is linked to more than 110 ports in over 60 different countries around the world. It is handling the world's biggest vessels. (DP World London Gateway 2018.)

The Port has area of 175ha. Its berth is 17m depth that makes it possible to receive the cargo vessel that can handle up to 18,000teu. The Port has the latest Navis SPARCS N4 terminal operating system (TOS). The system has automated container handling equipment that are used for automating the processes at the main gate, container yard and at the rail terminal. The port has the latest facilities for safety, cost-efficiency and timesaving. The facilities are included a lot of automation systems. (ShipTechnology no date.)

The Port is one of the most integrated logistics hubs in UK's. It has its own international rail terminal and logistics park. Port is located the nearby London, just 28 miles away, and nearby highway M25 only 10 miles away. That makes it accessible hub for import and export. It also has the biggest logistics park in Europe, which makes every operation more flexible. (DP World London Gateway no date.)

The logistics park has area of 227 ha. Approximately the area of 86 ha is used to B8 warehousing. That area is used by retailers such as Lidl, Ups and CMA CGM. The park includes also building, rail terminal, truck parking space, roadways, service corridors and sustainable urban drainage system (SUDS). (ShipTechnology no date.)

London gateway in numbers:

Port area: 175ha (Port terminal) and 227ha (The logistics park)

Maximum draft: 17m

Docks: 3

Quay cranes: 12

Shuttle carriers: 40

Stacking cranes: 60

Container terminals: 1

Railway terminal: 775m. (DP World London Gateway na date.)

## 7 RESEARCH AND ANALYZING METHODS

The research method chosen for the thesis was qualitative research. In addition to the already existing literature and online materials, information was collected via semi-structured interviews and benchmark.

Qualitative research aims to understand the phenomenon, which is unknown or there is no earlier information available considering the phenomenon, by the help of questions. Those questions are not detailed because the main objective of qualitative research is to find new information and not to study already known phenomenon. (Kananen 2014, 16 – 17.)

Qualitative research means research that one wants to find answers without statistic method or other numeric means. There is used words and sentences, and the goal is to describe, understand and interpret the phenomenon.
Typical features of qualitative research are:

- Research is completed in real environment
- Information is gathered in the interaction with the ones to be examined
- The material is collected by a researcher who is in active role
- The material is collected from several sources such as literature, figures and interviews, for the study
- The analysis of the material is inductive, interactive and recursive
- The perspective, significance and opinion of the subjects are taken into account
- The objective of the research is to achieve good understanding of the phenomenon that it is investigating

(Kananen 2014, 18 – 19.)

## 7.1 Semi-structured interview

The purpose of a semi-structured interview is to get an insight into the phenomenon being studied by discussing related topics with the interviewee. Semi-structured interview proceeds with the interviewee by one theme at a time and delves deeper through more specific questions into more detailed issues. Themes chosen in advance the interviewer can ensure that the interview stays at the topic and each theme are considered properly. (Kananen 2014, 76 – 77.)

In order to choose the right themes into the interview, the researcher must have a preconception considering the phenomenon that is under investigation. The chosen themes have to be versatile enough that with those help an understanding of the phenomenon will be obtained. There must be drawn up a theme body to the semi-structured interview, this helps to ensure the clear proceeding of the interview and handling of each subject. (Kananen 2017, 50 – 52.)

Semi-structured interview can be arranged also as internet interview or by phone. It is important to create interaction between interviewer and interviewee. Parties doesn’t have to meet face to face, but the interview can be carried out by utilizing the possibilities offered by the internet, for instance as Skype-call. That facilitates the arranging of the interviews particularly with interviewees who are living more distant. Semi-structured interview is possible to arrange also by an e-mail, in that case it is not enough that the questions are sent to the interviewee, but in order to get more exact understanding there must be several rounds in the interview. Then the interviewer has to ask the detailed questions in a new e-mail message, which in normal situation are asked in the face to face interaction. For that reason, e-mail interview is slower method than normal face to face or the online interview. (Kananen 2017, 52 – 53.)

## 7.2 Analyzing method

Qualitative analysis consists of two stages, the reduction of observations and solving of the riddle (Alasuutari 39). In the simplifying of observations two different parts can be separated. First of all, the material is always examined only from a certain theoretical-methodological perspective. When examining the material, attention is paid only to what is essential from the point of view of a theoretical frame of reference and different framing of a question even though in the same study the material can be examined from many perspectives. In this way, the text mass or image materials being analyzed is simplified to a slightly more manageable number of discrete “raw observations”. The idea of the second stage of simplifying is to reduce the number of observations further by combining them. Separate raw observations are combined into one observation or at the very least, into fewer groups of observations. This is achieved by looking for a common feature or denominator of the observations or a formative rule that applies in all directions without exception to the whole material. In such a combination of observations, the starting point is the idea that the material is thought to consist examples of the same phenomenon. (Alasuutari 40.)

By looking for the common features, the connecting of observations does not mean that the objective of the simplifying, which belongs to a qualitative analysis, would be to define type cases or type individuals. Instead in a qualitative analysis even one exception overturns the rule, it shows that the matter must be thought about again. The observation produced by connecting observations must hold true without exception to all the raw observations; the material cannot include warring cases against the simplified observation sentence. Often this leads to the changes of a theoretical frame of reference or a point of view of the study. (Alasuutari 42.)

The observations that have been simplified in the solving of the riddle are explained by referring those to study and to theoretical frame of reference. Individual references to the material also are used as clues of the doing of significance interpretations in a qualitative study in addition to the macro observations that have been produced with the simplifying of raw observations. In

them an individual case can be described in more detailed way or for example, speech quotations can be used which can give a good interpretation tip or illustrate the interpretation. (Alasuutari 52.)

### 7.3 Implementation of the study

The research was conducted by theme interviews which were arranged via Microsoft Teams application. Interview requests were sent by an email to five European ports which have functional systems for multimodality and some of which are related to inland waterway transportation. In total three contacts from Port of HaminaKotka, Oy Saimaa Terminals Ab and Port of London Authority participated in the interview. Two contacts from Ports of Stockholm and Port of Duisburg weren't participating.

The first interview was held on 30 October 2020 via Microsoft Teams with Mr. Martin Garside, Public Affairs Manager from Port of London Authority. The second interview was held on 4 November 2020 via Microsoft Teams with Mr. Ville Kuitunen, Sales Manager from Port of HaminaKotka. Third interview was conducted via an email, questions were sent to Mr. Hannu Kaipainen, Director, Service Production from Oy Saimaa Terminals Ab. The questions were sent also to a contact person in Stockholm Ports, but unfortunately, they didn't have time to answer those.

The interviews were saved and the material was transcribed to a written form from the recordings. The observations and analysis were done from the written interview material. Other part of the study was conducted by an international benchmark. Information for the benchmark was searched from the home pages and annual reports of the selected ports.

The semi-structured interview was chosen as an information collection method because it enables an interviewee a free word under a specific theme and the influence of an interviewer does not affect on the answers that much. Another reason was that semi-structured interview gives more space for opinions and wider answers than the exact questions of some specific matter. The

implementation via Microsoft Teams enabled the interaction between interviewers and interviewees and it also enabled interviews with European ports.
The interview questions (seen at Appendix 1) were built around the themes of the thesis topic and the basis was to find answers to the research questions that were:

- What would be the optimal model for a transshipment hub in inland waterway traffic?
- What kind of factors have an influence on the operation of the transshipment hub?

Draft questions were sent to the commissioner for approval, after that those were finalized, and interviews started. The themes of the questions were inland waterway transportations, transshipment hub concept and multimodal transportations. In addition, there were two extra questions about digitalization and cooperation between ports.

The inland waterway transportation theme included four (4) questions.
The target was to clarify important factors when opening new transport connections, inland waterway transportations effects on the environment, its problems and future prospects.

The transshipment hub concept theme included eight (8) questions, which aimed to define the optimal model of the transshipment hub. With the help of the questions one searched factors that effect on hub's effectivity, which services would be reasonable to offer and which kind of arrangements there is good to have.

The multimodal transportation theme included five (5) questions, those were related to the facing of different transport modes, improvement of effectivity, advantages and disadvantages as well as future prospects.

By two (2) extra questions one wanted to find out the effect of digitalization on the earlier themes as well as find out if there is any cooperation between ports and transshipment hubs. At the end of an interview there was a possibility to have a free word regarding to the interview themes.

Observations were collected from the interview materials, which were combined in order to find similarities and draw the conclusions of which are best practices and operating models that are reasonable to implement. The material obtained from the interviews was examined from the perspective of the theory used in this study.

## 8 RESULTS

From the questions regarding the inland waterway transportation theme, there were several things that showed up in the interview with Mr. Garside from Port of London Authority. In London, the land area for the port facilities is very expensive and hard to find because of the high population of the metropolitan city, public planning and legal processes that can take years. Investments in the cargo handling technology and other facility related matters are dependable on the port operator and already existing road and railway links are worth to be utilized as much as possible. Several bridges goes across the river Thames, which are constraining the vessel sizes. There are two main cargo types that are transported via Thames River, project logistics and waste materials. The big sized construction materials and other oversized cargoes are transported by barges along the river, which prevents traffic congestions in the city. Energy efficiency is better in the waterway transportations, and environmental effects such as noise and air pollution are smaller than in the road transportations. In the Thames there is tide water that creates natural renewable energy flow in total of four knots. Despite the need for new equipment, the future is seen as very positive. In London the inland waterway is the main way to transport waste materials and it is in an important role in project logistics and reducing to freight transport away from the city streets and that is the key factor why inland waterway transportations will be needed in London also in future.

The transshipment hub concept theme created a great conversation with Mr. Garside. According to his opinion, the targeted consumer market locations are defining the optimal location for the transshipment hub. At River Thames it is possible to have a port terminal in London area, near building sites and industry

because of wharf safeguarding that prevents selling of working wharf's for property use. As an example of the transshipment hub, he described London Gateway, a large modern warehouse at the deep sea container port with great connections to the railway and road networks of the United Kingdom as well as other European ports. The main theme that came up in the discussion related to the hub's efficiency was the capacity of rail and road networks. In London there are huge problems with the adequacy of transport capacity, which has an impact on the terminals' efficiency as well. The bottlenecks of the terminal area are mainly caused by the road and railway traffic, at the river there isn't container traffic, yet, but huge volumes of project logistics and waste material transportations and those are going smoothly because the river is big and wide enough. The modern warehouse system is important in order to unload and re-load the cargo easily to the next transport mode. For smaller customers, the warehouse services are important. At London Gateway the main market area is central London and that's why the customer service operations are mainly moving cargo to the terminal where it is unloaded into smaller pallets for onward transport performed by lorries. For smaller customers, the freight integrator service could create economic benefits by smaller transportation and road costs.

Multimodal transportations at London Gateway and Tilbury are performed in a way that containers are unloaded from ship to a container park, from where some leave quickly by lorry and others are unpacked in the nearby warehouse into smaller units for distribution. In the Tilbury warehouse area the connections to other transport modes are strong. Multimodal connections are available to the road network with a good connection to M25 motorway, three railway links to the main rail line connection across the United Kingdom, and the inland waterway connection by the River Thames. The flexibility is the most significant benefit of the multimodal transportation, if there are problems with capacity it gives options for the implementation of the transport, also, it offers the maximum flexibility for the customer's point of view and the environmental benefits are visible if one really switch of from roads to waterways and rails. The future potential of the multimodal transportation is depending on good connections and the development maintenance of those.

In addition to the main themes, there were two extra questions, one related to the digitalization and the other related to the cooperation between ports and transshipment hubs. According to Mr. Garside the digitalization is having a strong impact already on logistics and he underlined the importance of the modern warehousing systems as a part of fluent and effective transshipment hub operations. The cooperation between the ports in the UK is rather limited because of the fact that they are commercial rivals.

An interview with Port of HaminaKotka was implemented with Mr. Ville Kuituinen. The first theme of the interview was based on the inland waterway transport. According to Mr. Kuitunen, when opening a new water connection, existing routes must be taken into account, as the construction of new ones is very expensive, and it is difficult to get a permission, and even if a permission is obtained, it can take many years. Existing connections, such as rail and road connections, must also be taken into account. Also, before opening a new connection, one should take into consideration who might be the customers, because the location must be right for them. Building a new fairway has always an environmental impact, so it is important to think carefully about where to build and if it possible to use the existing infrastructure, because human activities never benefit the nature. The inland waterway transport is more environmentally friendly than many other modes of transport because the ship transports larger volumes of goods. The inland waterway transport will benefit the surrounding areas as employment increases in the area, as well as increasing tax revenues. In addition, as a new player enters the area, it can act as a magnet for other players. The biggest problem of the inland waterway transport in Finland is the freezing of water during the wintertime, which stops the ship traffic. In addition, because the canals are small, it is difficult to use an icebreaker in fairways. There is a lot of potential in the inland waterway transport in Finland, because there is a lot of water area there that needs to be developed. The problem is the expensive constructions of fairways. In terms of the climate change, they would be a good option.

The second theme was about the transshipment hub. According to Mr. Kuitunen, the hub should be located close to the canal, because good transport

connections are affecting the hub efficiency. Other factors affecting the efficiency were the ship sizes that should be large enough and cargo handling capacity. The efficiency can also be increased by keeping the fairways open in the wintertime. Problems with the hub can include fairway sizes as well as a large difference in the freight volume and actual freight capacity. In the conversation of hub's most important features came up that hub responds to market needs, as well as its versatility in terms of customers.

The Freight Integrator service was not so familiar to Mr. Kuitunen because, according to him, it is not so common an operation in their port. The service would be good for the small flows of goods that Freight Forwarders could provide. Cargo types could be even bulk and containers. For large ports as HaminaKotka, this kind of service would not work properly because the volumes of a single shipment are large.

The third theme was multimodal transport. In the port of HaminaKotka, multimodal transports meet, for example, when goods are unloaded into a warehouse after arriving at the port, after that they are reloaded to another ship, or when goods are loaded directly from a ship onto a truck. The multimodal transport increases the flexibility in the supply chain and enables shipments to small ports. When the goods are moved on top of the truck, it allows access anywhere geographically. The problem is that the multimodal transport increases the cost of transport, not always but for the most part, in some cases they even save money. According to Kuitunen, the future potential of the multimodal transport is good if it is placed right.

Finally, we had two extra questions about the digitalization and cooperation between ports. Mr. Kuitunen explained to us that 5G which is in use in the port is not 5G, actually it is like “4,5G”. He said that in Finland none of the ports have 5G. When 5G will be in use in port it would create possibility to use the autonomous robots and remote control of them. He thought that it would take some time, because there aren’t even apps for 5G. Mr. Kuitunen said that there are much more important things to do before 5G, like make shipping more

efficient and reduce the impact on the environment. There is also a problem that every human has a different vision about digitalization and how it is supposed to integrate in use. The potential is big, because the fast network will create many new possibilities.

Finnish ports are commercial competitors, but that doesn't affect on access to assistance. Ports have good spirit they can always ask help from each other. But help can't effect on business. The ports employees meet sometimes, and digitalization helps to stay in touch.

The interview of Oy Saimaa Terminals Ab was implemented with Mr. Hannu Kaipainen, who is Director of Service Production. From the inland waterway theme factors that came up, were when opening the new inland waterway connection, it requires regular traffic, sufficient volume and that the customers are committed to a possible reduction in cargo volumes, etc. There are many benefits when the cargo is transferred from a rubber wheel to waterborne transport, it is environmentally friendly e.g. it improves fuel efficiency and reduces a need for road maintenance and repairs. Kaipainen's opinion was that rubber wheels and rail transport will increasingly serve as feeder traffic to inland ports. There are also some problems in the inland waterway transport that came up in interview, the problems are mainly related to the fragmented transportation of large customers. Cargo quantities are suitable for road transport and the requisites of ships are not sufficient to collect cargo from warehouses. Customers take small batches and do not accept large quantities but drive the car to the place of consumption one at a time. The current situation in the inland waterway transportation is that it is growing and, in the future e.g. environmental values will guide cargo to shipping.

According to Mr. Kaipainen, the efficient operation of the transshipment hub concept depends entirely on the container shipping companies. If the container depot operation could start in inland, the transshipment hub operation could work. So far, shipping companies have not started depot operations and are not nominating their containers elsewhere than in seaports due to low transport

volumes. Almost all import containers are returned to seaports. Without regular container traffic, setting up a transshipment hub at inland is not worthwhile because every stopover and loading costs money. Mr. Kaipainen named the duration of the shipments, scheduling and product safety as the three most important factors that ensure the efficient operations of the transshipment hub. He stated that one must be able to offer all logistics services from the beginning of packaging and labeling to the customers.

Freight integrator service has been implemented in the Saimaa area already. According to Mr. Kaipainen, general cargoes are loaded for aggregate cargo e.g. from the Saimaa area and those have had 2-3 customers' cargoes. The service is provided on behalf of the port operator whenever shipments are negotiated with customers, but the small volume of cargo is a problem. If customers undertook to pay for a dead cargo, even if the ship is not full and the load of a shipper is insufficient, for example due to a market disruption or a problem in production. A port operator (or freight forwarder) who arranges the cargo and buys it from the shipping company and then sells the space of the ship to the customer, cannot take the dead cargo for payment. Commitment on this from the customer’ side is therefore important. In conventional (LO LO) transports, the ship itself also limits the integration of different cargo compositions, i.e. it is not possible to load bulk cargo and e.g. paper or cardboard or some other easily contaminated cargo on the same ship. In seaports and RO RO transports it is easier to combine cargoes.

In the Saimaa terminal area, the multimodal transportation is seen in three transport modes that meet at the port, and in that respect they complement the transport chain. According to Mr. Kaipainen, the multimodal transportations always cost but for most part it is necessary. The benefit comes from the fact that consignments can be transported to a port warehouse, for example, as the consignments are completed and the suppliers have their own warehouses for production use, and the suppliers receive the service from door to the customer’s warehouse from one operator. The disadvantage is many different treatments for the same consignment, which can cause damage to the goods. The opinion of

Mr. Kaipainen is that the multimodal transportation is good and definitely necessary in the future as well.

# 9 CONCLUSIONS

The objective of this thesis was to identify the optimal model for the international inland waterway transshipment hub. The answers to the research questions obtained on the basis of the international benchmark and semi-structured interviews followed the issues raised in the theoretical part. The research questions were:

- What would be the optimal model for a transshipment hub in the inland waterway traffic?
- What kind of factors have an influence on the operations of the transshipment hub?

Based on the study, one can state that it is worthwhile to invest in fairways in the inland waterway transport. The size of the fairway must be large enough to have a sufficient capacity in relation to the freight volumes, in many places the problem is the size of the fairway, which leads to the situation where the fairway is congested and the goods cannot pass through, in which case those also does not pass through the transshipment hub. It is expensive to build entirely new routes, as well as to make alterations to the existing ones, so the necessary changes must be planned carefully in order to cope with as few alterations as possible and to save capital.

From the inland waterways, there must also be good connections to other modes of transport. Due to the variation of the Finnish seasons alone, there must be an alternative plan for the continuation of the traffic if some mode of transport cannot be utilized. The inland waterway transport in particular is affected by winter when inland waters and coastal areas freeze. Onward transport as train and road transport is necessary in Finland and cooperation with these operators is profitable.

When opening an inland waterway transport, it is important to define carefully the potential customers and not to rely too much on one customer group. Opening an

inland waterway transport requires capital, so it is important to be sure of the continuity of the demand before major investments are made. One of the key factors in ensuring the continuity of the demand is diversity.

The environmental benefits of the inland waterway transport are coming from the transport performance, the economy of scale leads to lower emissions from the transport of a single product, as more cargo can be transported at once. High volumes of the inland waterway and rail transport reduce the need for the road transport, which reduces the road traffic noise, vibration and air pollution. This is reflected as a positive phenomenon, especially in the urban areas and near the settlements.

Regarding the social benefits, there can be seen new jobs created as a result of the opening of new traffic and the tax revenues that come with it, the new port acts as a magnet and attracts new companies to the area. Finland has a lot of potential to increase the volume of the inland waterway transport.

The factors to be considered when setting up a transshipment hub include location selection, traffic connections, capacity decisions, traffic arrangements of the hub area, cargo handling, onward transportation, range of services, target markets and marketing.

The optimal location of the transshipment hub is close to the Saimaa Canal and the targeted markets. It is important that the location is also good from the customer’s point of view, efficiency increases when the traffic connections are open even in the winter, and the hub is easily accessible by various modes throughout the year. It is above all economically sensible to make the most of the existing transport connections. However, the traffic connections must be of sufficient quality in order to attract customers. There is about to begin the improvement works at the Saimaa Canal, which will improve the capacity of the canal. When developing a new hub, the capacity of the canal must be taken into account. The capacity must be sufficient and compatible with each other in the hub, waterway and road transport. If the capacity of the transport connections is

not sufficient to cover the volume of the cargo flowing through the transshipment hub, the goods will not move forward and accumulate in the hub.

The transport arrangements of the transshipment hub must be designed so that the arrival and departure of cargo are smooth. There should be good signage in the area, to make it difficult to get lost, and get the goods to the right place quickly and effortlessly. The infrastructure inside and outside the hub must also be designed to be safe so that accidents do not occur. For security reasons, the area should also be under control to prevent outsiders from entering.

The operator is needed for the transshipment hub so it can operate and handle cargo. The choice of operator affects the choice of cargo handling systems and equipment investments. Different types of cargo require different handling equipment and smooth operation also requires functional ERP systems, e.g. inventory management and tracking of shipments. The real need for automation must be carefully considered, because if the volumes are not going to be very large, it is not worth wasting capital on expensive automation.

The efficient operation of the Hub is affected by the quality and capacity of onward transports. For the onward transport, the hub must have good transport links nearby, such as a rail and a highway. There must also be good cooperation with transport companies, when cooperation plays, goods moves quickly and smoothly. If thinking onward there must be a sufficient number of goods to be transported, but not too much to fit on board. The quality of transport must be closely monitored so that the goods arrive at the customer unbroken and on time. In Finland, weather conditions must always be taken into account, as they affect the unloading time, track usability and speed limits.

From a customer service perspective, versatility and flexibility are the key factors. Hub operations can enable the transportation of different sizes of shipments between ports, by combining and separating small and large consignments into suitable entities, which is called consolidation. Today, companies need to be able to offer a wide range of services and at the same time specialize in something.

However, not everything can be done, so outsourcing some services is worth considering. It is profitable to offer at least short term warehousing services and consolidation of the shipments among loading and unloading services to one's customers. Customer research needs to be done carefully so that a suitable range of services can be put together. The interviews emphasized that it is not worth setting up the entire operation by relying on one customer group, and it is important to constantly market your own operations and acquire new customers.

Multimodal transportations enable the efficient and flexible flow of goods to the world. In order the flow of goods to be smooth, it must be well designed so that the different modes of transport meet each other as fluently as possible. According to the information received from the benchmark, there where the various modes of transport that meet smoothly of which result are an efficient port. For multimodal transport to be efficient, transport must be regular, which also increases the environmental benefits of shifting freight flows away from road traffic and reduces congestion on the road.

## 10 DISCUSSION

The objectives of the study were achieved thanks to the information obtained from the benchmark and the semi-structured interviews although the number of participants in the interviews was lower than originally intended. Eventually, the representatives from three ports participated in the interview, with the rest either refused or did not answer anything. The reason for this is certainly the long interview, which included three themes as well as 2 additional questions. The answers to the questions should have been written by hand or attended an interview through Teams. The quality of the three interviews conducted was very good, each one of them knew a lot of things although not everything could be answered exactly. However, the results can be considered reliable, as the material obtained from the interviews corresponds to the issues discussed in the theoretical part and to the good practices that emerged from the benchmark.

We assume that we did not receive answers to the questions that were sent by e-mail precisely because of the length of the interview and because the questions

were open ended, so it would have taken some time to answer them. Fortunately, in the interviews that were conducted through Teams we were able to explain and open up the questions if ambiguities emerged.

During the thesis, we got a lot of information about the operations of the Saimaa Canal, as well as about the operations of inland ports, which things should be efficient and functional, and how some areas can only be developed by adding new connections between the ports.

The results of the inland waterway transport in this work are in line with the previous thesis results: they would be a profitable and environmentally desirable mode of transport, but their utilization rate is relatively low. There are a few previous works on the transshipment hub concept, so some new information was gathered. We believe that this work will be useful for both the commissioner and others interested about the topic. A further research subject for this thesis could be the preparation of the transshipment hub's traffic plan, the mapping of the current state of the Saimaa Canal freight traffic and current customers, and the study of future potential or potential new uses for the Finnish inland waterway network.

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Appendix 1

# Semi-structured interview body

## Inland waterway transportations

1. When starting a new connection, what should be taken into account?
2. Which are the benefits for the environment and the neighboring area of using IWT?
3. What kind of problems there are in inland waterway transportations in your area?
4. What is the current state of inland waterway transportation and how do you see the future potential for it?

## Transshipment hub concept

1. Which would be the optimal location for the Transshipment hub? Which international connections are meeting there?
2. What factors can improve the efficiency of the Transshipment hub to your mind?
    a. Which would be the three most important matters?
3. Which are the bottlenecks and/or the problem areas of the terminal area?
4. When the freight comes from the inland area to the port area, what is special in traffic organization in your port?
5. Which are the most important qualities of the Transshipment hub?
    a. What services should be available for its customers?

One way to boost inland waterway transport is the Freight Integrator service. Many small and medium-sized enterprises have similar needs for freight transport, but this service has not yet been organized.
Questions:

- how to get companies to use the common integrator service?
- are there already known types of cargo that could be combined with this service?
- would such a service make hinterland connections to major ports more efficient? (Hinterland cargo chain development)

## Multimodal transportations

1. How do different transport modes meet each other?
2. How to make multimodal transports as effective as possible?
3. Transshipment, how do you think it effects on the profitability?
4. What are the benefits of multimodal transportation? Disadvantages?
5. Do you see future potential of multimodal transportation?

Extra questions:

1. Digitalization, which kind of effects are still expected?
2. Cooperation between ports and /or transshipment hubs, opinions?

Free word.

# Teemahaastattelu

## Sisävesikuljetukset

1. Mitä pitäisi ottaa huomioon, kun lähdetään avaamaan uutta liikenneyhteyttä?
2. Mitä hyötyä ympäristölle ja lähialueille on sisävesikuljetusten käytöstä?
3. Millaisia ongelmia sisävesikuljetuksissa on teidän alueellanne?
4. Mikä on tämänhetkinen sisävesikuljetusten tilanne ja millaisena näet sen potentiaalin tulevaisuudessa?

## Transshipment hub -konsepti

1. Mikä olisi mielestäsi paras sijainti Transshipment hub:lle? Mitkä kansainväliset yhteydet tarjoavat kuljetusmuodot kohtaisivat siellä?
2. Mitkä asiat mielestäsi voisivat parantaa hub: in tehokkuutta?
    a. Mitkä olisivat kolme tärkeintä tekijää?
3. Mitkä ovat mielestäsi terminaalialueen pullonkaulat / ongelmakohdat?
4. Rahdin saapuminen satamaan sisämaasta, mitä erityistä liikenteen ohjauksessa teidän satamassanne on?
5. Transshipment Hub:in tärkeimmät ominaisuudet?
    a. Mitä palveluita sen pitää pystyä tarjoamaan asiakkaille?

Yksi tapa vilkastuttaa sisävesikuljetuksia on Freight Integrator -palvelu. Monilla pienillä ja keskisuurilla yrityksillä on samanlaisia tarpeita tavarakuljetuksille, mutta kyseistä palvelua ei vielä ole organisoitu.

Kysymykset:
- miten yritykset saataisiin käyttämään yhteistä integraattoripalvelua?
- onko jo tiedossa lastityyppejä, jotka voitaisiin yhdistää tähän palveluun?
- tekisikö tällainen palvelu isojen satamien takamaayhteydet tehokkaammiksi? (Hinterland cargo chain development)

## Multimodaalikuljetukset

1. Miten eri liikennemuodot kohtaavat toisensa satamassanne?
2. Miten multimodaalikuljetukset saadaan mahdollisimman tehokkaiksi?
3. Jälleenlastaus, miten se vaikuttaa mielestäsi kannattavuuteen?
4. Mitkä ovat multimodaalikuljetusten hyödyt? Entä haitat?
5. Näetkö multimodaalikuljetuksissa tulevaisuuden potentiaalia?

Lisäkysymykset:

1. Digitalisaatio, millaisia vaikutuksia vielä odotetaan tulevan?
2. Satamien/ transshipment hubien välinen yhteistyö, mielipiteitä?

Vapaa sana.