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Transshipment Hub Concept: Report on the study.

"INFUTURE" Project

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INFUTURE

CONTENTS

INTRODUCTION

The purpose of this report is to understand the needs of inland waterway transport and to find out if there is a working transshipment hub model that would serve inland waterway traffic in Finland and the Saimaa Canal in effective way. The challenge was to identify the most efficient ways to handle cargo for this aim. The research questions were also concentrated at finding answers to the question of what would be the optimal model of a transshipment hub in inland waterways and what factors would influence the operation of such a hub.

In order to achieve a better understanding of the transshipment hub phenomenon the literature research method was applied.

Company semi-structured interviews were conducted to compile a description of the factors that guide the choice of mode of transport and what measures would make it easier for potential companies to make use of inland waterway transport. The interviews would help to make recommendations on technical solutions for ships and waterways, from the point of view of environmental safety and economic viability. We have started to focus on gathering information about existing hubs and the benefits they provide.

An international benchmarking method was also applied. The test was done by examining different ports' experience and facts related to inland waterway transport. The aim was to learn more about the best practices for port operations. The aim of the semi-structured interviews was to gain a deeper understanding of the Finnish industry representatives, and their demands. There were a number of interviewed port operators and ship owner companies' representatives in order to get better understanding of actual problems, and to notice their needs and requirements, too. Interviews were also conducted with representatives of the ports of Stockholm and Vyborg to get a better understanding of water system solutions similar to Finnish ones.

PART 1. Transshipment in the world of transport networks

Transshipment plays a vital role in the global supply chain today, allowing cargo to reach different parts of the world. The growth of global trade makes transshipment hub activity a noticeable trend of modern transport networks. Major transshipment ports are Shanghai, Shenzhen, Busan and Hong Kong. The Port of Singapore is the world's busiest transshipment hub, accounting for almost one-seventh of the world's total container transshipment volumes. European ports, such as Antwerp and Hamburg, can show effectiveness as a transshipment hub model.

Transshipment is the act of shipping goods to an intermediate destination prior to reaching their ultimate end-use. Jean-Paul Rodrigue, a professor at American University, has made a meaningful work on transport systems: "The Geography of Transport Systems". He explains transshipment as the transfer of goods from one carrier to another and/or from one mode to the other. Most open-study sources and reviewed literature examples use definitions, pictures, diagrams and findings based on the material in this book. (Rodrigue 2015)

Transshipment was initially developed to service smaller ports unable to accommodate large container ships, which is commonly due to limited draught and port infrastructure. Later maritime networks became more complex and specialised transshipment centres emerged. The goods can be transferred from ship to railway transport mode, or small shipments can be gathered to a large one. Before shipping to customers, goods can be stored in the warehouse. Transshipment requires significant space to store containers and cargo for a few days while waiting for the connecting ships.

The main objective of shipment is to minimise total transportation costs. The growth in global trade has involved greater quantities of containers in circulation, which has incited maritime shipping companies to rely more on transshipment hubs to connect different regions of the world. In 2012, the share of transshipment reached 28% of all the TEUs handled by ports around the world, double what it was 20 years earlier. (Rodrigue, 2020)

Geography plays an important role in shaping the shipping routes and the main transshipment centres are often located at the crossroads of shipping routes and where there is a channel. The main sea route passes through Panama, the Strait of Malacca, the Strait of Suez and Gibraltar. This route is especially used for Asia–Middle East–Europe trade.

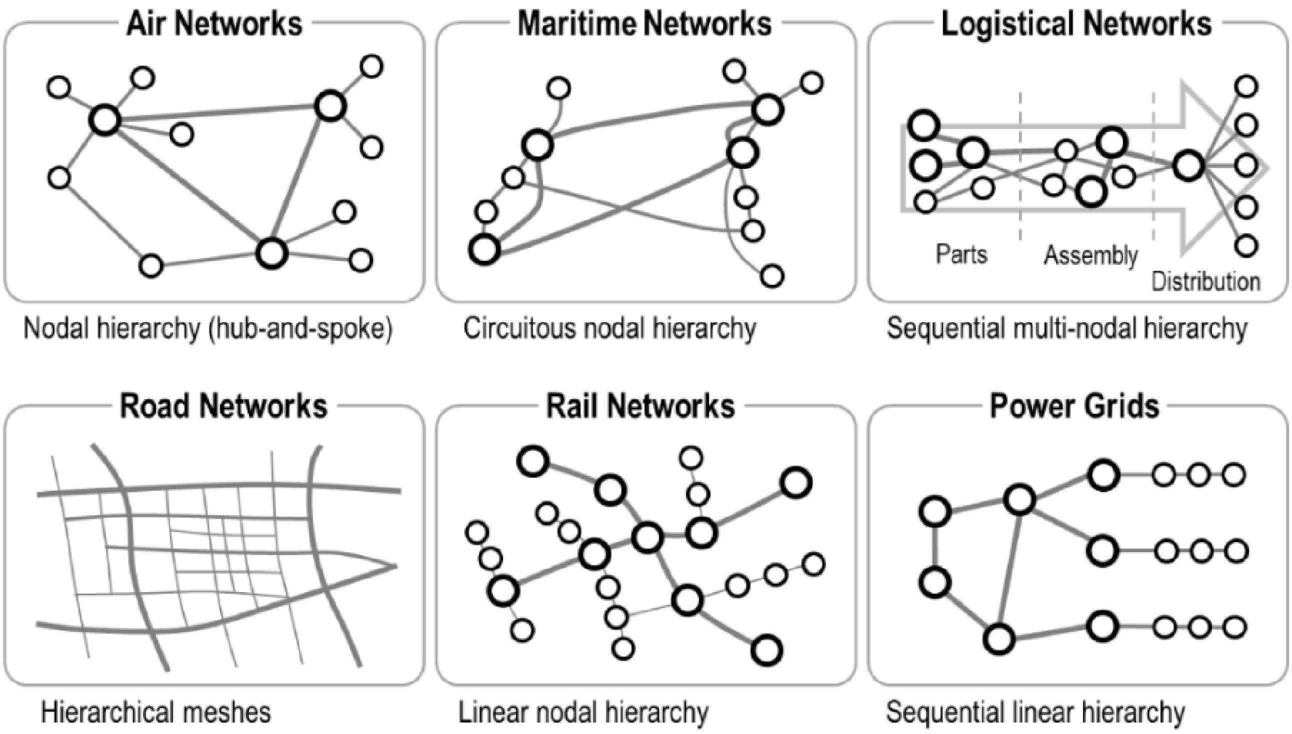
1.1 Transportation networks configuration by Dr. Rodrigue J-P

In "The Geography of Transport Systems", Dr. Rodrigue pays main attention to the spatial organisation of transportation and mobility.

The territorial structure of any region corresponds to a network of all its economic interactions. The term network refers to the framework of routes within a system of locations, identified as nodes. A route is a single link between two nodes that are part of a larger network. That can refer to tangible routes such as roads and rail, or less tangible routes such as air and sea corridors.

A transport network denotes either a permanent track (e.g. roads, rail, canals) or a scheduled service (e.g. airline, public transit, train). It can be extended to cover various types of links between points along which mobility can take place. The relevance of a network is related to its connectivity. Metcalfe's law states that the value of a network is proportional to the square of connected nodes so that complex networks are exponentially more valuable than simple networks since they offer a large number of options in connecting locations.

Roads and railways are composed of track infrastructure while maritime and air transports remain vaguely defined due to their higher spatial flexibility. Depending on the mode they represent, transportation networks have different configurations:



Picture 1.Types of Transportation Networks, Jean-Paul Rodrigue (2020)

- **Air networks**. This is a nodal hierarchy often organised around a hub-and-spoke structure, underlining that nodes (airports) are the core elements of air networks. The importance of a node is usually related to the passengers and freight traffic it handles and the level of linking to other nodes. There is a hierarchy of flows ranging from regional (short distance feeders) to international.
- **Maritime networks**. Such networks represent a nodal hierarchy, meaning that services are usually arranged in a sequence of nodes (ports) with internetworking services that return to the port of origin. While point-to-point services reflect bulk shipping, container shipping is organised between deep sea and feeder services, with transshipment hubs acting as the centre.
- **Logistical networks**. Such networks are a hierarchy of several nodes with separate networks within networks. A typical logistics sequence is organised along three stages – raw materials and parts, manufacturing, and distribution – each supported by a specific network, for example, manufacturing network, distribution network.
- **Road networks**. Such networks are hierarchical meshes, each serving a different scale. They have fixed paths with known capacity but no nodes. While a highway system is designed to connect a nation or a large region, local streets are only connecting activities to a wider framework.

- **Rail networks**. Such networks are a linear nodal hierarchy with nodes related to intermodal yards, train and transit stations. Because of the fixed character of their paths and capacity, they are allocated usage windows during which grouped units circulate.
- **Power grids**. Such networks have a linear hierarchy where the main nodes are power generation facilities from which electricity is distributed across high voltage transmission lines to stations for regional distribution. These substations transform electricity from high to low voltage, which is distributed to facilities for final use. Very close to the final consumer, transformers may further reduce the voltage to safer levels**. (**J.-P. Rodrigue (2020)

Here J-P. Rodrigue considered transport structures that are linked with transportation networks with key elements such as nodes, links, flows, hubs or corridors.

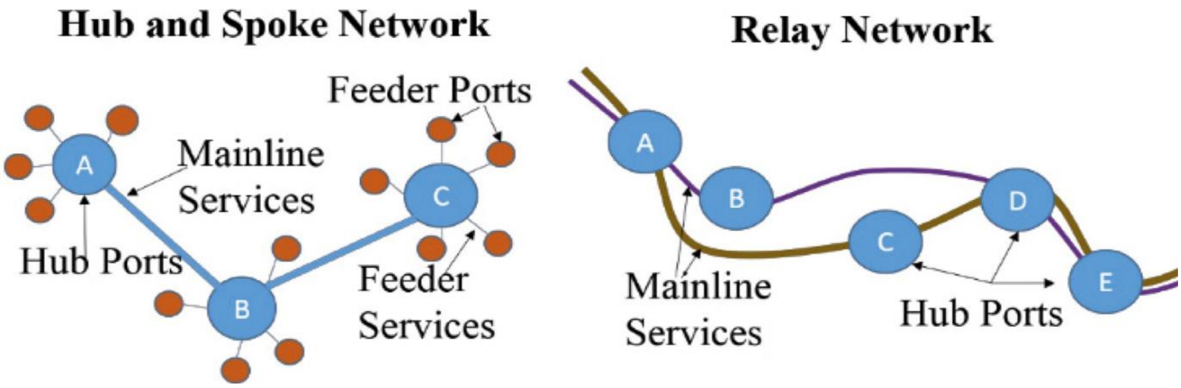
1.2 The place of transshipment hubs in a waterway transportation network

Despite the Hub and Spoke model being typical for air transport, this form of organisation route is applicable to other forms of transportation as well:

- Feeder ships on sea transport shipping containers from different ports to a central container terminal to be loaded onto larger vessels.
- Freight rail transport in which cargo is hauled to a central exchange terminal. Intermodal freight is often loaded from one mode to another at central hubs.
- Public transit uses various transport hubs to allow passengers to transfer between different lines.

In shipping transport Transshipment Hub means the port of intermediate destination of cargo. It means a port which is employed by a carrier for transshipping its carriers from one transportation line to another. (How to export, import, 2019)

Using a transshipment hub enables linking ports to the global maritime shipping system considering existing ship assets. The main idea is to improve the overall efficiency of the shipping network. Practically, all transshipments are the same from an operational standpoint, moving containers and cargoes from one ship to another using a port as a temporary site.



Picture 2 Hub and Spoke and Relay Networks. (Kavirathna .C.A 2018)

The insertion of a transshipment hub within existing networks takes three major forms:

These forms of transshipment hubs are serving different purposes. The first form is **hub-and-spoke** transshipment, which connects short-distance feeder lines and ports with long-distance deep-sea lines, linking regional and global shipping networks. The transshipment hub is usually a central location commanding access to a region. Ship capacity differs significantly between deep sea and feeder services. While the former usually involves the largest ships technically possible, feeder vessels are usually much smaller.(Picture 2)

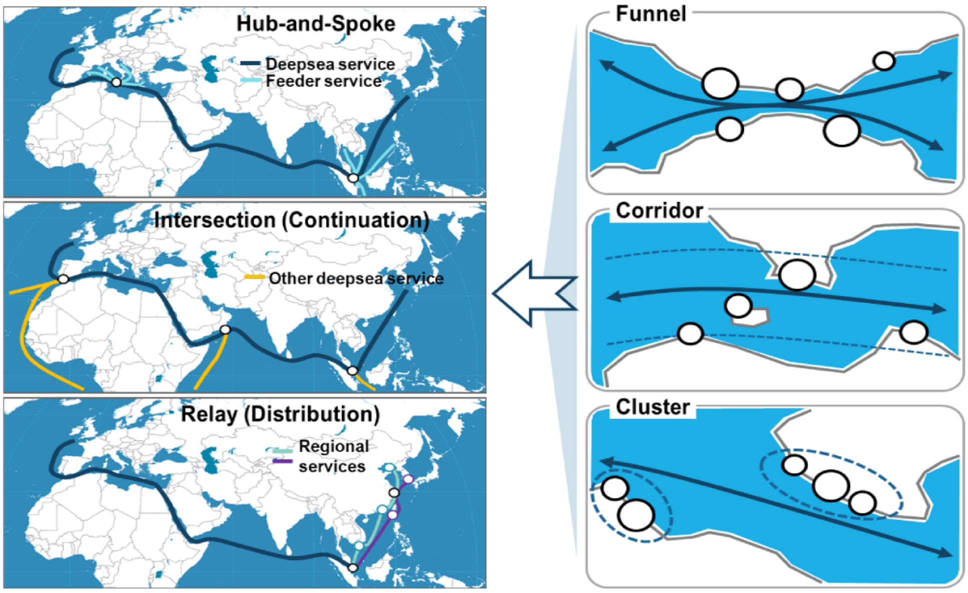
The second form is called **intersection** transshipment, where the transshipment hub acts as a point of interchange between several long-distance shipping routes. It usually involves the movement of cargo between large ships since deep-sea routes are prone to economies of scale.

The third form involves **relay** transshipment where the transshipment hub connects shipping routes along the same region, but serving different port calls. Ship capacity can differ since regional routes can be serviced by smaller ships. (Rodrigue 2015)

In all three cases a deep-sea vessel discharges containers in the transshipment terminal which 1–3 days later is picked up by a smaller container ship (feeder) or another large deep-sea vessel (relay and interlining). Prof. Dr. Notteboom T. estimates that 85% of the global transshipment market is connected to hub-and-spoke operations and 15% to relay/interlining.(State of European port system 2014)

Transshipment was initially developed to service smaller ports that had poor nautical accessibility (sites unable to accommodate larger container ships) or limited infrastructure, which led to the setting of hub-and-spoke networks. At a later stage, intersection and relay forms of transshipment were introduced, enabling different connectivity levels within global maritime shipping networks. Intermediate hubs tend to have three dominant locations:

- **Funnel**. Locations such as strategic passages create a funnel effect for shipping lanes, making them attractive for transshipment because of network convergence.
- **Corridor**. Important shipping lanes offer the opportunity for a hub having a low deviation to emerge.
- **Cluster**. Transshipment hubs tend to cluster and compete with each other.



Picture 3 Insertion and location of transshipment hubs (The Geography of Transport Systems 2020.)

1.3 Containers in the transport system

Containerisation has changed the world. Previously ships would hold multiply smaller loads all jumbled together into a cargo hold. Now the sorting of cargo into containers is done before the cargo is loaded. It brings great efficiency to the loading process.

The developments of containerisation and intermodal transportation are different and mutually inclusive ways of development, but they both rely on driving forces linked with technology, infrastructures and management. At the same time, container and intermodal transport are interrelated. (Rodrigue J-P 2020). Container terminals are hubs of intermodal transport. This means that containers change the mode of transport from a sea or inland water vessel to rail or road, moving overland.

The TEU (Twenty-foot Equivalent Unit) is the standard measure for containerised traffic. Transshipment points for container transport are an important part of the functioning and competitiveness of global logistics systems.

There is a range of advantages of using container shipping. Here are the main ones:

1 Fast transportation at low cost.

2 High cargo security during transport with low energy consumption.

When all the goods are loaded into the shipping container, it is sealed completely.

3 Container shipping is advantageous when it comes to transporting goods. The minimum weight it can transport is one tonne regardless of the kind of good you would like to ship. (K.Adams 2020)

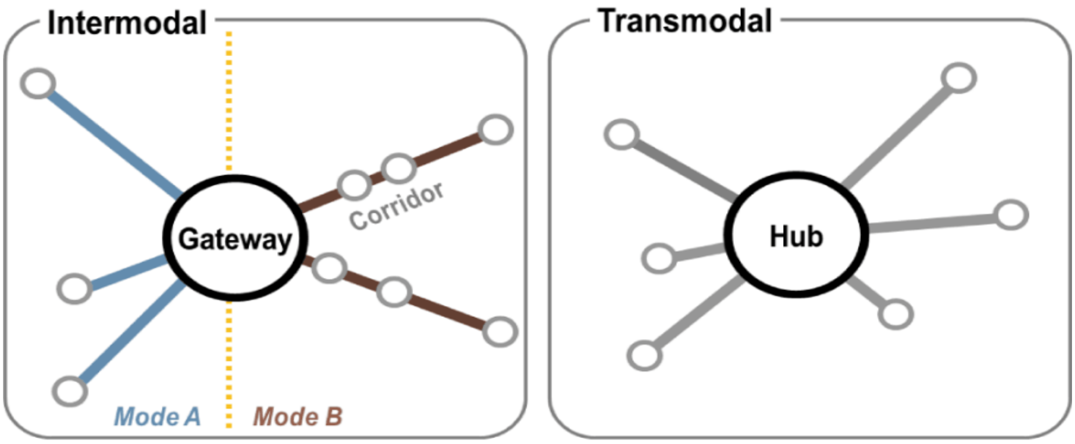
Though the benefits of containerisation are abundant and undisputable, containerisation brings in its wake a host of many logistical problems. Containers are good for stuffing cargo inside and delivering the cargo safely to its destination, but what do you do with the empty containers if there is no corresponding cargo to fill up the container for the return leg. Such empty container movement could cost USD 2,000 or more per box for it to be shipped from one port to another. In addition, empty containers may travel thousands of kilometres overland for repositioning. The cost of repositioning empties could even exceed that of a new container. Also the handling of laden containers requires lifting equipment of at least 35-ton capacity, something that is not available in small ports. (Larry Lam, Adam Iskounen 2010)

1.4 Multimodality: gateways and hubs

Multimodal transport is a combination of two or more modes of transportation of goods, such as air, road, rail, or sea, also called combined transport. Gateways and hubs are locations where global connection of cargo flows meet and have many connections. Global cargo flows are handled by centres labelled as gateways and hubs, depending on their geographical and modal context.

Gateway. A location offering accessibility to a large system of circulation of freight and passengers. Gateways use the advantage of a favourable location such as highway junctions, the confluence of rivers, a good port site, and have been the object of a significant accumulation of transport infrastructures such as terminals and their links.

Hub. A central point for the collection, sorting, transshipment and distribution of goods for an area. This concept comes from a term used in air transport for passengers as well as for freight and describes collection and distribution through a single point such as the "Hub and Spoke" concept.



Picture 4 Gateways and Hubs (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 of transport meet, termed as intermodal. Gateway implies a shift from one mode to the other. The hub is the place where goods are shifted between the same transport modes, termed as transmodal. A hub has a central location in a transport system with many inbound and outbound connections of the same mode.

The understanding of the forms of interaction within such hubs will help to make transshipment hub model be based on reality and possibilities, demands and potential.

The improvement and development of multimodal transport have directly influenced the development of hub ports. The hub approach becomes more favourable with the increase of cargo volumes and vessel sizes. Cargo from the origin is loaded onto a vessel irrespective of cargo destination and then transported to the "central hub". In the hub, all of the cargo is reloaded to different destinations, segregated and consolidated, so that cargo for each destination point is reloaded on separate feeder vessels. The hub approach is the ideal logistic concept to achieve cost-effective transport. (Multimodal transport in the function of the port system containerisation development 2012)

1.5 Transshipment hubs on sea transport

Hub Port is an area of activity with the function of being a hub for goods transshipment and a gateway for economic and manufacturing sectors through the connection of inland transport systems and ship feeder systems.

Hub Port is built on a large scale. Included in it is a system of multiple wharves, shore cranes and rear cargo storage areas. These jetties usually have a specification of about 400m in length. The draught depth is greater than 14m and the crane for loading and unloading onshore has a lifting capacity of over 40 tonnes and a reach of more than 40m.

The basic criteria that make up Hub Port include:

1. Location
   In order to be able to build and constitute Hub Port, it is very important to select and locate the right location. So what position is considered appropriate for Hub Port. These are the areas along the main shipping routes and are surrounded by many large industrial zones. In addition, the port must also be located in areas with a deep water level, over 14m. When these requirements are met, the new port can accommodate mother ships with a tonnage of 100,000 DWT.
2. Free-trade area
   In addition to meeting the aforementioned location requirements, the Hub Port must establish free-trade zones. This will contribute to attracting cargo flows from surrounding countries to focus on Hub Port. That is the reason why the transit time is shortened, increasing the rotation of goods to the port.
3. Port charges
   For Hub Port, the port rates, as well as the cost of handling services in the port area, must always be attractive, transparent and specific.
4. Additional utility services
   In Hub Port, the wharves are designed so that mother ships can be accommodated (mother ships are ships with a weight of over 80,000–100,000 DWT and a capacity of over 8,000 TEU). The mother ships will carry out the work of loading and unloading.

In Hub Port, the following services are indispensable:

- Telecommunication services.
- Ship repair service.
- Providing water, fuel and crew members.
- Customs support at the port throughout the operation.

5. Capacity
   Hub Port must be fully equipped with modern equipment to coordinate operations within the port reasonably. In addition, there are needs for application of information technology to the optimal management of port operations and container information stored on the yards.

The construction and use of Hub Port will bring the following specific benefits:

1. Create the ability to take advantage of scale

Using a Hub Port can create the ability to take advantage of scale because then it is possible to maximise the size of ships between the two hubs. Meanwhile, it ensures no wastage of ship space when transporting goods to the surrounding small ports, because a port has been replaced by a feeder.

2. Minimise the level of complexity

Without Hub Port, feeder ports must work directly with feeder ports on other continents. Now that there is a Hub Port, each feeder only exists for transactions with a few entrepôt ports concentrated in each region.

3. Shorten the rotation and storage times of goods

Why using a Hub Port can create the ability to take advantage of scale. That is because when it is possible to maximise the size of ships between the two hubs. Meanwhile, it ensures no wastage of ship space when transporting goods to the surrounding small ports, because it has been replaced by a feeder.

1.6 European inland ports: transportation and changing functions

Many factors contribute to the establishment of logistics in some ports of transshipment hubs. It is clear that hubs such as Singapore and Panama occupy places of strategic importance in world shipping, providing them with a very high level of connectivity. The Singapore or Panama hubs are located close to regional markets, which is an important fact from a cost-effectiveness point of view.

Europe's network of inland waterways links the maritime ports with nearly all of its economic centres. This should provide a lot of opportunities for cost-effective and sustainable IWT hinterland transport solutions to inland hubs as part of global and regional supply chains. (Slack B. 2015)

In 2011, the European Commission published the White Paper on Transport. Its purpose is to show the paths towards a competitive and resource-efficient transport system (European Commission, 10.3.2019). The importance in the development of the AGN network is the connection between short-sea shipping and the inland waterways. (White paper 2011)

An inland port is a cargo terminal located inland that is connected to one or more seaports via some transport corridors. An inland port can take some functions in container circling, which could include stowage of empties, stuffing, un-stuffing, freight consolidation, customs inspection and clearance, container repairs, etc.

Other valuable functions of inland ports are:

- Empty container storage. Approximately 20% of worldwide marine container traffic consists of empty moves (Lam, Iskounen, 2010). In many ports, laden containers are delivered to consignees, and the empty containers returned straight away to the port, only to be trucked out again for stuffing with export cargo. Inland ports can certainly eliminate such costly empty moves by providing convenient location for storage and exchange.

- Containerisation of bulk commodities in inland ports can be offered to seaports. Inland ports can play an important role in helping the seaports they serve achieve a balanced trade.

The inland ports play a main role in the multimodal transport chains as they provide transfer points to other modes and are connected with logistics centres, industrial areas, agricultural areas or large consumer markets. Especially the links, preferably as short as possible to minimise last-mile transport by truck, with the economic and industrial activities are important elements in the inland ports planning process. We can conclude that the roles of inland ports are fundamentally changing and the following roles that inland ports can play are identified, some of which can be combined:

•Multimodal hub on the Transport Corridors:

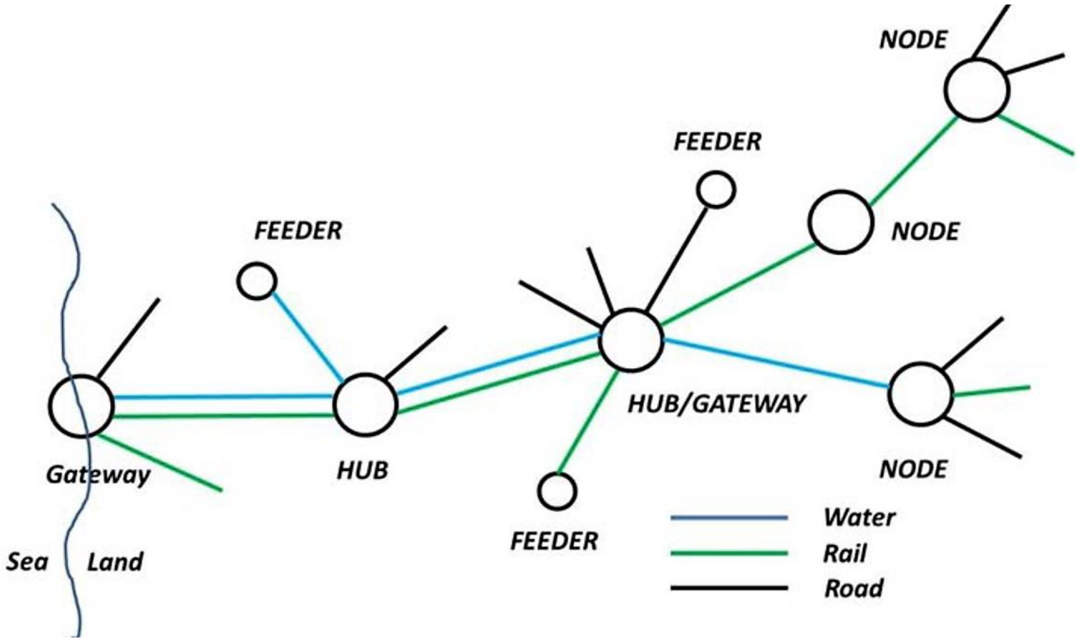
- Interface between the maritime and land modes of transport (rail, road and inland waterways transport).
- Extended gates of the major seaports.

•Platform for the regional economy

•Interface between long distance transport and local logistics:

- Sustainable city logistics and use of small waterways
- Cargo bundling, innovation and smart solutions (IWT- good practice manual 2015)

Inland ports fit within a regional economic geography by linking a region to global supply chains. Firstly, inland ports represent the terminal itself, notably in terms of volume, capacity and performance. The second feature is logistics activities around the inland terminal, often by means of a geographic clustering of logistics companies. The third side of inland ports represents an array of retailing and manufacturing activities in the hinterland where inputs or outputs are handled or managed by the logistics activities.



Picture 5.The various roles of inland ports in a multimodal corridor (IWT- good practice manual, 2015)

The picture describes possible combinations of modes for inland ports. Water transport meets rail and road transport in Hubs and Gateways for transhipping and achieving better results and effectiveness in providing safe and environmentally-friendly solutions in mobility.

The same like in sea hubs in Saimaa region it is important to determining a suitable location for a Transshipment Hub. It is a critical element of the terminal establishment process, a decision on which the functionality of the entire intermodal freight distribution chain depends. The 2015 research “Inland Intermodal Terminals Location Criteria Evaluation” points out the main criteria in location evaluation.

First, these should be identified: flexibility, safety and security, reliability, time, and accessibility of location. Next, environmental criteria should be evaluated: goods flows, spatial, technical–technological and organisational.

However, traffic characteristics have an impact on the selection of terminal location. A good position and connection to the European traffic corridor network is essential for a terminal’s success. Considered from the regional economic point of view, a Hub on a traffic corridor has development priority. Intermodal terminals of European significance ensure international access to the entire European intermodal network of high performances.

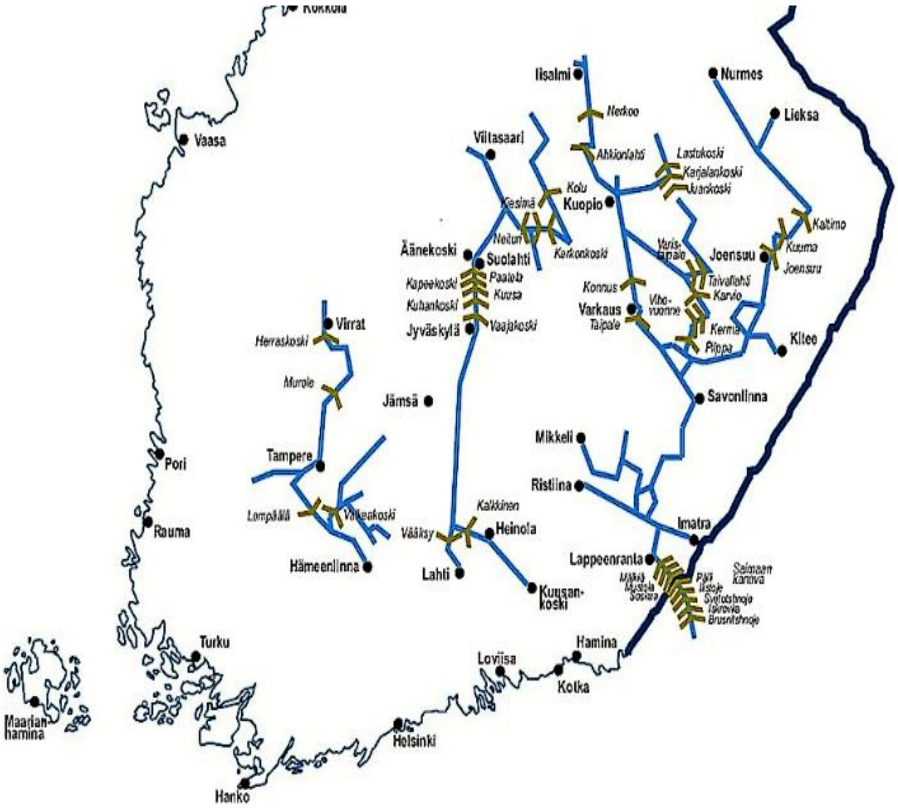
This paper is going to study the characteristics of existing in the project area ports and compare them for deciding on suitable locations for Transshipment Hub transformation.

PART 2. Inland Waterway transport in Finland

The network of fairways in Finland consists of coastal fairways, inland waterways, and canals. The total length of the fairway network covers approximately 16,000 km, of which coastal fairways account for 8,200 km and inland waterways for 7,800 km. Inland waterways connect many lakes, the largest of them being Suur-Saimaa. Shipping can start from distant Kuopio or Joensuu, flows through Saimaa to Lappeenranta, and continues along the Saimaa canal deep-water routes to Vyborg and the Gulf of Finland

Inland waterway traffic in Finland is concentrated in the Saimaa region. Saimaa inland waterways can be reached only by passing through the Saimaa Canal area as this is the only part of Finland with inland waterway goods transport. The Saimaa Canal is Finland's only inland waterway to the Gulf of Finland and the Baltic Sea, in addition to which there is a connection to the Russian river network all the way to the Volga.

The current alignment of the Saimaa Canal was opened to traffic in 1968. The length of the canal is 42.9 km, of which 23.3 km is on the Finnish side and 19.6 km on the Russian side. The Finnish state has leased the canal area on the side of the Russian Federation with a lease agreement until 2062.



The Saimaa Canal enables foreign traffic and merchant shipping on Saimaa. The canal has a total of 8 locks and 6 fixed bridges. The height difference between the sea and Lake Saimaa is about 76 metres.

Picture 6. Locations of canals and locks of inland waterways of Finland (Finnish Transport Agency 2019)

The maximum size of ships that are allowed to operate on the Saimaa Canal:

- Length: 82.5 m
- Beam (width): 12.6 m
- Draught: 4.35 m
- Height of mast: 24.5 m

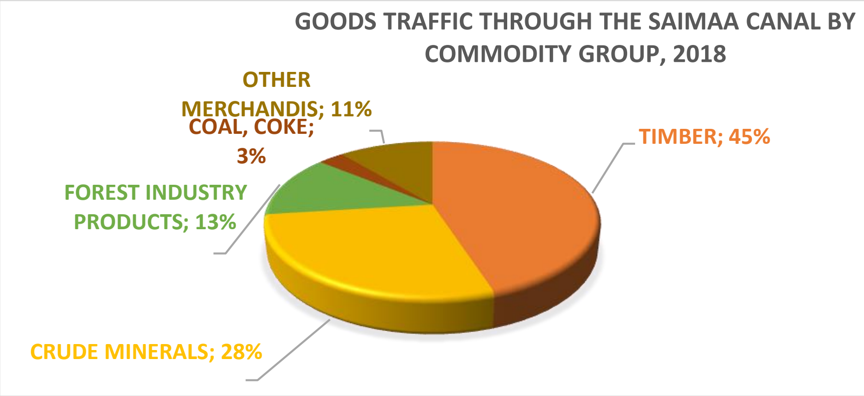
This canal allows seagoing ships that operate in the Saimaa waterways to transport goods to the whole of Europe, including Russia, and sometimes quite far into the hinterland (France, Germany the UK), without transshipment.

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

2.1 Volume of transport through the Saimaa Canal

Based on the national Portnet system, the Finnish Transport and Communications Agency reported that freight traffic in 2018 was 1.30 million tonnes of freight traffic on the Saimaa Canal. International traffic amounted to 1.23 million tonnes, domestic 0.07 million tonnes.

In 2020, a total of 2,148 tonnes of transport was registered through the Saimaa Canal in domestic traffic.



Picture 7. Goods traffic through the Saimaa Canal by commodity group (Finnish Transport Agency 2019)

In 2020, a total of about 2.5 million tonnes of cargo moved in Saimaa, including floating. In 2019, a total of about 110,000 passengers travelled on passenger ships during the season. (Finnish Transport Agency 2019)

Timber (93%) and raw minerals (70%) are mostly imported goods while forest industry products are mostly exported (99%). Coal and coke, chemical products and other goods are imported while fertilisers and metals are exported to Finland. Domestic transport consists of the transport of coal and coke. Timber is mostly imported from Russia and Estonia.

The Netherlands has a lot of cargo flows for both the export and import of raw minerals and cement. Most fertilisers are exported to Sweden, Germany and Denmark. The majority of the forest industry's shipments are exported to the Netherlands, Germany, Poland, France and the UK. The Russian Federation is one of the main trading partners with a long history of partnership in international trade, waterway transport collaboration and cross-border projects. (Thematic report, 2020)

Passenger traffic on passenger ships is the most important part of river-sea passenger traffic in Finland (almost 16,500 passengers in 2018). In 2018, about 2,290 passengers passed through the Saimaa Canal in pleasure boats.

2.3 Infrastructure and fleet of the Saimaa region

There is a total of eight locks on the canal: the upper three locks in the Finnish part of the canal and the lower five locks situated on the Russian side of the border.

In the next few years, significant projects for the development of inland waterway transport will be the extension of the Saimaa Canal closures and the raising of the canal water surface, which will allow larger vessels to use the canal and offer a workable solution to develop waterway transport.

Inland navigation can handle large volumes of cargo. Containers in inland vessels have more than sufficient compatibility and help to avoid traffic congestion.

The deepest fairways in the inland waterways are the Saimaa Canal and the Saimaa deep-water channels, where the maximum authorised draught is 4.35 m. The fairways are long and they have many narrow and winding sections.

Most ships sail through the Saimaa Canal under Dutch (31%), Antiguan and Barbudan (23%) flags, also under Finnish (8%), Cypriot (4%) or other (6%) flags. There is a big share of ships with Russian flags (28%) in the canal (Finnish Transport Agency 2019)

In the frames of this project, this tradition continues and the common goal gives different ways to enhance trade relations. Possible ways could be the fleet renovation decisions, IWT norms, rules and initiatives to simplify legislating documents, and mutual activity on the Transshipment Hub Concept development.

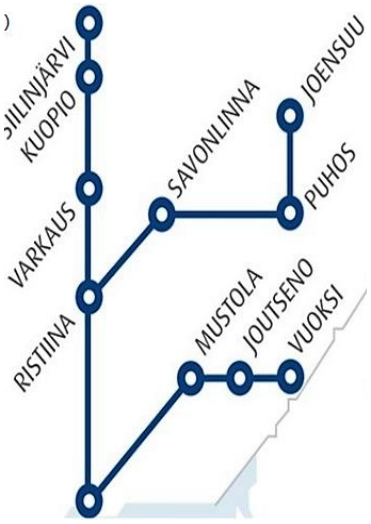
2.3 Inland ports in a system of IWT

Saimaa has a wide range of ports for both cargo and passenger traffic.

Some of the ports are well-equipped for container loading and some have big areas and modern cranes. The ownership of the port give us two groups of ports in the Saimaa region.

Industry-owned ports are:

- Siilinjärvi (Yara) (fertilisers)
- Siilinjärvi (Sibelco) (stone, quartz sand)
- Imatra/Vuoksi (StoraEnso) (timber, paper, pulp, steel)
- Lappeenranta/Joutseno (StoraEnso) (salt, raw minerals)
- St. Michel/Ristiina (UPM) (timber)
- Lappeenranta/Kaukas (UPM) (timber)
- Lappeenranta/Pulp (Metsä Group) (timber)



Picture of ports in Saimaa area

Municipality-owned ports are:

•**Lappeenranta**/Mustola (poles, salt, stone)

Mustola is located in the Saimaa watershed and is only 20 km from the Russian border. Mustola's competitive advantage is the opportunity to handle Russian inland waterway vessels, barges and river vessels that cannot be handled in other Finnish ports due to the size of the vessels.

Port terminal service capacity:

- 68,000 m2 of paved field space
- unpaved field space 50,000 m2
- 31,000 m2 of covered storage space
- container field 10 ha
- 20 electrical seats for refrigeration containers

- 7 berths, two of which have a direct rail connection

maximum ship sizes:
length 82.5 m, width 12.8 m, draught 4.3

In addition, there is a passenger port and 2 guest berths.

•**Joensuu** (timber, talc, pulp, cement, poles, rapeseed, salt)

The freight port of Joensuu is one of the busiest ports in the lake Saimaa area. The port is accessed by rail and road and it offers full forwarding services for all transport modes making it a true hub for all modes of transport.

Number of berths: 5

- Maximum size of vessels:
- Length: 82.5 m (after 2024: 93 m)
- Width: 12.6 m
- Draught: 4.35 m

Services:

- Stevedoring
- Forwarding
- Material handling
- Truck scales
- Warehousing
- Terminals 2 ha
    - paved storage field 2.5 ha
    - gravel yard 20.5 ha

- Mooring and unmooring
- Water
- Waste management

•**Varkaus** (sawn timber, rapeseed)

The Port of Akonniemi serves as a port for international maritime traffic.

Number of berths: 2

Maximum size of vessels:

- Length: 82.5 m
- Width: 12.6 m
- Draught: 4.35 m

Services:

• Water

• Fuel station

• Waste management

• Warehousing services

Interconnections: direct access to port by rail and road (Main roads 5 and 23)

The Port of Taipale serves as a port for domestic raw wood traffic.

Number of berths: 3

Maximum size of vessels:

• Length: 82.5 m

• Width: 12.6 m

• Draught: 4.35m

Interconnections: Direct access to port by road (Main roads 5 and 23)

•**Kuopio** (coal, rapeseed)

Port of Kumpusaari

Number of berths: 2

Maximum size of vessels

- Length: 82.5 m

- Width: 12.6 m
- Draught: 4.35 m

- Water
- Electricity
- Waste management
- Warehousing

Services:

- unpaved field 33,661 m2
- paved field 18,657 m2
- uncovered storage area 7,100 m2
- terminal 2,422 m2
- roofed sawn timber storage 614 m2

• Mooring and unmooring

•**Savonlinna** (Timber, poles, coal)

Port of Vuohisaari

Number of Berths:1, length of berth 100 m

Maximum size of vessels:

- Length: 82.5 m
- Width: 12.6 m
- Draught: 4.35 m

Services:

• Electricity

• Water

• Bilge

• Septic tank station

Connections:

• Good access by rail and road (NaviSaimaa, 2020)

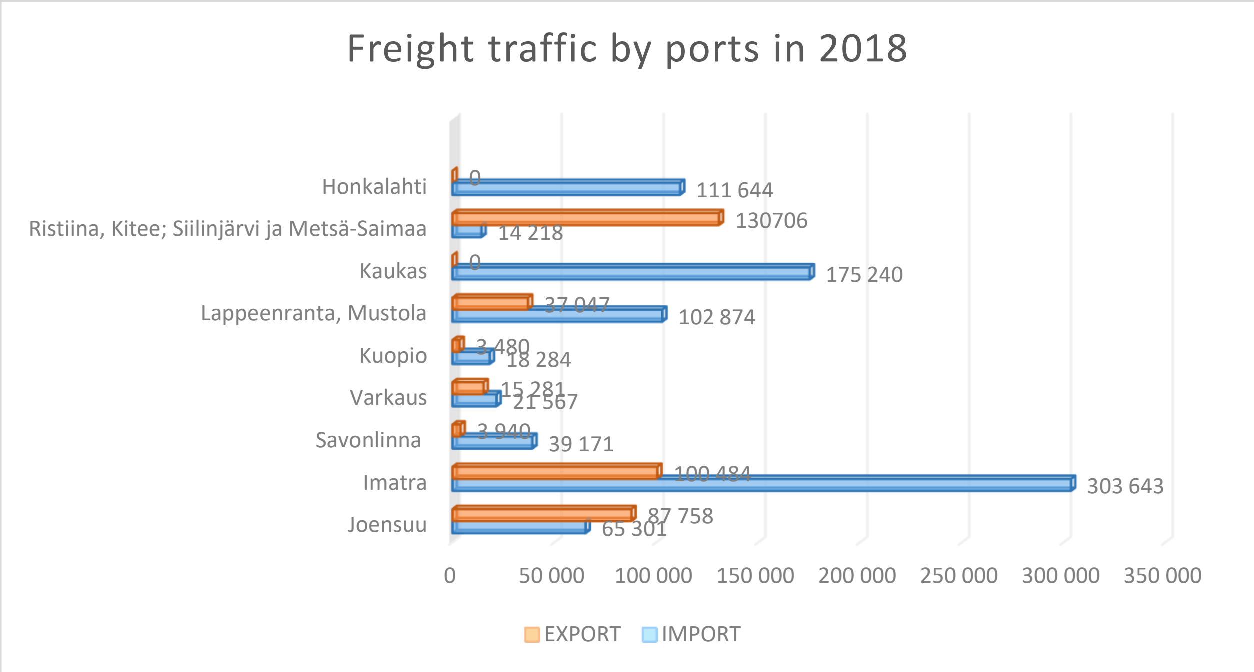
There is a passenger port and guest marinas in Savonlinna.

The ports in the Saimaa region are well-equipped for the needs that they mostly meet: passengers and bulk freight. Besides, there is an important connection to the road and rail lines in Joensuu, Lappeenranta, Varkaus and Savonlinna ports. Usually transshipment is taking place when the mode of transport is changing on the delivery journey, so the access to the port by other modes of transport plays a crucial role in choosing the transshipment hub location.

Robert Tyler Lipscomb in his work "Strategic criteria for evaluating inland freight hub locations" noticed that the alternative with better access to highways, railroads, etc. will be more capable of supporting new logistics developments. He also pays attention to the Industrial Development as a support to the logistics from both local industry and regional economic development agencies. Lipscomb adds some other important criteria, such as capacity of the region and the sustainability.

The ports of Saimaa concentrate the cargo flows of the Saimaa industry that are loaded onto the freight ships next. Each port can be the hub with surrounding spokes of freight flows, connecting them to the next point of the journey. According to the infrastructure characteristics, we have strong possibilities of hub development in the ports of Joensuu, Lappeenranta, Varkaus and Savonlinna.

Terminal equipment and capacity of the port are considered by Rose, Abramovic and Brnjac as the factors of the development of intermodal terminals, since greater intermodal terminal turnover generates higher investments and specialisation. The capacity of ports is used differently from year to year, but according to the statistics below, we can see that Imatra, Joensuu, Kaukas and Lappeenranta ports had the biggest freight flows in 2018.



Picture 8 International maritime transport of goods through the Saimaa Canal by port and commodity in 2018 (Finnish Transport Agency 2019)

The largest import ports in Saimaa in 2019 were Lappeenranta, Imatra and Joutseno. The largest import flows are raw wood from Russia to Lappeenranta and Imatra, and raw minerals from the Netherlands to Joutseno. The largest export ports are Siilinjärvi, Imatra and Joensuu. Siilinjärvi exports fertilisers to Sweden, Denmark and other Baltic countries, as well as raw minerals to its home country. Imatra exports the most paper and board to Poland, the Netherlands and Sweden, and pulp to Germany. Joensuu's largest export products are pulp, which is exported to Germany and the Netherlands, and raw minerals to the Netherlands. (Pohjois-Karjalan liitto, 2020)

These core freight flows highlight the ports of Lappeenranta and Joensuu with constant movement of cargo with bigger volumes compared with other hinterland ports. In evaluation of these ports we can use the quantitative data, such as the number of interstate highways and railroads serving the region of the tub. Based on them we see that the size of the port of Lappeenranta is small and Joensuu medium. However, they should be evaluated with qualitative data such as the support of local industry, to measure a region’s logistics development potential.

The Saimaa area’s well-equipped inland water ports are providing industry and society with a wide range of services. Modern equipment of sufficient capacity ensures a continuous flow of freight through the intermodal terminal, but the terminal development depends primarily on the position of the terminal in relation to the traffic infrastructure. Development of hinterland ports both in Finland and Russia leads to the development of international trade and support to local enterprises.

PART 3 Implementing set of interviews and analysing the study.

In order to achieve the goals of the “Infuture” project there was primarily specified a range of tasks for WP1 in Transshipment hub development. The main tasks were to clarify the potential cargo flows and study the current flows, determine the container transport specific in Saimaa traffic and evaluate the container transport potential. Adding to these tasks there was the core task of gathering a Transshipment Port service and characteristics list.

It was necessary to identify the relevant stakeholders next. The Saimaa area represents an area full of industrial enterprises and many small and big companies, but in order to find some potential flows, the list of stakeholders was extended. The paper, cement and mineral industries that surround the Saimaa area could make the most significant material flows for the Hub concept. That is why Stora Enso, UPM, Yara International were determined as respondents for the interview. According to the set tasks a questionnaire was created to describe points of development. The respondents were chosen representing Finnish business as consignee to IWT and representing port operators, logistic firms and ship owner companies. Appendix 3 shows the wide range of waterway transport actors and their relationships, excepting consignees. There was created another list of questions according to the specific of work of interviewed experts. It supposed interviews with the port operators, ship owner companies, logistics operator firms’ representatives.

for better understanding the waterway transport needs and to gather opinions to the development of hub. Most respondents were interviewed by phone, but there were meetings with interviewees, too.

Finally materials were made in the form of a written report. Some of the report was not taken into the analysing process due to the insufficient analysis information contained.

Another method of research was a summary of all relevant studies on the different hub sections or similar routes. This way assisted gathering the hub concept features and also brought several findings.

One of them was described in the Canadian research “Study on Potential Hub-and-Spoke Container Transshipment Operations in Eastern Canada for Marine Movements of Freight (Short Sea Shipping)” made for transport Canada in 2008. The authors took the work of the Port of Kotka as an example of successful activity over many other ports in the world. This fact led this study to pay special attention to Port of HaminaKotka activity, facilitites and potential for the inland transport development.

Another finding was the research of a European project. The Interreg project 2018–2019 “Overview transshipment methods for inland waterways of: Bulk, Palletised goods, Project cargo, Containers” observed transshipment methods in practice. It published a report with **minimum required waterside infrastructure:**

For bulk cargo – Bollards (with solid ground for installing crane), Standard quay wall (UDL 1.4t/m² -Area Pressure approx. 10t/m²–25t/m²; depending on the configuration)

for palletised goods – Bollards and Standard quay wall

for project cargo – Bollards, Bollards+quay with asphalt or suitable access for trucks, standard quay wall

containers – Heavy-duty quay wall, Standard quay wall (UDL 1.4t/m² -Area Pressure approx.

10t/m²–25t/m²; depending on the configuration), Bollards+ quay with asphalt or suitable access for trucks.

These are the most important Transshipment Hub characteristics of required equipment for transhipping. The existing ports in Saimaa area are well equipped with cranes and lifts, but this list of infrastructure objects could be checked there specifically in case of a ready decision to develop a Hub in one of the offered ports.

Next we consider the most important results gathered from implemented interviews in 2019–2021.

3.1 Description of infrastructure characteristics.

It was noticed that 35.3% the respondents mentioned the locks extending project as an important decision, though there was no direct question about it in the questionnaire. Some respondents stated about the uselessness of optimising the Saimaa waterways without the decision to renovate the locks. The idea of this renovation was to bring more efficiency and competitiveness to the IWT by enlarging all eight locks by 11 metres in length and raising the water level in the canal by 10 cm. Realisation of these steps would result in a new vessel size able to enter the Saimaa deep-water fairway. This would also prolong the IWT season up to 11 months per year. There was the opinion that “extending the locks is an actual demand”. The decision to develop the canal was awaited for years.

Only after the most of the interviews were implemented did the Finnish Government make a decision and reserve EUR 90 million for the extension of the locks of the Saimaa canal this year. Before this step, stakeholders didn't consider the development of the waterway or some of them did not see any potential for the growth of the waterway.

Together with the locks extending issue, the question of the old fleet was raised. The Finnish fleet consists of vessels about 30 years old and it takes several years to renovate the fleet. But the decision to start building the ships depends on the decision to renovate the locks. If locks are longer, the ships can be of the new Saimax-type, longer than before. New ship design depends greatly on the geographical situation, the sailing area, the waterways infrastructure and weather conditions. The maximum dimensions are as follows: length 82.5 m, beam 12.6 m, height from water surface 24.5 m and draught 4.35 m. The maximum size of the vessels will increase once the Saimaa Canal renovation has been completed.

Appendix 5 shows the main characteristics of the vessel demand for inland water, picked up from interviews. The specifications of ships navigating on the Saimaa inland waterways suppose an ice class. 42.2% of respondents could add their own recommendations to the ship concept.

17.6% of respondents mentioned the good level of infrastructure of IWT; most ports are well-equipped and have good access to the other means of transport.

In responding to the question on navigation period, interviewees showed great interest in prolonging it up to 11 months. The problem with the winter season is the bottleneck of IWT of the Nordic countries. The year-round navigation is mostly preferable in order to increase the competitiveness of inland waterborne transport. There are opinions that once cargo is sent by trucks to seaports it is hard to return them back to the inland waterways, "greener" than road transport. But one respondent added that "inventing the modern equipment for keeping the canal open longer, the authorised company always should keep in mind extra energy consumption for invented removable bows and extra emissions from ice breakers. It could start to be more polluting than trucks."

3.2 Logistic performance of cargo flows.

The study of groups of commodities on Saimaa traffic was based on Transport agency's statistics, previous inland waterway projects materials and expert interviews conducted in Oct. 2019–January 2021.

The main cargo flows are constantly in the statistics for over 50 years: timber, forest industry products, floating of wood, fertilisers, talc etc. Saimaa Canal was always of strong interest for the Finnish forest industry. The dynamic of growing cargo flows is shown in Appendix 4. There are no crucial differences from year to year; changes happen in volumes but not in commodity groups. We traditionally see timber, raw wood and fertilisers.

The main **import** cargo flows are:

- Mining industry: importing cement from Latvia to Joensuu
- Chemical industry: importing raw minerals from the Netherlands to Lappeenranta
- Forest industry: importing raw wood from Russia and from the Baltic countries
- Forest industry: importing pulp from Portugal to Joensuu

and the main **export** cargo flows in the Saimaa region are:

- Forest industry: exporting pulp, paper and sawn timber from the Saimaa area to Sweden and Central Europe
- Mining industry: exporting talc from Joensuu to the Netherlands
- Mining industry: exporting fertiliser from Siilinjärvi to Sweden, Denmark, the Netherlands and Belgium
- Steel industry: exporting special steel from Imatra to Germany and Sweden
- Forest industry: exporting timber poles from Joensuu to the UK
- Mining industry: transporting stone and quartz and from Siilinjärvi to the industry’s own factories on the Finnish coast.

Machine technologies have some new routes exporting freight flows to Latin America.

We suppose cargo flows will not see significant changes in the near future and new cargo flows were not discovered.

There are currently no new plant investments in sight that would significantly increase the canal's transport volume. Previously there was considered Finnpulp as such a plant in Kuopio, but the project wasn’t granted an environmental permit by the highest administrative court. Interviewed industry leaders suggested caution that the production volume will remain at the same level, with the exception of the machine technology industry, which required gradual growth. Andritz Oy, Mantsinen Group Ltd and forest industry companies UPM and Stora Enso had significant investments in 2019, which could lead to an increase in cargo flows. An increase in freight flow was expected at the time of the interview, when it was difficult to predict the state of the global pandemic. The coronavirus will no doubt change our plans and affect the world economy.

According to the the Finnish Transport Infrastructure Agency, almost 1.3 million tonnes of goods passed through the Saimaa Canal in 2020. That is more than a 25% increase compared to the previous year. Due to coronavirus restrictions, there was no recreational or passenger vessel traffic in the canal during 2020. (Finnish Transport Infrastructure Agency, 2020)

However, the old cargo flows or new ones probably can be predicted in an improved and renewed canal. Investments in the Saimaa Canal attract attention and bring more perspectives that are not obvious yet.

3.3 Container traffic on Saimaa.

The advantages of container shipping are supposed to make transport of cargo easier. Small cargoes from different consignees can be integrated into one ship transport. The containers can be transported from the Saimaa region by ships as feeder transport to a seaport and onwards to overseas destinations.

The situation with container shipping and the feasibility of container shipping to Europe has changed over the years due to changes in the market situation. Starting container shipping does not necessarily require a large investment if the port already has sufficient crane capacity.

Regular container transport usually requires the following factors:

- Sufficient volume of the cargo to the vessel in both directions
- Adequate frequency (departures once a week or more)
- Port of entry must have a sufficiently extensive international connection, for instance, Bremerhaven
- Competitive price compared to others modes of transport
- Availability of empty containers on the territory (Regional Council of North Karelia, 2020)

According to the interviews, respondents don’t see great potential in container transport right now.

Two respondents see the situation in a pessimistic way, that there are absolutely no cargo types for container traffic on Saimaa.

76.5% respondents noticed the availability of road transport and its competitive nature: “the availability of river ships is not suitable for all the exporters. Besides, the speed of river vessels is limited by locks, stormy weather,and fog… So many factors limit the speed of a vessel.” From this point of view, containers don’t seem to be in demand. Respondents also underlined that “there should be a little bit more export traffic than there is these days.”

There is no container traffic in Saimaa, but some containers are transported to seaports by road. Some of the logistics chains of industrial operators are already designed today so that material transfers, for example to sea containers, are made in port areas. This could be a good potential for container flows, especially knowing that some of the companies with road container transportations are interested in waterway shipments in case there are regular shipments. Saimaa’s new dimensions and new vessels would also enable container transport.

Despite the growth of containerisation in the world, there are some doubts in its potential future development of inland freight transport systems. The conclusions on the comparing analysis in a Canadian Short Sea shipping showed difficulties in analysing the potential of Hub-and-Spoke shipping. The author was trying to find the potential for feeder services and new regional short sea shipping services taking into account existing lines. Despite the opportunities, he noticed the private sector has been slow to develop services in eastern Canada. The main reason has been a lack of critical mass of traffic. (Frost, 2016) So, sufficient demand on container transportation is missing in the Saimaa region, but its development opportunity is open.

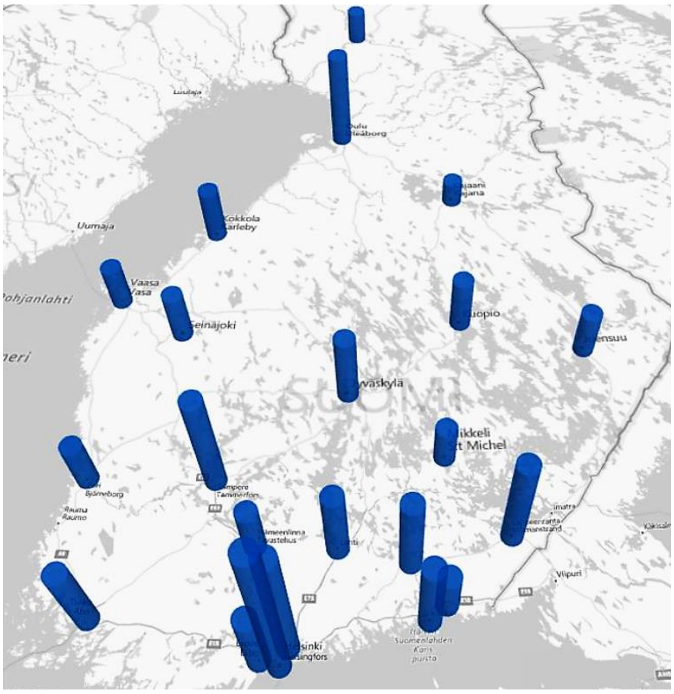
3.4. Evaluating development of inland ports in Saimaa

The transshipment hub location should be determined by capacity to move freight and access to different transport modes. A region with better access to highways, railroads, etc. will be more capable of supporting new logistics developments. This choice should include comprehensive analysis of access to renewable energy sources and sustainable technology.

Infrastructure can be measured simply by identifying the highways, railroads, and waterways and the existing airports and multimodal terminals in the region and determining the capacity that each one can handle.

The Ports of Lappeenranta and Joensuu were mentioned in the interviews several times. The location of these ports shows good access to different transport modes and gives proximity to the producing enterprises and market.

These ports are very important hubs as a large part of road and waterborne transport passes through these city areas and they create a large share of employees working in warehousing, transport and terminal operations. The most significant node for rail freight transport in Finland is Lappeenranta. This fact allows the multimodal hub development to be considered. Besides, these two ports are marked as main transport nodes by the Transport Agency.



Picture 9. Freight nodes (Finnish Transport and Communication Agency, 2019)

Quantitative data comparing these two potential Hub locations shows that the port of Joensuu is smaller than Mustola in Lappeenranta; the Port of Lappeenranta is equipped with 7 berths and big fields for storage and movement of transport. However there should next be conducted detailed research to take into account all sides of cargo flows. To identify competitive dynamics, it would be better to analyse the market share, growth of handling, shipping services, vessel sizes, and slot capacities among IWT ports.

The industrial activities are focused on the paper, cement and mineral industries and the most significant material flows for the transportation concept are their raw materials or products. In particular, the transport which today comes from the industrial operators of Saimaa by truck, rail or ship in the Baltic Sea ports can be seen as a potential transshipment hub concept. It is possible to consider the location of the hub in hinterland ports closer to the border to get hub-and-spoke form of connections. It also can be closest to the inland waterway seaport, such as the Port of HaminaKotka or the Port of Vyborg, in case of a large proportion of water transport with Russia. Currently it sees a big share of raw wood import.

Drawing on international examples, as well as lessons from the Canadian ports’ experience, a number of key success factors for the development of hub-and-spoke networks and related feeder services were identified:

- A critical mass of feeder traffic from/to a hub (consistency and reliability of volumes)
- Reliable, year-round access to feeder routes that serve key markets
- Competitive advantage of sea routes relative to alternative rail and road routes
- Low transshipment and handling fees at hub and feeder ports
- A regulatory environment that is conducive to investment in marine transport (Frost, 2016)

Sea routes and year-round access to them give a large advantage to the sea ports as a transshipment centre for all cargo flows including inland cargo flows and Saimaa transport. As the Finnish Transport and Communication Agency reported, one of the most important freight ports nationwide is the Port of HaminaKotka. It is included in the transport corridor of Saimaa cargo flows and it is also the closest to a seaport. This port transformation into a transshipment Hub for inland waterways is worth considering.

3.5 Transshipment Hub characteristics

In order to gather a description of the core Hub characteristics, interviewees were asked about characteristics of existing infrastructure and services and planned features for the Hub.

The questionnaire aimed to cover a comprehensive range of tasks, such as sharing the vessel and consolidating of cargoes, difficulties of project cargo management, schedule-making and many others. Interviews were not always able to get full descriptions and answers, but the main demands were opened from them.

Container transport is not considered as a realistic option for Saimaa, as for respondents it looks like extra charges for loading-unloading and container moves. But 17.6% of respondents admitted that they consider container traffic attractive to them. One interviewee pointed out that "our deliveries could be shifted to inland waterways. We would be interested a lot in implementing all the transportation from Joensuu to Europe by waterway; this decision can be attractive for us."

Custom clearance or border control was not mentioned at all as an obstacle or an improvement issue in interviews and it is based on long-term experience and professional attitudes to the legislation and procedure on the border. Same cargo types have the same customs rules from year to yeasr and curently they don't have more requirements than before. Port service also was satisfying for respondents, no claimes interviews revealed. Respondents are satisfied with all service offerings.

In these interviews the environmental issues came up, and also the role of small and middle-sized enterprises in shared cargo transport was underlined. The inland waterways could also be used in some project transports. Unfortunately, companies interested in project cargo transport were unsatisfied with **logistic services** offered. Pricing was mentioned as the issue for the project cargo and cost-effectiveness. According to the calculations of one respondent, truck delivery of the project cargo to Saint Petersburg takes 8 hours and costs under 1000 euros, but the same transportation of the cargo by inland ship would take much more time, supposedly about 24 hours and costs 2000–2500 euros. Reliable **cargo integrators** with experience in a wide range of cargo and cargo groups in the Lake Saimaa region are needed and they could develop new business models to serve enterprises. Freight integrator service/cargo integrator/logistic integrator is a company taking care of the logistic tasks of arranging cargo movement, like the freight forwarder, but also owns the assets.

There are two main types of companies who can provide freight services: integrators and freight forwarders. The freight forwarder is a third party provider, often without assets such as planes, who arranges the transportation of your goods from pick up through to delivery. The integrator also arranges the delivery of your goods but also owns the assets. (Air freight 2016) In waterways, by integrator we understand almost the same as freight forwarding company, but with parcels smaller than 45 kg/100 lbs.

22.2% of all the respondents see the importance of integrator services on the traffic of the Saimaa region; one shipping company representative mentioned that an “Independent cargo synchroniser could be of use”.

For some industrial representatives “the role of shipping companies in marketing their spare capacity to shippers is key”, but shipping companies are hoping to delegate this option to an integrator company.

Two respondents showed their interest in the regular traffic through Saimaa to Europe, one of them noted, “the Saimaa transport line needs to be more competitive, comparing to European transport ways. Transportations need to be improved in frequency and in intercity decisions. The important decisions could be done in shipbuilding, too.”

The necessity of following service for the inland waterways was defined:

- Making transport routes and schedules
- Searching for suitable vessels
- Booking of port services
- Marketing and stakeholder communication
- Other services. They were not determined as very important but together with typical port services are found to be useful.

It could be hard to organise relevant traffic management systems along the corridor in an inland port only and in this case the idea of a seaport as the Transshipment Hub seems to be logical.

Such a hub can play an important role as a strategic centre for the maritime sector, where trade, shipping and additional maritime services expand and create opportunities for great economic development and new business and employment opportunities for the country's younger generation.

A logistics centre should preferably be served by a variety of communication modes such as road, rail, sea, inland waterways inside and outside the country, providing multimodal connection. These connections reflected in pictures 2 and 5 of Hub-and-spoke hubs.

Interviews have brought some **other findings** that can be used for the planning of transshipment hub development:

- Cargo freight in Saimaa is represented by big companies with large volumes of bulk cargo; it is cost-effective for transporting bulk and break bulk.
- The location of the Saimaa watershed and the actors in its area is logistically challenging, so its specific has a strong impact on the entire logistics chain.
- The import of raw wood from Russia and the Baltic countries is a big part of collaboration; the decline of import would influence the whole picture of turnover.
- Half of industry companies' representatives were interested in part loadings with other companies.
- Winter conditions disturb water transportation and big parts of cargoes shifted to road transportation for getting to the seaports may never come back to inland waterways.

The Saimaa Canal should be using automation, changes to support year-round traffic and higher volumes of waterborne traffic. Large container transport also requires changes to ports, including those owned by cities.

- 17.4% of respondents drew an idea of studying the practice of Swedish port development as a successful and similar to to Finnish one. We study their experience in the next part.

PART 4. Benchmarking the experience of European ports

There are a number of ports worldwide with developed transhipping systems. Singapore’s hub port is a complex stream of activity, handling 500 million tonnes of cargo every year. Their successful practice cannot be compared to smaller ports in another geographical situations.

In order to study the best models of transshipment and effective port Hub functioning it could be interesting to apply the European ports’ practice.

In Europe, the main waterways include:

The Rhine and its tributary rivers (Main, Neckar, Mosel).

The river system in the Benelux countries and northern France, including main canals such as the Albert Canal between Antwerp and Liège.

The Rhône-Saône basin.

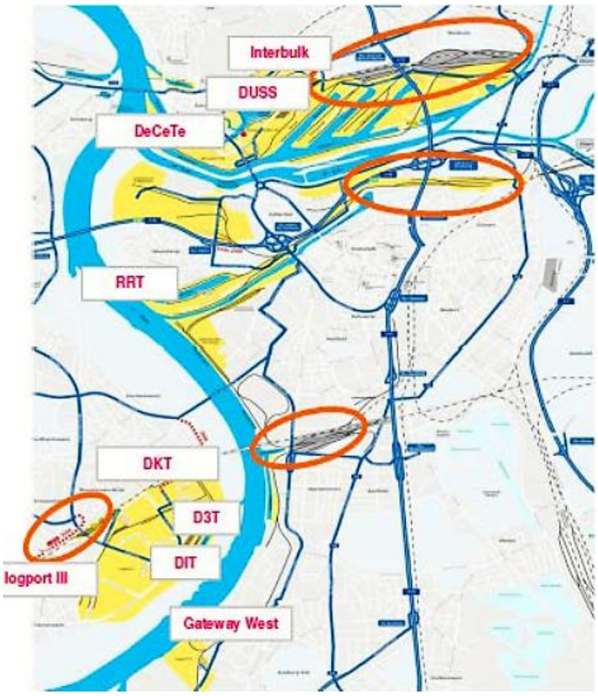
The Northern network around the Elbe and Weser and associated canals, the Rhine-Main-Danube linking the Alpine Region to the Black Sea. (Rodrigue, 2010)

The competitive port landscape of Northern Europe provided the presence of a large number of well established ports within 300 km of the Rhine-Sheldt Delta. Competition drives these ports to develop their hinterland connectivity through various waterway and rail transport corridors. In this respect, Northern Europe has seen the emergence of some of the largest intermodal terminals in the world today. Duisburg, for example, achieved a throughput of 55 m tonnes of cargo in 2008 including more than 1 million TEU carried on barge and rail, and is now possibly the largest inland port in the world. Extensive rail corridors are now extending to most parts of Germany, and neighbouring countries. (Lam L., Imounen A, 2010)

4.1 Port of Duisburg

The 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. Europe’s largest consumer market is in the area – over 30 million consumers within a radius of 150 kilometres. The Port of Duisburg, also known as Duisport, is the world’s greatest inland port and Central Europe’s leading logistics hub. In a year, approximately 20,000 ships and 25,000 trains are handled. Picture 10 shows an overview of the Port of Duisburg. The Port of Duisburg in numbers:

- Port area: 1,500 ha
- Warehouse space: 2 million m2
- Tank room for liquid goods: 0.6 million m3
- Maximum draught: 17.05 m
- Port basins: 21
- Gantry cranes: 21
- Container terminals: 8
- Railway tracks: 200 km (Duisport: Facts and figures 2020).



The port of Duisburg, Duisport, is an impressive complex of multimodal terminals, industrial activities and logistic zones, with frequent and seamless connections with seaports such as Rotterdam and Antwerp, and the European consumer and production regions. And since the creation of the Eurasian land bridge, Duisburg serves as a terminal on the railway link with all parts of China including Chongqing. Duisburg is probably the best example of where successful transformations of old industrial areas into high-end quality multimodal logistic zones using the extended gate concept have taken place.

Picture 10. Port of Duisburg

Especially Logport, a recent redevelopment of an old steel plant into a new logistic site is interesting, and it shows that by physically integrating multimodal facilities, this acts as a catalyst in attracting other logistics activities, leading to ever-increasing bundling possibilities of cargo flows (Inland Waterway transport 2015).

4.2 Port of London

London Gateway Port is one part of the Port of London. It is an automated deep-sea container port, which has been developed by DP World. It is located on the north bank of the River Thames in Essex. Construction of the port was started in 2010 and it started operating in 2013. (Ship Technology 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 an area of 175ha. Its berth is 17m deep, which makes it possible to receive cargo vessels that can handle up to 18,000 TEU.

The port has the latest Navis SPARCS N4 terminal operating system (TOS). The system has automated container handling equipment that is 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. (Ship Technology no date.)

The port is one of the most integrated logistics hubs in the UK. It has its own international rail terminal and logistics park. The port is located close to London, just 28 miles away, and near by the M25 motorway, only 10 miles away. That makes it an 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 an area of 227 ha.

The approximately 86 ha area is used for warehousing. The park includes also buildings, arail terminal, truck parking space, roadways, service corridors and a sustainable urban drainage system. (Ship Technology no date.)

London Gateway in numbers:

- 47 Port area: 175 ha (port terminal) and 227 ha (the logistics park)
- Maximum draught: 17m Docks: 3

- Quay cranes: 12
- Shuttle carriers: 40
- Stacking cranes: 60
- Container terminals: 1
- Railway terminal: 775 m. (DP World London Gateway no date.)

The research of Koivu S., Sabitova V. in 2020 shows that in London the land area for port facilities is very expensive and not widely available.

In London, the inland waterway is the main way to transport waste materials and it plays an important role in project logistics and that is the key factor why inland waterway transportations will be needed in perspective. 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 switches from roads to waterways and rail. (Transshipment Hub concept, 2020)

The specific of the Port of London is in big volumes and great opportunities. DP World's London Gateway Port is a £1.5 billion terminal capable of handling the largest deep-sea container ships. Ultimately the development of the port will feature a 2,700 metre-long container quay with a fully developed capacity of 3.5 million TEU (standard container units) a year. It will then be the largest multi-modal logistics and business park in the South East of England.

The practice of ports of big size and large volumes of cargo meeting their own challenges, but the port of Lappeenranta is of smaller size and it doesn´t meet congestions. It also may lead to the lack of similar features in order to take a model for port development in Finland. The Transshipment Hub in London is well-developed and their experience when comparing to the smaller capacity ports' development cannot be very useful. However the form of connection is possible to be applied with the main seaport connected to the inland ports.

4.3 Port of Stockholm

The Swedish waterway system consists of lakes and canals, which lead to the coast. This geographical similarity to the Finnish specific made us take a closer look at the ways of growing and developing neighbouring waterways. Also Finnish shipping company representatives refer to the Swedish experience of waterway transport support as successful.

Sweden has two inland waterways areas. One contains the Port of Gothenburg, the Göta Alv river and Lake Vänern with another lake and a big canal, but the capacity of the port of Gothenburg is large and the waterway is loaded a lot.

The second is Södertälje Canal, Lake Mälaren and parts of the Stockholm area. The Södertalje Canal connects the Baltic Sea with Lake Mälaren. The canal is 3.3 miles long and has one lock. The lock is 135 metres long. The Swedish Transport Agency has classified more waterways, such as the Göta Canal (connecting Lake Vänern to the Baltic sea) and inner coastal waterways, but these areas have not yet been ratified by the government. The canal system with a lock, lakes and seaport looks very similar to Finnish waterways. Besides, the Nordic countries have similar weather conditions and geographical features.

Infrastructure details

- 32 hectares
- 800 metre quay length
- 16.5 metre depth alongside
- 8 straddle carriers
- 22 units, wide crane out-reach
- 65 tonnes twin-lift 20' under spreader (81 tonnes under heavy lift cargo beam)
- 500,000 TEU capacity per year
- Rail connection

Picture 11. Port of Stockholm. (River-sea transport in Europe 2020)

The container terminal at Stockholm Norvik Port is operated by Hutchison Ports, the world's leading port network with 52 ports in 27 countries. Mrs Camilla Strumpel, Chief Communications officer representing the Port of Stockholm, supposed that this fact became crucial for the port development changes in recent years. Through the collaboration with Hutchison Ports, Stockholm is integrated into the global freight routes. In her opinion that was a strategically right decision. The parent company of Hutchison Ports, known as the Hong Kong port operator, is Hutchison Whampoa, operating in most European ports. The network of Hutchinson offices makes the documenting, contacts and operating much easier with a high level of effectiveness.

Supporting services offered

- Foodstuff Control by the Swedish National Food Administration
- Strip and Stuff
- Storage
- Electricity connection
- Pre-trip Inspection (PTI)
- Cleaning
- Repairs
- LNG

Feeder connections

Several feeder ships call each week at Stockholm Norvik, providing direct connections to Antwerp, Hamburg and Bremerhaven, as well as other ports. Operating shipping companies are MSC Sweden and Unifeeder Sweden.

Rail and sea transport in synergy. The container terminal has collaboration with a rail transport solution provider. The port is also working to develop rail transport solutions for customers so that services meet their needs as far as possible.

The Norvik container terminal in the Port of Stockholm was built in May 2020. The construction started in 2016 and its aim was to avoid congestion around Stockholm. The new port is situated in Nynäsham, a distance of about 50 kilometres from Stockholm. Nynäsham has deeper fairway than in Stockholm port. Besides, it can get better connection to the inland waterway through the canal. That makes the Swedish waterways around Stockholm similar to the Finnish IWT with the Saimaa Canal.

The port of Norvik, south of Stockholm, has 44 hectares of land, of which the container terminal accounts for 32 hectares. It has deep fairway and good connections to the heart of Sweden. The total length of the piers is 1,325 metres and the water depth, according to Mrs Pia Berglund, National Inland Shipping Coordinator at the Swedish Transport Administration, Norvik, will generate both economic and environmental benefits as the new port will bring ships and cargo closer to Sweden's largest markets.

Mrs Berglund in an online conversation noted that a successful way to improve the waterway was first to **realise** that there is **a strong competition** between road transport and inland waterway transport, which is not easy to avoid. The regular, fast, mobile and competitive road solutions are bringing profit to industrial sector of community. It must be taken seriously into account and authorities should bring a real package of measures/statements/fees/rates and regulations to get inland waterway competitiveness.

Besides, Mrs.Berglund supposed that waterway transport issues started to be under improvement due and thanks to the **strong political will** of the Government as it happened in Sweden. There was a pack of persistent actions and common work of involved authorities and in tough collaboration with municipal groups and port experts. Groups of professionals started the improvement of commercial attractiveness of the waterways based on calculated commercial perspectives of investments in IWT of Sweden.

One of the most noticeable governmental supportive measures was mentioned several times in interviews with Finnish ship owner companies. Eco-bonus is supporting companies, which can receive a state compensation if once a year they prove the utilisation of waterway transport calculated in a certain number of shifted tracks. This measure motivates and influences the environmental understanding of logistics chains' profit. Eco-bonus is successfully implemented in the most successful European waterways, like in Rotterdam. **Eco-bonus** can be a successful initiative for Finland as well, if it starts to stimulate consignees to predict receiving bonuses by using existing sustainable routes more than road transport.

Despite some bonus implementing, Sweden also applies fairway dues for calling ships (with fees dependent on the size of the ship and the weight of the cargo carried). Added to this, pilot fees are expensive.

PART 5 Transshipment Hub concept for Inland waterways

A transport network, such as ports including passenger terminals, railway stations, logistic platforms and freight terminals located in and around an urban area, is connected with other parts of that infrastructure and with the infrastructure for regional and local traffic.

We see that the inland waterways are not having open entrance to the sea; they have to make a curve through the Russian territory. World transshipment centres often include shipping and maritime services such as ship management, agency, finance, insurance, brokerage and survey, etc.

Small inland ports with small lists of services meet the needs of shippers and their services are quite satisfactory to the surveyed shippers, but the practice of Transshipment Hubs in Europe shows additional factors for hub selection.

The main selection factors for the Transshipment Hub in literature are:

- proximity to a major routes
- intermediate location connecting feeder and deep-sea services
- hinterland access
- greater than 13.5m depth to accommodate post-Panamax vessels
- large yard area for temporary storage (Noteboom 2008)

These wide ranges of parameters lead us to the Finnish seaport consideration.

Finland has 2 Core Network Corridors crossing the country. One of them, the North Sea-Baltic Corridor, stretches from the North Sea ports of Antwerp, Rotterdam, Amsterdam, Bremen and Hamburg through Poland to the Belarus border and to the Baltic countries' ports as well as to southernmost Finland. It covers rail, road, airports, ports, RRT's and inland waterways. The Saimaa waterway network is a natural link to be included into this corridor. On the way of cargo flows there is Finland's biggest universal port, HaminaKotka. It serves as an important hub in Europe and in the Baltic Sea region.

Do the factors traditionally accepted in selection of Transshipment Hub find confirmation in the characteristics of the port? It is possible to learn from the next chapter.

5.1 Port of HaminaKotka in a system of two ports.

The basic criteria for choosing the port with proper location from existing ports should be cargo flows. The products of the wood-processing industry are the most important export articles of Finland. More than 40 per cent of the exports of Finnish sawn timber are carried through the port of HaminaKotka. (Port of HaminaKotka no date)

The Port of HaminaKotka is located in South-Eastern Finland in the European Union near the border with Russia, and in the immediate vicinity of the E18 motorway and rail connections. The location and transport connections of the Port of HaminaKotka render it a major transit route and a hub for all modes of transport. HaminaKotka is the biggest universal, export, container and transit port in Finland, with regular connections to all major European seaports and thereby to the other parts of the world.

Port area in figures:

1100 ha of land area

1400 ha of sea area

max draught 15.3 m

docks 9 km

berths 76

railway tracks 90 km

Transshipment of containers is about 600,000 TEUs. The transshipment of import cargo is about 5 millions tonnes a year, and export cargo can be about 10 million tonnes (PortNews 2018). It is possible to handle 15 m tonnes in the Port of HaminaKotka. In 2019, a total of 18.1 million tonnes of cargo passed through the port (18,092,212). The containers were 677,621 TEUs. In terms of ship traffic, 3,181 ships called at the port. (Naski K. 2020)

Figures are relevant to the factors of transshipment hub selection drawn by Noteboom: draught is more than 13.5m, which gives access to the bigger ships and there is a large yard.

The strengths of HaminaKotka comprise frequent sea transport connections, versatile services and operators specialised in the handling of the products of the wood-processing industry. The excellent location of the port, direct access to the E18 motorway, well-functioning rail links, diversity of warehouses and extensive field areas enable the best service.

The study of Canadian researchers prepared for Transport Canada evaluates the work of this port as an example of successful international feeder services. The port of Kotka in Finland, for example, is the end of a spoke for many feeder routes. The port has 19 feeder calls per week and 13 Ro-Ro vessel calls, connecting it to hubs and markets in the Netherlands, Belgium, Germany, Russia, the United Kingdom (UK) and Spain. Its growth is due to its proximity to the fast-growing Russian market. An example of a successful feeder operator is Team Lines, which operates about 35 chartered vessels from four major hubs, with Hamburg and Bremerhaven being the main ones. From those two ports, they operate to ports in the UK, Scandinavia, the eastern Baltic states (Estonia, Latvia and Lithuania), Poland and Russia. From Rotterdam and Antwerp, they operate to France, Portugal, Spain and the UK. It operates on a weekly, fixed-day basis or more frequently. (Study on potentional Hub-and-Spoke, 2008)

A transshipment centre includes shipping and maritime services such as ship management, agency, finance, insurance, brokerage and survey, etc.

M. Rauanheimo Oy is a Finnish logistics company with expertise in stevedoring, forwarding and shipping and many years of experience in seaports. Sales Manager of Rauanheimo Tommi Sievers has mentioned a two-port system that could serve more than large industries. It could be Joensuu-Hamina, or Lappeenranta-Kotka or some other suitable port pair. Cooperation will make use of inland waterway transport and increase its competitiveness. The two-port system would open up regular scheduled traffic to provide a suitable round-trip route for feeder vessels. It would be possible to transport goods to European ports, even inland ones.

The research of similar business-models carried out by Roso V., Dawn R., Ruamsook K., Stefánsson G. in 2015 compares and analyses the collaboration of two port systems in Australia, Sweden and the United States. They noticed that these pairs are working effectively and there can be noticed a share of 1.6% in the United States, 2% in Australia and 7.6% in Sweden of seaport flows run to the inland ports. In Finland, the Swedish model of collaboration is attracting attention, according to the conducted interviews.

Sweden appears to be employing growth strategies as they are running higher volumes of freight through their inland ports and investing in value-added services beyond the standard services of rail transport to/from the seaport, transshipment, customs clearance and storage.

Distant inland ports tend to offer services adequate for big customers in the area or to attract new customers. Quality of seaport and inland rail connectivity, in turn, is key to realising the potential advantages of inland ports. However, the researchers Roso V., Dawn R., Ruamsook K., Stefánsson G. are pointing to the meaning of the development policies associated with provisions of logistics infrastructure for hinterland accessibility and inter-connectivity among different modes of transportation. Sufficient logistic service was a very important issue in implementing this work, too. Among interviewees there was an opinion that there was no logistic service that they needed, especially service related to project cargo deliveries, but some respondents hoped to see logistic service of lower prices, with enough regular transports and with the opportunity to share shipments and send small parts of cargo.

The industry and market access of inland ports and a wide range of seaport services, combined with the development of intermodal transport, are meeting a wider range of customer needs and contributing to the development of both inland and maritime water transport.

5.2 Port of Vyborg

Inland waterway flows go from Finland through the Finnish part of the Saimaa Canal to the Russian area the Port of Vyborg is on their way. This seaport is smaller than the port of HaminaKotka but it has a great location for Finnish freight cargoes. The time has now come to focus on feeder ports, inland ports, transport corridors, as well as coastal shipping. Port investment should not be just about headline-grabbing deep-water mega ports, but should instead be based on achieving balanced development in various regions of the country.

The commercial seaport of Vyborg is an important transport point in the Baltic Sea. The port is connected with the whole transportation network of Russia by sea, river, railway and road lines. It is also connected with Baltic countries and with the countries of the North Europe by sea and railway lines. The Port of Vyborg is the main transshipment point for Russian exports delivered to Finland via the Saimaa Canal.

Port in figures:

Picture 11 Port of Vyborg (Portlog.ru)

- Port Logistics
- Max size vessel in limited 135.0m length
- 6.5m depth
- 1500m total length of 13 berths
- 164 cars/day
- More than 6000m of railway tracks
- 9 cranes
- 51,479m2 total storage space:

779m2 indoor storage/47,700m2 outdoor storage

Cargo turnover for the seaport of Vyborg in 2020 was for 9 months about 490,000 Tonnes, 117 vessels were served in 2019. Total cargo turnover reached 1,234,359 tonnes (http://www.portlog.ru/en/about-us/)

The port offers transshipment of a wide range of general cargo, dry bulk, food and chemical liquid bulk.

Olga Ansberg, General Director of Port Logistics, explained in an interview that the port freezes, but navigation lasts all year round. She highlighted an interaction in Vyborg port with Finnish cargo flows:

In 2019, the port handled 11,054.06 tonnes of cargo from Finland.

In 2020, the port handled 8454.87 tonnes of cargo from Finland.

378,497.93 tonnes of cargo went to Finland via the Port of Vyborg in 2019.

13,654.95 tonnes of cargo went to Finland via the Port of Vyborg in 2020.

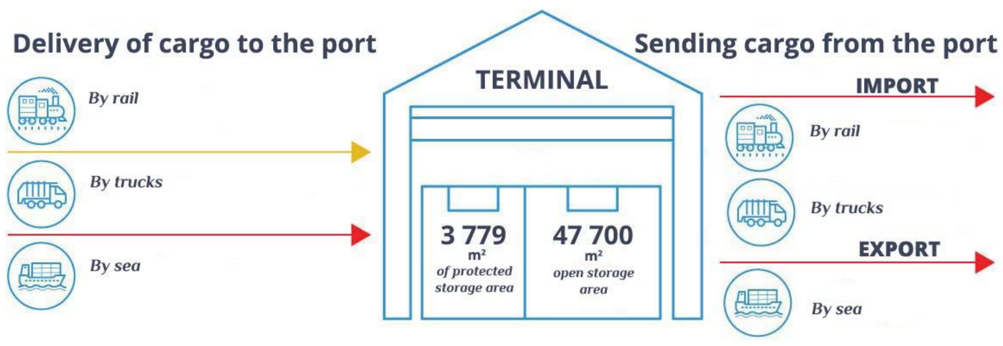
There is no container transport in Vyborg port, like in the area of Lake Saimaa and the canal. Ms Ansberg reminds us that the port: “has enough fields and area for the sizes of the arriving fleet, like container ships. The operational storage area is about 200 TEU, and also we have more area for additional loadings, movements and for keeping empty containers. We are a mid-size port, ready to deal with mid-size vessels for about 400 TEU.”

The General Director takes a flexible approach to the work and development of the port. It is planned to increase the area of covered warehouses in the territory of the port. In 2021, the Port of Vyborg put into operation a special facility for liquid cargo including but not limited by IMO classes 4, 5 and 9. There is a full range of services available for cargoes like lignosulphonate, liquid mineral fertilisers, non-hazardous oils, etc. The company also plans to obtain the necessary documents and carry out re-equipment to work with liquid cargo of the 3rd class of danger.

One of interesting port plans to use in infrastructure development is to change the maximum size vessels: currently vessels in port have to be 135 m long, but 141 m is planned. The port can offer multimodal transsshipments with 8 km of railway inside the port area. But most logistic decisions from Finland to Russia will choose straight delivery by rail from Finland to any point in Russia, because it is easier, with no extra logistics stitching.

From Ms Ansberg’s point of view short-leg shipments don’t show cost-effectiveness. Longer trips are more obvious in profit. She explains that there is “such a term as train traffic triangle. It can be more expensive than combined modes of transportation, because every container chassis costs money every day. Russian-Finnish border crossing as a rule creates a delay for the delivery of cargo; transport waits there for a long time. In sea transport, daily payments are more predictable. The logistics chain should be counted step by step, because there are components that are not obvious at the very beginning of planning the trip. But they can bring the attractive profit.”

The picture below gives a full description of the multimodal facilities and container transport potential of the Port of Vyborg.



Picture 12 Port of Vyborg (portofvyborg.ru)

5.3 Transshipment Hub: business model

The ports and infrastructure of the Finnish inland water system can definitely be compared to the top transshipment hubs in the world. Such famous examples of successful functioning and growing transshipment hubs like Panama, Singapore or Antwerp are interesting but obviously they have a big number of differences in cargo volumes, geography and principles of functioning, so we find it difficult to compare with inland ports and take their experience into the development of our ports. But we should remember that all these successful port have started as transit points on the transport routes and finally they have grown to become massive hubs.

In the frames of the "Infuture" project there is a task of compiling a description of the international Transshipment Hub and the services it contains. According to the interviews and study of the ports, the container option is a distant reality, and there can be offered possible functional model of Transshipment hubs based on existing cargo flows. Sea and inland ports act as multimodal hubs for fully integrated mobility and logistics systems. Connectivity for operations can be provided without paper documents in digital form in order to provide operative decisions.

The research of two port systems made by Roso V, Dawn R., Ruamsook K., Stefánsson G. in 2015 identifies 17 types of services offered: 4 standard services includes rail drayage transport, transshipment, storage and customs clearance and 13 value-added services: cleaning, repair, inspection, quarantine, stripping and stuffing, empty container depots, reefer plugs, cross-docking, quality and inventory control, pre-assembly, packing/unpacking/repacking, freight forwarding and non-drayage container haulage. This practice of two ports in cooperation can act as a business model for the Hub. It is possible to carry out this model with inland ports like Joensuu or Lappeenranta with the Oort of HaminaKotka or the Port of Vyborg.
The Port of Vyborg got new owners in December 2017, after which it started the improvement work and earned some achievements. But the previous condition of the port was not progressive and it still struggles to get basic needs. Automatisation of the Port of Vyborg is a second circle of needs. The process of port developing meets basic problems.

The Transshipment Hub aims for development of the transport waterway system. It should bring freight flows from disintegrated operations and modal network to a coordinated system of IWT and multimodal network. The operator of logistics tasks is highly desired by the results of interviews. The cargo integrator service is the top-priority wish of respondents. Its main task is to combine and consolidate smaller parts of cargo and find better logistics solution for the industrial enterprises, small and mid-sized companies. Unfortunately, for most respondents transshipment means additional cost for the cargo owner. Concerns about transhipping costs make the idea of Hub development unsuitable. Maybe some discount package from the port operator or integrator can solve the high pricing or find better solutions.

We need to realise that the Hub & Spoke networks in inland container shipping are effective in case there is constant cargo flow movement and also if there are container shipping demands. The experience of European ports is important, but cargo flows in Finland waterways are different and have their own features. Almost half of all container transport to and from Finland is carried through HaminaKotka. The market condition is changing and now we are witnessing a reality that is likely to make changes in the transport routine. It is quite possible that the situation with container transportation will finally develop, which in turn will bring development to the existing ports and the volumes of water transportation.

The development of a business model also relates to the governance of the hub terminal. It seems a prerequisite that Finnish ship owners have to play a leading role in establishing the hub terminal. Huge investments are needed to build such a terminal. The exploitation of the terminal could be performed by this group of investors; they could grant a concession to a terminal operator. It can be an independent terminal operator with neutral position to customers of the terminal.(Konings R. 2015)

Another business model is borrowed from the research of 2014 and named as Appendix 1. There is a general form of mission. The mission generates knowledge based on efficiency and effectiveness:

Port Company and Internal Port Terminal are intending to make the port attractive to the participants in the transport logistics chain, the investors, and the citizens. It must stand out, in the national and international port sector, for its infrastructure management, port facilitation, and sustainable development.

Externalised Port Terminals administrate and operate a Port Terminal.

Previous Logistics Zones integrate logistics chains by means of a cargo services platform, with high levels of quality, safety, innovation and technology oriented at facilitating international commerce in a harmonious setting aligned with the environment.

To form a single business model it is necessary to have evaluating research with figures calculated.

In analysing seaports there were core factors like depth of fairway allowing ships to arrive to the port. Comparing the Port of HaminaKotka and the Port of Vyborg fairways we notice that 6.5 depth is unsuitable for the ocean vessels.

It is apparent that only looking at one criterion is not sufficient for getting a comprehensive look at whether or not a location can serve the present and future needs of the transportation system. Rather, all of the criteria must be considered according to the needs of the stakeholders.

The draft of next steps towards Transshipment Hubs are:

1) multimodal transport market analysis with possibilities for multimodal improvements

2) implementation plan, containing assessment of risks and the identification of measures to be taken in order to mitigate negative environmental impacts and the estimated investments.

According to the assessments, it would be possible to make a business model in an accurate and suitable form.

It is equally important to remember that investments, arrangement and support of the transshipment hub should proceed from the objective need for it in the presence of sufficient volumes of freight traffic. The initiative, as we see it, can come from manufacturers and industrial enterprises. When calculating possible routes for the transportation of their products, they turn to logistics departments and see concrete prospects for transshipment on the necessary routes, including intermodal transshipments.

SUMMARY

This report considered the theoretical features of Transshipment Hub, studied the best practices of European ports, implemented a group of interviews with inland waterway actors and potential stakeholders, considered transhipping and multimodality in the order of further integration of inland waterway transport in the intermodal supply chain. Inland navigation can play a crucial role in increasing supply chain service performance.

Inland navigation and river-sea shipping depends on the infrastructure of rivers, canals and waterways. The hub-and-spoke transportation network design is modelled as a multi-commodity flow-based hub and spoke system, giving rise to a gateway hub location problem. The models of hubs and gateways reflect the current European types of ports. European transshipment hubs are showing effective practice of all types of cargo including container traffic. The Port of London is even named London Gateway. The Port of London is an interesting transshipment hub also because it carries 60% of all goods that are transported on the UK's inland waterways. (Port of London Economic Impact Study, 2020)

There was found the practice of full integration between gateway and inland ports, where activities in the supply chain can be carried out at any place in the chain. This seaport-inland port dynamic was studied with the example of Swedish ports, Australian ports and ports of the US. Their successful collaboration could be a business model for the Transshipment Hub concept.

Another interesting finding is the Swedish port practice of optimising waterway transport. Out of the interview with the National Inland Shipping coordinator at the Swedish transport Administration, Mrs. Pia Berglund, came a piece of advice:

- to admit the competitive advantages of road transport and take them into serious consideration. The result could be eco-bonus for waterway customers or relevant solutions.

- to base the development on the calculated proven benefits and on the strong will of authorities.

The hub location is also relevant for the potential flows that are available for going through the hub. From this point of view, location on the base of the existing transport port is favourable and a logical decision. The Hub port selection criteria were mainly identified through the literature review. They have to be based on quantitative factors, such as freight flows, labour supply and existing infrastructure and qualitative factors, such as community readiness and liveability.

The implemented interviews highlighted the core needs of the inland waterway actors. The decision of inland waterway system development was discussed for many years, but an investment of about EUR 100 million was made by the Finnish government for the extension of the lock chambers of the Saimaa Canal. This will allow larger vessels to pass through the Saimaa Canal with bigger cargo volumes. Respondents noticed a need to develop the inland waterway system in Russia accordingly. Container shipping was not mentioned as a need by most interviewees, but existing container traffic could bring better transport connection to some of them. The interviewees emphasised that it is not worth setting up the Hub based on container transport. It can be an assisting option in a list of intermodal and transhipping service offerings.

The need of renovation of old fleet was obvious for respondents and both Russia and Finland admit that the building of ships needs to be updated. Both infrastructure and new vessels require greener decisions, cost-effectiveness and winter conditions smart solutions.

Ultimately, the success of the transshipment hub and related services will depend on the perceived commercial viability of these services from the perspective of potential private sector investors/operators. This also implies a high demand for water transport services of enterprises as consignees.

Interviews conducted in the period of 2019–2021 brought the wide range of possible services targetted to optimise the waterway logistics. The importance of the logistic service with the freight integrator functions was offered first from the other services. Also mentioned were regular liner service, loading-unloading, warehousing and cargo handling service. Most of these are standard. Out of the literature reviews we can add some more standard services includes rail drayage transport, transshipment, storage and customs clearance. Additional value-added services are optional for the ready Transshipment Hub concept; in the case of container transportation they can add cleaning of containers and empty container depot service. In our report we don’t see container service as reasonable in the near future.

The Transshipment Hub concept on multimodal transportations could be a real option. The inland ports of Lappeenranta and Joensuu and seaports of HaminaKotka and Vyborg can be chosen due to their access to the other modes of transport. The transshipment forms of hub-and-spoke connection can be successfully applied there.

Private sector involvement is therefore one safeguard in ensuring that decisions are made on a sound commercial and market-oriented basis, with risks and rewards going hand-in-hand to the parties involved. Feeder ports and inlands ports are really two sides of the same coin. Allocating a country's scarce resources to developing an efficient network of feeder ports and inlands ports has a much larger multiplier effect than setting up transshipment ports in some remote locations. (Lam L, Iskounen A. 2010). Feeder ports and inland ports are truly the gateways for their respective hinterlands, vital for a region's industrial and economic development, and thus helping to achieve more balanced development of both Finland and Russia.

The result would be seen in fast and reliable shipping over short and long distances between ports, urban areas, industrial and agricultural centres. The growth of cargo flows is expected to be provided by improved infrastructure. Entrepreneurs make extensive use of the opportunities provided by IWT to develop new business models. Sea and inland ports act as multimodal hubs. Smart inland shipping is playing an increasingly important role in international logistics, with inland ports connected with each other and providing service for logistics hubs, creating new industrial synergies and providing jobs.

CONCLUSIONS

Decisions to locate new logistics facilities or infrastructure generally involve significant resources and a variety of stakeholder groups. Determining which criteria are the most important must be done with all of the stakeholders in mind. Therefore, it is important to gain an accurate perspective from each stakeholder group to determine the priority that each identified criterion should receive.

Transshipment Hub implementation has to be beneficial both for the environment and for people in the surrounding areas. In Finland there is a lot of water area around Lake Saimaa and its development brings a massive potential for the inland waterway transport and for the international trade. However, the use of existing infrastructure is the most rational way to avoid expense and having construction of new fairways with negative environmental impact.

The inland waterway transport is more sustainable than many other modes of transport because the ship transports larger volumes of goods and less harmful emissions to the environment.

The Hub development will increase employment in the surrounding areas, as well as increase tax revenues.

It is also obvious that as soon as a new activity or construction happens, it immediately attracts the attention of a large group of people. Interested parties start to consider a new player as an opportunity or as a start for their own development.

Interviewing showed that there is continuing interest in industrial production per channel. Companies located far from the waterway are attracted by the profitability and opportunities of water transport to be environmentally-friendly. The majority of respondents stated that extending the locks would significantly increase the attractiveness of the waterway. This improvement allows the use of large vessels on Lake Saimaa. Shipping companies will have the opportunity to start building ships of new dimensions and requirements. During the interview, a list of recommendations from water transport operators was collected. The technical requirements have been identified for the needs of the IACS classes and the EU inland waterway directives. Typical ships for Saimaa routes are DWT 3500 and meet the ice class requirements of FS 1A. Most respondents noticed 1A and 1B class as needed. But for the needs of manoeuvring there was the necessity to be equipped with a side bow thruster. Bio-fuel, speed and other recommendations are presented in Appendix 5.

According to the information received from the benchmark, container transport has a significant share in the waterway transport of European ports. But the problem of shifting cargoes from roads to the greener waterways is relevant and ports are finding the competing of IWT with road transport a real problem. Sweden underlines that solving it needs a flexible approach. Ports are making decisions based on calculations and on existing cargo flows. European transshipment hub practices show the importance of container transport in linking waterways to main freight corridors and the importance of accessing deeper fairways for the development of the IWT.

As future research it is supposed that further investigations with calculated benefits make the next step of port development into a Transshipment Hub. The establishment of a Transshipment hub and service development will usher a new horizon of prosperity and sustainable security for the Finnish people. The implementation of this concept essentially relies on strong national will and perspective vision of port leaders and basically could be the potential strategic plan for successful future development of IWT.

It should be noted that the economic slowdown in the world economy that was caused by the pandemic situation can bring reduced cargo growth and volume available for shipping companies. It is important that if short sea or feeder service can demonstrate significant cost reductions over competing modes, then shippers (and shipping lines) may give alternative routings some consideration. Competition from other modes may nevertheless increase, given the drop in traffic demand.

With the right public support programmes and investments, the development of the Port of Vyborg can play a more important role in the movement of freight and in the optimisation of the inland waterway transport of both Finland and the Russian Federation.

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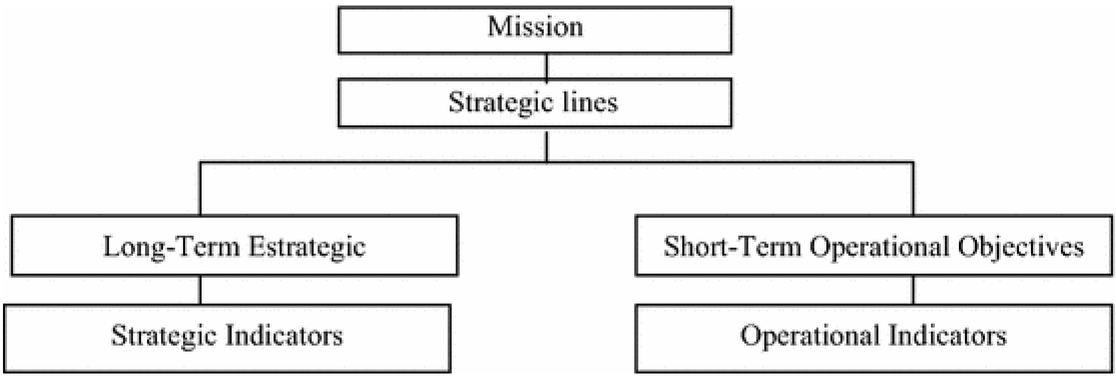
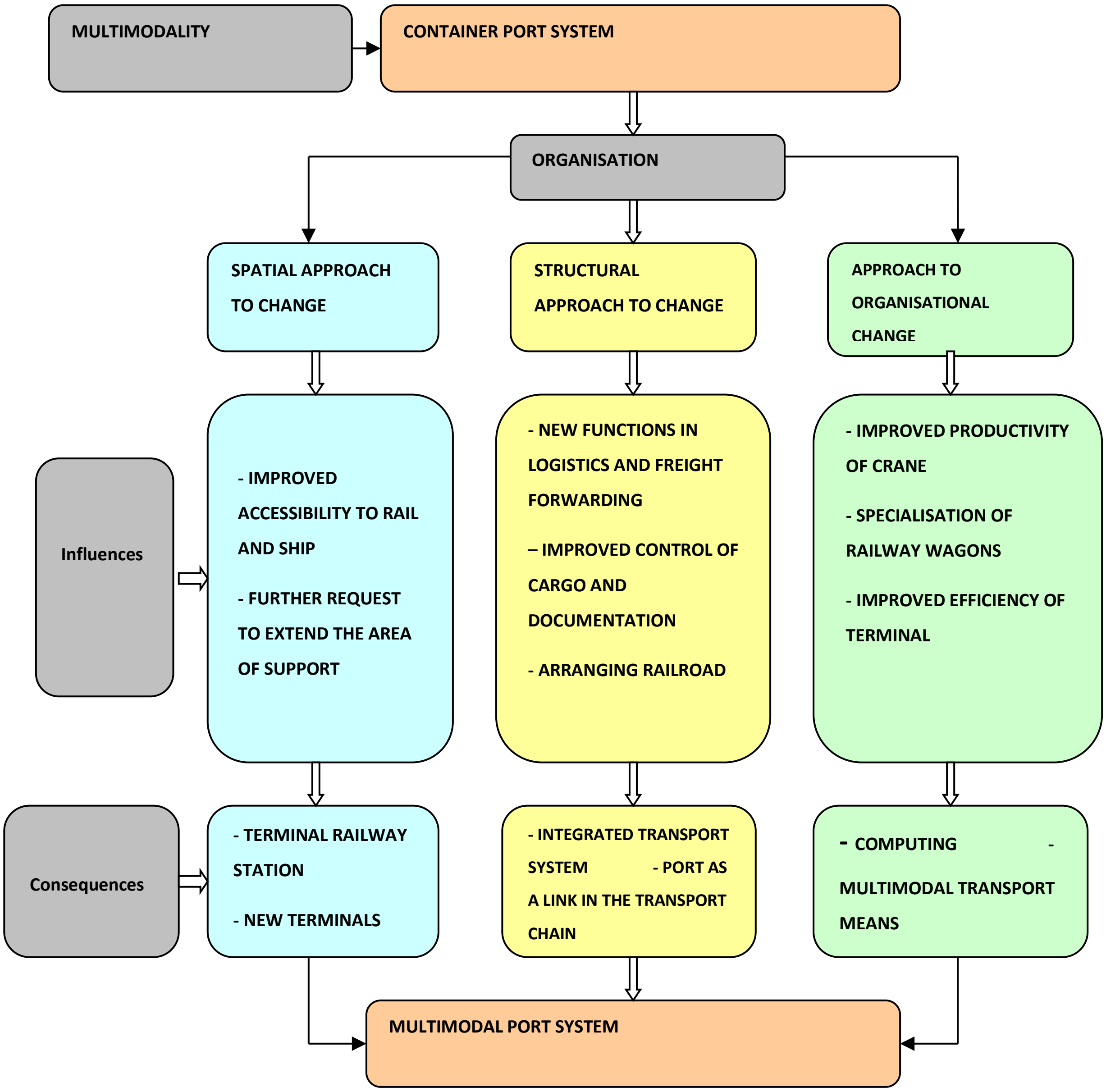
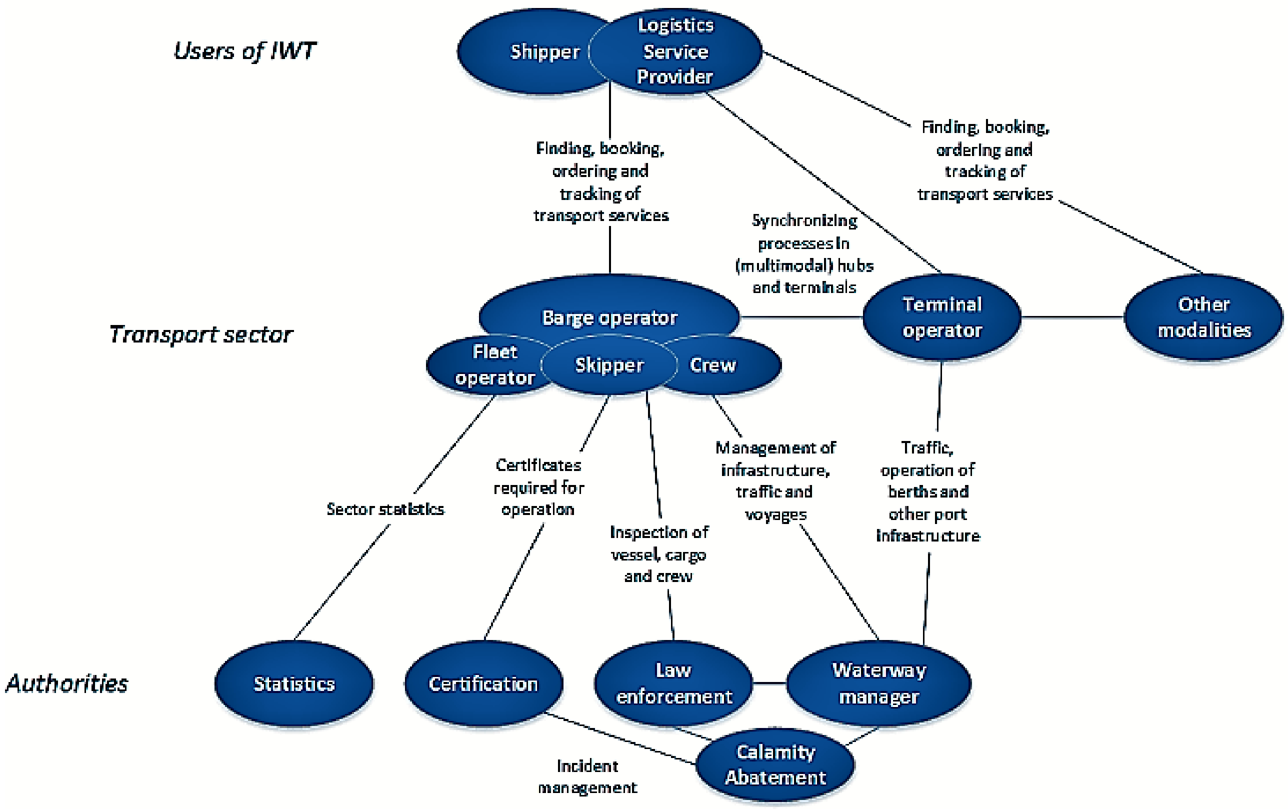
Appendix 1Business model (Cordova F, Duran C., 2014)



Appendix 2 Impacts of multimodal transport on the process of containerisation in the port, source: Tauzović,

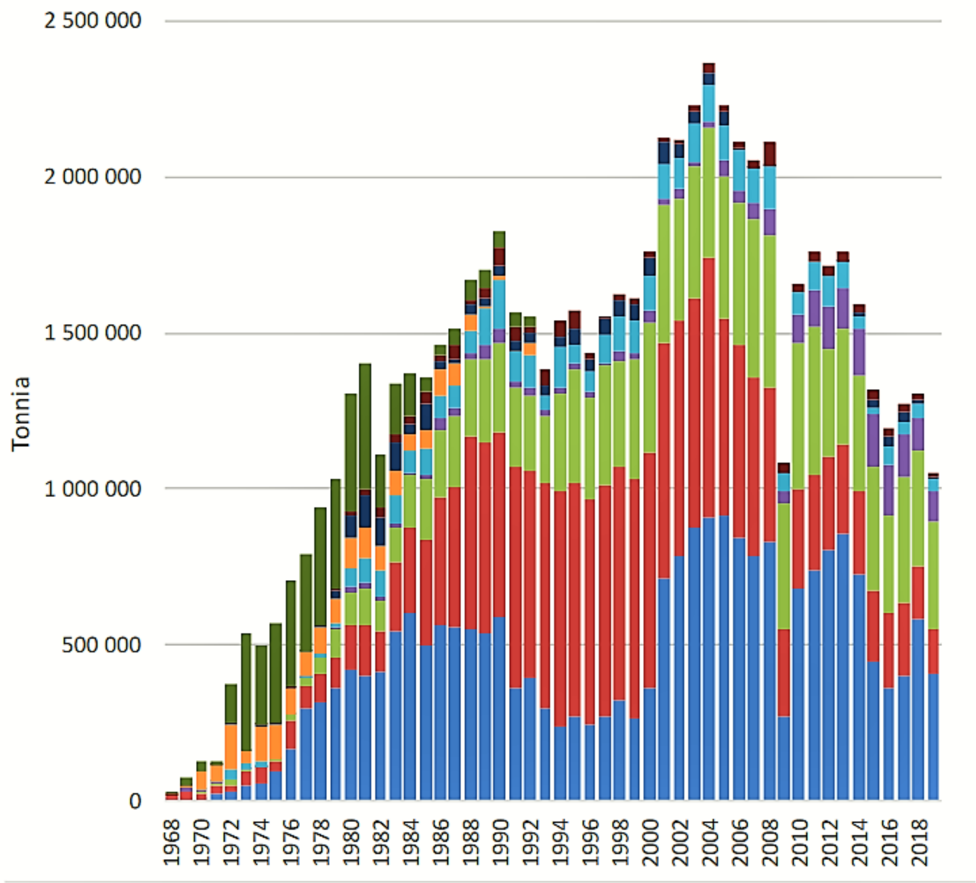


Appendix 3



Waterway transport actors and their relationships. (Digital Inland Waterway area, 2017)

Appendix 4



- Log floating
- Other
- Metals
- Petroleum products
- Coal
- Chemicals, fertilisers
- Crude minerals
- Forest industry products
- Raw wood

Source: Saimaan tavaraliikenteen yhteiskuntataloudelliset vaikutukset. Kuljetusvaihtoehtojen skenaariovertailu 2020.

Appendix 5

A list of recommendations for vessel concept

Joensuun laivaus:

The best ice class is definitely IA that can move in quite thick ice circumstances

IB ice class is reasonable, it can offer bigger capacity, with the maximum wide and length 82.5 x 12.6 x 4.35

Finnshipping Oy

A typical vessel is RMS Saimaa with the flag of Antigua and Barbuda. It is satisfying with and can be recommended as a proper model:

gross tonnage 2069 t

Summer DWT 2634 t

Length overall 80.1 x 12.5 m

speed max 10.3/ average 9.0 knots

the LNG fuel

Fertall

Timber: IA class, 10 knots speed is enough,

+All our vessels are well-equipped and easy to control, but sometimes we noticed the necessity to be equipped with a **side bow thruster**. In my job in, for instance, Kaukas port, the situation when two ships arrived to unload is typical. The waterway size there don't allow them both to unload, this port is small, so one of the vessels stays at a distance. So, the unloaded one starts to manouevre to give way to another one. That's when the dangerous situation starts. Having a strong side wind the situation starts to be dangerous. Manoeuvring is hard to control and sometimes the vessel is crashing into pier.

+ notice for ports: The crane gripper's shape has sharp corners. Sharp corners have their functioning in other cargoes, I suppose, but not for unloading-loading wood. Sometimes these sharp corners break the ship's casing. The ship will not be broken, but the situation is not safe. These situations could occur even 5 times a season, that's why it would be better to use no sharp corners on grippers, if possible.

Helsinki Chartering

Ice class 1C is enough, 1B and 1A .

For freight transport 10–12 knots is a proper speed comparing with intercity transportation of 20 knots. Higher speed demands more fuel which occupies space from the vessel's capacity. The competitiveness and cost-effectiveness of water transportation are decreasing with it.

MeriAura

First of all, it would be nice to have eco-coasters, which pollute less and work on bio-fuel. The next recommendations I got from our technical department. They state that we need to install a ballast handling system; it also influences emission numbers. We should change the fuel to make greenhouse gas emissions lower, but it depends only on the fuel provider.

It is important to know the tonnage of the vessel. Our recommendations are based on our own experience and the best ship for us is the Eco-Coaster Mirva; it doesn't fit the dimensions of the Saimaa waterway but all the characteristics should be close to this perfect ship.

Technical data

TC-Owner	Meriaura Ltd.
Type	VG EcoCoaster
Classification	BV I Hull Mach, Finnish/Swedish ice class 1A,
Flag	Finland
GT / NT	3405 / 1636
DWAT	**5019**
DWCC Summer/Winter	**4850**
Length (LoA)	103 m
Breadth	13.60 m
Draught	6.10 m

Air draught in ballast / loaded	23.5 m
Cargo hold	216,000cbft, **6116m^3** movable bulkheads 2pcs, partial tween decks (5950m^3 with bulkheads)
Hold dimensions	64.80 x 11.20 x 8.65 m
Hatch covers	pontoon type, load 2t/m2, grain holes
Service speed	10.5 knots
Main engine	1650 kW
Bow thruster	1 x 500 kW

Yara

Since we do not have inland shipping in Saimaa, we do not see Saimaa traffic as a separate or different mode of transport compared to our shipping from seaports, so river-sea ships are in use. Ice class is a must-have.

ILS Oy/Niklas Rönnberg

The technical requirements have been identified for the needs of the IACS classes and the EU inland waterway directives. For example, at Wagenborg, Saimamax ships per DWT 3500 and meet the ice class requirements of FS 1A.

The new ship must be energy efficient, environmentally friendly, low emission and capable of operating safely with a small crew. The small crew, the narrow fairways of Saimaa and the winter require reliable technical solutions and possible autonomous solutions.

C&C Port Agency Finland

Next ballast water treatment facilities will become mandatory. Also remotely-controlled safety devices increase navigation safety.

ScanPole

Interested in share loadings for containers, route towards Rotterdam

Sulzer

Logistics department is interested in deliveries of 30 containers.

Stora Enso

Store Enso considers existing vessels useful in order to improve the conditions on Saimaa and better service of reliable clients of Saimaa.

UPM

There are mostly break bulk, barges and STK-types vessels in use on Saimaa.

There will be an important digital connection. UPM has covered the need for vessels – ordered 7 new Ro-Lo and Lo-Lo vessels with LNG fuel. Vessels are powered by liquefied natural gas (LNG), which reduces carbon dioxide emissions by about 25% compared to marine oil. In addition, nitrogen oxide emissions are reduced by 85% and sulphur oxide emissions by 99%. At the same time, soot particle emissions are reduced by 99 per cent.

Andritz

No recommendation, but it always has project cargoes, up to 120 t for unit. They would like regular traffic to plan easier.

Mantsinen Group

Breadth of the vessel should be the maximum possible.

Meriaura’s Meri and Aura are very useful to us.

M/S Meri

Multipurpose deck cargo

DWCC 4500

Work deck area 166.0m^2

ICE CLASS 1A

Length, moduled	105.4 m
Breadth	18.8 m

Draught, light/summer	3.50/ 4.7 m
Service speed	12 kn
Ballast capacity	5700 m^3
Ballast pumps	2 x 350 m^3/h
Work deck area	1610 m^2, 85.7 x 18.8 m
Main engines	3 x 1200kW Wärtsilä 6L20, IFO or MDO or LBF (Bio fuel)
Propulsion	2 x 1400 kW Schottel SRP 2020 FPP
Bow thruster	2 x 450 kW Schottel CPP

M/S Aura

Multipurpose deck cargo

DWCC 4500

Work deck area 1558m^2

ICE CLASS 1A

LOA / LPP	101.8m / 95.50 m
Breadth	18.8 m
Draught Light/Summer	3.5 / 4.9m
Engine	2 x 1600 kW Wärtsilä 6R32
Propulsion	2 x Azimuth thrusters 1600kW@750 rpm
Bow thrusters	1 x 450 + 2 x 700kW ZF-Marine
Speed	11 kn
Ballast capacity	4181 m^3

Ballast pumps 2 x 250 m^3/h

Appendix 6

Appendix 1A

Semi-structured interview

Inland waterway transportations

1. When starting a new connection, what should be taken into account?

2. What are the benefits for the environment and the neighbouring 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 transportation and how do you see the future potential for it?

Transshipment hub concept

1. What place would be the optimal location for the Transshipment hub? What international connections are meeting there?

2. What factors can improve the efficiency of the Transshipment hub in your mind?

a. What 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 organisation in your port?

5. What are the main features of the Transshipment hub?

a. What services should be available for its customers?

Multimodal transportations

1. How do different transport modes meet each other?

2. How to make multimodal transports as effective as possible?

3. What effects on profitability features of transhipping can you name?

4. What are the benefits of multimodal transportation? Disadvantages?

5. Do you see future potential of multimodal transportation?

Extra questions:

1. Digitalisation, what kinds of effects are expected?

2. Cooperation between ports and/or transshipment hubs, opinions?

Appendix 6b

- What kind of transport routes do you have? What kind of traffic do you have?

-What kind of transportation do you have now?

- Do you see any changes in the flow of goods in the nearest future? Will transport volumes increase or decrease?

- How will the investment in the Saimaa Canal affect how the environmental issues impact the volumes of inland waterway transport?

- Could you share information on which ships you use?

- What new technology will be needed on ships? (fuel solutions, digital solutions, cargo handling, other?)

- How important do you see the impact of remotely-controlled devices on navigation safety? Do you think smart solutions can extend the navigation period?

- What technical recommendations could you make for the future?

- How will the development of multimodal hubs/centres affect business and ship design?

- How do you see the potential of containers in increasing inland waterway transport? Can they play a role in inland waterway transport in the near future?

- Special transport: has your company had project freight, how often? What types of project cargo? What size cargo?

Port services

- Are you satisfied with inland port services and seaport inland waterway transport services?

- What services do you need more? If you would be able to get them, what kind of services would you need?

- Combine the load

- Marketing and stakeholder communication

- Others (planning of transport routes and timetables, search for suitable vessels, reservation of port services)