Appendix A
Functional analysis of Sea Technology Floating Terminal
- stakeholder requirements and response

Project TRV 2022/108064 Sea Technology Terminal
Report 2024-10-31

Preface

The project is a collaborative work between Sea Technology, as an entrepreneur and technology developer, and RISE, as a leading research institute in Sweden, which enables the combination of practical application of results at the same time as the research front in the field is moved forward.

In this report all stakeholders and customers are identified and an effort is made to anticipate their interest and requirements for participation. Some of the anticipated views of customers need to be verified through interviews.

An important part of the project is to contribute to the promotion of rapid transformation of container shipping into the environmentally friendly mode of transport that is needed and within reach.

As this report is part of an ongoing R&D-project supported by Trafikverket an important group of readers are those who will take over and further develop the project according to the project plan. A number of interviews are to be made with our identified customers and stakeholders in later stage.

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Abstract

Abstract

The Floating Platform is a floating island, a floating port, with a capacity to berth Ultra Large Container Vessels (ULCV) on one side and transfer containers over the platform to feeder ships on the other side by robots, i.e. autonomous cargo handling equipment. The economy of scale talks for ULCV on long distance and feeders on short distance. The platform will ease congestion in the major ports and release the roads from heavy traffic. When fully utilized the platform will have a through-put of around 5 - 6 million TEUs.

The platform is developed aiming to be sustainable with regard to the environment. In the first stage the diesel generators needed for electricity will be fuelled by bio-diesel. In the next stage we introduce Small Modular Reactor (SMR) on board for the purpose. Then there will be electricity enough to produce fresh water and/or electricity to sell to closely located cities on shore. Feeder vessels may be run on fossil-free fuel and in some cases for shorter distances on batteries.

In this report all stakeholders and customers are identified and an effort is made to anticipate their interest and requirements for participation. Some of the anticipated views of customers were verified through interviews reported in the main report[1]. However, the study concludes that the STFT is ready to be integrated in the supply chains of major container routes.

1. Method

Initially the method conforms to Quality Function Deployment (QFD) in the way stakeholders and customers are identified. The functional requirements of stakeholders and customers are described by judgement from professional experience, reading homepages of mentioned stakeholders and customers and in a few cases by interviews. The value of the exercise is to bring to the surface what we can assume is of interest in order to prepare interviews with key persons in our industry. Further on there is a description on how functional requirements are met by a selection of equipment with measurable features. Supply chains are derived from a homepage "Fluent cargo" which gives numerous of supply chains for each given couple of "starting point – end point". Fluent cargo is educational for anyone interested in trans ocean services.

The description of STFT as a "green hub" is inspired by requirements from planned wind farms around the Swedish coast.

2. Limitations

An approach like this deploying QFD should involve a team of expertise and a large number of interviews. The interviews based on the pre-analysis and structure presented here were documented and further analysed in the main report[1].

3. Background

The project supported by The Swedish Transport Administration (Swedish: Trafikverket) is a collaborative project between Sea Technology, as an entrepreneur and technology developer, and SSPA/RISE, as a leading research institute in Sweden, which enables the combination of practical application of results at the same time as the research front in the field is moved forward.

The "head of family" Bengt Lundqvist is in the community of Naval Architects well known and recognized for the early development of the Ro-Ro-concept introduced already in 1955 by Wallenius Lines. He has experience of the development of new concepts in shipping, many of them realized [*)].

The well-known shipping broker Clarkson contacted Bengt Lundqvist in year 2015. Clarkson's had observed congestion in ports both on the sea side and inland. Shortage of berths and shortage of land to expand and congested roads around the ports in many places around the world.

This is the background to an intensive development of the platform. It would have been good to have a customer all along, but STFT have managed to come far without. The platform has a detailed specification and three South-Korean ship yards have offered to build. Building time is about three years from the time of order. Technically it is in principle ready to be ordered, however, when a customer shows interest there is of course a lot to go through and some modifications to the request of a customer will take place.

STFT has already negotiated with subcontractors who all sit on essential knowledge that can only be fully utilized with the understanding of this complex product. Anyone who starts from scratch may use less experienced engineers and the risk of costly design mistakes is not to be ignored.

The purpose of this part-study is to deepen the understanding of stakeholders and customers that are needed to fully utilise the potential of the platform.

The platform will arrive to an environment where transhipping between Ultra Large Container Vessels (ULCV) and feeders is already utilised.

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*) Design of

- the first Pure Car Carrier (PCC) 1972
- offshore drilling Unit in The North Sea
- new tankers with dedicated clean water ballast tanks
- shipyard´s developments
- vault welding

4. The problem to be solved

Port congestion is widespread both on the sea side and around cities onshore which makes container shipping increasingly difficult around the world. Limited space for expansion and precious land that can be used for housing make it difficult for major ports to meet the increased demand. The congestion problem in ports causes delays and higher costs. The problem will not decrease as volumes and vessel sizes increase. Our hypothesis is that floating platforms for trans-shipping can solve the problems and at the same time contribute to sustainable transport on land and at sea.

5. Typical ships in container traffic

5.1 Ships

Currently, several types of container vessels are available, each with distinct features based on their size, see Table 1 and Figure 1. ULCVs are designed for very long distances, such as routes from Asia to Europe. Their economies of scale make them advantageous, with lower fuel consumption per TEU and reduced crew and administrative costs. Recent studies show that it is economically justified for container shipping lines to increase ship sizes to 25,000 TEU in a short period (Ge et al., 2021). The main reason for this is that as ship sizes increase, the unit cost of fuel consumption, maintenance, and materials declines.

Table 2 - Different types and sizes of container ships as referred to in literature

Type and capacity in TEU	Principal particulars – typical max LxBxT
Feeders less than 500 TEU	length and draft: 100x7.3 m
Feeders max 999 TEU	length and draft: 140x8.8 m
HANDY 1000 – 1999 TEU	length and draft: 190x11.4 m
SUB-PANAMX 2000 – 2999 TEU	length and draft: 227x12.0 m
PANAMX over 3000 TEU	length and draft: 294x12.6 m
POST-PANAMAX 3000 – 7999 TEU	LxBxT: 370x43x14.5 m
POST-PANAMAX+ 8000 – 9999 TEU	LxBxT: 350x45.6x14.6 m
SUPERPOST-PANAMX 10000 – 15000 TEU	LxBxT: 399x56.0x16.0 m
ULCV all above 15000 TEU	LxBxT: 399x60x17.5 m
*A large number of ULCV of 24.000 TEU were delivered during 2023	

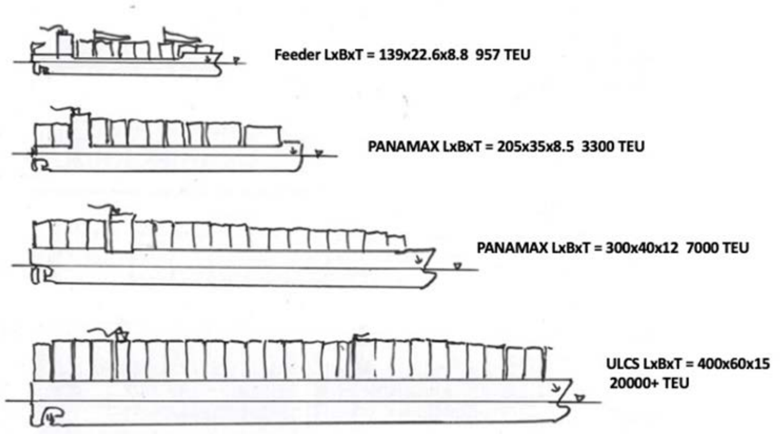

Figure 1 - Container ships of different size

5.2. Fairway limits

The Suez canal - the current channel depth of the canal allows for a maximum of 20.1 metres of draft. There are plans to increase the permitted draft.

The Kiel canal – Max ship length 235 m; max ship beam 32.5 m; max draft 9.5 m

The Store Baelt fairway Depths limitations:
Dybe Rende (the deep trench) In clear weather vessels can transit Store Baelt in a least draft of 12.8 meter.
The controlling draft in the passage through Store Baelt for Route T is 19 meter except for the northbound lane through Osterrenden where the maximum draft is 17m. The controlling draft in the passage for Route H is 12 meter. This route is mandatory for vessels with drafts of 10m or less.

Skandiaporten – a fairway to the port of Gothenburg - the deepening of the fairway from 13.5 up to 17.5 meters will permit ships dimensions : LxBxT = 430x65x17.5 m according to the homepage of the port.

6. Megatrends

Valuable cargo is transported in containers. Future container traffic is expected to increase more than GDP. Due to economy of scale increasingly larger ships - these Ultra Large Container Vessel (ULCV) replace medium size container vessels. Most ports have problem with ship´s draft as ULCVs take over traffic. At boom the largest container ports are congested with queues to the quays. This applies to Rotterdam, Gothenburg, Shanghai and more. Hinterland roads are congested.
These problems and more can be solved with an outsourced floating terminal located in deeper water outside. World population and sea transport grows rapidly together.

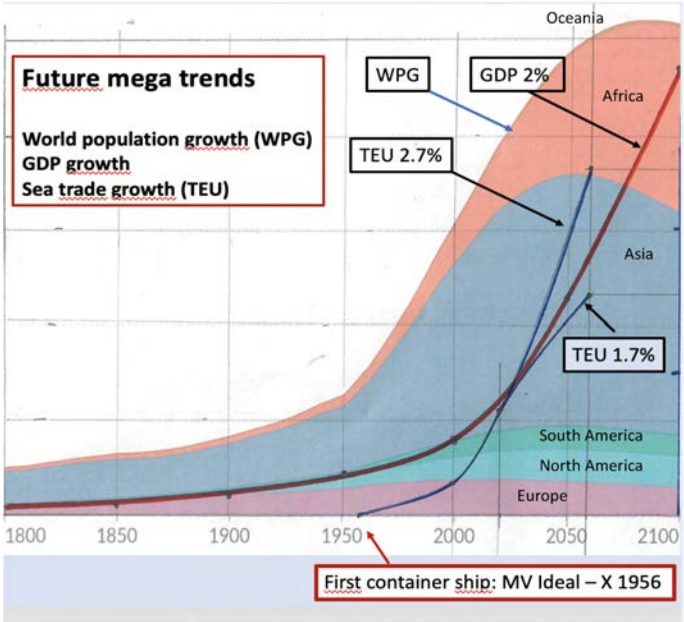

Figure 2 Mega trends
World population growth (WPG) is indicated to peak around 2090, while Gross Domestic Product (GDP) worldwide is expected to continue grow with about 2% annually. Most of the dry cargo will be transported by containers (TEU) which is indicted to grow at the most by 2.7% and at least by 1.7%; This graph is based on Our World in Data. Source: https://ourworldindata.org/region-population-2100

7. The economy of scale is driving force for the capacity of the ships

The economy of scale talks for ULCV on long distance and feeders on short distance, see figure 2.

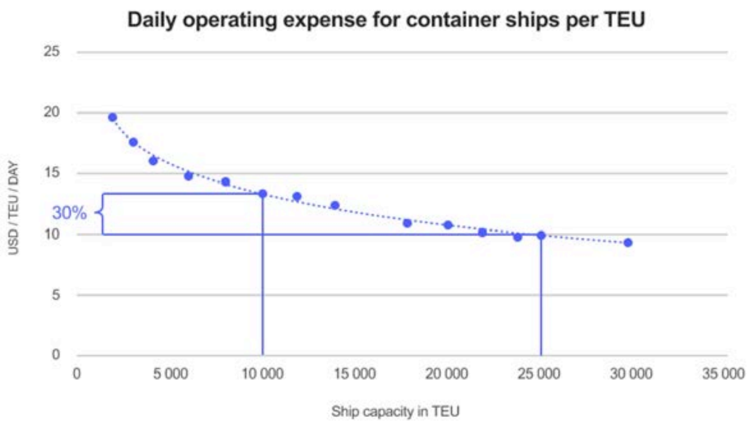

Figure 3 Daily Operating Expenses for Containerships per TEU
Source: Alphaliner
https://transportgeography.org/contents/chapter3/transport-costs/operating-costs-containerships/

8. Stakeholders and customers identified

A customer is someone that pays for the whole thing or for services
A stakeholder is someone who has views and influence on the realization of the product without being the final customer. A stakeholder may be a physical person or group of persons or a legal person - state, port etc - who benefits or is harmed with direct or indirect economic consequences i.e. taxpayers or neighbours.

Table 3
Stakeholders and customers with their requirements and expectations

Stakeholder/ customer	Description	Functional requirements and expectations (Voice of the customer)
Financiers	Contributors with money together with final owners of STFT	STFT should provide good business and give return to invested capital in accordance with agreement; solve port shortcomings
STFT owner	STFT owner may be the same as a nearby coastal port owner The owner is responsible for the quality of long term maintenance	STFT should operate with low maintenance costs and without interruption to provide good business and give return to invested capital
Major port owner in the vicinity of STFT location	The port owner is usually a municipal or a state who owns the land and the equipment installed to make it a port	STFT is seen as a possible extension of the land based port alternatively considers the platform a hostile investment by a competitor
STFT operator	STFT operator may be the same as a nearby coastal port operator	STFT should operate without interruption to provide good business for the operator meaning that STFT must provide # easy access to the platform for ships, supply ships, workboats and helicopters # quick and reliable mooring of ships coming and leaving # steady platform (very little motion of the platform in all directions) # good overview of operations on the platform # low conflict with fairways
Small and Medium-Sized Ports (SMSP) i.e. coastal container port owner	The port owner is most likely a municipality	STFT should provide - easy integration with ordinary business of the coastal port - synergies with coastal ports
Coastal container operator of the SMSP	The operator may be a private company or the port owner	STFT should provide easy integration with ordinary operation of the coastal port with synergies versus coastal ports
Workers and workers union with the logistics	Most of the logistics will be handled by autonomous vehicles but some displacements may have to be handled “ad hoc”.	STFT should provide - means of clear communication - safety measures to avoid hazardous conflict with autonomous vehicles

IMO	Responsibility: Safe fairways in stationary operation and safe towing	STFT must fulfil all international regulations of a floating platform through fulfilment of conditions required by Maritime authorities
National Maritime Authority	General safety for everyone in physical contact with STFT Safe conditions for workers and subcontractors. Deliver certificates on IMO-regulated safety measures that has been given status as law.	STFT provides all by Maritime authority required information
Classification Society (DMV. LR, ABS…)	The purpose is to control and deliver certification of structural integrity and mechanical function in agreement with high standard in order for Insurance companies to accept risks.	STFT interact with Classification Society and delivers required information. This information is listed in rule books.
Ship owners	Large Container (ULCV) ship owners Feeder vessel owners	In the end STFT delivers the platform. A shipowner may want to participate in finalization of the concept
Ship brokers (ex. Clarkson)	Shipbrokers are specialist intermediaries/negotiators between shipowners and charterers	STFT interacts with a mayor ship broker in order to pick up important information to make operation smooth
Newbuilding shipyard	Main shipyard and subcontractors	STFT finalizes the technical specification and requires the final offer. Writes the contract together with shipowner and other financiers STFT follow up the construction work at the ship yard
Subcontractors to newbuilding shipyard	Delivers control systems, engines and pumps etc.	Together with the ship yard STFT provides subcontractor with best information of subcontractors' contribution to the system
Repair yard/subcontractors on maintenance of STFT under operation	The repair yard/sub-contractors have different knowledge, products and services -structure -machinery -IT (overall logistics and autonomy vehicles)	When required by the repair yard STFT interacts with mayor subcontractors in order to provide the project with best offers (price and delivery times)
A nearby city in rural Africa or South America or other undeveloped countries	A town in within short distance by sea from the platform	Interested in buying fresh water or electricity from STFT
The general public	Can be represented by NGO such as Confederation of Swedish Enterprise (Svenskt Näringsliv) Swedish Confederation of Professional Associations (SACO) Swedish Confederation of Professional Employees (TCO) Swedish Union of Clerical and Technical Employees in Industry (SIF) Swedish Trade Union Confederation (LO) Central Organisation of the Workers of Sweden (SAC) The general public will appear through newspaper and TV	Either direct or through relevant magazines and media inform the general public of new logistics for supply chains i.e. container transportation and energy supply

9. Deeper description of stakeholders and stakeholders' interest

- this description is based only on personal prejudgment. Most of them were confirmed by interviews reported in the main report[1]. The preparation for interviews were supported by these descriptions.

9.1 Financiers

Find below some thoughts on possible financiers. Some of these thoughts can be replaced by the resulted interviews.
What financiers need for a decision to contribute with a substantial amount of money

General requirements
Before involvement it is likely that financiers without deep knowledge of shipping will see a ***binding offer from the shipyard*** that also includes important subcontractors as well as ***certificates and environmental permits*** and ***a selected operator*** who can develop the logistics during the three-year construction period

Pension funds

- *Sovereign funds*: Funds controlled directly by the state. This ranking only includes sovereign funds that are established by national authorities.
- *Public sector funds:* Funds that cover public sector workers such as government employees and teachers in provincial or state sponsored plans.
- *Private independent funds:* Funds controlled by private sector organizations that are authorized to manage pension plans from different employers.
- *Corporate funds:* Funds that cover workers in company sponsored pension plans.

We may assume that pension funds are not very interested in the technology in itself. They want return on invested money. They rely on the reputation of the developers and future owners.

STFT needs to show an agreement with and owner and possibly an operator before they invest. Then there is probably almost unlimited money for investment. Their required return in % is up for negotiation. Find below a link to worlds larges funds.
https://www.visualcapitalist.com/worlds-100-biggest-pension-funds/#google_vignette

A consortium of 7 – 8 banks. One of the banks take the lead. They may like to take risk if there is a god prospect of return of the money. A consortium of banks have a similar attitude to the investment as pension funds. Some banks may have market specialists and thus more interested in the particular business.
STFT needs an agreement with and owner and possibly an operator before they invest.

The World Bank or the World Bank Group is an independent supranational organization that works together within the framework of the UN's Economic and Social Council. It consists of five international organizations responsible for providing financial assistance and advice to countries with the aim of promoting economic development and eradicating poverty.

The World Bank Group finances over 1700 investment projects in some 130 countries in a wide range of industries and sectors. About 80 percent of total financing each year is in the transport water & sanitation and energy & extractives sectors. World Bank assistance is generally long-term and is funded by member country contributions and by issuing bonds.

Investment Project Financing provides financing to governments for activities that create the physical/social infrastructure necessary to reduce poverty and create sustainable development.

The Bank approves over 200 projects in the course of a year. The task of identifying and proposing projects for World Bank financing lies mainly with borrowing governments.

Example: West Africa Coastal Areas Resilience Investment Project (WACA) The WACA program enables participating countries to stabilize the coastline prevent the loss of critical infrastructure such as coastal roads for transportation and preserve the health and productivity of coastal waters.

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In order to receive support from World Bank we most likely need to contact a country that has some earlier experience from World Bank support, like a West African country.
If they think there is a great opportunity, then an application may support the investment.

It’s not unlikely that US are interested in protecting hegemony by investing in a port in West Africa. Then a merge of mutual interests between US and Guinea Bissau could give it a push forward thus influencing The World Bank Group.

Example of a trigger: An application from Guinea Bissau supported by other countries, among others USA .

Individual billionaires, for example Elon Musk, Bill Gates at.al.
https://en.wikipedia.org/wiki/The_World%27s_Billionaires
Swedish billionaires are a factor of ten lower in wealth than the world's "top ten" above.https://sv.wikipedia.org/wiki/Lista_över_svenska_miljardärer_(2023)

In order to approach successfully individual billionaires, I think one needs to reach them through someone they know well – a Champion. They may take a particular interest in the environmental green approach to strengthen their trade mark. If it is good for humanity and no back lash, then there is money.
A trigger: Convince with “green” trade mark improver.

9.2 STFT Owners

Find below examples of potential owners and a discussion of what do they need for a decision to buy the concept

I think that a potential owner ***may want to participate in the development*** rather than buying a “key-ready” platform.
A large ship owner with experience of ULCVs; find below in order of importance sorted after capacity of their fleet with number of ship x mean capacity in TEU per ship; Number of ULCVs

- **MSC** (Switzerland/Italy) Capacity = 740x6530 TEU = 4.832.709 TEUs
- **Maersk** (Denmark) Capacity = 696x6014 TEU = 4.185.693 TEUs
- **CMA CGM** (France) Capacity = 604x5645 TEU = 3.409.776 TEUs
- **COSCO** Shipping Lines (China) = 464x6222 TEU = 2.886.908 TEUs

Total capacity in the world is abt. 27.000.000 TEUs

MSC - It is not possible to find out what they need from their annual business report. Wordings from the CEO are very general.

Maersk is a more technology-oriented shipowner as the company has managed as owners of shipyards and operated container ports. Maersk has the most exiting annual reports. Maersk are working with many "green" solutions.
https://ml-eu.globenewswire.com/Resource/Download/2f63098a-d33e-41d9-9eb0-068bb0c3eb04
CMA CGM have a relation to China and Taiwan, which means rather close contact with a coastline with local ports.
COSCO is of course also related to Chinese ports by the Chinese state. The platform STFT could make good service along the Chinese coast.

9.3 Major port owner in the vicinity of STFT location

A minor remark on a potential owner in the vicinity of the STFT platform: It is of course of great interest to have an owner that can cooperate closely to a nearby land based port. The opposite, with a harsh competition is most likely in the long term not sustainable

An example of ranking of the support given by ports is here given by **CMA CGM Group** (logistics consultants) 'rank' ports as being supportive to shipping operations?
Citation from CMA CGM:

Commercial aspects
- Marketing intelligence
- Loyalty of shippers to "their" port
- Ports activeness with local agents regional offices shipping Lines' management
- Ports sharing their vision of developments
- Ports contributing to the densification of their region's / country 's inland networks

Nautical aspects
- Ports keeping abreast of increasing vessels' size
- Water depth
- Turning circles
- Quay wall strength
- Contribution to manoeuvres with simulators

Operational aspects
- Watching filling factors of terminals
- Monitoring performances
- Berth productivity
- QC productivity
- Idle time at berth
- Waiting upon arrival

9.4 Operator of the new floating trans-shipment terminal - STFT
- what do the operators need to involve themselves with in the concept of STFT?

We have at least two kinds of operators of the platform. One is the owner who within its organization employs a team of operators. The operation is "outsourced" to a company that makes a business deal with the owner. In this case the length of the contract may differ and the boundaries of the agreement. The consequences of these differences is something that can be explored later on.

Most likely the operator will start planning of operation of the system when there is an owner of STFT and the platform is known in all details, i.e. it is under construction at the shipyard. However, the operator may prefer to be involved in the final design of the platform, in particular with the cargo handling equipment. The following things are of interest for the operator:

- Tug boats available to tow ships to the quay-side of the platform needed
- Capacity and reliability of the AutoMoor - Trelleborg's rope-free automated mooring system, i.e. number of items and quality
- Capacity, flexibility and reliability of the ULCV side gantry cranes – container ship-to-shore (STS), i.e. number of cranes and quality
- Flexibility and reliability of high performance spreaders
- Capacity and reliability of the autonomous control of the large "ship to quay and reverse" gantry crane operation.
- Capacity and reliability of autonomous Rubber Tyred Container Gantry Crane RTG, , i.e. number of cranes and quality
- Redundancy system for the in case of trouble with the equipment on the platform
- Capacity, flexibility and reliability of the gantry cranes on the feeder ship side of the platform – container ship to quay and reverse, i.e. number of cranes and quality
- Enough space for container storage between the ULCV side and the feeder side of the platform.
- Offices for the logistic planning and the remote control system of that system
- The operator or his subcontractor will be responsible for all service that is required from the ships during their short stay. This means that the operator must have overview of the capacity of ballast water supply, fuel supply, lubrication oil supply, other kind of bunker needed (food, drinking water…)
- Green electric power for both the operation of all loading and discharge equipment
- Green electric power for supply of the ships

9.5 Coastal container port owners and operators
– what do they need involve themselves with investments in the STFT?

STFT is seen as a possible extension of the land based port. STFT must operate without interruption to provide good business for the operator meaning that STFT must provide easy access to the FCT for ships, supply ships, workboats and helicopters. It is also required to have quick and reliable mooring of ships coming and leaving. The FCT must be a steady platform with very small motions due to waves from all directions. The operators must have good overview of operations on the platform to control the autonomous cranes and RTG that moves the cargo. The FCT must be positioned with low conflict to ordinary traffic in the general fairways
A large number of small and medium size ports are identified (SMSP).

Some of the SMSPs will most likely have a lot more activity in the future after the establishment of STFT in Kattegat as the main idea of STFT is to move traffic from roads to short sea shipping.
In short, most of the SMSPs will experience increased traffic before they make big investments. However, a good logistic research study about the future of the ports is needed to encourage investments.
The typical investment will cover

- Negotiations with stakeholders
- Quays and loading equipment
- Roads for local road distribution

https://www.marineinsight.com/know-more/major-ports-in-the-baltic-sea/

9.6 Workers and workers union

- Transport Workers' Union/Harbour worker´s Union – what do they need to welcome this innovation?

The importance of the trade unions must not be underestimated in our development of a new transport system. Transport Workers' Unions are more international as the trade is global.

The International Transport Workers' Federation (ITF) is a democratic affiliate-led federation recognised as the world's leading transport authority. ITF organizes 740 affiliated trade unions from over 150 countries. There are 18.5 million working men and women across the world in transport business, both sea trade and road transport.. The headquarter is located in London with offices in Abidjan Amman Geneva Hong Kong Montreal Nairobi New Delhi Panama Rio de Janeiro Singapore Sydney and Tokyo.

https://www.itfglobal.org/enhttps://www.itfglobal.org/en/sector/seafarers/container-safety
https://www.itfglobal.org/en/sector/seafarers/sustainable-shipping

9.6.1 Transportarbetareförbundet

The Swedish Transport Workers Union, Transport, was formed in 1897 on the initiative of Charles Lindley and is one of the fourteen trade unions that are part of the National Organization in Sweden (LO). Transport publishes the magazine "Transportarbetaren" and the union has the slogan: "We work for political, social and economic democracy". The Union has approximately 57,000 members – not only sea trade then. The association organizes a number of different industries and professional areas mainly within the transport industry, cleaning and the security industry.
In 1972 a number of dock workers broke away from Transport and formed the Harbour Workers' Union (Svenska Hamnarbetareförbundet). Since then the two unions have competed with each other to organize the dock workers.

9.6.2 Svenska Hamnarbetareförbundet

The Swedish Harbour Workers' Union is an independent trade union that is not part of any national organization such as LO or SAC. The union is a member of the organization IDC (International Dockworkers Council) and through it has a strong contact network that extends all over the world.
From what is written above we understand that trade unions are powerful. One need to understand ”what´s in it for them”.

General observation concerning interaction between STFT operators and workers unions
Trans-shipping i.e. reloading from ULCV to feeders is a normal procedure. Feeders distribute cargo along coastlines in short sea shipping in competition with lorry cargo traffic.
The platform STFT will have impact on the supply chains. Transport Workers' Union may have influence on the successful establishment of the platform STFT as it will move traffic from roads to short sea shipping.

Also, some work opportunities will be lost in the port. However most of the work in the largest ports is already performed with autonomy systems. The Unions will most likely have no influence on the operation of the platform STFT itself as the operation is to be fully autotomized. Unions may have indirect influence as by their members being present in other parts of the supply chain, i.e. some early contacts with unions may be of value.

9.7 IMO - how will IMO interact with the process of certification of STFT as a floating platform

IMO and the National Maritime authorities. As it is a fixed moored installation international conventions such as SOLAS and other IMO governed regulations do not apply as it is not a ship or maritime at least as far as the platform part is concerned. Possibly the Swedish Maritime Administration (Sjöfartsverket) may have views on shipping routes. The Swedish Transport Agency (Transportstyrelsen) handles rules and supervision for Swedish ships but will probably not be the licensing authority in this case. This is closer to a permit such as for offshore wind power which is discussed extensively these days. See further information at The Sea and Water Authority (Havs- och vattenmyndigheten)

https://www.havochvatten.se/arbete-i-vatten-och-energiproduktion/vindkraft-till-havs/tillstand.html

9.8 Ship owners in the container trade - feeders and ULCVs
– How will they react before and after the establishment of STFT?

This question can be answered properly only by interviews. However, some thoughts could be fruitful as preparation before the interviews.
The platform is supposed to offer full service to the ships. It is important that this service is supplied during the discharge and loading time. Quay is the most expensive part of the platform. It must not be the bottle neck of the operations. Most of the service is only by bringing bunker fluids into the ships and waste water off the ship through pipes or hoses by pumping. Any dry bunker is much quicker to load and discharge. All this requires its own logistics. The communication about the service must not be ad hoc but planning in advance is important for keeping time. If electronic or mechanical maintenance work is required by the ship owner/fleet manager this must be done in the short time off discharge and loading containers. This does not differ much from the praxis at shore ports. As most ship owners have a broker to handle the contacts with ports and other ship owners it should be enough to have the views of the brokers on the logistics of cargo handling.
Any risk of damage to the ships that can be linked to the platform is handled by the insurance companies

9.9 Ship brokers
– What will their role be in the establishment of STFT

Shipbroking is a financial service which forms part of the global shipping industry. Shipbrokers are specialist intermediaries/negotiators (i.e. brokers) between shipowners and charterers who use ships to transport cargo or between buyers and sellers of vessels.
We believe that ship brokers need to be interviewed in order to fully understand the complexity of the establishment of the STFT in any environment. I fact, the first idea about the STFT came up in early discussion between ship broker Clarkson and naval architect Bengt Lundqvist. The documentation of general requirements on the STFT is extensive and available for internal use within the project.

9.10 The newbuilding shipyard has been deeply involved in the project since 2016 and has offered to build.
9.11 Subcontractors to the newbuilding are dependent on the ship and sometimes on the customer.
9.12 Subcontractors for the maintenance of STFT under operation will have influence on the design. This is further studied in https://kth.diva-portal.org/smash/record.jsf?pid=diva2%3A1599590&dswid=-527

9.13 The general public has not yet been approached. However, the team has several members with experience to simulate the general public. In the next phase it is of interest to perform an survey.

10. The STFT response to stakeholders requirements

The STFT has been developed to meet stakeholder and customer requirements, see Table 4. The platform's size and capacity are designed to serve ULCVs, which currently have principal dimensions of LxBxT 399x61x17.5 m and a capacity of up to 25,000 TEU. Future growth in vessel size is anticipated, and the STFT must be equipped to meet this demand. For ease of reference, although the STFT is not a "ship" per se, this paper will refer to the accommodation block as fore end, the machinery as aft end, the ULCV side as port, and the feeder side as starboard.

Table 5 – Technical data of STFT to meet customer requirements

Item	Data
Outline Specification	STFT in-shore type Kattegat Terminal; April 2024
Principal particulars	LxBxD 600/700x360x30 m
Two extensions for superstructures:	Dimensions: 2 x 120 x 50 m
Draft and freeboard	17 meters draft and 13 meters freeboard = quay height
Displacement	at draft = 17 meters the displacement is 3.876.000 m^3
Container stowage capacity and payload	60.000 TEU
Weight of containers and consumables	1.000.000 tons
Ballast water capacity	3.300.000 tons
Services for ULCV and feeder ships	ULCV with 30.000 TEU
Platform for cargo	215.000 m^2
Handling equipment	automated rubber-tired gantries (RTG)
Fresh water tank capacity	100.000 tons
Production of fresh water	Enough to service all ships and the crew of the platform
Diesel/Methanol oil capacity	100.000 tons

The port side of the terminal will be served by ten fully automated, state-of-the-art ULCV ship-to-shore (STS) cranes with an outreach capable of serving up to 25 rows or more. The current generation of the largest ULCVs can carry containers 23–24 rows wide on deck. The extended outreach of these cranes allows for the "next generation" of ULCVs, above 25,000 TEU to operate with the STFT.

The starboard side of the STFT, the "feeder side", can serve several feeder vessels simultaneously within the total available "quay" length of 600 meters. This side is equipped with 12 STS cranes, with an outreach capable of serving vessels up to 20 container rows wide~~.~~ ~~(~~A 5,000 TEU Panamax container vessel is typically 13 rows wide, while the new generation of 5,000 TEU wide-beam vessels typically has 15 rows~~)~~. The annual throughput of the STFT is projected to be around 5–6 million TEU, sufficient to support two ULCV services operating simultaneously, i.e., two ULCV calls per week. Theoretically, the STFT could handle three

ULCV services with an annual throughput of approximately 2.8 million TEU, though practical limitations, such as feeder capacity, may prevent this.
The STFT cranes are designed to accommodate any foreseeable future upsizing of feeder vessels. For container transitions and stacking on the terminal deck, whether side-to-side, along the ring line, or other stacking movements, 50 battery-operated mover-units will be installed. These units include rubber-tyred gantries, straddle carriers, stacking cranes, shuttle carriers, automatic guided vehicles, forklifts or equivalent equipment.
A fully automated system will be implemented for loading, discharging, moving, and stacking all containers, including movements to and from vessels, the terminal deck, and all onboard stacking operations. This system will be managed from the control and command centre.
The STFT has an operational draft of 18.0 meters, providing a "quay" height/freeboard of 17.0 meters. There will be five internal deck levels, from top to bottom: the terminal deck, three intermediate decks, and the bottom deck. The bottom deck and the double bottom will primarily house ballast water tanks.
The terminal deck has a total area of approximately 215,000 m² (about 22 hectares), providing storage for around 36,000 TEUs and a total load capacity of about 600,000 metric tons. The technical lifespan is estimated at 60 years.

10.1 The STFT is a design that will meet the requirements with following features

- At the short end of the platform speed boats, supply ships, dedicated tug boats have access to platforms/lower quays.
- On the ULCV side there is ten (10) fully automated state of the art ULCV-STS cranes with outreach able to serve 25 rows of containers or more on an ULCV with suitable spreaders
- On the “feeder side” there is 12 STS with outreach up to 20 rows of containers
- The deck is about 215,000 square meters giving storage of 36,000 TEU and a total load of 600,000 metric tons.
- The annual throughput is in the region of 5 – 6 million TEU per year. There is a superstructure with living quarters with 250 cabins, a command centre on top and a helicopter landing.
- Large tank volumes for all desired bunker: fuel, lubrication oil, water
- Water purification systems for drinking water and all kinds of waste water.
- Electric power supply from gen-sets are initially operated on bio-diesel, later on Small Modular Reactor (SMR). Biodiesel will be economically imported in large quantities and stored on board of STFT both for generation of electricity and to be pumped over to ships
- The platform will include 3000 charging points for refrigerated containers, each 10 kW. When all this are connected the power requirement from refrigerated containers alone will be 30 MW + power loss in the cabling.
- Technical Lifetime of 60 Years can be reached with an ambitious maintenance system[2]
  http://kth.diva-portal.org/smash/record.jsf?pid=diva2%3A1599590&dswid=-658

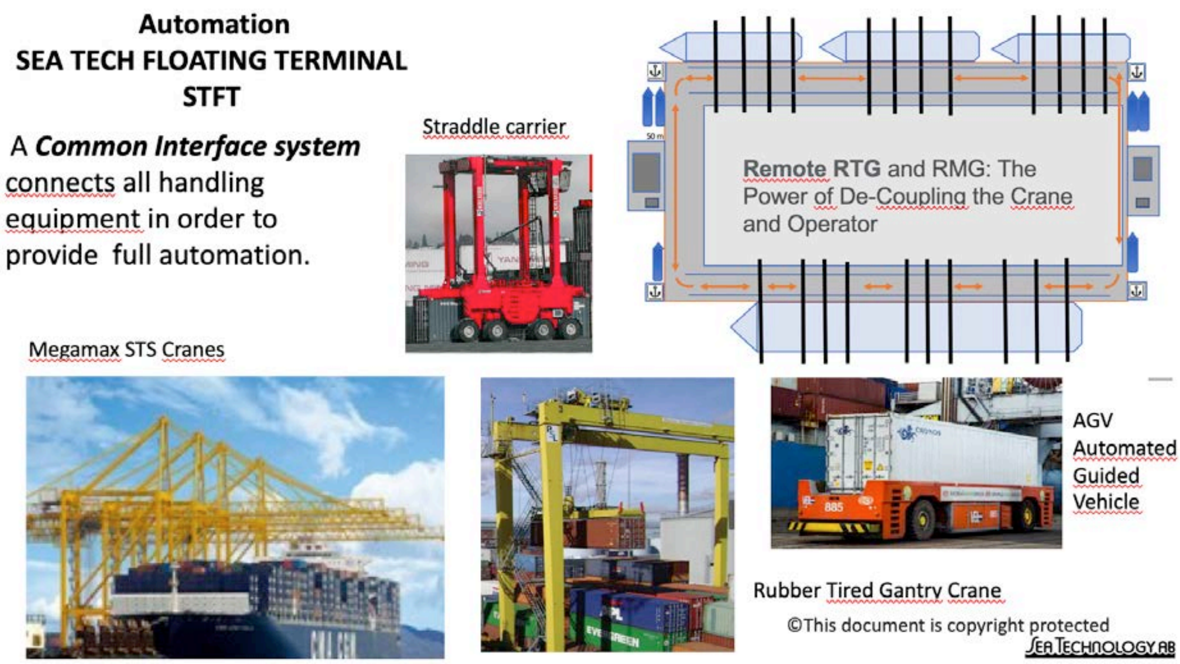

Figure 4 Example of autonomous equipment to move containers on the platform

10.2 A maintenance system for technical lifetime of 60 years

A MSc-thesis[2] work has investigated the opportunities to reach a prolonged lifetime of the floating platform. The purpose was to show how to provide a technical lifetime of 60 years. The work has identified life limiting factors in need of extended efforts, examining possible remedial approaches, and providing recommendations of implementations of these approaches to make a technical life of 60 years and economically feasible technically possible. The method was based on Systems Engineering and in particular inspired from quality function deployment or QFD.
Based on the thesis Sea Technology can develop a design strategy and a maintenance strategy to meet these requirements through a technical life of 60 years.

11. Overview of sea and river ports in the Nordic Countries with turnover in numbers

Approximate present container cargo flow annually around a STFT in Kattegat is
Finland 2 MTEU, Russia 2 MTEU, Klaipeda 1 MTEU, Poland 4.5 MTEU, Gothenburg 0.9 MTEU, Sweden Baltic 1,2 MTEU, Denmark 1 MTEU, Norway 1.5 MTEU, Iceland 0.5 MTEU and Baltic Sea all others 1.5 MTEU adds up to 25 MTEU.
When STFT is in place it handles 5 - 6 MTEU which is initially a reasonable capacity for business.
The following graph is produced in order to show potential for intermodal container shipping around a trans-shipment terminal STFT in Kattegat, figure 5.

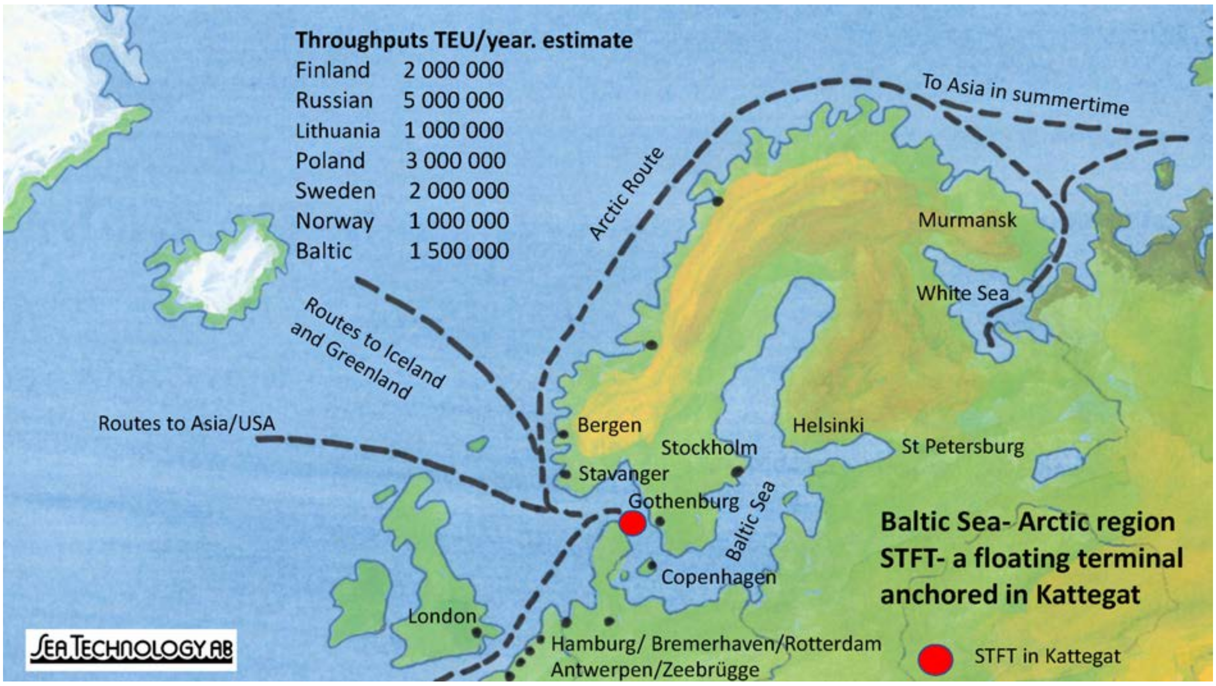

Figure 5 Overview of sea ports and fairways in the Baltic Sea-Arctic region

The graph gives an overview of fairways and ports around STFT located in Kattegat. The Arctic route may in the future, when the Arctic sea ice is gone due to climate change, pass over the North Pole directly to the main Asian Ports of Japan and China.

Sea and river ports in the Nordic countries

Here follows sea and river ports along the Swedish coast with the container sea terminals marked with red dots. The information comes from the link of SEARATES.
https://www.searates.com/maritime/sweden

There are numerous of other smaller and larger ports for other purposes than containers. Most of these ports are small or very small. Full information can be reached through the link above.

The link gives also dry ports inland. The red marked in the map are selected - will take containers, however some of these ports are today “Ro-ro”-ports.

Figure 6 Swedish ports

In 2020, nearly 1.6 million TEUs of containerized goods were handled in ports in Sweden. This was the second-highest volume of containers processed at Swedish ports in the observed period. The highest volume was recorded in 2019 when some 1.63 million TEUs of containerized goods were handled at ports in the country. https://www.statista.com/statistics/1279034/volume-of-containers-handled-in-sweden-annually/

In the following the description of a few container ports in Sweden are given. When utilizing the homepage/link Fluentcargo on these ports on the distance Shanghai – actual minor port we notice that we need rail or truck to finalise the supply chan. This effort is not done for all ports in this report. It is only to show a method of analysis and to open up the mind of the reader.

Gothenburg – the major shipping port in Kattegat

AP Möller is operating the APM Terminals of Gothenburg, the largest container port in Scandinavia. It is able to handle the world’s largest 24,000 TEU-vessels, presently by discharge part-load in Rotterdam due to limited depth, ay the maximum depth in Gothenburg's harbour is today 13.5 metres. The container throughput of Skandiahamnen is slightly short of 1 MTEU per year. In the first half year of 2023 there was a through-put of 446 TEU, which was 3% up from the previous year. The terminal handles around 20 port calls each week, including direct calls from other continents as well as feeder vessels from other ports in northern Europe. There are plans to deepen the shipping channel for “Skandiaporten”. Once completed in 2026, the terminal will be able to operate at its full potential. Free of tides and ice, the terminal operates all year round. It is possible to follow the traffic on a map over the harbour to and from the port in “real time” by the link https://www.marinetraffic.com/en/ais/details/ports/350?name=GOTEBORG&country=Sweden

Rail connections between Gothenburg and Swedish industry. Over 70% of Swedish industry is located within a 500 kilometre radius. The terminal has on-dock rail facilities with specialist cranes and six rail-shuttle tracks and a rail length to accommodate three full-length trains (750 m). More than 70 rail shuttles per week offer easy access to the most important Swedish logistical nodes. Approximately half of all containers to and from the container terminal are transported by rail today.

Piteå
UN/LOCODE: SEPIT
Max length/breadth of ships 250 m/35 m
Fairway depth: 11.2 m
Good connection with railway
The new rail shuttle was put into service this past weekend and will arrive at the port every week going forward. The 500 meter long train comes loaded with 72 containers (TEU*) of forest products from Piteå primarily intended for the Asian markets.
Piteå is the larger one of Umeå and Piteå when it comes to container traffic.

https://www.fluentcargo.com/search?o=Shanghai+%28CNSHG%29&d=Piteå%2C+Sweden

Umeå
UN/LOCODE:SEUME
Fairway depth: 10.2 m
Good connection with river boats and railway
The port of Umeå is one of the largest ports in the northern Nordic region with an annual general cargo volume of 2.5 million tonnes. Half of the goods are forest products. Other goods are oil feed and project transport such as e.g. wind power components. The port's container volumes are steadily increasing currently approx. 40000 TEU are handled annually. The port is strategically located on the naturally shortest route across the northern Bothnian Sea and has good connections to Finland the continent and Great Britain. The port of Umeå is a year-round port with good conditions for the winter period.

https://www.fluentcargo.com/search?o=Shanghai+%28CNSHG%29&d=Umeå%2C+Sweden

Sundsvall
UN/LOCODE: SESDL
Max draft 11.3 m
https://www.sundsvallshamn.se/om-foretaget/om-hamnarna/
With 800 m of quay and approximately 3 hectares of land it is possible to handle various types of ships and cargoes the port is one of the EU's priority ports so-called "comprehensive port" and thus an important part of the international flow of goods. Annually approx. 1.9 million tonnes of general goods are handled in various ways such as containers or bulk cars and various machines are also handled in the port. The largest player is SCA which stores and ships out its products via the port. The stevedoring operations within Tunadalshamnen have been run since 2008 by SCA Logistics AB. Railway facility: Industrial track unelectrified with a total length of approx. 1100m divided into four gauge tracks.
https://www.fluentcargo.com/search?o=Shanghai+%28CNSHG%29&d=Sundsvall%2C+Sweden

Gävle/Karskär Port
UN/LOCODESEKAS
The Port of Karskär is a very small port in Sweden. See the live map of ship positions in Karskär, schedules for vessels arriving, a port call history, the list of ships currently in port, a company register and the local weather forecast.

Stockholm
UN/LOCODE: SESTO
For containers the port authority refer to Norvik

Södertälje Port
UN/LOCODE:SESJE
For containers the port authority refer to Norvik

Nynäshamn
UN/LOCODE:SENYN
The container terminal in Stockholm Norvik Hamn is operated by Hutchison Ports.
State-of-the-art infrastructure20 hectares450 meters of quay16.5 meters deep at the quay, 8 gantry trucks, 2 super post panamax cranes, 22 unit reach out from crane 65 ton lifting capacity with lifting yoke at 2x20' (twin-lift) 81 ton lifting capacity in hook 500000 TEU per year fully developed. Railway. The container terminal in Stockholm Norvik Hamn is operated by Hutchison Ports the world's largest terminal operator 54 ports in 25 countries. Through the collaboration with Hutchison Ports Stockholm is integrated into global shipping routes.

https://www.fluentcargo.com/search?o=Shanghai+%28CNSHG%29&d=Nynäshamn%2C+Sweden

Norrköping
UN/LOCODE:SENRK
Norrköpings hamn, Pampus port and terminal

Norrköping's container port does not receive the largest ULCV fully loaded due to limited depth. As it is in Gothenburg (before Skandiaporten is realized) you have to unload to enter the port which allows 13.5 m draft.

https://www.fluentcargo.com/search?o=Shanghai+%28CNSHG%29&d=Norrköping%2C+Sweden

Lidköping at Lake Vänern

When Fluent Cargo
https://www.fluentcargo.com/search?o=Shanghai+%28CNSHG%29&d=Lidköping%2C+Sweden
is used the snap-shot gives ten (10) options, all ending with truck transport on roads for distances between 137 km from Gothenburg up to 745 km from Århus.

When a ship broker tries to reach Lidköping by direct ship via a Brittish seaport like Felixtowe or Immingham Fluent Cargo does not give any direct sea transportation to Lidköping. The passage through Trollhättan does not yet permit any efficient container mode of transport. For all these cases the proposed supply chain ends with truck transportation on motorways.

Karlshamn
UN/LOCODE:SEKAN
Quays/Terminals for container traffic. The port has capacity for ships with a maximum length of 200 m and a draft of 10.4 m which means the greater share of the container ships that operate in the Baltic Sea. The port has customs warehouses.

Åhus Port
UN/LOCODE: SEAHU
Åhus Harbour is one of southern Sweden's more significant bulk ports and is southeast Sweden's largest container port.

Malmö
Deepwater seaport – very large
UN/LOCODE: SEMMA
length of ship max 300 m
draft 8.4 m
LOADING EQUIPMENT
Six terminal tractors/tug masters. Three Reach stackers, max 45 t, stacking 5 high, lifting height 15 m, outreach 6,3 m
CRANE. One gantry crane, 45 tonnes under single lift spreader, 60 tonnes under hook beam, outreach 35 m. Malmö Port presents itself together with Copenhagen Port

9.5.1 Container ports in the Eastern part of the Baltic Sea

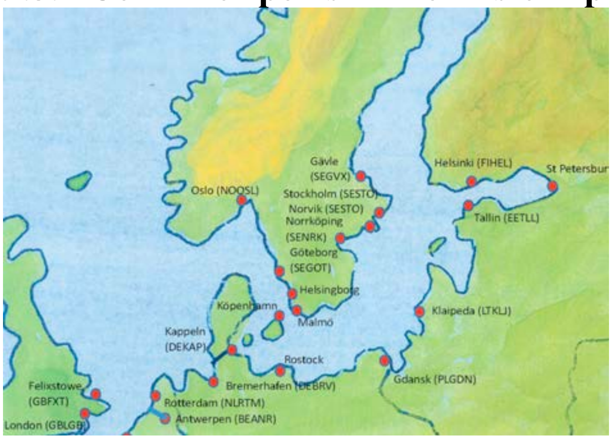

Figure 7 Overview of Baltic harbours

The total container throughput (measured in TEUs - Twenty-foot Equivalent Units) of all ports in the Baltic Sea region is difficult to estimate accurately, as it depends on the specific definition of the region and the inclusion of smaller ports. However, according to statistics from the Baltic Ports Organization, the combined container throughput of the major ports in the Baltic Sea region was approximately 7.5 million TEUs in 2020. This includes the ports of Gdansk, Saint Petersburg, Riga, Gdynia, Klaipeda, Tallinn, Helsinki, Gothenburg, and others. It is worth noting that the container throughput of these ports can fluctuate significantly from year to year due to various factors such as global trade volumes, economic conditions, and competition between ports.

The biggest container ports in the Baltic Sea are:
Port of Gdansk, Poland - The Port of Gdansk is the largest container port in the Baltic Sea and one of the fastest-growing ports in Europe. It handled over 2.4 million TEUs in 2020, which represents an increase of more than 10% compared to the previous year.
Port of Saint Petersburg, Russia - The Port of Saint Petersburg is the second largest container port in the Baltic Sea and the largest port in Russia. It handled more than 1.5 million TEUs in 2020, making it one of the busiest ports in the region.
Port of Riga, Latvia - The Port of Riga is the third largest container port in the Baltic Sea and the largest port in Latvia. It handled more than 650,000 TEUs in 2020 and is an important hub for container traffic between Northern Europe and Russia.
Port of Gdynia, Poland - The Port of Gdynia is the fourth largest container port in the Baltic Sea and the second largest port in Poland. It handled more than 565,000 TEUs in 2020 and is an important hub for container traffic in the region.
Port of Klaipeda, Lithuania - The Port of Klaipeda is the fifth largest container port in the Baltic Sea and the largest port in Lithuania. It handled more than 420,000 TEUs in 2020 and is an important gateway for container traffic to and from the Baltic states.

Ports of Finland
The red dots below represent the container terminals of Finland. The information is extracted from "marine insight", see link below. The link contains a lot more information about all sea and river and lake ports of Finland. However most of the ports are minor or insignificant for container traffic.
https://www.marineinsight.com/know-more/ports-in-finland/

Figure 8 Container ports of Finland

Helsinki is the biggest commercial and passenger port, possessing the largest container handling facility in Finland. Approximately 8,750 vessels and 10,210,000 tonnes of cargo, including 405,000 TEU and 10,000 passengers are handled at the port annually.
https://www.fluentcargo.com/search?o=Shanghai+%28CNSHG%29&d=Helsinki+%28FIHEL%29

Ports of western Russia

Figure 9 Western Russia seaport
Western Russia sea port through put TEU/year. Saint Petersburg has 920.000 TEU, Ust-Luga 482.000 (2020) and Kaliningrad has had 150.000 TEU

https://www.searates.com/maritime/russia

Sea ports of Estonia

Figure 10 Container ports of Estonia

UN/LOCODE EETLL
Through-put of Tallin old port140.000 TEU
Total through-put for Estonia was 288.000 TEU in 2022.

Ports of Latvia
https://www.searates.com/maritime/latvia
Trough put in Ríga port 2023 was 465.000 TEU

Figure 11 Sea port of Latvia

Sea port of Lithuania
UN/LOCODE LTKLJ
Total through put 1.050.000 TEU annually (2022)
https://www.searates.com/maritime/lithuania

Figure 12 Ports of Lithuania

Ports of Poland
https://www.searates.com/maritime/poland
Total through put in container ports 3.050.000 TEU annually

Figure 13 Ports of Poland

Ports of Germany
Total through put for Germany is 14.000.000 TEU annually (2022)

Figure 14 Container Sea Ports of Germany
https://www.searates.com/maritime/germany
The biggest container ports in Germany are:
Port of Hamburg - Located on the river Elbe, the Port of Hamburg is the largest container port in Germany and one of the busiest in Europe. In 2020, it handled over 8 million TEUs of containerized cargo.
Port of Bremerhaven - Located on the North Sea coast, the Port of Bremerhaven is the second largest container port in Germany. It is a major hub for container traffic to and from Asia and the Americas, and in 2020, it handled over 5.4 million TEUs.
Port of Wilhelmshaven - Located on the North Sea coast, the Port of Wilhelmshaven is the third largest container port in Germany. It is a relatively new port, having opened in 2012, and in 2020, it handled over 1.5 million TEUs.
Port of Duisburg - Located inland on the Rhine river, the Port of Duisburg is the largest inland port in Europe and the fourth largest container port in Germany. In 2020, it handled over 4.3 million TEUs.
Port of Bremen - Located on the river Weser, the Port of Bremen is the fifth largest container port in Germany. It is a major hub for container traffic to and from Scandinavia and the Baltic states, and in 2020, it handled over 1.5 million TEUs
In this graph some inland container terminals are also marked.

Ports of Denmark
https://www.searates.com/maritime/denmark
Total through put in Denmark 1.080.000 TEU annually

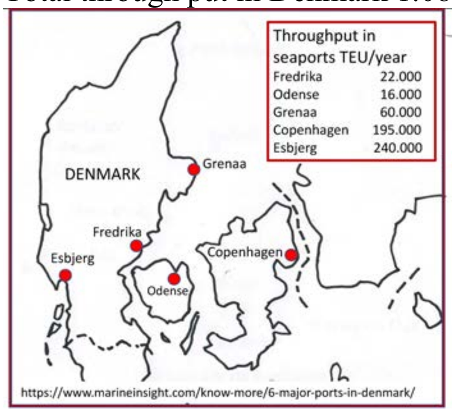

Figure 15 Sea container ports of Denmark

Ports of Norway
https://www.searates.com/maritime/norway
Total through put 933.000 TEU annually

Figure 16 Sea container ports of Norway

Port of Oslo
UN/LOCODE:NOOSL
Middle size
Norway's largest and busiest port with lots of container ships cruise ships and ferries.
Sjursøya container terminal

Status: OpenIMO port facility number: NOOSL-0006Latitude: 59 º 54'26" NLongitude: 10º 42'55" EPort facility Name: Sjursøya container terminal. Port facility description: Lo-Lo ContainerPort facility taken part in alternative arrangement: NoPort facility has approved port facility security plan: YesData of facility security plan approval: 01/07/2004Maritime security point of contact: +047 23 49 26 50 (24 hour service)

Cargo and container handling ***Oslo Havn KF*** is Norway's largest port with approx. 320 tankers a year container ships every weekday in addition to boats with construction materials salt sand and cement. The port operations are concentrated with good connections to the railway terminals at Alnabru. Most of the cargo handling takes place in Sydhavna. Goods types and terminals - types of goods quays cranes terminal services and strip & stuff Sydhavna - info on cranes quay length and railway. The following are unloaded/loaded in Sydhavna: containers cars salt cement sand petroleum products building materials and general cargo Westhavna - info on cranes quay length and railway cars. In Vesthavna the following is unloaded/loaded: salt general cargo building materials Services - stevedore terminal services bagging ship waste line agents shipping companies inspection companies workshop services Fixed calls - fixed lines to and from Oslo with information about the shipping company

The minor port mapped above are most likely a municipality owned. The operation is likely to be outsourced to a professional operator.
This customer/stakeholder = port owners/operators of small to large size sea ports of northern Europe will most likely be involved by contacts from the operator of the STFT platform These contacts will take place before the platform is finally ordered as the operator of STFT needs to have overview of the logistics.

12. Current supply chains – a study by Fluent Cargo - a web based program

The focus in this comparison is on supply chains from Shanghai to many ports of Northern Europe. Most containerised cargo is carried by ULCVs arriving at Rotterdam or Antwerp where reloading to feeder vessels or lorries take place. There are computer programs available to customers and brokers for analysis of supply chains. In this project we have made use of Fluent cargo, a comprehensive web-based program (www.fluentcargo.com). Most routes around the world were compared and a selection is documented in the report, Appendix A.

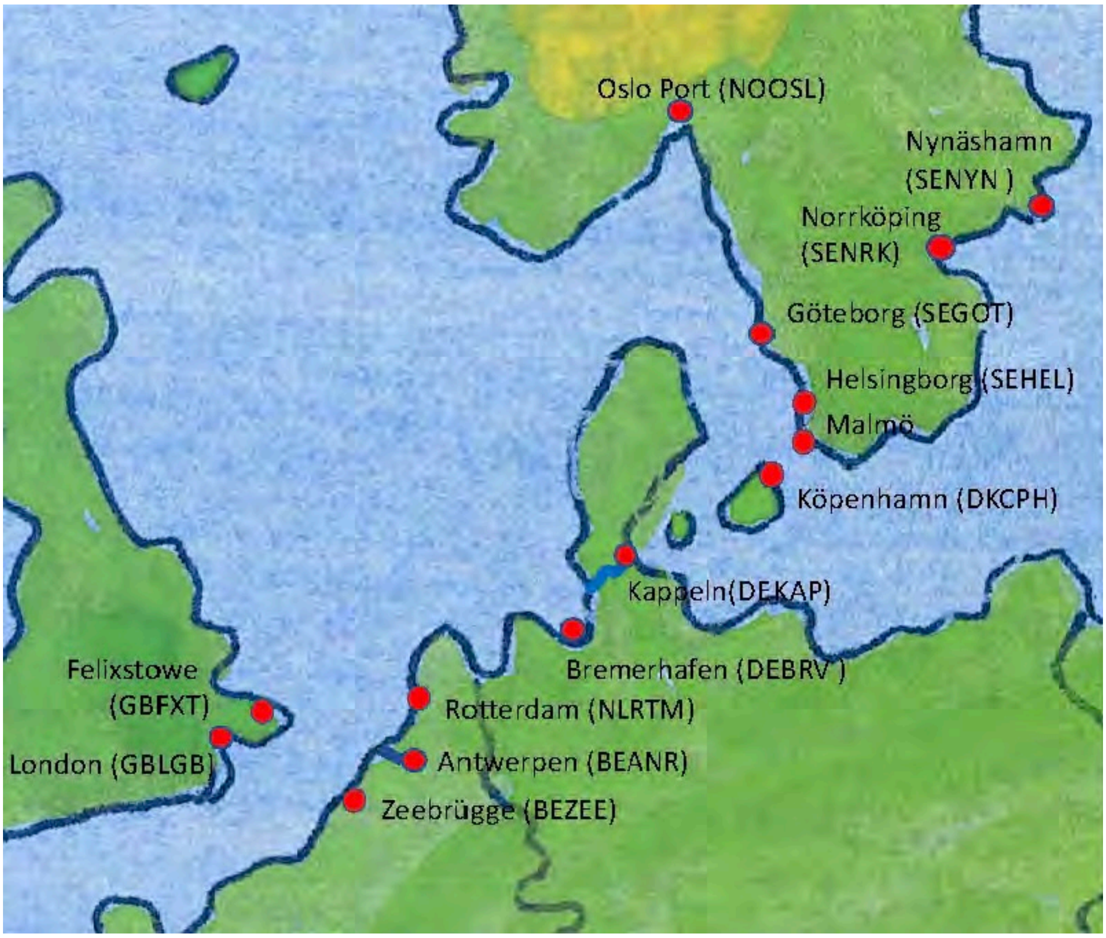

Figure 17 – A visualization of different ports in Northern Europe.

In figure 17 a number of major ports in Northern Europe and smaller ports are shown. As an example, ULCVs from Asia frequently reach Rotterdam. From this port trucks or feeder vessels take over distribution. By utilising Fluent cargo many different routes are identified depending on availability. Fluent cargo also gives distances between ports. When trucks and trains are options this will also be shown. When using this webpage for a "port to port" request you get at least ten options, exemplified in Table 6, with distances and time travelled described.

Table 6 – Supply chains derived from using the program Fluent Cargo.

Three options proposed by Fluent Cargo for the supply of containers between Shanghai and Gothenburg			
Option 1	**Leg number**	**Port to port**	**Distance/hours**
	1	Shanghai - Antwerp	10700 nm/745 h
	2	Antwerp - Norrkoping	800 nm/88 h
	3	truck to Gothenburg	322 km/3.5 h
Option 2	**Leg number**	**Port to port**	**Distance/hours**
	1	truck to Xiamen	1061 km/11 h
	2	Xiamen - Felixstowe	10.000 nm/632 h
	3	Felixstowe – Bremerhaven	307 nm/18 h
	4	Bremerhaven - Kristianstad	277 nm/20 h
	5	Truck to Gothenburg	589 km/7 h
Option 3	**Leg number**	**Port to port**	**Distance/hours**
	1	Shanghai - Antwerp	10.700 nm/745 h
	2	Antwerp - Oslo	607 nm/43 h
	3	Truck to Gothenburg	288 km/3.2 h
Remark: There will be cargo transfer between ships in ports along the route several times; Typically: Antwerp – Oslo will be with a feeder ship MSC ABIGAIL of 1 118 TEU			

The port of Antwerp is attractive. Antwerp has a throughput of 10 MTEU, a maximum water depth of 12.2 m and maximum length of ship about 150 m (500 ft). This means that ULCV are not suitable. When industry is picking up again and the world trade comes back to full utilization the ULCV will be the normal for shipping between Shanghai and Europe. Then ships will go to deeper ports and the STFT will be competitive. https://www.container-xchange.com/blog/port-of antwerp/#facts_and_figures_of_port_of_antwerp

An example of supply chain for ship from Shanghai to Gothenburg via Felixstowe, Bremerhaven, Kristiansand; truck to Gothenburg is shown in table 7 below.

Table 7 - An example of supply chain from Shanghai to Gothenburg.

An example of supply chain Ships from Shanghai to Gothenburg via Felixstowe, Bremerhaven, Kristiansand; truck to Gothenburg				
Legs	Port to port	Service ship/lorry LxBxT m	Type of ship (number of TEU)	Distance/hours
1st leg	Shanghai – Felixstowe	ULCV: MSC CHINA (IMO 9936642 399x61x14.2 m	ULCV for 24.117 TEU	10700 nm/745 h
2nd leg	Felixstowe - Bremerhaven	MSC POH LIN (IMO 9279977) 294x31x10.9 m	Panamax (old) For 5.059 TEU	307 nm/ 18 h
3rd leg	Bremerhaven - Kristiansand	BENEDICT (IMO 9327578) 148x23x7.2	Feeder 1.100 TEU	277 nm/ 20 h
4th leg	Kristiansand – Gothenburg	truck	truck 4 TEU	288 km / 3.2 h

If successful, future supply chains will be considerably influenced by the presence of an FCT in Kattegat. About 20% of the cargo to Finland, Sweden, Norway, Denmark, Iceland, Poland and the Baltic states could be transferred over this FCT in Kattegat. Furthermore, if feeders take over the regional distribution from trucks to minor ports this will save money and reduce emissions of carbon dioxide from fossil fuel. As a consequence, less road traffic around these minor ports will be seen to the benefit of local population.

A few supply chains are selected in order to demonstrate the effect of a STFT in Kattegat. The assumption is that there is enough cargo coming to the north of Europe to fully utilize the platform a throughput of 5 - 6 million TEU/year. It is equivalent with 250 ULCVs fully loaded or 365 ULCVs 70% loaded. This is approximately one ULCV per day. The turn-around time of 24 ours at port is realistic with the container cranes operating simultaneously.

12. Operating cost estimates

Maritime shipping is highly sensitive (elastic) to bunker fuel costs, representing between 45 and 50% of operating costs with limited opportunities to mitigate outside slow steaming. Still, from a comparative perspective, maritime shipping has less fuel price sensitivity than trucking and rail, implying that higher energy prices are likely to trigger the consideration of routing options that have a port call the closest possible to the destination of the shipments.

Two supply chains below are shown as an example.
1) A fully loaded ULCV (24000 TEU) arriving to the STFT and transfer 2000 TEU to a fully loaded feeder for transfer to Oslo the following fuel consumption appears per TEU to be compared with
2) A rather poor "traditional" supply chain where a fully loaded ULCV transfer a TEU to a lorry driving all the way to Oslo.

Figure 18 In this figure the STFT is located in Kattegat.

The distance from Shanghai to the STFT in Kattegat is 11130 nm, which gives an operating cost for ULCV (25000 TEU): 0.007 $/TEU&nm of 78 US$. For ULCV the fuel consumption stands for about 50% of total cost of operation at sea, depending on fluctuating oil prices.

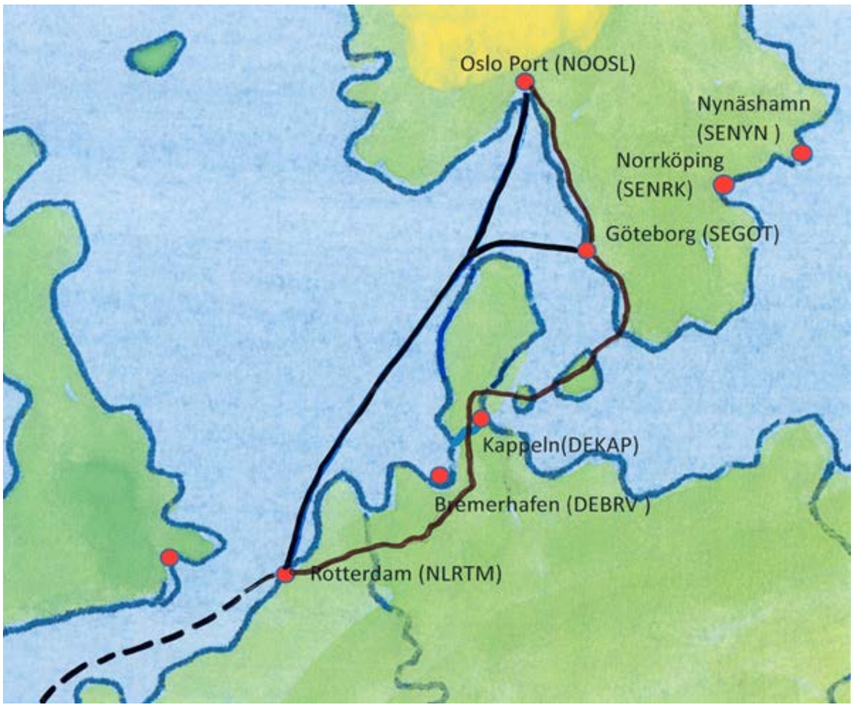

Figure 19 In Rotterdam the options are feeders to Oslo or trucks on road via Gothenburg to Oslo.

By utilising Fluent cargo common transport routes for a FEU from Rotterdam to Oslo are with ULCVs that docks in Rotterdam. In Rotterdam the options are feeders to Oslo or trucks on road via Gothenburg to Oslo. When you search with Fluentcargo for sea transport from Shanghai to Oslo most often you get Gothenburg for trans-shipment with land transport from Gothenburg to Oslo. When you ask specifically for sea transport from Rotterdam to Oslo one get response accordingly

Details on distances of and fuel consumption can be found in table 8 below.

Table 8 - Trucks or feeders from Rotterdam to Oslo – a comparison of fuel consumption

Specification of carrier and port to port	**Distance [km]**	**fuel consumption [litre]**
Truck distance Rotterdam – Gothenburg – Oslo	1576	630
Truck distance Gothenburg – Oslo	294	117 (part of above)
Feeder distance the STFT Kattegat – Oslo	273	11
Distance for feeder (4000 TEU) from Rotterdam to Oslo	1000	40

Comparing the numbers in table 8 concludes with a great saving of fuel by using ships instead of trucks on the distance Rotterdam – Oslo. The saving is about (630 – 40) = 590 litre/FEU. A general view of the routes taken from Shanghai to Europe is shown in figure 20.

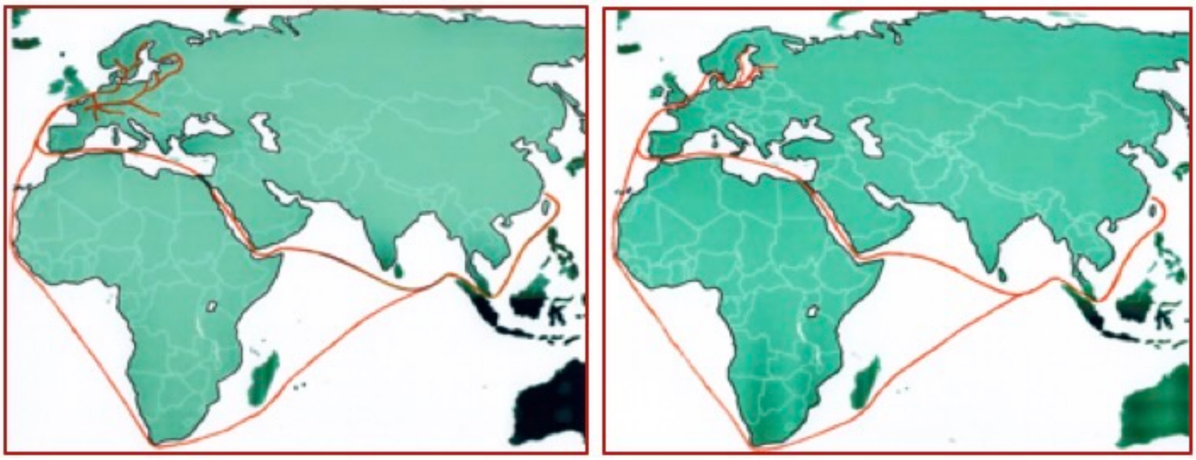

Figure 20 The graph to the left shows common supply chains from Shanghai to Europe and the Baltic states. To right are the more favourable routes when fuel consumption and CO2-emissions is considered

13. Comparison between traditional supply chains and supply chains involving STFT in Kattegat.

Find below a supply chain of interest for comparison There is a link “Fluentcargo” to different transport modes https://www.fluentcargo.com/routes/rotterdam-nl/goteborg-se

Shanghai to Gothenburg with Maersk stops at three (3) ports on the way to Gothenburg: the Port of Tanjung Pelepas (MYTPP) in Malaysia; Rotterdam Port Netherlands (NLRTM); Bremerhaven Port Germany (DEBRV).
The stops at each of these ports are very short, typically four (4) hours according to Fluent Cargo. A typical Maersk ship on this route is M/S MADRID MAERSK (IMO 9778791) speed of 17.7 knots The total sea distance of about 11.100 nautical will take 26 days at sea. Fluent Cargo states 36 days "logistics time" which means that collection of cargo in Shanghai and the three stops requires. Suez Canal is approximately 104 nautical miles and the speed limit is 9 knots. The channel then takes about 12 hours.
https://www.fluentcargo.com/search?o=Shanghai%20(CNSHG)&d=Goteborg,%20Sweden

Shipping from Shanghai to Rotterdam may take 29 days with frequent stops under way
https://www.fluentcargo.com/search?o=Shanghai%20(CNSHG)&d=Rotterdam,%20Netherlands

With truck from Rotterdam to Gothenburg it takes 11h55m i.e. 12 hours.
https://www.fluentcargo.com/search?o=Rotterdam,%20Netherlands&d=Goteborg,%20Sweden

Observation: Trucks will almost always be quicker than shipping where-ever you compare. The difference that gives shipping a favour is cost and carbon and other emissions.

Shanghai – Gdansk in Polen (PLGDN)

Permitted draft 12.2 m
Throughput in Gdansk is about 2 MTEU/year (year 2022)

https://www.fluentcargo.com/search?o=Shanghai%2C+China&d=Gdańsk%2C+Poland

Shanghai to Gdansk with one ship M/S TOKYO (IMO 9310238) 8 063 TEU

The route according to Fluent Cargo passes The Suez and The Kiel canals
Shanghai <truck 1061 km; 11 h> Xiamen (72 h) <10.743 nm; 634 h> Gdansk (72h) <truck 9 km; 0.25h> Gdansk ***Total time 37 (30) days***
Therese are four (4) port calls (CNYTN → SGSIN → GBFXT → BEZEE) before the last voyage to Gdansk in Poland

Figure 21 This route with this ship all the way - M/S TOKYO (IMO 9310238) 8 063 TEU

Shanghai to Gdansk with M/S GREENLAND (IMO 9895006) 15 254 TEU and truck from Rotterdam to Gdansk

1) Shanghai <truck 293 km; 3 h> Ningbo (CNNGB) <10.860 nm; 659 h> Rotterdam (96 h) <1288 km; 11.6h> Gdansk ***Total time 34 (27) days***

Figure 22 With this route M/S GREENLAND (IMO 9895006) 15 254 TEU will discharge the containers in Rotterdam for truck transport to Gdansk

Comment
Depending on cargo volumes the route may include road transport by truck. The transport may take the shortcut through the Kiel Canal if the cargo volume permits a medium size ship.

14. Reshaping supply chains by the introduction of STFT in Kattegat

A few supply chains are selected in order to demonstrate the effect of a STFT in Kattegat. We then assume that there is enough cargo coming to the north of Europe to give our platform a throughput of 6 million TEU/year. It is equivalent with 250 ULCVs fully loaded or 365 ULCVs 70% loaded. This is approximately one ultra large ship per day.

The turn-around time of 24 ours at port is realistic with the container cranes operating simultaneously. In order to calculate alternative costs, we will not use freight rates because these vary too much in a volatile market. Instead we can use operating costs for shipping. It is more difficult to separate truck costs in operative costs and freight costs. If we assume that the operating cost of trucks are about 2/3 of the freight rates we get a value for comparison. According to reference
https://www.researchgate.net/figure/The-annually-service-time-on-container-ships_tbl5_299600017
the total annual cruising time for a container ship is around 6440 hours per year.
https://transportgeography.org/contents/chapter4/transportation-and-energy/fuel-consumption-containerships/

About speed
"Normal (20-25 knots; 37.0 – 46.3 km/hr). Represents the optimal cruising speed a containership and its engine have been designed to travel at. It also reflects the hydrodynamic limits of the hull to perform within acceptable fuel consumption levels. Most containerships are designed to travel at speeds around 24 knots."
For simplicity this is applied that for all ships in this study
With a mean speed during cruising we get 6440x24 nautical miles per year = 154.000 nautical miles (nm) and finally, we get a value for the operating cost for different size of ships to be used in a comparison

Operating cost estimates
Panamax (4000 TEU): 2300/154000 $/TEU&nm = 0.015 $/TEU&nm
Post-Panamax (6000 TEU): 1950/154000 $/TEU&nm = 0.013 $/TEU&nm
Post-Panamax Plus (10.000 TEU): 1450/154000 $/TEU&nm = 0.0094 $/TEU&nm
In order to estimate how much a ULCV costs a reference to
https://transportgeography.org/contents/chapter3/transport-costs/operating-costs-containerships/
will result in
ULCV (25000 TEU): 0.007 $/TEU&nm

These is of course a mean values that can be used for comparisons.

We also need the cost of truck and rail transfer per kilometre
In general, you can expect the following costs:
20-foot container: €1.50 per kilometre by truck
Transport by train: €1.25 per kilometre by train

Operating costs of container ships different size

Table 9 Annual operating costs of Panamx and Postpanamx container ships in MUS $
Exclusive of the significant amortization costs related to the ship purchase (principal and interest).

Type of ship / Type of cost	Panamax 4000 TEU)	Post-Panamax 6000 TEU	Post-Panamax Plus 10.000 TEU
Manning	0.83	0.83	0.83
Repair and maintenance	0.84	1.0	1.16
Insurance	0.82	1.1	1.75
Stores and lubes	0.26	0.33	0.33
Administration	0.17	0.17	0.17
Fuel	4.3	5.8	7.3
Port charges	1.9	2.6	3.0
Total per ship	9.2	11.8	14.5

Source: Drewry Shipping Consultants Ltd. The numbers are read from a diagram
https://transportgeography.org/contents/chapter5/maritime-transportation/containerships-operating-costs-panamax-post-panamax/

A roundtrip by a Container Vessel between China and Europe is about 45 days. The annual cost per ship given in table 9 above. The container tariff is another issue, volatile depending on the market.

Operating costs
https://transportgeography.org/contents/chapter5/maritime-transportation/containerships-operating-costs-panamax-post-panamax

Ideal supply chains in the future

On the assumption that feeder vessels can take over most of the container transports within Northern Europe and that the feeder frequency to destinations is good enough for the customers a much fossil fuel and road congestion can be avoided. Figure 23 shows one common supply chain that will be replaced with feeder vessels in that scenario.

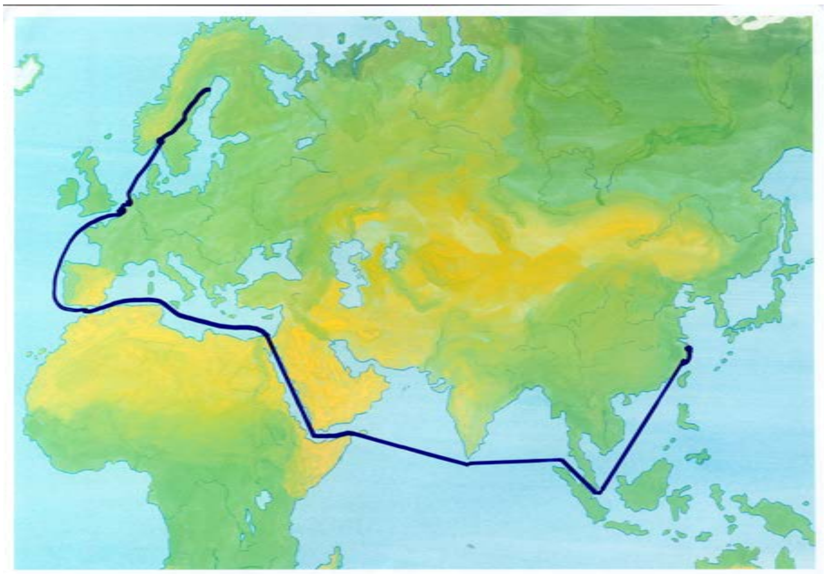

Figure 23 A supply chain between Shanghai and Piteå or Umeå

An usual supply chain between Shanghai and Piteå or Umeå is with ULCV to Rotterdam or Antwerp. Transfer to feeder for Oslo or Gothenburg and then truck to final destination. Both Umeå and Piteå are located close to the sea.

As trade generally will increase it is more likely that feeder vessels will be available and filled with payload to satisfy customers which require prompt delivery. An ideal map of supply will look like figure 24.

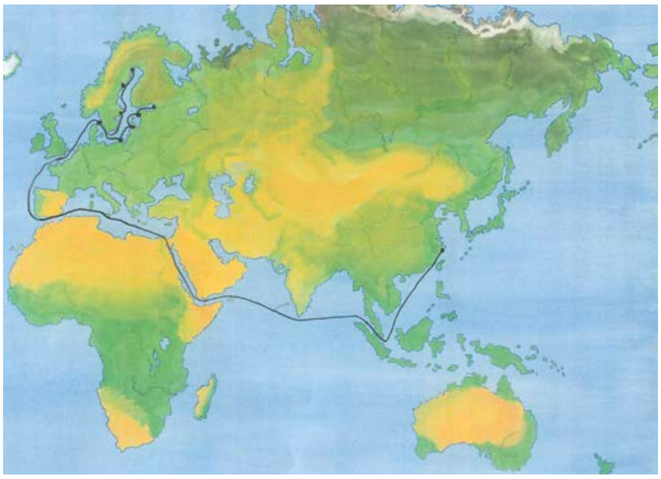

Figure 24 The future ideal routes between Shanghai and the cities around the Baltic Sea

16. Discussion

The function analysis identified seventeen (17) stakeholders of importance from potential financiers the FCT owner major port owners in the vicinity of the platform to general public. Their requirements are met by a short description the equipment and procedures of STFT the floating container terminal with a detailed technical specification used by the Korean shipyards who offered to build. The function analysis report was useful for the preparing of interviews with stakeholders. The function analysis also included description of supply chains as they appear with much details when utilizing Fluentcargo a web based program that provides all current supply chains between an out-port to ant location in the world.

17. Conclusions

When Fluentcargo was applied to Northern Europe it was evident that many supply chains were finalized with rathe long distance road transportation by trucks rom Rotterdam to ports in Northern Europe. This gives opportunities for a floating the trans-shipment platform in Kattegat to contribute by an extension for Gothenburg harbour. A strong case to save fuel and costs is indicated by using fully loaded ULCVs to a FCT in Kattegat for transfer of cargo to feeder ships.

References

Most references are given directly in the text above by links to websites.

1) The Transformative Role of Floating Container Terminals in Sustainable Supply Chains and Climate Resilience
2) Henrik Lindholm MSC-thesis at KTH 2021
https://kth.diva-portal.org/smash/record.jsf?pid=diva2%3A1599590&dswid=-527

https://www.mynewsdesk.com/se/gavle-hamn/news/unifeeder-introducerar-ny-veckovis-linje-mellan-gaevle-hamn-och-polen-374102

https://moverdb.com/sv/top-49-container-ports/
https://transport.ec.europa.eu/transport-modes/maritime/motorways-sea_en

https://op.europa.eu/en/publication-detail/-/publication/d37790ea-b6ef-11ec-b6f4-01aa75ed71a1

"The Transpolar Sea Route (TSR) would use the central part of the Arctic to directly link the Strait of Bering and the Atlantic Ocean of Murmansk. This route is hypothetical as it involves ice-free conditions that are not yet observed."

https://transportgeography.org/contents/chapter1/transportation-and-space/polar-shipping-routes/

From the link ”Operating costs of container ships”
https://transportgeography.org/contents/chapter5/maritime-transportation/containerships-operating-costs-panamax-post-panamax/

”Maritime shipping is highly sensitive (elastic) to bunker fuel costs, representing between 45 and 50% of operating costs with limited opportunities to mitigate outside slow steaming. Still, from a comparative perspective, maritime shipping has less fuel price sensitivity than trucking and rail, implying that higher energy prices are likely to trigger the consideration of routing options that have a port call the closest possible to the destination of the shipments.

A standard Panamax containership has operational costs of about $9 million per year. The most significant expenses are related to fuel (46%) and port charges (21%), which are variable costs. This is transcribed in annual operating costs of about $2,314 per TEU. Not shown here are the significant amortization costs related to the ship purchase (principal and interest). The incentive to use larger containerships is quite clear from the perspective of maritime shippers, which led to a new generation of 10,000 TEU containerships being introduced in 2007. In this case, fuel and port charges account respectively for 50% and 21% of their annual operating costs, while manning costs remain constant. However, annual operating costs per TEU drop by more than one-half to $1,449. The principle of economies of scale is thus a strong factor in containerized maritime shipping

Before and up to 2004 The governmental dues per ton goods for domestic traffic in Sweden are for a 500 kilometres long transport 7 times higher per ton for a sea transport than for rail transport and almost twice as high as for road transport.
https://en.mariterm.se/wp-content/uploads/2016/08/Baltic-Palette-final.pdf

A scientific paper on Optimizing Transportation between Sea Ports and Regions by Road Transport and Rail and Inland Waterway Transport Means Including “Last Mile” Solutions https://www.mdpi.com/2076-3417/12/20/10652

Enclosure A

Calculation of an hypothetical supply chain.

Shanghai – Kristinehamn – long distance with container and different routes including STFT – detailed calculation based on an assumed STFT in Kattegat and assumed enlargement of Trollhätte locks.

To ensure the future of shipping on lake Vänern the Swedish Transport Administration in collaboration with the Swedish Maritime Administration are building new navigational locks in in Lilla Edet, Trollhättan and Vänersborg. By 2030 the current locks are considered to have reached their technical life expectancy. New locks are needed to ensure the shipping transportation needed by the industry to create conditions for a future shift of transportation from roads to shipping to enable larger vessels to traffic the canal in the future. https://bransch.trafikverket.se/en/startpage/projects/seafare-construction-projects/locks-in-trollhatte-canal/

<table>
<tr><td colspan="6">CASE A – This supply chain is here given with a conventional transport with ship of 15,000 TEU capacity to Gothenburg and further with lorry to Kristinehamn</td></tr>
<tr><td>Cost at port of export Shanghai (CNSHG)</td><td>Cost of ocean freight (OF)</td><td>Handling cost of Gothenburg terminal (SEGO)end of ocean freight (OF)</td><td>Cost of regional transport
- coastal shipping or lorry</td><td>Handling cost in Torsby – end of transport</td><td>Total cost per February 2023</td></tr>
<tr><td>Included in cost of freight</td><td>900 US $
February 16 - 23</td><td>ISPD/D 18 €
THC/D 1470 SEK
FWD-S 90SEK
Env-fee 40 SEK
Release 95 SEK
Wharf. 346 SEK
Adm fee ~ 0
Total in 213 US $</td><td>SEK 7500 total inclusive current fuel surcharge, adjusted monthly
for 340 km to Torsby; recalculated for Kristinehamn 300 km yields 6600 SEK

Total 630 US $</td><td>Local distribution from lorry to smaller parcels or in case of ship over Vänern there is a lift in port to lorry at Torsby</td><td>Bottom line for 1 TEU
1743 US $</td></tr>
<tr><td colspan="6">-</td></tr>
<tr><td colspan="6">CASE B - This supply chain is simulated with transport by ULCV of 25,000 TEU capacity to an assumed STFT in Kattegat for transfer to a feeder ship (400 TEU) to Kristinehamn (Requires enlargement of Trollhätte locks, which is planned)</td></tr>
<tr><td>Included in cost of freight</td><td>630 US $
Estimated 3o% down from tariff February 16 - 23</td><td>ISPD/D 18 €
THC/D 2x140 US$/TEU
FWD-S 90 SEK
Env-fee 40 SEK
Adm fee ~ 0

Total in 312 US $

Alternative by using ”estimated average charge” 200 US$/TEU instead of 280 US$/TEU we save
80 US$/TEU</td><td>Guess 30 US $/TEU in daily cost for the short sea shipping of 400 boxes
= 12,000
Pilot cost 160,000 (tariff) SEK = 15,200 US $
Fairway charge and sluicing (6 locks) (tariff)
216,000 SEK = 20,600 US $
Calculated per TEU gives
total 120 US $/TEU</td><td>Lift off ship to lorry in Kristinehamn guess
140 US $/TEU</td><td>Bottom line for 1 TEU

1202 US $

Alternative bottom line 1122 US$/TEU</td></tr>
<tr><td colspan="6">-</td></tr>
</table>

CASE C, see below in the comments and conclusions

ISP/D Security discharge
THC/D lift from ship to lorry or lift to feeder
FWD-S Fairway dues in Swedish waters
Env-fee Environmental fee
Wharf. = Wharfage
Administration fee is the "bill of Lading" (fraktsedel) distributed over the entire load - becomes negligible

Comments and to the analysis of the inland waterway supply chains to Kristinehamn
The analysis is based on an offer from a well-known Swedish ship broker who gave an offer for one TEU from Shanghai to Torsby by 16 February 2023 – recalculated to Kristinehamn. He mentioned that Ocean Freight “OF”-freight rates where down to 1/10 of what it was only half a year ago. When freight rates OF are much higher the benefit with ULCV are dominant on this supply chain, thus the benefit of STFT is even more evident.
In this calculation it is assumed that we have two addition vertical cargo handling in “CASE B” compared to “CASE A” with the same cost /lift. This may be conservative, i.e. the in the comparison, on the other hand STFT must also have the income.
“CASE B” is 541 US $ better than “CASE A” or with alternative bottom line approx. 621 US$/TEU than “CASE A”.

“CASE C”: From this analysis a third alternative is easily calculated. This is with a 15,000 TEU ship arriving to Gothenburg and reloading to feeder for further transport by sea to Kristinehamn.
The cost/TEU will be 900 + 312 + 120 + 140 = 1472 US $/TEU
alternative bottom line we save 80 US$/TEU which the yields a result of 1472-80 = 1393 US$/TEU
which is 351 better than CASE A but to the benefit of STFT 730 US $/TEU better or 810 US $/TEU better than with lorry to Kristinehamn.

This is the price that applies today until February 28 2023 the prices are very volatile "fresh goods" and there have been large movements over time.

Information from the ship broker that was used for this study.:

CNSHG-SEGOT

OF: USD900/20', USD1425/40'

ISPS/D: EUR18/ctn
THC/D: SEK1470/ctn
Fairway dues: SEK90/20, SEK180/40'
Environment fee: SEK3/ton
Release fee: SEK95/ctn
Wharfage: SEK346/20, SEK490/40'
Adm fee: SEK775/BL

Truck: Gothenburg - Torsby SEK 7500 in total incl. current fuel surcharge which is adjusted monthly.

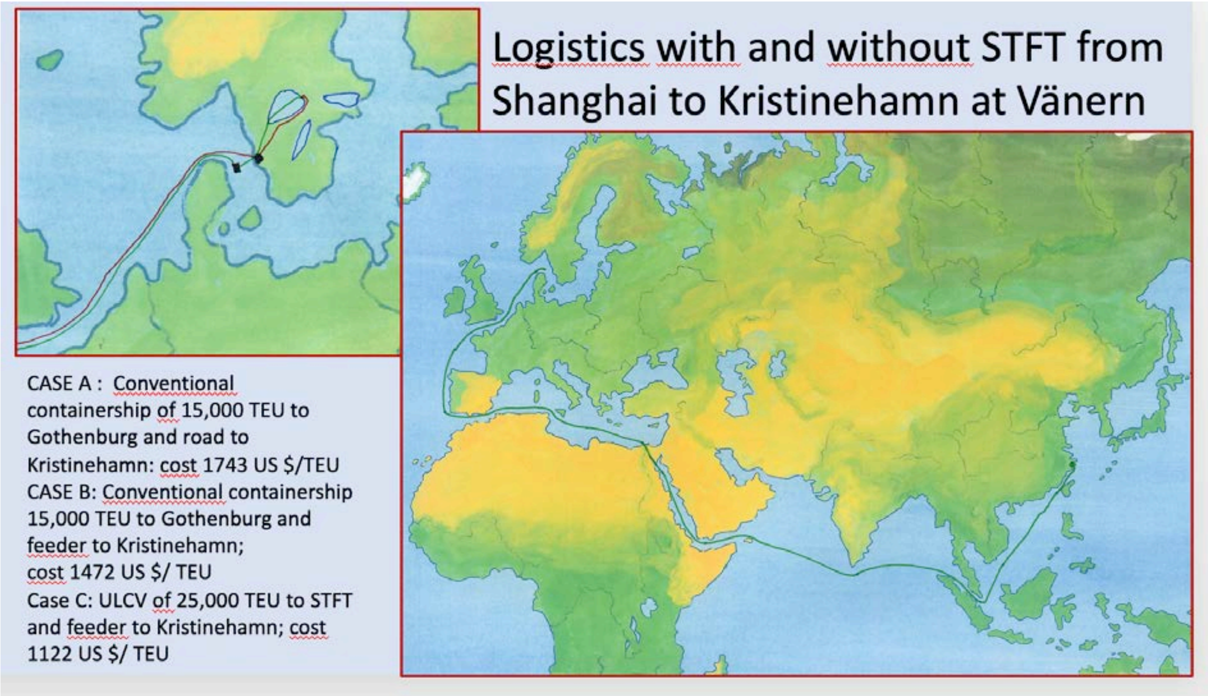

Figure Demonstration of cost difference with and without STFT in Kattegat on maps

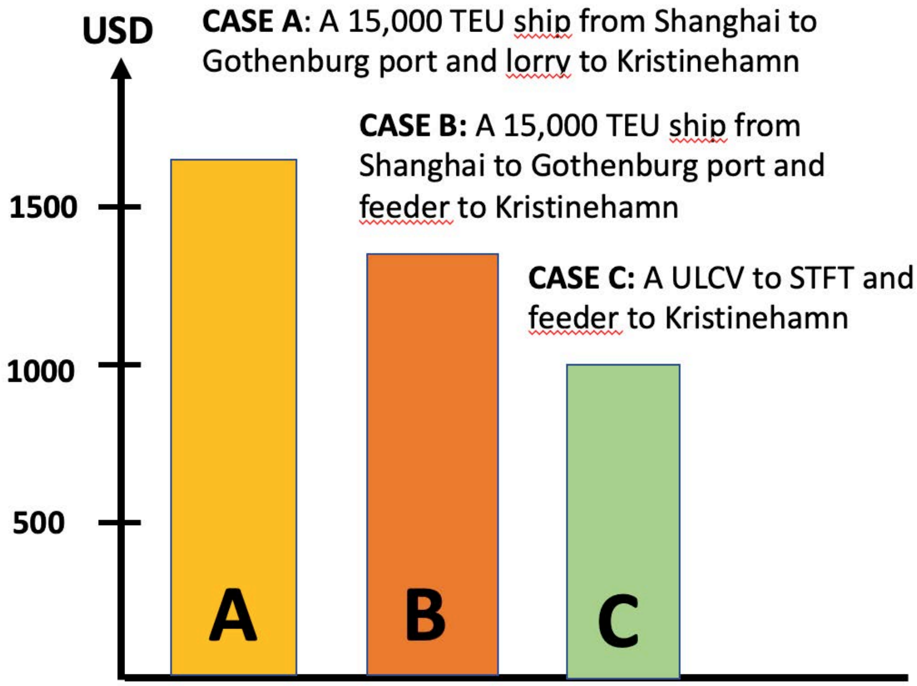

Figure Demonstration of cost difference with and without STFT in Kattegat in diagram; snapshot in time, based on one broker offer when the trans ocean tariffs were low

Enclosure B

References on autonomous ships
It will be a long time before autonomous maritime transport becomes a reality, if at all. On short distances near harbours the maintenance problems are handled reasonably easy. Other security issues may arise such as the hijacking of unattended ships. An autonomous electric-powered barge may have a reduced crew with security people.
https://www.nyteknik.se/fordon/japanska-farjan-korde-autonomt-i-sju-timmar/115792

https://edition.cnn.com/travel/article/norway-self-driving-ferries-zeabuz-spc-intl/index.html

https://qz.com/2126751/japan-is-home-to-the-worlds-first-autonomous-container-ships/

Reference on Freight Rates and Transport Costs
https://unctad.org/system/files/official-document/rmt2022ch3_en.pdf

European road transport rates rise further; see where it has been highest

https://trans.info/european-road-transport-rates-rise-further-see-where-it-has-been-more-severe-250003

https://www.cis-international.de/en-gb/container-spedition

Through put of all countries globally – a good overview
For comparison between all countries in the world the following link gives through put of all countries. https://www.ceicdata.com/en/indicator/estonia/container-port-throughput

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