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THE BEST PRACTICES FOR DIGITALIZATION OF CARGO PORTS IN EASTERN GULF OF FINLAND

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Abstract

The aim of the thesis was to define the best digitization methods or techniques that will produce the best results for cargo port operations, while taking into account the goals of sustainable development, climate change, economic development, digitalization of the marine ecosystem and education. The thesis was made as an assignment for the Get Ready project.

The theoretical part of the thesis consists of various laws and regulations and environmental requirements related to ports or port operations. The objective of this thesis was to study what are the harmful environmental impacts of ports and shipping and what are the different ways in which they can be reduced, what are the advantages and disadvantages of digitalization for ports and present the most common types of digital solutions used in ports and what kind of methods, techniques, best practices are used in ports.

The original plan in the empirical part of the thesis was to identify the best practices of digitalization in Russian and Finnish ports, but no response was received from the Russian operators so the plan was changed to study only the best practices of digitalization in Finnish ports. The questionnaire was sent to 29 different ports, and 12 responses were received. In addition, three in-depth interviews were conducted.

Even if the number of responses obtained in the study was quite low, the responses provided much information, and the topic seemed to be familiar to the respondents. The responses to the interviews were of good quality. The commissioner utilizes the theoretical part and research results obtained from the research in the activities related to the project.

Keywords

digitalization, best practices, ports, environment

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Tiivistelmä

Opinnäytetyön tavoitteena on selvittää, mitkä ovat parhaat digitalisointimenetelmät tai tekniikat, jotka tuottavat parhaat tulokset lastisatamatoiminnoille, ottaen huomioon kestävän kehityksen tavoitteet; ilmastonmuutos, taloudellinen kehitys, meriekosysteemin digitalisointi ja koulutus. Opinnäytetyö tehtiin toimeksiantona Get Ready -hankkeelle.

Opinnäytetyön teoreettinen osa koostuu monista satamiin tai satamatoimintoihin liittyvistä laeista ja määräyksistä sekä ympäristövaatimuksista. Mitkä ovat satamien ja merenkulun haitalliset ympäristövaikutukset ja millä tavoin niitä voidaan vähentää? Mitkä ovat digitalisaation edut ja haitat satamissa? Ja esitetään yleisimmät satamissa käytettävät digitaaliset ratkaisut. Millaisia menetelmiä, tekniikoita ja parhaita käytäntöjä satamissa käytetään?

Opinnäytetyön alkuperäisen suunnitelman tavoitteena oli selvittää Venäjän ja Suomen satamien digitalisoinnin parhaat käytännöt, mutta venäläisiltä ei saatu vastauksia, joten suunnitelmaa muutettiin tutkimaan vain suomalaisten satamien digitalisoinnin parhaita käytäntöjä. Kysely lähetettiin 29 eri satamaan, mistä saatiin 12 vastausta, ja lisäksi tehtiin 3 syvähaastattelua.

Vaikka tutkimuksessa saatujen vastausten määrä oli melko pieni, vastaukset antoivat paljon tietoa, ja aihe näytti olevan vastaajille tuttu. Haastatteluihin annetut vastaukset olivat hyvälaatuisia. Komissaari hyödyntää tutkimuksesta saatua teoreettista osaa ja tutkimustuloksia projektiin liittyvissä toimissa.

Asiasanat

digitalisaatio, parhaat käytännöt, satamat, ympäristö

CONTENTS

APPENDICES

1 INTRODUCTION

1.1 General background of the study

Approximately 15% of global maritime trade is performed in the Baltic Sea region. With an average of 2,000 vessels in the Baltic Sea at any particular time, it is one of the world's busiest shipping hubs and one of the most polluted sea areas in the world. Port operations and shipping cause emissions to the atmosphere, water and shores, posing threats to the health of ecosystems by producing pollution and destroying habitats. Efforts must be made to ensure the safe passage of ships and reduce emissions in the Baltic Sea region, both in ports and on vessels. (Gritsenko 2016, 72–80.)

International trade and sea transport are very important for the Finnish economy. On average, 90% of Finnish exports and 80% of imports are carried by sea. Finland's geographical location and population result in relatively small traffic flows, while long distances and, in normal winters, severe ice conditions in ports increase logistics costs. An important prerequisite for Finland is to maintain efficient transport routes. Maritime transport faces many challenges such as emissions from shipping, climate change and the growing need for energy. (Maritime transport… 2014, 5)

Approximately 2.5% of global greenhouse gas emissions come from shipping and this is expected to grow by 50-250 percent in the coming decades if emissions are not kept under control. The strategy adopted by the IMO's Marine Environment Protection Committee (MEPC) in 2018 aim to reduce the total annual GHG emissions by at least 50% by 2050 compared to 2008. Greenhouse gas (GHG) emissions from shipping are a contributing factor to global climate change. The International Maritime Organization’s (later IMO) strategy for minimizing greenhouse gas emissions mainly applies to sulfur oxides (SOx), nitrogen oxides (NOx), particulate matter (PM) and carbon dioxide (CO2). The strategy includes a specific reference which is a pathway of CO2 emissions

reduction consistent with the Paris Agreement temperature goals. (Low carbon… 2020; Finland encourages…2019a; UN agency launches… 2019a.)

In order to prevent and reduce emissions, a great amount of work has done by different organizations e.g. IMO and EU (Adoption of the initial…2018; Progress made in…no date). For example, at the summit in 2015, the leaders of the member states of the United Nations (later UN) agreed on 17 different goals for sustainable development. The UN's 2030 Sustainable Development Goals aim to secure good living opportunities for future generations on Earth as well as for existing generations. There is a strong link between the goals, and in order to achieve one goal, the other goals must also be taken into account as defined by sustainable development. (Kestävän kehityksen… no date.) The Get Ready project is committed to these United Nations goals, with special focus on climate change, economic development, the digitalization of the marine ecosystem, and education.

Increased greenhouse gases cause global warming which increases the frequency of extreme weather conditions. At present, global temperature is 0.8 degrees Celsius more than in 1880, and a rate of global warming above 2 degrees Celsius is believed to have devastating consequences. The European Union places great importance on the fact that the temperature does not rise above 2 degrees Celsius and has set targets for its member states to prevent warming and wants to set an example for the rest of the world. (Ilmastonmuutos 2014, 3-5.) The European Union's climate policy aims to reduce greenhouse gas emissions by 40 percent from 1990 levels by 2030 and almost 80-95 percent by 2050, and by that achieve a low-carbon economy (Ilmastonmuutos 2014, 8).

Climate change, as well as digitalization, are megatrends that affect logistics and its development in many ways in the future, such as demand, logistics services and quality purposes (Pöyskö et al. 2016, 9.) Digitalization has profoundly transformed production and working methods in many professions and sectors,

as well as work tasks, but at the same time it has created new tasks (Tekoälyajan työ 2018, 13).

Currently, there are many organizations in port communities that possess information that could be shared to others rather than each operator searching for and processing the same information separately within their own organizations. Sharing information at its best would speed up processed, make operation more efficient and prevent ambiguities. The aim should be to improve the flow of information and create a common operation platform This would make the operations smoother, more efficient, safer and more environmentally friendly. (Saarikoski & Helminen 2019, 50.)

1.2 Get Ready project

The thesis is being commissioned by Xamk for a project called Get Ready – Getting ready for the cross-border challenges in the Eastern Gulf of Finland which aims to develop the Russian and Finnish coastal areas and the port environment from an environmental point of view. The project is a follow-up to a previous ENPI CBC program (2007-2013) which has carried out under the project name “Ecologically Friendly Port” (Project – Ecologically friendly port 2018.)

The Getting Ready for the cross-border challenges: Capacity building in sustainable shore use (Get Ready) project was launched in May 2019. It is funded by the South-East Finland-Russia CBC programme 2014-2020. The total budget for the project is 812,713 Euros. The total duration of the project is 36 months. The project is implemented in cooperation between Finland and Russian with seven partners. The lead partner of the project is Eco-Express-Service LLC from Russia, city of Saint Petersburg area. Other partners from Russia are Federal State Budgetary Institution “State Hydrological Institute” (SHI), and Saint Petersburg State University, and partners from Finland comprise University of Turku Centre for Maritime studies, South-Eastern University of Applied Sciences

(XAMK), Finnish Environmental Institute (SYKE) and Kotka Maritime Research Association (KMRA).

The main objectives of the project:

- Develop the coastal region and the ports in Finland and Russia on the principle of sustainable development
- Implement environmental innovations in cross-border region
- Disseminate best practices and environmental solutions on coastal zone management and for sustainable shore use
- Attract attention and interest to increase environmental friendliness and cooperation between ports, shipping companies and public authorities
- Increase the awareness and preparedness of citizens to reduce the effects of climate change

All the seven project partners have their own roles in the project, and South-Eastern Finland University of Applied Sciences (Xamk) is in charge of the development, implementation and reporting of the project, and responsible for delivering the planned output of the agreed project activities, prepare a scientific article on future legislation and regulations, write a report on best practices and methods of digitalization in decision making for decreasing environmental impacts in coastal zones and port environments, organize one-day training on digitalization as a tool in environmental management in Finland and in Saint Petersburg and support the lead partner and work in cooperation with other project partners. (Get Ready 2019.)

2 PURPOSE AND METHODOLOGY OF THIS STUDY

The purpose of this thesis is to examine the best practices of digitalization in Finnish cargo ports, study national and international legislation and regulations and review best practices for developing digitalization in the port environment

with an emphasis on environmental protection. In the conceptual basis section, material was collected from a variety of literary sources, primarily electronic sources.

In the empirical part ports and their stakeholders were surveyed and interviewed, with the aim of detect similarities and differences in the digitalization processes of Russian and Finnish ports. The purpose was to study the current level of digitalization of port authorities and how future trends in digitalization will affect port operations and support climate goals.

The thesis is structured nine chapters. Chapter 1 investigate the topic in general and introduces the project commissioner’s including the main purposes and Xamk's responsibilities. Chapter 2 introduces the content of the thesis in general terms. Chapter 3 study the port related laws and emission requirements. There are many different pieces of legislation that apply to ports and their surrounding areas, but this study only presents the most important ones. Chapter 4 investigate the negative environmental impacts of shipping and ports and potential means to reduce them. Chapter 5 examine digitalization and various digital solutions. Chapter 6 study various port best practices, chases and projects. Chapter 7 examine questions and answers from interviews and questionnaires. Chapter 8 investigate the results of the best practices obtained in the theory section of this thesis compared to the responses to the survey and interviews. Chapter 9 investigate the conclusions and results of the study.

3 PORT RELATED LAWS AND EMISSION REQUIREMENTS

Different EU and international laws and regulations, as well as national legislation, affect shipping, port management and operations, and the areas surrounding ports. These laws and regulations aim to prevent the effects of emissions on the environment, e.g. water and soil, birds and habitats, air quality and climate change and to help ports and shipping operators to develop their business in a sustainable manner. ESPO made a work package (Green guide) on

port legislation in 2012, which might be beneficial when gearing operations towards more sustainable port environment.

3.1 The Bird and Habitat directives

EU legislation contains over twenty laws or directives affecting ports and port-related areas. The very first EU environmental legislation is council directive, 79/409/EEC, also known as the birds' directive, accepted in April 1979. It was amended in 2009 and is now identified as directive 2009/147/EC. The directive protects wild bird species and their habitats in Europe. It covers the protection, control and management of wild bird species. Birds shall not be deliberately killed, trapped, disturbed in any way, in particular during nesting, and shall not be used for commercial purposes. It is also prohibited to destroy or restrict birds' resting places and breeding sites. (Directive 2009/147/EC 2010.)

Council directive 92/43/EEC, also known the habitats directive, was accepted in May 1992. This EU environmental legislation directive protects wild fauna, flora and nature. The purpose of this directive is to contribute to the maintenance of biodiversity, protect species and habitats and promote the survival of the species in their natural environment. (Council directive 92/43EEC no date.)

These two directives are the most important nature protection legislation in the European Union and together form the cornerstone of European nature conservation policy and are linked together to the Natura 2000 network.
The Natura 2000 network is EU-wide and aims at a long-term protection of rare and threatened habitats and species as well as breeding and resting sites. Without protection, species and habitats are in danger of disappearing or becoming endangered. There are 2,000 species and over 200 habitats in Europe that are considered sufficiently critical to be designated as Natura 2000 sites. (Natura 2000 2019.)

The EU member states have the initiative to propose a site for the Natura 2000 network, also known as Site of Community Importance (SCI). The areas included in the network are designated as Special Areas of Conservation (SAC). The network also includes Special Protection Areas (SPA) designated and selected by the Member States in compliance with the Birds Directive. The member states will benefit from the protection of Natura 2000 sites in their territory, and the network aims to improve the vitality of ecosystems. (Natura 2000 2019.)

The European Commission has framed a strategy to preserve biodiversity. Biodiversity is at stake, which means that we may not obtain the same benefit from nature as we did until now. This is perceived as a serious problem in the world in addition to climate change, and it may have a major impact on the environment, economies, and societies. In 2011, the European Commission adopted a target to halting the loss of biodiversity and degradation ecosystem in the EU by 2020. (Communication… no date.)
Targets of the strategy:

- Improvement of species and habitats protection by EU nature legislation
- Maintaining and enhancing the need of ecosystems and the services
- Consideration of biodiversity in agriculture, forestry and fisheries
- Prevent of spreading alien species to new habitats
- Improvement of EU action to combat natural degradation in globally. (Communication… no date.)

This strategy is aimed at reversing biodiversity loss and speeding up the EU's transition towards a resource efficient and green economy (Communication… no date).

3.2 The Sulphur directive

Sulfur oxides are released into the atmosphere when sulfur-containing fuels are burned. Sulfur oxides are known to impact human health, causing a variety of diseases. When released into the atmosphere, they can cause acid rain which in

turn can damage soil and water, causing acidification in the sea. It is therefore important to limit sulfur emissions in order to maintain good air quality while protecting the environment from pollution. (Directive 2016/802 2016.)

First Directive 1999/32 / EC to reduce the sulfur content of certain liquid fuels was given in April 1999. It has been amended several times, most recently in May 2016 when it was re-issued as Sulfur Directive (Directive 2016/802). The aim of the directive is to prevent the serious negative consequences for human health and the environment caused by poor air quality by imposing restrictions on the use of oil-based sulfur fuels in their territories, territorial waters and exclusive economic zones (EEZ). (Directive 2016/802 2016.)

International Maritime Organization (IMO) regulations to reduce sulphur oxides (SO_x) emissions from ships first came into force in 2005, under Annex VI of the International Convention for the Prevention of Pollution from Ships (known as the MARPOL Convention) (Sulphur 2020). From first January 2020, the sulphur content of marine fuel in European water must not exceed 0.5%, and in Emission Control Areas (ECAS) the limit is 0.1%. The IMO has established four ECAS areas, including the North Sea and the Baltic Sea (Sulphur oxides 2020).

3.3 International Convention for the Prevention of Pollution from Ships (MARPOL)

On 2 November in 1973, IMO adopted the MARPOL convention. It has been amended several times over the years. MARPOL can be considered one of the most important international marine environmental conventions for its major contribution to the prevention of pollution from international shipping. The Convention includes six annexes whose provisions are intended to prevent and minimize pollution from ships by operational or accidental causes.
Annexes are:

I. *Regulations for the Prevention of Pollution by Oil*

II. *Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk*
III. *Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form*
IV. *Prevention of Pollution by Sewage from Ships*
V. *Prevention of Pollution by Garbage from Ships*
VI. *Prevention of Air Pollution from Ships*. (International convention 2020.)

3.4 Greenhouse gas emissions

According to Decisions on 23 April 2009, the European Parliament and the Council approved Decision No 406/2009/EC on the Member States' efforts to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020 (Decisions… 2009).

The target was set by the European Council in March 2007 so that the Earth's temperature would not rise above 2 degrees Celsius. The aim is to prevent this globally by reducing greenhouse gas emissions by least 30 percent by 2020 and 50 percent by 2050 compared to 1990 levels. The EU Member States, together with the developed countries, should lead the way in reaching the global emissions target and demonstrate their commitment to the common goal. The aim is not only to reduce greenhouse gas emissions but also to improve energy efficiency. (Decision… 2009.)

3.5 Port reception facilities

Directive 2000/59 / EC of the European Parliament and of the Council of 27 November 2000 concerns port reception facilities for ship-generated waste and cargo residues. The directive aim is to protect the seas and prevent pollution in the seas and coasts, and reduce the discharge of ship-generated waste and cargo residues into the sea by providing port reception facilities for ship-generated waste and cargo residues. Some of the main priorities is to improve

the availability and efficiency of reception equipment and to enforce compliance more effectively. Access to reception facilities should be made available to all, regardless of ship size and nationality. Also, ships should be required to dispose of all its waste at the port reception facilities before leaving for the sea to prevent the waste from entering the sea. (Euroopan parlamentin… 2000.)

3.6 Maritime spatial planning

The Marine Conservation Directive 2014/89 / EU came into force in 2014 and aims to increase co-operation between EU countries, and promote economic growth and sustainable development in marine areas, and encourage use of natural resources. Maritime Spatial Planning (MSP) is needed to prevent the deterioration of the seas due to overfishing, pollution and climate change. A plan is needed for the most sustainable exploitation of marine areas. The plan must take into account the environmental aspects and give full consideration to how the area will be used and how much the use will burden the sea. (Merialuesuunnittelun 2016, 2; Taustat haltuun… 2017a.)

The Ministry of the Environment is responsible for maritime spatial planning in Finland, and provinces, in cooperation with the labor unions, have been assigned to prepare maritime spatial plans by 2021, while the other EU Member States will also prepare their own national plans by that time. The EU's idea of establishing maritime spatial plans has its origins in the idea of uniting Europeans as cooperation increases and ensuring that economic growth in the EU continues. (Taustat haltuun… 2017b.)

3.7 Special and particular sensitive areas

The Baltic Sea was listed under MARPOL as “special area” on 2 November 1973, which means that the area requires special protection by compulsory methods to prevent marine pollution (Special Areas… 2020). The Baltic Sea was also approved as a particularly sensitive sea area (PSSA) by International Maritime

Organization in 2005. PSSA is an area of special ecological, socio-economic or scientific importance that is vulnerable to damage caused by international shipping (Particularly sensitive sea areas 2020).

4 POLLUTION FROM PORTS AND SHIPS

The EU's measures to ease the environmental and economic situation by shifting transport from roads to the sea (Tapaninen 2019, 45; Short sea shipping 2020). Given the requirements and the environmental impact of maritime transport is a cheaper and more environmentally friendly way of transporting goods than land transport (Tapaninen 2019, 104; Towards more... 2016).

However, maritime transport has many adverse effects on the environment such as noise, waste, congestion, accidents, emissions to water and air, consumption of natural resources, and access of foreign organisms to sensitive ecosystems. Human exposure to various pollutants has also been studied, and a link with deaths due to environmental pollution has been identified. (Tapaninen 2019,105; Final report 2017.)

In Finland, ports must have an environmental permit for their operations because it may pose a risk of environmental pollution. No permit will be granted if a particular operation is significantly harmful to the environment or causes harm to human health. The environmental permit requires compliance with the environmental legislation and regulations. Transport and hydraulic engineering cause most of the environmental problems in the port. These environmental problems, which may arise as a result of the port's operations, will be closely monitored, and any shortcomings will be addressed, and the operations will be re-organized if the need arises. (Ympäristöluvat 2020a; Toiminnan vaikutukset 2016a.)

4.1 Air emissions from ships and ports

Climate change, which is warming the Earth and raising its average temperature, is due in part to the greenhouse gases that are released into the atmosphere mostly by human activity. Climate change is causing problems for shipping operations such as rising water levels and increasing storms. Shipping accounts for 2.5% of global greenhouse gas emissions. (Tapaninen 2019,107; Finland encourages…2019b.)

Sea transport and port activities cause emissions in forms of various gases and fine particles. The significant amount of emissions in the port is produced by internal combustion engines of ships, trucks, trains and other vehicles. (Tapaninen 2019, 104-105; Ports primer...2020.)

Emissions of sulfur oxides are detrimental to human health, exacerbate air quality and cause acidification on land and in water. Sulfur has not been used in road transport for decades, but ships have been allowed to use high-sulfur fuels. In order to reduce sulfur emissions, there are international regulations in place, whit the permitted sulfur content of fuel set at 0.1% in the Baltic and North Sea from 2015 onwards. In the rest of the world, the limit of 0.5% will take effect from 2020 onwards. In some ports, ships can be connected to the electricity grid while in port, which reduces emissions of sulfur oxides. However, the different electricity standards on ships and the lack of power systems in ports limit the use of electricity. (Tapaninen 2019, 108-109; Nitrogen emissions...2016a.)

Nitrogen oxide emissions (NOx) form harmful atmospheric ozone which is a health hazard to humans. Nitrogen oxide emissions also worsen air quality and cause eutrophication of waterways. LNG fuels or catalysts are capable of reducing nitrogen oxides from internal combustion engines. New ships and special areas will be subject to strict NOx emission limits in 2021. (Tapaninen 2019, 109; Nitrogen emissions...2016b.)

Particulate matter affecting the human respiratory system is produced during the combustion process, particularly in diesel engines. The formation of fine particles is influenced by the sulfur and ash content of the fuel and the type of engine and can be reduced by low sulfur fuels. (Tapaninen 2019, 110; Air pollution...2019.)

Short-lived air pollutant black carbon is an emission that contributes to climate change, especially in the Arctic region. In the Arctic region, temperatures are rising twice as fast as in other parts of the world and the shrinking ice cover enables increased ship operation in those areas. The share of sea transportation in the production of black carbon emissions is small, but with the projected growth in traffic, the total amount of emissions is significant. Black carbon has direct as well as indirect effects on the climate. The direct effect comes when black carbon floats in the air and heat the atmosphere by absorbing sunlight. Indirectly, it affects the properties of clouds. In the Arctic region, the deposition of black carbon on snow or ice accelerates melting. On ships, black carbon is formed by the incomplete combustion of fuel, and specifically the combustion of fossil or biofuels. The IMO has developed control methods to reduce black carbon, such as reducing the ship's speed, using alternative fuels such as LNG, switching to low-sulfur fuels, and fitting exhaust scrubbers, filters, and other purifying equipment. (Yliskylä-Peuralahti et al. 2016, 50-58.)

4.2 Discharges to water from ports and ships

There are two types of wastewater from ships, black and grey water. Black water is human waste from toilets (sewage) and gray water is cleaning waste from sinks and showers. Even though sewage pollutes the sea, it can still be discharged according to certain regulations. According to international regulations, sewage may be discharged untreated within 12 nautical miles of the shore or 3 nautical miles of the shore when treated. There are no restrictions on gray water. (Tapaninen 2019, 110; Prevention of pollution...2020.)

The largest source of wastewater is passenger ships. According to international regulations, from 2019 onwards, new passenger ships operating in special areas (the Baltic and North Sea) will have to treat sewage before it can be discharged into the sea or alternatively leave it at port reception facilities, where it will be led to waste water treatment plants. Onwards 2021, the regulation will be extended to all passenger ships. (Tapaninen 2019, 110-111; Sewage management...2017.) According to the Finnish Ports Association, it has been the practice for many years that passenger ships that regularly operate in Finland have left their sewage in ports. (Toiminnan vaikutukset 2016b).

Ballast water is used on board to stabilize the vessel and make it seaworthy. Water is taken into the vessel at the same time as the cargo is unloaded and pumped off as the vessel is being loaded so that the vessel remains stable. Ballast water has been found to contain a variety of organisms and bacteria, and when a ship sails to a new port, the organisms migrate to the new habitat and cause various problems there. The organisms are then called invasive species because they do not normally belong to that habitat. Since alien species cause problems and destroy local populations, they must be prevented from spreading. The means to prevent spreading should include the change of ballast water during the voyage. The ballast water regulations entered into force in the autumn of 2017 when vessels were obliged to install ballast water treatment equipment during docking, no later than autumn 2022. Ballast water may also be disposed of at the port if the port has a reception facility for that purpose. However, this is quite unlikely, at least for large tankers, because of the large amount of water. (Tapaninen 2019, 111-112; Ballast water...2020.)

The ship's fuel consumption increases as the micro-organisms attach to the bottom of the ship and slow down the ship's passage. The adhesion of small organisms is prevented by painting the bottom of the vessel with toxic paint. However, since the most toxic paints have been banned for a few years now, the bottom of the ships has been mechanically cleaned by divers. (Tapaninen 2019, 112; Anti-fouling system 2020.)

4.3 Ship's solid waste

The ship generates waste just like any other workplace, such as metals, glasses, bio-waste, cardboard, plastics, paper, and mixed waste and hazardous waste. In the old days, ships discharged all waste into the sea, but this has been banned since 2013. Ships with a gross tonnage of more than 400 have been required to have a garbage record book and a plan for waste treatment and disposal since 1995. (Tapaninen 2019, 112-113; Garbage 2020a.)

Ships carry a variety of cargo. Cargo residues should be removed from the hold before loading another type of cargo into the same space, whether harmful or harmless to the environment. From the beginning of 2013, harmful cargo residues and washing water should be left in port reception systems. Non-hazardous cargo residues and washing waters can be discharged into the sea 12 miles offshore if the port is unable to receive these non-hazardous residues. (Tapaninen 2019, 113.; Garbage 2020b.)

When handling the ship's bulk cargo, its loading and unloading process is closely monitored to ensure that cargo dust is not released into the environment and environmentally friendly loading methods are used to prevent it (Toiminnan vaikutukset 2016c; Garbage 2020c).

4.4 Effects on underwater nature and noise pollution

The environment in the vicinity of ports and waterways, both underwater and terrestrial environments, is affected by noise pollution. Noise pollution from port equipment and ships is considered very disturbing. There are ways to reduce noise pollution, such as the use of shore-side electricity on ships, construction of noise barriers, isolation of the ship's engine room, tightening of noise standards for various port machinery and the restriction of evening and night-time

stevedoring and ship traffic. (Tapaninen 2019, 113; Environmental impacts...2019.)

Marine propeller flows, port construction operations, dredging and ship and port pollution affects fish stocks, sea vegetation, bottom sediments, benthic animals and water quality in the underwater environment. Also, bird species and other species that depend on the marine environment are not immune to the effects. When the construction of ports and waterways was done, must be taken into account the needs of the underwater environment to reduce the adverse effects. (Tapaninen 2019, 113; Noise pollution...2016.)

In Finland and also in Sweden, all ports have to obtain an environmental permit for their operations and that is why environmental regulations are strictest than elsewhere in Europe. In addition to the environmental permit, ports must comply with environmental policies and undergo an environmental impact assessment (EIA). In order to determine the level of environmental protection, it is necessary to collect environmental information on a regular basis. It is also important to collect information that is comparable to previous studies consistent and understandable so as to obtain a reliable picture of the condition of the environment and changes in the condition will be noticed and can be therefore improved. (Ympäristöluvat 2020b; Brunila 2014.)

The Sulfur Directive, which entered into force in 2015, has set 0.1% sulfur (NO_2) limits for ships in the Baltic and the North Sea and 0.5% globally to take effect in 2020, so ships must install sulfur scrubbers or switch to low-sulfur fuel or to alternative fuels such as liquefied natural gas (LNG) to meet the requirements. In 2016, the Baltic Sea and the North Sea was recognized as Nitrogen Emission Control Areas (NECA), which meant an 80% reduction in NOx emissions compared to previous levels. The regulation also applies to new vessels built after 2021 when they sail in NECA areas. The solution for ships is to switch to LNG or install a catalytic converter. Reduced emissions will improve coastal air

quality, decreace nitrogen load in the sea and prevent eutrophication. (Laivojen typpipäästöjä… 2016; Nitrogen emissions...2016c.)

According to ESPO Environmental Report (2019, 4), the top three environmental priorities are air quality, energy consumption and climate change. Already over 50% of ports in Europe provide onshore power supply (OPS) to ships, and one in three ports provide LNG refueling, which demonstrates that a major priority for ports is to take into account climate change to make their infrastructure climate-friendly in the future. The data in the report was collected from 94 ESPO-member EU/EEA ports. (ESPO 2019, 18-19.) European Sea Ports Organization (ESPO) was created in Brussel 1993. It acts as an information network for European port authorities with the mission of achieving an efficient, safe and environmentally friendly port operations by influencing public policies in the European Union. (Our Organization 2020.)

5 DIGITALIZATION

Digitalization is a megatrend that dominates the direction of the future. It is revolutionizing the entire shipping industry. The development of digital and electronic solutions is constantly growing and their use in ports will be increased. Digital innovations are needed to meet the port's high demands such as productivity, sustainability, efficiency, and safety. However, digitalization is dependent on the size of the port and how it is done in practice. In the Baltic Sea area, the ports are searching for solutions to improve their productivity, efficiency, cost-effectiveness and environmentally practices. Each port attempts to find a specialisation to offset the competition with the other ports in their vicinity. (Saarikoski et al. 2019.)

The Government of Finland has adopted a decision on the principles of digitalization of information on the transport of goods. The decision has four objectives:

- significantly improve the flow of information within and between logistics chains
- increase the functionality of short-range logistics
- invest in the development of intelligent logistics automation
- accelerate the digitalization of ports. (Tiedon hyödyntämisellä… 2018a.)

National and EU regulations on the protection of business and business secrets and personal data, as well as information security, must be carefully considered in all actions (Tiedon hyödyntämisellä… 2018b).

According to the Ministry of Traffic and Communication, in maritime logistics, the promotion of digitalization would enable a safe, smooth, unrestricted, and uncompromised transfer of data, goods and people. With digitalization benefits such as, economic growt, reduced emissions and increased transport safety can be achieved. Digitalization makes it possible to reduce fuel consumption, increase the efficiency of loading operations, improve the performance of vessels and increase the efficiency of technological solutions. (Antikainen 2019a.)

Digitalization is expected to improve a company's ability to achieve its goals and deliver the desired results. There are also side effects in digitalization, which can delay the realization of benefits if they are not recognized and their negative impact is not reduced. Digital tools can make work environments more efficient, but in some cases, they can also slow down the flow of information and disrupt work. Factors that slow down the flow of information include unrealistic expectations about the impact of the tools, lack of training in their use, and error situations. (Vuori et al. 2018.)

5.1 Open data

Open data is computer-readable data available for free and can be shared as public or private information depending on the terms of use. Organizations and private persons can download open data from the Internet anywhere in the world

and use it how and where they want. Open data information is legally and technically free to reuse and is free of charge. (Saarikoski et al. 2019 p.13-14).

In order for open data to be exploited and used, it must be reliable. Its further use should be planned, and, in addition, it should be ensured that no third party can access, modify or destroy the data. The reliability of open data is ensured by constant maintenance and constant updating of data changes. (Datan avaamisen ABC… 2019, 14.)

Today, there is an abundance of open data, especially public administration data such as weather data, traffic data, spatial data, and vehicle data (Koski et al. 2017, 7). Not all information is open data and the main reason for this is the cost structure (Koski et al. 2017, 13). All open data in Finland is conveniently located on one website (avoindata.fi) and can be utilized from there by various means for the needs of an individual citizen, organization or software developer. The purpose of the service is to provide an open, ready-made portal for everyone to use free of charge. The service also offers an open interface for all data. (Suomen kaikki… no date.)

An Application Programming Interface or API is a software mediator that can provide information or services to applications or other information systems. In other words, it allows two applications to communicate with each other. The interface may be a mere data interface through which the data contained in the service can be read to other systems, or it may be a functional interface that also provides computational algorithms or the ability to change system information through the interface. (Avoimen rajapinnan… 2014.) In order to avoid having to retrieve data individually, the interfaces can be used to automate regular needs for the use of open data. This makes the data more accessible, and keeps it up to date, which improves the quality and brings higher benefits to it users. (Avoindata.fi:n käyttö… no date.)

5.2 Automation and robotics

Automation and robotics aim to improve the quality of work and reduce costs. The benefits include decreased human errors and delays, increased efficiency and work satisfaction along with an improved customer experience. (Pervilä 2019.) Automation and robotics are expected to improve the quality of production and lower production and labor costs. Automation and robots are already used in ports for many different types of vehicles such as work machines, ships, trains, trucks and equipment such as container cranes, and other cargo handling equipment. (Pöyskö et al. 2016, 35-36; Saarikoski et al. 2019 p.27-28.)

An automatic ship mooring system has been in use in the port of Helsinki at one berth for passenger ferries since 2016, and from the beginning of 2021 a similar system will be taked into use at another berth. The system speeds up the ship’s mooring time. The mooring system can be controlled from the port or the ship's bridge, and only one person is needed to operate it. In addition to its speed and ease of use, it also has good effects on the environment. The Port of Helsinki is located in the middle of the city, so reducing noise and emissions are important for residents living next to the port. (Toinen automaattinen… 2019.)

According to the Ministry of Transport and Communications, in order to promote the development of maritime transport, the Baltic Sea should be made an international pilot environment for autonomous maritime transport. Automation is possible as a result of the rapid development and advancement of digitalization. Automation is also seen to have an impact on improving the competitiveness, efficiency, productivity, safety and environmental sustainability of ports. (Antikainen 2019b.)

There are only a small fraction of fully automated ports in the world. However, development is moving in that direction, and automation is taking place in small steps. In ports, the transition to automation has required that all systems communicate to order to optimize results. In addition to improved efficiency, the

work environment becomes safer through automation as accidents and damage are reduced and environmental impact is decreased when route optimization helps to save energy. (Aalto 2019, 12-14.)

In Finland, the relatively small flows of goods are an obstacle to port automation due to high investment costs. It is not expected to provide sufficient cost benefits as a result. Automation and robotics are also blamed on displacing human labor. However, in the future, lower costs will allow more automation in ports of smaller freight flows. (Pöyskö et al. 2016, 35-36; Saarikoski et al. 2019 p.27-28.)

5.3 Internet of Things (IoT)

The Internet of Things connects smart objects to a global network with various other technologies, such as sensors/actuators, radio frequency identification, and machine-to-machine communication devices, and provides multiple support features such as smart identification, location information, object tracking, object monitoring and process management. (Jahn et al. 2017, 26-27.)

The Internet of Things shortly or IoT means that digital devices and systems are connected with each other by communicating and exchanging data via the internet. This enables remote control and real-time data for their users. IoT can be used in many ways in the port. For example, equipment and devices can be equipped with sensors and transmitters which can track a shipment, monitor a warehouse storage, and the temperature of a cargo container and eliminate congestion in the port area by indicating designated parking spaces for trucks. The Internet of Things has enabled easier and more effective operation monitoring for ports and freight companies. All this can reduce costs and assist in producing more revenue. (Ozkoca 2017.)

With the help of the Internet of Things, it is possible to prevent interference from the numerous devices and machines connected to the network. This means that the device or machine that fails in some way informs itself so that maintenance

can be ordered in advance to prevent possible downtime. The port is also able to monitor the use of equipment or machinery, even quay structures, and anticipate maintenance needs accordingly. A common situation awareness between the various actors in the port area is also obtained by using positioning devices, in which case it is possible to predict arrival times and monitor and control the units moving in the area. (Ahonen 2019.)

5.4 Cloud services

In the past, the software was run and files were often stored on the user's computer or the internal network of the organization. Today, it is more common to use cloud-based software hosted on vendor servers and accessed through a web browser. This allows systems and files to be "in the cloud" and accessible from anywhere at any time. Such access by many different devices also poses a security risk. (Saarikoski et al. 2019 p.28).

If a company wants to store its own data and programs in a "cloud" instead of its own server, it means that it will then store them on the server of a cloud-based company and access them over the Internet from computers and mobile devices. This is useful if the device is lost or damaged as cloud services often provide automatic backups to keep data and programs safe. Cloud services make it easy to share files and programs, allowing anyone with permission to view and use shared files anytime and anywhere. Content can also be protected by a password and, if a higher level of security is needed, access can be directed through the 2-step authentication. (Kangasniemi et al. 2017.)

Cloud services as well as other information networks may be subject to security risks. It is important for companies to address threats and anticipate them well in advance when thinking of outsourcing cloud services, and it is always advisable to maintain and improve the level of security at all times. The worst threats to an organization can be:

- criminals hijacking devices where updates are out of date

- extortion programs allowing criminals to lock in data
- fraudulent phishing messages leading to huge financial losses
- Potential cyber-attacks compromising the service provider's devices and causing problems for the organization

Still, being properly prepared for security challenges, the use of cloud services is safe and secure. (Korpela 2019.)

5.5 5G

5G represents the future of network technology designed to importantly improve mobile connectivity. Connections are expected to improve significantly over the 4G network, nearly tenfold. Speed estimates are too early to say, but the lowest download speeds would be one gigabyte per second and the highest estimates are up to 800 gigabits per second. Current 4G network speeds are in the order of 100 megabits per second. (Nurmela 2019.)

In Finland, 5G networks are already in place and have been in operation since 2019, and globally they will be deployed by the end of 2020. In order to connect even in the weakest coverage areas, 5G networks will co-exist with the 3G and 4G networks. Faster mobile networks improve traffic safety and provide live streaming with better picture and sound quality. The 5G network also enables significantly more devices to be interconnected, such as connecting multiple sensors to a mobile network, which increases the number of IoT applications. The daily live environment is becoming smarter and more cohesive, and energy efficiency is improving. (Nurmela 2019.)

For example, in logistics, 5G enables faster and larger data transfers, which improves real-time visibility throughout the supply chain. Connecting more devices to the Internet of Things and to the entire supply chain creates a stream of data whose real-time signaling triggers events to provide an even more efficient supply chain. (Carter 2019.)

5.6 Cybersecurity

As digitalization grows, information security becomes more important than ever. Cyber security is not only about securing data, it is a much broader concept where data security is only a small part. (Rousku 2012.) Security risks are increasing nowadays because there is more equipment than people. It is important to invest in effective cyber-security measures to protect systems, software and networks from potential digital attacks. (What is cybersecurity no date.)

Digital attacks on companies are done by simple means such as email. Therefore, it is important for the company to train its own employees to recognize different scam attempts and understand the importance of being alert and committed to good security practices. It would be wise for a company to incorporate cyber security as part of its risk management and also to provide its team management with updated information to support decision making.

One of the most devastating cyber-attacks happened on 27 June 2017 when the Danish A.P. Møller-Maersk, one of world's largest shipping companys, had a severe information technology disruption. The malware NotPetya destroyed Maersk's entire information technology infrastructure, including computers and other information and communication technology equipment in 574 offices in 130 countries worldwide. It took months for Maersk to recover from the attack, and the cost of repairing malware damage was $ 300 million U.S. dollars. Many other multinationals besides Maersks were attacked by NotPetya and the White House estimates that the total damage has been $ 10 billion U.S dollars. (Greenberg 2018.)

5.7 Blockchain technology

Logistics data is mostly document-centric and processed manually. Traditionally, in the logistics chain, information is transmitted between two consecutive

operators, which can lead to data being re-entered into the system up to eight times, thus increasing the possibility of an error in the input data. This causes problems in data quality, inefficiencies and data mismatches, systematic problems, overloading or underloading of transport equipment, deviations from the planned schedule and longer waiting times and re-scheduling, and sometimes lack of correspondence between the cargo and the accompanying documents. (Korpela 2019,12.)

Also, data can be in different formats made by different operators, for example, paper document, pdf or excel file. As a result, data is not electronically compatible and, thus, the sharing and transmission of information to other actors is prevented and the productivity of work is impaired. Distributed logistics/blockchains are one way to improve the efficiency of logistics by offering more accurate data, ensuring transparency and usability, improving information security, and reducing costs. (Korpela 2019,12-13.)

Blockchain technology makes it possible to exchange and share information from many different parties involved in a blockchain network by producing and maintaining distributed databases. Unknown parties can make changes to the database and store data that is timestamped and uniquely identifiable and cannot be retrospectively changed, but all account transactions remain permanently in the database and are accessible for everyone to see. This ensures reliable operation between the parties and does not require the use of third parties. (Kinnunen et al. 2017, 10.) Also, smart contracts (code), images and texts can be stored in a block chain. Smart contracts allow the parties to determine the rules and penalties associated with the contract, and the contract also automatically enforces them without the need for a lawyer. (Kinnunen et al. 2017, 13-15).

As an example of a blockchain, Kouvolan Innovation Oy's SmartLog project has been developing a new Internet of Things based IT solution that uses blockchain technology to optimize the transport of goods while making them more self-driving. The application is designed for logistics companies and enables

smoother, timely and faster delivery of goods to customers with lower costs. In addition, the flow of information becomes more transparent and faster. The project involves partners from Finland, Estonia, Latvia and Sweden and is partly funded by the Interreg Central Baltic funding source. (Kinnunen et al. 2017, 23; Smart Log 2016.)

In August 2018, a digital platform called TradeLens was launched as a result of a collaboration between IBM and Maersk. TradeLens utilizes blockchain technology in its platform to improve knowledge sharing and foster collaboration between different supply chains, thus advancing and facilitating global trade and promoting industrial innovation. TradeLens' aim is to bring all parties in the supply chain to a single platform where information is shared securely and collaboratively, utilizing the operating principles of the blockchain. By December 2019, 175 organizations had already joined the platform and more than 2 million transactions were registered per day. (Digitizing the global… 2020; Helminen & Saarikoski 2019, 38-39.)

5.8 Social Media

For a company, social media can be used as a communication and marketing channel. The most important matter for a company when using social media channels is to set purpose for their social media strategy and define what aspect there is to share and to whom and what they want to achieve. It is good to be cautious when investing, share current issues about your business and expertise, determine the interest of target audiences, and create content regularly. The more resources a company has, the more visibility it can gain on various social media channels such as Facebook, Twitter, Instagram, and LinkedIn. (Muurinen no date.)

6 BEST PRACTICES, CASES AND PROJECTS OF DIGITALIZATION

According to Cambridge Dictionary and Investopedia, the best practices comporise the most effective ideas, techniques, or methods that have been adopted because they produce the best results or have become standard ways to do business in compliance with laws and ethical requirements. (Best practices 2020; Kenton 2019.)

6.1 3D operating system at the Port of HaminaKotka

The Port of HaminaKotka cooperates with a high-tech company VRT Finland Oy to build the world's smartest digital port. HaminaKotka, the largest universal port in Finland, and VRT Finland Oy is increasingly cooperating in the maintenance of the port area and structures, an operation which began in 2016. VRT Finland has developed a 3D operating system where a multi-scanner can be used to perform underwater and above-ground inspections of structures and, together with VRT BIM 3D online service, facilitate the digital of storage, utilization, sharing and inter-comparison of data. In the port, the system improves both day-to-day operations and maintenance by enabling preventive repairs and maintenance. Operations will be further enhanced by centralizing information in one place and ensuring that it is easy to use and unambiguous, and by managing the life cycle of structures. This makes it easier to find and locate items that require repair. The cooperation between VRT and the port began with the inspection of underwater structures, but is now being extended to cover the above-ground facilities in the port area, with the entire port area being accessible for monitoring through an online system, also by mobile devices. (Maailman älykkäin… 2018.)

6.2 5G VIIMA project

The Finnish industry is reforming, and it is primarily important to build smart knowledge-based digital value chains for global markets in collaboration with industry and research institutes (Jättihanke… 2019a).

The two-year 5G VIIMA project explores the applicability of 5G technology to industrial practice. The project explores and tests the utilization of digitalization and wirelessness in an industrial environment, incorporating the inventions of network technology and the latest innovations in the ICT industry such as fields of virtual and augmented reality (VR and AR), video analytics, autonomous devices, sensor systems and how the solutions obtained will bring real value to this researched environment. Also analyzing the business environment explores the formation of the value chain and how network and data manageability and ownership occur in industrial solutions. (Jättihanke… 2019b.)

The 5G VIIMA project is coordinated by the University of Oulu and is funded by Business Finland and the companies involved in the project. The budget for the study is EUR 6 million. 5G VIIMA, which leverages and collaborates on the Finnish 5G Test Network Ecosystem, is the largest project in Finland to research and test 5G applications. (Jättihanke… 2019c.)

Important for the project is to be able to test real-world challenges in real-world environments. The challenges include logistics, security, maintenance, travel optimization and guidance. The companies that are involved with the project offer the opportunity to the testing environment. As a result, four different test sites have been selected, at each site will build a local 5G network. The test sites are the Port of Oulu and the base station factory, the power grid in Espoo and the port equipment test area in Tampere. (Jättihanke… 2019d.)

The aim of the project is to provide information on the various industrial applications of 5G, the use cases for mobile networks, and the requirements they impose for practical implementation, intended to facilitate the deployment of 5G systems and services in the future. Creating a good ecosystem between research organizations, companies and public authorities is essential to ensuring that things are working properly and for real needs. Key issues include reliability, quality of service, low power consumption, data collection and usage, minimal

network latency, cloud services, virtualization, endurance, automation, artificial intelligence utilization and sensor systems. (Jättihanke… 2019e.)

6.3 GreenVoyage2050 -project

The collaboration between the Norwegian government and the IMO has resulted in the GreenVoyage-2050 project, whose primary goal is to reduce greenhouse gas emissions from shipping worldwide. The project will support and accelerate the IMO's original strategy by improving knowledge and skills sharing, experimenting and finding solutions to curb emissions as a joint global effort. The project has been funded for the next two years and is expected to involve more than 50 countries around the world. The UN's two goals of sustainable development are also supported by this project, climate change and the sustainable use of the oceans. (UN agency launches… 2019b.)

6.4 The project of improving the efficiency of maritime transport

The aim of this project is to improve maritime traffic between Finland and Sweden, on the Rauma-Gävle and Turku-Stockholm routes. Aiming at the efficient flow of goods and passengers, achieving best practices and sustainable results, and further developing the intermodal route and improving the exchange of information between the different actors.
The project will be implemented with a budget of n 4.5 million and will last for approximately three years, from 1.3.2018 to 28.2.2021. The project aims to use sea traffic management (STM). This will improve port efficiency, information exchange, transit times and anticipation, thereby improving traffic quality and flow along the routes. (Efficient flow 2018.)

STM is a tool that provides an effective exchange of information in real-time between the marine and land-based parties, thus improving the timeliness and reliability of shipments. At the same time, the safety of maritime transport is

increased and the burden on the environment is reduced through lower fuel consumption. (About sea… no date.)

STM provides services such as *Route Cross-Check;* where a ship's planned route is sent for review and can then be corrected, based on updated map data, to a new route plan, avoiding risk areas and locations. *Route optimization*; where you provide the best information for a ship's route planning, including fairway drafts, weather forecasts for that route, optimizing fuel consumption or avoiding encounters with other ships. *Ship to Ship route exchange;* to avoid incidents with other ships by providing information on the intentions of other ships. *Navigation Warnings*; which improves maritime safety by sending information directly to the ship's ECDIS system about the various navigational warnings to whom the warnings apply. *Enhanced monitoring;* ables to anticipate abnormalities on the ship or problems with scheduling, with shore centers suggesting various changes to be made to eliminate the problems. *Port call synchronization*; where ships are told when they can come to port at the right time, and by adjusting speed, the ship can avoid anchoring while saving on fuel costs. *Port call optimization*; making port calls more transparent with open planning when port operations are timely adjusted between ships and hinterland transport. Improves the predictability and resource efficiency of all port operators. *Winter navigation;* tells ship about the current ice conditions important information and the use of icebreaking services and the best routes for the ship. *Importing pilot routes;* where approach routes are agreed with the pilot and consensus is reached. *Search and Rescue;* where the ship's electronic charts provide areas and routes for the Sar-unit and thus improve the search and rescue operation. (STM services no date.)

6.5 Energy Efficiency Desing Index tool and Ship Energy Efficiency Management Program

In the summer of 2011, together with the approved amendments to MARPOL Annex VI, the Energy Efficiency Desing Index (EEDI) and the Ship Energy

Efficiency Management Program (SEEMP) became mandatory for new ships. The International Maritime Organization (IMO) has developed a tool called Energy Efficiency Desing Index (EEDI) to determine and design performance values for new ships. The tool can be used to plan the fuel consumption of a ship in relation to the amount of goods transported, thereby increasing the fuel efficiency of the ship's engines. Ships must also have a Ship Energy Efficiency Management Plan (SEEMP) in line with international regulations to reduce greenhouse gases. However, while it is known that existing measures are not sufficient to reduce shipping emissions, the International Maritime Organization (IMO) has adopted a strategy to reduce shipping emissions in spring 2018. In such cases, maritime emissions need to be reduced by at least 50 percent by 2050 compared to 2008. (Tapaninen 2019, 107-108; Energy efficiency 2020.)

6.6 The port community system in the Netherlands

As a result of the cooperation between the ports of Rotterdam and Amsterdam, Portbase and its port community system were created in 2009. This is due to the need to make the logistics chains of Dutch ports more efficient, faster and to keep costs low. Also, making the country's ports one of the smartest in Europe. (About us no date.)

The port community system provides up to 40 different services, intelligent IT solutions to all actors in the logistics chain; designed to facilitate and speed up the operation and exchange of information throughout the chain, which means in practice fewer e-mails, phone calls and load kilometers. The exchange of information between all participants is successful and it is sufficient that the information is entered into the system only once. Due to the open platform, anyone interested in adding value to the port community and providing their services can also use the system. (The port community system no date.)

6.7 Best practices for the port authority, terminal operators and fleet owners

There are various activities that can be done in the harbors for the well-being of the environment, and according to the Environmental Protection Agency (EPA) defines of best practices as follows:

- ***Learn about near-port community considerations*** *– Orient your port to consider unique environmental justice situations of near-port communities with the goal of working to be a good neighbor for building social equity. Work collaboratively with near-port communities to identify needs and issues related to port activities.*
- ***Establish anti-idling policies*** *– By establishing an anti-idling policy for trucks, locomotives and cargo handling equipment, diesel emissions can be effectively reduced. Turning off engines when not in use is the smartest and easiest way to reduce air pollution and save money. Not only does unnecessary idling waste fuel, but it causes wear and tear on the engine which requires more maintenance.*
- ***Expand off-peak operations hours to avoid congestion*** *– By extending terminal gate hours beyond the regular schedule or offering incentives for off-peak operations, truck queuing, idling, and traffic congestion are shortened. Not only does this increase flow and efficiency, but reduces the impacts of diesel exhaust during ozone hours.*
- ***Retrofit with verified technologies, use cleaner fuels and operate more efficiently*** *– Install or require installation of emission reduction devices, replace engines or equipment, use cleaner fuels, and implement operational efficiencies which have been tested and verified. These technologies are cost-effective and yield substantial emission reductions.*
- ***Develop an Environmental Management System*** *– Ports across the globe are adopting Environmental Management Systems (EMS) as a way to plan for continuous improvement in environmental performance.*

- ***Develop an emissions inventory*** *– An emissions inventory is necessary for port authorities to understand and quantify the air quality impacts of current port operations. Ports are major contributors of NOx, PM, SOx, and air toxics. Emissions inventories help to assess the impacts of port expansion or increased activity and provide a baseline for developing emission mitigation strategies and track performance over time.*
- ***Develop educational programs on air pollution and emissions reductions for terminal operators and fleet owners*** *– One barrier to implementing cost-effective emissions reduction strategies is lack of knowledge on the part of terminal operators and fleet owners about various options. Guidance and education on air quality, air pollutants, technologies and ways to implement emissions reduction strategies not only increase awareness but also increase the opportunities to reduce emissions.*
- ***Substitute electric power for diesel power*** *– Using electric shoreside power at berth or "cold ironing," rather than running auxiliary diesel engines is effective for ports and vessels that have long hoteling times, multiple annual vessel calls, and high auxiliary power needs, such as cruise ships.*
- ***Substitute rail or barge for trucking*** *– Using rail or barge instead trucking increases the volume flow and efficiency of cargo in and out of the port. Rail and barge offer less congestion than trucks and reduces diesel exhaust from unnecessary idling.*
- ***Freight Consolidation*** *– Merging less-than-truckload and low-density shipments into full truckload intermodal container shipments headed to and from ports. Employing better container weight and volume management to reduce the number of containers needed. Improving product design to minimize shipping weight and/or volume, so more goods can be moved in each shipment. Using less packaging to fit more product into each container, thus reducing overall number of containers, and truck or rail delivery miles in and around ports. One example is to use plastic slip*

sheets instead of pallets which are larger and heavier, and often constructed of wood or composite material.

- ***Optimized Freight Networks and Information Technology*** *– Locating freight infrastructure and vehicle routing to reduce drayage vehicle miles traveled and exposure of populations to truck exhaust. Improving forecast planning, satellite tracking and container identification for ease of access and location resulting in more efficient management and tracking of container freight. Improving and harmonizing port terminal information portal systems to better manage pickups and deliveries at ports, which reduces unnecessary truck queuing and idling time.*
- ***Greater Use of Rail*** *– Constructing distribution, production, and manufacturing centers with rail access that link to port on-dock rail facilities, and eliminate unnecessary port dray truck miles between port and rail terminals. Scheduling production/delivery dates to enable greater use of rail, which eliminates unnecessary truck movements in and around ports*
- ***Electrification of Refrigerated Units*** *– Opting to ship temperature-controlled goods in trailers and intermodal containers equipped with electric plug-in refrigeration units allows the use of local electricity to power the refrigeration rather than diesel engines attached to the units. Pollution from electricity generation is usually less than diesel engines.*
- ***Trucking and Port Efficiency*** *– Offering more flexible appointment windows for truck pickup and delivery of port-bound cargo, to allow the carrier to better time its arrival at the port, which reduces unnecessary idling or queuing at the port. Unloading, stacking and organizing containers by shipper from large shippers to promote free-flow container operations. Truckers simply take the next available container from the stack, instead of possibly having port container moving equipment sift through multiple containers. This reduces pollution and saves energy by requiring fewer moves per container. This process works in reverse as well, allowing drivers to pick up empty containers at the distribution centers and return them to the port.* (Port authority best practices 2018.)

7 INTERVIEWS

The research part was implemented with the Webropol program. The original plan was to carry out an international study and compare the best practices of Russian and Finnish ports. With the help of the Russian partners in the project, the Webropol survey was translated into Russian and forwarded to Russian ports. We don't know the exact number of how many the survey was sent to, but the survey was opened 30 times, to which no one responded. Unfortunately, we did not receive any responses from the Russians, so the original plan could not be implemented. The low response rate to the survey is probably due to the length of the survey (26 questions) and the fact that people do not have time to respond due to urgency.

The surveys were first sent in late November and interviews were conducted during January, with some reminder messages sent about the surveys during the spring. The questionnaire was sent by e-mail to 29 ports, from which 12 responses were received and the respondents were either port managing directors, supervisors or other senior employees. In addition to these, the survey was conducted as a traditional in-depth interview with 3 respondents. The total number of responses was therefore 15. There were so few responses that we decided with the project leaders to combine these responses from surveys and interviews, making the results more comprehensive.

7.1 Questions for Finnish ports and stakeholders (Appendix 1)

Open data

a. Almost all respondents said they were using some open data services. The most widely used were meteorological service, weather services, water level information, vessel tracking services, Port Net Vessel Traffic Information and AIS data. Some respondents also used road and train traffic data, customs or other authority data, map and price list data, and statistical data.

b. Weather data and shipping services such as Port Net and AIS data are the most used. Shipowners and partners also shared information privately, such as ship schedules, trailer departure times on the ship, trailer photos at the port gate, the vehicle registration information of harbors and hourly tracking of machines.

c. Weather data and shipping services such as Port Net and AIS data are the most used. Shipowners and partners also shared information privately, such as ship schedules, trailer departure times on the ship, trailer photos at the port gate, the vehicle registration information of harbors and hourly tracking of machines.

d. The most common answer was the Internet and another site provided by a service provider, such as an extranet, where logging in provides access to information.

e. The answers were evenly distributed half, with another half offering and another half not. This will certainly depend on what open data services the respondents are using. For example, the meteorological institute's weather data and ship positioning services shared information system interfaces.

Automation and robotics

f. There was a consensus amongst respondents that everyone believed automation would evolve in the future, such as the increasing introduction of automation, increasing digitalization, the use of the machine and artificial intelligence in cargo handling and the use of robots in customer service. And they are believed to have a positive impact on competitiveness, improve predictability and security and increase efficiency. Some believe that change will happen quickly, some believe that it is slow because of the high cost of automation and the lack of common standards for ports.

g. All respondents believed that it was a risk and should be addressed with sufficient seriousness. For example, if security risks are not known or understood, then they will not be protected against them either. However, security is expected to improve with the 5G network.

h. Respondents thought that between 5 and 10 years. Depending on where you invest. In small ports, investment in robots and automation are not profitable.

i. Small ports do not see significant growth due to too small volumes. It also depends on the cargo that is being processed whether the cargo handling can be automated. A few believed that growth would be significant, 10-15 percent, even 20-35 percent in Port's with regular liner shipping and because this will significantly improve port efficiency and speed up ship calls.

Internet of Things

j. In port's, there is already a great deal of information available, but it is scattered across different systems. The most important thing that was raised was the knowledge of the port's transport chain, real-time timetable information in the harbor area from vessels, train and car traffic, cranes and other cargo handling equipment. Other important things were the condition of roads, structures and equipment, energy consumption, changes in water level. The use of open data for all parties to view and thereby develop logistics solutions. Clear rules for sharing information, how the owner of the information distributes the information, to whom and at what cost.

k. Location and time independent use, ease of use, speed, multiple devices on one device (just one device to control many things at the same time), and security issues such as emergency communication.

l. This was seen as a good thing by the respondents and received support from everyone, which was also seen to happen in the future. However, with modest expectations, starting with gathering all the information in one place and

moving forward with it. High-speed and digital network connections are seen as helping to document and advance the use of blockchain technology. The port's traditional infrastructure is considered as important as the digital infrastructure in the future.

m. Cooperation with other ports received a positive response (support) from all respondents. Foremost among this was the pioneering role of the major ports and setting an example for others, investing in information security, the importance of benefiting all parties, and the importance of the actors within the port with whom they otherwise cooperate. However, the competitive factors between different ports are still perceived as an obstacle to cooperation.

Cloud services

n. Most respondents use both. Some information in the cloud and some in their own information systems. Cloud service users have been happy with the service, but security issues are somewhat thoughtful. A few respondents kept the information completely in their own information systems. Keeping information in one's own information system is perceived to be safer and more secure when the information is so-called in own control.

o. About half of the respondents had no answer to this question. But the rest of the respondents saw this as possible, and the good thing was the reduction in paper documents, the improvement of real-time information and information security. There was a desire for generalization and training to make better use of blockchains.

Cybersecurity

p. All of the respondents were somehow prepared for cyber-attacks. The least prepared were relying on backups and firewalls, while others had outsourced security completely. Staff security training, contingency plans and training.

q. Judging by the answers, these things are confidential, yet some respondents said that this was part of their crisis communication plan and that these things were being prepared for and practiced.

r. Most of the respondents thought employees understood. The situation is constantly monitored, and the employees are trained accordingly. Most also felt that top management was ready to invest in protecting the organization and training employees. Some respondents were of the opinion that not all employees may understand or care about risks. It is perceived that the greatest security risk is the users, that is, the people, and if the systems are not used or are not interested in learning, then even the finest systems will not work. The training was considered important as well as restricting access to specific places for certain people.

s. The respondents were largely prepared. They have comprehensive plans for what will be updated and tested. Some had outsourced this service.

Social media

t. Half of the respondents use it, only some of them use it daily, the rest less often.

u. Mainly Twitter, Whatsapp, Instagram, Facebook, LinkedIn and Youtube.

v. Facebook, LinkedIn, Instagram, Whatsapp and Twitter were mentioned as important. And it is believed that new platforms are coming as social media usage is increasing and that's why it is worth tracking and picking the most useful solutions.

Questions for sustainability of ports

w. The legislation imposes pressures and demands to reduce emissions. And there is an increasing focus on environmental issues and sustainable development goals, and they are taken into account in all activities.

x. Respondents had various ways to reduce emissions, some in consider and some in already implementation, such as replacing old machines with new ones, battery-powered machines, intelligent LED lighting, self-generated electricity (solar, wind), providing shore power to ships, combining transportation, optimizing lane travel, reducing machine travel, enhancing stormwater filtration, tracking with sensors and digital duals, preventing bulk cargo dusting, investing in digitalization and automation.

y. Most of the respondents had the option of LNG refueling and some respondents had biofuel refueling. However, all fuels can be ordered by road to ports if necessary.

1. Ballast water can be received either to a tank truck or to a municipal sewage system. However, large amounts of water are difficult to implement for many.

2. Opportunities are seen as positive. Mobility is reduced and emissions are thereby reduced when information can be retrieved remotely, and ERP is improved when the action is more correct, higher quality and more accurate. Sensors are used to measure emissions and thereby reduce emissions. Likewise, real-time information on port infrastructure about their condition extends service life and saves money by prioritizing the use of money based on what needs repairing and not correcting anything unnecessarily or too early, reducing environmental impact through life cycle thinking. Automated check-in would speed up the process and reduce idle time and resulting emissions. Improving the flow of information between ships and the port, such as berth information, reduces the ship's fuel consumption when speed can be

optimized with the expected arrival time, which also reduces emissions. Heating of storage buildings with renewable energy.

3. Digitalization is seen as better information management and can result in more accurate and better results. Today, there are much better solutions and tools to develop information management infrastructure, than it was five years ago. Opening open data more widely between ports and companies would allow the development of applications and systems and would certainly benefit all parties.

7.2 Specific questions for Finnish ports (Appendix 2)

1. The Legislation is seen as a potential facilitator to get companies of all sizes involved and agree on common rules for all.

2. Digitization is seen as a requirement for the future. Every port is believed to invest in it anyway, and if not, it could undermine the port's competitiveness.

3. Cooperation opportunities with different actors are seen as one way to promote the issue, and then common mode of operation can also be used to take advantage of development.

4. **4.1** The correctness of documents can be verified in many different technical ways, such as checking that the information has come from the right place and in the right way, or just by random sampling.

   4.2 When different projects are done in collaboration with others, then little by little we can move towards this over time.

5. Yes. Manual processing steps are eliminated, so cost savings are clearest, as well as processes are streamlined, making things more efficient.

6. It definitely brings some kind of requirements.

7. The model that is created at the time of making, it is believed to be the model that will be used.

8. Streamlining operations is the clearest benefit. Improving the efficiency of operators and ports, such as the timely receipt of the information on the arrival of transport units at the port, will improve scheduling and offset congestion. Access to the port can be timely and this reduces queuing and also leaving the port is faster.

9. It gets even better. Through improved operational reliability, cargo safety is also believed to improve.

10. Common ground rules/data sharing model for companies and private actors, where reliability should be the number one priority. When sharing data between companies, trust that the shared data will not be accessible except to those to whom the rights have been granted.

11. These issues have already been considered in various projects and seem to be on the agenda at the moment anyway.

8 COMPARISON OF THE RESULTS WITH ACKNOWLEDGED BEST PRACTICES

In this thesis, port operations and their best practices were studied. This section compares the results obtained in the Get Ready survey and interviews concerning best practices with the discussion in the theoretical part of this thesis.

Based on the survey and interviews, the best practices in ports with respect to preventing emissions to the atmosphere and water are as follows:

- renewal of machinery and equipment to improve energy efficiency and lower consumption
- increased electrification of machines and equipment for example by switching to battery-powered machines
- intelligently controlled LED lighting to reduce light pollution and energy consumption
- independent energy production utilizing solar and wind power
- improved stormwater filtration
- shore-side electricity for ships
- the shifting of transport onto rails instead of rubber wheels
- construction of LT network to improve data collection and transmission and increase automation and digitalization to streamline the transport chain
- monitoring with sensors and digital twins
- automation of scheduled check-in to speed up the ship's stay in port
- combined modes of transport
- the development of environmental program measuring the emissions from port buildings, to monitor their energy consumption and assess the potential of solar panels to in decreasing electricity consumption
- choice of energy provider
- environmental permits for bulk loading operations.

The potential of digitalization to reduce the environmental impact of day-to-day operations in ports was seen in the following aspects:

- the reduction of shipments and retrievals by automated inventory
- elimination of certain wastes in a suitable port by improving the flow of information between ships and shipowners
- improved and streamlined efficiency in transport
- increased sustainability by heating storage buildings with renewable energy
- improved flow of information between ports and ships which allows ships to adjust their speed

- integrated programs for the continuous improvement of the state of the environment
- more accurate for measuring emissions
- optimized driving routes and the focus on life cycle of buildings and equipment to prioritize the need for repairs

When comparing the best practices introduced in the theoretical part of the study with previous surveys and interviews, the results were almost consistent with each other. However slight differences had noted.

The theoretical part presented a few projects that had not been mentioned in the surveys and interviews. Projects are often seen as beneficial for identifying best practices and solutions to improve port operations. However, the survey did not actually concentrate on projects, but instead it aimed to determine what actions had been taken to improve operations, so it is quite possible that ports are also involved in various projects at the moment.

Among best practices that were not mentioned in the surveys and interviews were the increasement of port opening hours to prevent peak congestion and thereby reduce emissions in the port, electrification of refrigerated containers, use of cleaner/alternative fuels, measurements on emissions to identify the air quality impacts of port operations, development of emission reduction strategies, guidance and training to raise awareness, the implement of better air quality, air pollution, technologies and emission reduction strategies.

One commonly acknowledged best practice that was not mentioned in the interviews and surveys was the port community system used in the Netherlands. May be due to the fact that such a system does not exist in Finland, which does not mean that there would be no need for a similar system. The interviews and surveys as well as the theoretical study supported the fact that Finland would need a system where information is entered only once and then easily and

quickly shared between operators, which would benefit all parties in the logistics chain.

9 CONCLUSIONS

The purpose of the thesis was to examine the best practices ports have in terms of digitalization and environmental protection. The theoretical part reviewed various laws and regulations and emission requirements that affect the operation of ports. It also investigates the different types of digital solutions available and ways to utilize them to help ports to become more efficient and environmentally friendly. This section presents the conclusions of the study.

The research questions that were presented at the beginning of the thesis were as follows:

- What is the current level of digitalisation in ports?
- How can digitalization support climate goals?
- What are the adverse environmental impacts of ports and shipping and how can they be reduced?
- What are the advantages and disadvantages of digitalization in ports?
- What methods, techniques and best practices are used in ports?

This study shows about the level of digitalization of Finnish ports that there is not much open data or information available that is perceived as useful in ports. Interfaces were not yet very widely used either. This may be explained by the fact that the benefits of open data and interfaces may not be known or may not be sufficiently familiar, and there may be a need for training in this regard. Open data by definition is free of charge, so it seems that data collected in ports is not very willingly passed on to others for free, at least if not benefiting both the sender and the receiver. Arguably, more open information sharing might improve the operations of a port as a whole and also facilitate the development of various applications based on information.

The use of automation and robotics is not very common in Finnish ports. The main reasons for this are the high costs and the fact that cargo flows are relatively small in Finland, so investment in automation does not seem very attractive at the moment. This may change in the future as automation becomes more common and prices fall. Most of Finland's imports and exports are carried by sea, and the logistical location is challenging. Therefore, it would be important for Finland to remain competitive and keep up with technological change, even if only a small step at a time. Information security issues in automation and robotics proved to be well known, and the existence of risks was recognized. It seems that there will be more investments in the future as technology becomes more widespread.

By means of the numerous devices and sensors connected to the Internet of Things in the port area, respondents hoped to receive important information about the port’s infrastructure, traffic flow, equipment and weather. Based on the answers, data seemed to be already at least partially available from different devices and sensors, but it was found to be scattered across different systems. There was also much information that was not yet available, but which would be of great benefit to the port. The use of electronic and portable devices was seen as in advantage due to the quick response time and ease of use. Many did not yet have knowledge of blockchain technology, so training on this issue could make a difference. The main observations I made were that it would make sense to gather all the existing information in one place, to invest in information sharing and that ports are large areas and without a comprehensive and well-functioning network infrastructure, the Internet of Things will not get the most out of it.

The preparedness of ports for cybersecurity was in good shape, even quite comprehensively. Many rely on an outsourced service for cybersecurity. Which is a good solution in the sense that if the company does not have skilled personnel, then it is good to trust those who know things best. Respondents' concern was that the employees did not necessarily understand all the risks, in which case I

would see the need for training. This was a topic that did not receive many responses, due to the confidentiality of the subject.

Social media channels were used by only half of the respondents. This could be due to the fact that in cargo ports where are no passengers, there are not perceived to be relevant to appear on social media or there are no resources to invest in visibility on social media adequately. As the world becomes more digital, the role of social media channels in marketing and in all information will certainly become even more important.

From theory and interviews became clear how significantly the digitalization supports the achievement of climate goals. Various sensors can be used to measure emissions, and after analyzing the results to influence the generation of pollutants. Sensors can be used to streamline port traffic. The reduction of exhaust emission from queuing by lessening the congestion peaks and optimizing the driving routes. That makes traffic smoother and timelier. A 3D image of the port's above-ground as well as underwater structures helps to get a real picture of the condition of the structures and not having to renew structures unnecessarily or too early is more environmentally friendly.

Digitalization will certainly lead to even greater results in improving the state of the environment than what it was examined in this thesis. Because the larger goal of my thesis was to find best practices, due to that I saw no reason to look for more environment goals than what I already have got found in this study. But instead, I could have presented more best practices in order to get an even more comprehensive result, and therefore the comparison with the results from the interviews and surveys would have been better.

In the theoretical part of the study in chapter four, a fairly comprehensive answer was received to the question about the harmful environmental impacts of ports and shipping and how they can be reduced. Many laws and environmental requirements that apply to ports and their operations also help reduce these

emissions that occur in ports. Climate well-being is now receiving a great deal of attention worldwide, and this is really important for the planet to remain viable for future generations.

According to the results of this study, digitalization clearly has more advantages than disadvantages in ports. The benefits of digitalization were so great that the disadvantage may be that expectations and desired results do not materialize as expected. If the data cannot be used correctly, there are shortcomings in the training, but also error situations in the equipment can interfere with the operation, which slows down or even prevents the flow of information and can thus interfere with work.

The objectives of the study were achieved. Although the sample from the interviews remained small, the responses were of such high quality and well supported the information obtained in the theoretical part.

The Webropol program is perhaps the best tool for conducting surveys, but so many surveys are conducted that people no longer have the resources or time to respond to surveys, so then it can happen that there are not as many responses as expected. As was the case in this study, there were very few responses and there may be many reasons for this, including the fact that the survey may not have been considered important after opening, the survey was long and would take a long time to answer it. The questionnaire contained 26 questions and the specific questionnaire contained 10 questions, and the questions were only open-ended questions, in which case the answers must be written in their own words. Open-ended questions require the respondent to have extensive knowledge of the subject in order to obtain high-quality answers. Combined with the above, hurry is certainly the significant reason. It is believed that the current global COVID-19 pandemic, in the final stages, contributed to the lack of answers, because people have more important things to think about these days. In the future, it would certainly make sense to try to arrange personal interviews than to

use a Webropol program, or at least to ask more closed-ended questions for the survey.

In my opinion, the reliability of the thesis was achieved, although the original plan to compare Finnish and Russian ports failed. However, relatively small sample of the answers was received from Finnish ports, the answers were high quality and were well known and thoughtful from respondents and they had a clear view of the topics. The theoretical part also supported the answers obtained and similarities were found. The main purpose of the study was to examine the best practices of port digitalization and these were answered in the study.

The research could be used as a tool to help decide what could and should be done in ports to promote digitalization.

As a further research proposal, one could examine how digitalization will evolve as a tool for decision-making and will the current global pandemic accelerate the development of digitalization?
In the current global pandemic, with the increase in telecommuting, how can the reliability of connections and also the reliability of data be ensured?
Will the pandemic affects the increase in telecommuting in the future and how should such pandemics be responded or prepared for and how will other countries respond or prepared for them?

When started to write this thesis, writing in English felt really difficult, especially at first. However, the topic was really interesting, and a lot of material was found from various sources. A little by little, the thesis began to progress, and we held meetings with the supervisors every two to four weeks to see how the study was progressing and what should be focused on next. However, the thesis progressed systematically, but it required hard discipline. Although, I completed my thesis as expected and on schedule. Xamk was very pleased with the results and hopefully, it will be great benefit for the Get Ready project. Thanks to my supervisors, they supported my learning and the progress of my thesis really well.

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GET READY QUESTIONS FOR FINNISH HARBORS AND STAKEHOLDERS

South-Eastern Finland University of Applied Sciences (Xamk) examines both current and future legislation, and regulations related to the use of ports and the coast, searching the best practices for the development of digitalization of port owners and operators, as well as shipping companies. The project is implementing capacity building in professional competencies via education and training, training content of digitalization of ports and cases of smart ports and managing environmental issues.

GET READY -KYSYMYKSET SUOMALAISILLE SATAMILLE JA SIDOSRYHMILLE

Kaakkois-Suomen ammattikorkeakoulu (Xamk) tutkii satamien ja rannikkojen käyttöön liittyvää nykyistä, sekä tulevaa lainsäädäntöä että määräyksiä. Xamk etsii myös parhaita käytäntöjä satamien omistajien ja niiden operaattoreiden, sekä sidosryhmien digitalisoinnin kehittämiseksi. Hankkeen tavoitteena on kehittää ammatillisen osaamisen valmiuksia ja koulutusta. Tärkeitä tavoitteita ovat myös satamien digitalisointi, "Smart Port" -älysatamien koulutussisältö sekä ympäristöasioiden hallinta.

The purpose of this questionnaire is to find out similarities and differences of digitalization on Russian and Finnish ports.

Most Finnish harbors are limited liability companies owned by the local municipalities (20 of 24 ports). These port organizations and private corporations on the port area are relatively small communities. They are managing own information and communication technology systems by themselves. These organizations have collected data that could benefit other companies in their operations on the port regions.

Digitalization is a remarkable social phenomenon, cultural change and a worldwide megatrend. It shall change the whole traffic system, so as a maritime and transport stakeholder, ports need to be part of the digital ecosystem.

Tämän kyselyn tarkoituksena on selvittää Suomen ja Venäjän satamien digitalisoinnin yhtäläisyyksiä sekä eroja

Suurin osa suomalaisista satamista on paikallisten kuntien omistamia osakeyhtiöitä, jotka luovat suhteellisen pienen ja toimivan yhteisön satamaorganisaation ja yksityisien yrityksien kesken satama-alueella. Satama-alueilla toimivat yritykset hallitsevat itse omia tieto- ja viestintätekniikkajärjestelmiään. Nämä organisaatiot keräävät jatkuvasti tietoja, joista voisi olla hyötyä myös muille yrityksille toiminnassaan satama-alueilla.

Digitaalisuus on merkittävä sosiaalinen ilmiö, kulttuurimuutos ja maailmanlaajuinen megatrendi. Se muuttaa koko liikennejärjestelmää, joten meriliikenteen ja liikenteen sidosryhmänä satamien on oltava osa digitaalista ekosysteemiä.

Questions for digitalization of ports:

Open data is free information and computer readable data provided by the public or private corporations and technical infrastructure systems. Information can be photos or pdf files. Data can also be for example xml- or csv-files, which are able to reprocess by the computer systems.

Open data is free of charge, both legally and technically reusable without any compensations to the provider of this information. Finnish Population Register Center provides a lot of open data for free in the website: https://www.avoindata.fi/en . Helsinki region shares open public data here: https://hri.fi/en_gb/

Avoin data on ilmaista, tietokoneella luettavaa tietoa, jonka tarjoavat julkiset tai yksityiset yritykset teknisistä infrastruktuurijärjestelmistään. Tiedot voivat olla valokuvia, pdf-tiedostoja tai esimerkiksi xml- tai csv-tiedostoja, joiden tarjoamaa tietoa voivat tietojärjestelmät käsitellä uudelleen.

Avoin tieto on ilmaista, sekä laillisesti että teknisesti uudelleenkäytettävää ilman korvauksia näiden tietojen tarjoajalle. Suomen väestörekisterikeskus tarjoaa ilmaiseksi paljon avointa tietoa verkkosivustolta: https://www.avoindata.fi . Helsingin seutu jakaa avoimen julkisen tiedon täällä: https://hri.fi/fi_fi/

a. Which kind of open data your company/port can find from **the public sources**? Millaista avointa dataa yrityksenne tai satamanne käyttää julkisista palveluista?

b. Which kind of open data your company/port can find from **the private sources**? Millaista avointa dataa yrityksenne tai satamanne käyttää yksityisistä palveluista?

c. Where can you find this data? Mistä löydätte tämän tiedon?

d. Do they provide API, Application Programming Interfaces for downloading data from the sources? Tarjoaako tiedontuottaja rajapinnan tietojärjestelmäänsä (API, Application Programming Interface)?

Automation and robotics are technologies, which are supposed to produce more quality and less production cost. On the port, automation and robotics could use in the cargo operations, autonomic cranes, trucks, trains and ships. Even automooring for vessels is in use on the one berth in the Helsinki harbor today.

Automaatio ja robotiikka ovat tekniikoita, joiden oletetaan tuottavan laadukkaampaa tuotantoa ja laskevan tuotantokustannuksia. Satamassa automaatiota ja robotteja voidaan käyttää lastitoiminnoissa, autonostureissa, kuorma-autoissa ja junissa sekä laivoissa. Jopa aluksen automaattinen laiturikiinnitys on nykyään käytössä Helsingin Jätkäsaaren sataman yhdessä laiturissa.

e. How do you feel that automation will evolve in the future and affect the competitiveness of ports? Miten uskotte automaation kehittyvän tulevaisuudessa ja vaikuttavan satamien kilpailukykyyn?

f. What you think about safety and security issues with automation and robotics? Mitä olette mieltä automaation ja robotiikan turvallisuus- ja tietoturvallisuusasioista?

g. How long time do you believe it takes when return on investments will be positive after investing on automation and robotics for ports? Kuinka kauan mielestänne kuluu aikaa, jotta sijoituksen tuotto on satamien automaation ja robotiikan investointien jälkeen positiivinen?

h. Do you see that investing cargo-handling automation, automated storage and terminals will increase effectiveness significantly in the future? Kuinka merkittävästi oletatte tehokkuuden lisääntyvän tulevaisuudessa pääomia sijoitettaessa lastinkäsittelyautomaatioon, automatisoituun varastointiin ja terminaaleihin? Perustele.

Internet of Things (IoT) and the other name for same function is Machine-to-Machine communication (M2M). IoT means digital solutions how to connect digital devices, machines, engines and buildings to a network. All these equipment have connected each other's. Those are remote controlled, and their data can analyzed in real time. All kind of installed sensors can send relevant information from these machines.

This real time data can utilized in different ways for providing new quality services. One possibility is to process this enormous data by Artificial Intelligence (AI). The user can identify any disturbance or divergence from the AI information. User can and react before the process or machines break and order maintenance or service if needed. Artificial Intelligence can also order this service automatically. IoT and sensors can use 5G mobile networks to transmit data to cloud services.

Esineiden Internet (IoT) tunnetaan myös nimellä koneiden välinen viestintä (Machine-to-Machine, M2M). IoT tarkoittaa digitaalisia ratkaisuja laitteiden, koneiden, moottorien ja rakennusten yhdistämistä Internet-verkossa. Yhdistetyt laitteet ovat kauko- tai etäohjattavia, ja niistä saatavia tietoja voidaan analysoida reaaliajassa. Koneisiin ja laitteisiin asennetut anturit voivat lähettää asiaankuuluvaa tietoa koneista ja niiden liikkeestä.

Tätä reaaliaikaista tietoa voidaan hyödyntää eri tavoin tarjoamalla uusia laadukkaita palveluita. Yksi mahdollisuus on käsitellä tätä valtavaa tietoa keinoälyllä (Artificial Intelligence, AI), jonka tiedosta käyttäjä voi tunnistaa häiriöt tai poikkeamat. Käyttäjä voi reagoida ja toimia ennen prosessin tai koneiden rikkoutumista, ja tilata tarvittaessa huoltoa tai huoltoa koneelle. Keinoäly voi myös tilata tämän huoltopalvelun automaattisesti. IoT ja anturit voivat käyttää 5G-matkaviestinverkkoja tiedon siirtämiseen pilvipalveluihin.

i. Which information and data would be important for your company/port? Is it able to find with the existing equipment and sensors? Mikä tieto olisi tärkeää saada yrityksellenne / satamallenne? Onko sitä mahdollista saada olemassaolevista laitteista ja antureista?

j. Mobile services and applications can used with different kind of electronic devices. What is the major benefit of using mobile services? Matkapuhelinpalveluita ja sovelluksia voidaan käyttää erityyppisten elektronisten laitteiden kanssa. Mikä on matkaviestinpalveluiden käytön suurin hyöty?

k. What do you think about developing digital infrastructure to connect different devices and to get more data? Mitä mieltä olet digitaalisen infrastruktuurin kehittämisestä yhdistämään erilaisia laitteita ja saamaan niistä lisää tietoa?

l. Do you see any possibility to cooperate and distribute data together with other companies/ports nearby your premises? Näettekö, että tiedon jakaminen olis mahdollista yhteistyössä muiden lähellä olevien yritysten / satamien kanssa?

Cloud services are administrated applications for centered software systems, which can be used any kind of devices, any time and place where is network to internet. The security risk for data is login to application with multiple device systems.

Pilvipalvelut ovat sovelluksia keskitetyille ohjelmisto- ja tallennusjärjestelmille, joita voidaan käyttää minkä tahansa tyyppisissä päätelaitteissa, sekä paikoissa missä on Internet-verkko. Tietoturvariskejä esiintyy kirjautumiseen sovellukseen useiden erilaisten laitejärjestelmien kanssa.

m. Do you have resources to keep vulnerable data in your own company/port or do you use cloud service? Are you satisfied for the service? Onko yrityksellänne resursseja pitää arvokkaita tietoja omassa tietojärjestelmässä vai käytättekö pilvipalveluita? Oletteko tyytyväisiä palveluun?

n. What do you think about using blockchain technology for new services, for example forwarding and smart contracting? Mitä mieltä olette blockchain-tekniikan käytöstä uusissa palveluissa, esimerkiksi huolinnassa ja älysopimuksissa (smart contract)?

Cybersecurity. Danish A.P. Møller-Maersk shipping company had a serious information technology incident after cyber-attack in 27th of June 2017. This so-called NotPetya cyber weapon devastated computers and ICT equipment in different 574 offices in 130 countries. The cost for recover of this cyber invasion was $ 300 Million U.S. dollars for Maersk. Total damages from NotPetya have been total $ 10 billion U.S. dollars as estimated by the White House.

Kyberturvallisuus Tanskalaiselle A. P. Møller-Maerskin varustamolle tapahtui vakava tietoverkkohyökkäys 27. kesäkuuta 2017. Tämä NotPetyaksi kutsuttu kyberase tuhosi tietokoneita ja ICT-laitteita kaikkiaan 574:ssä toimistossa yli 130 maassa. Tietoverkkohyökkäyksen palauttamiskustannukset olivat Maerskille 300 miljoonaa Yhdysvaltain dollaria. NotPetyan vahingot ovat kokonaisuudessaan olleet Valkoisen talon arvioiden mukaan yhteensä 10 miljardia Yhdysvaltain dollaria.

o. How have your company/port prepared and secured ICT systems for cyber-attacks? Kuinka yrityksenne on varautunut tietojärjestelmien kyberhyökkäyksiin?

p. Which kind of guidance and decisions your top management will do in operational level and crisis management with media if your company suffers with cyber-attack? Mikäli yrityksenne joutuu tietohyökkäyksen kohteeksi, niin millaisia operatiivisia ohjeita ja kriisihallinnanpäätöksiä ylin johtonne pystyy tekemään mediaa varten?

q. Does your employees understand the cyber threats? Is your top management ready to invest for organization's protection and educate employees? Ymmärtävätkö työntekijänne verkkouhat? Onko ylin johtonne valmis investoimaan organisaationne suojaamiseksi ja työntekijöiden kouluttamiseen?

r. Which kind of response and recovery plans do you have in your company/port to mitigate damage of cyber-attack? Are these internal plans tested and updated? Millainen reagointi- ja pelastussuunnitelma yrityksellänsi / satamassanne on kyberhyökkäysten aiheuttamien vahinkojen minimoimiseksi? Testataanko ja päivitetäänkö teillä näitä sisäisiä suunnitelmia?

Social media can be seen very powerful tool in the business and crisis management today. Customer service and personal contact can maintained also in any situations thru networks.

Sosiaalinen media nähdään tehokkaana työkaluna liiketoiminnassa ja kriisinhallinnassa nykyisin. Asiakaspalvelua ja henkilökohtainen yhteyttä asiakkaisiin voidaan ylläpitää myös verkon kautta.

s. Does your company/port use social media in its daily work? Käyttääkö yrityksenne sosiaalista mediaa hyväkseen päivittäisessä työskentelyssä?

t. What are main the platforms using social media? Mitä sosiaalisia medioita käytätte pääsääntöisin?

u. Please give **your opinion**, which are the most important technologies in the near future. Kerro mielipiteesi, mitkä teknologiat ovat tärkeimpiä tulevaisuudessa (sosiaalisessa mediassa).

Questions for sustainability of ports. Kestävä kehityksen satamakysymykset:

The sustainability framework is challenging of creating innovations for sustainable ports, protecting environment and mitigating climate change. The United Nations has defined the Sustainable Development Goals for the year 2030. The Sustainable Development Goals (SDG's) are to achieve a better and more sustainable future for all.The European Commission has a strategic long-term vision to be prosperous, modern, competitive and climate-neutral economy by the year 2050.

The European objective is to keep the global temperature increase below 2°C and decrease it to 1.5°C.The European Union's climate policy is guiding to reduce greenhouse gas emissions at least 40% from the 1990 levels by the year 2030 and targets for European Union climate policy until year 2050 to a low carbon economy. The share of maritime transport greenhouse gas (later GHG) emissions is 13.6 % by the European Environment agency in the end of November 2018. Aviation represents 13.3 % and road transport 72.1 % shares GHG emissions.

Global Maritime Forum informs that ships carry 90 % of global trade by volume. The International Maritime Organization (IMO)'s has launched a strategy for reducing GHG emissions from shipping on the middle of May 2019. GreenVoyage-2050 project shall reduce emissions by testing technical solutions, enhancing knowledge and sharing information to GHG reduction strategy. By the IMO Marine Environment Protection Committee (MEPC), the shipping sector is cutting overall CO2 output by 50 percent by year 2050. Emission reductions continues until to zero carbon emissions entirely.The port stakeholders have strong guidance of the national and international legislation. Maritime law covers United Nations Convention on the Law of the Sea (UNCLOS) and International Maritime Organization's (IMO) regulation and global standards for the safety, security and environmental performance of international shipping.

Kestävän viitekehyksen luominen on haastavaa kehittää satamille, samalla suojella ympäristöä ja hillitä ilmastomuutosta. Yhdistyneet Kansakunnat on määritellyt kestävän kehityksen tavoitteet vuodelle 2030. Kestävän kehityksen tavoitteilla (Sustainable Development Goals, SDG) on päästävä parempaan ja kestävämpään tulevaisuuteen kaikille. Euroopan komissiolla on strateginen pitkän aikavälin visio menestyväksi, uudenaikaiseksi, kilpailukykyiseksi ja saada ilmastoneutraalit taloudet vuoteen 2050 mennessä.

Eurooppalainen tavoite on pitää maapallon lämpötilan nousu alle 2° Celsius asteessa ja laskea se 1,5° C-asteeseen. Euroopan unionin ilmastopolitiikassa pyritään vähentämään kasvihuonekaasupäästöjä vähintään 40% vuoden 1990 tasosta vuoteen 2030 mennessä. Euroopan unionin ilmastopolitiikan tavoitteet ovat päästä vähähiiliseen talouteen vuoteen 2050 mennessä. Euroopan ympäristöjärjestön mukaan meriliikenteen kasvihuonekaasupäästöjen (Greenhousegas, GHG) osuus on 13,6% marraskuun 2018 loppuun mennessä. Ilmailu edustaa 13,3% ja maantiekuljetusten osuus 72,1% kasvihuonekaasupäästöistä.

Global Maritime Forum ilmoittaa, että alukset kuljettavat 90 prosenttia maailmankaupasta. Kansainvälisen merenkulkujärjestön (International Maritime Organization, IMO) on julkaissut toukokuussa 2019 laatimansa strategian meriliikenteen kasvihuonekaasupäästöjen vähentämiseksi. GreenVoyage-2050 -projekti tavoittelee päästövähennyksiä testaamalla teknisiä ratkaisuja, parantamalla ja jakamalla tietoja kasvihuonekaasupäästöjen vähentämisstrategiaksi. IMO:n meriympäristönsuojelukomitean (Marine Environment Protection Committee, MEPC) mukaan merenkulkuala vähentää hiilidioksidipäästöjä 50 prosentilla vuoteen 2050 mennessä. Päästövähennykset jatkuvat, kunnes hiilidioksidipäästöt ovat kokonaan nollatasolla. Sataman sidosryhmillä on vahvat ohjeet kansallisesta ja kansainvälisestä lainsäädännöstä. Merilaki kattaa Yhdistyneiden Kansakuntien merioikeusyleissopimuksen (United Nations Convention on the Law of the Sea, UNCLOS) ja Kansainvälisen merenkulkujärjestön (IMO) määräykset sekä kansainvälisen merenkulun turvallisuutta, että ympäristönsuojelua koskevat yleiset standardit.

v. Which kind of national legislation is going to affect mitigating climate change your company / port in the near future? Miten kansallinen lainsäädäntö tulee vaikuttamaan ilmastonmuutoksen lieventämiseen yritykseesi / satamaan lähitulevaisuudessa?

w. What technologies, operational changes and best practices do you plan to implement to reduce emissions to air and water in your company/port in the near future? Mitä tekniikoita, toiminnallisia muutoksia ja parhaita käytäntöjä aiotte toteuttaa vähentääksenne ilmanpäästöjä veteen liittyviä päästöjä yrityksessänne / satamassanne lähitulevaisuudessa?

x. What alternative fuels does your company needs/port currently provides to ships (e.g. LNG, methane and biofuels)? Mitä vaihtoehtoisia polttoaineita yrityksenne tarvitsee / satamanne tarjoaa tällä hetkellä aluksille (esimerkiksi nesteytettyä maakaasua (LNG), metaania ja biopolttoaineita)?

IMO has legislation that regulates management of ballast water from ships with the aim to minimize the risk of introducing non-native species through the discharge of ballast water and sediments into other coastal regions.

IMO:n lainsäädäntö säätelee alusten painolastiveden hallintaa, tavoitteena minimoida vieraslajien ja sedimenttien leviäminen aluksien painolastivesistä rannikkoalueille.

1. How have you prepared to handle vessel's ballast water management in your company / port? Kuinka olet valmistatuneet käsittelemään aluksien painolastivesien käsittelyä yrityksessänne / satamassanne?

2. How do generally see digitalization as tool to decrease environmental impacts in your daily operations now and in the near future? You can give example what and/or how your company has made for decreasing environmental impacts.

   Kuinka näette digitalisaation mahdollisuuden vähentää ympäristövaikutuksia päivittäisessä toiminnassanne nyt ja lähitulevaisuudessa? Voitte antaa esimerkin siitä, mitä ja/tai miten yrityksenne tulee vähentämään ympäristövaikutuksia.

3. Free comments or thought about questionnaire? Muita ajatuksia ja vapaita kommentteja kyselystä?

Thank You for Your time, we appreciate the answers! Paljon kiitoksia, arvostamme todella paljon apuanne ja vastauksianne!

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GET READY – TARKENNETUT KYSYMYKSET SUOMALAISILLE SATAMILLE

Kaakkois-Suomen ammattikorkeakoulu (Xamk) tutkii satamien ja rannikkojen käyttöön liittyviä nykyistä, sekä tulevaa lainsäädäntöä että määräyksiä. Xamk etsii myös parhaita käytäntöjä satamien omistajien ja niiden operaattoreiden, sekä sidosryhmien digitalisoinnin kehittämiseksi.

Kyselyn tarkoituksena on selvittää rahtialusliikenteen ja logistiikkasektorin digitalisoitumista.

Digitaalisuus on merkittävä sosiaalinen ilmiö, kulttuurimuutos ja maailmanlaajuinen megatrendi. Se muuttaa koko liikennejärjestelmää, joten meriliikenteen ja liikenteen sidosryhmänä satamien on oltava osa digitaalista ekosysteemiä.

Tarkennetut kysymykset, avoin data ja automaatio/robotiikka:

Avoin data on ilmaista, tietokoneella luettavaa tietoa, jonka tarjoavat julkiset tai yksityiset yritykset teknisistä infrastruktuurijärjestelmistään. Aiemman kyselyn tuloksena toteamme, että satamat käyttävät lähinnä säätietoja, Portnet-järjestelmää ja aluksien AIS-tietoja hyväkseen tiedonsaamisessa.

Suurimpia ongelmia datan avoimuudessa lienee se, ettei avointa dataa ole saatavissa kuin julkisten yritysten kautta. Yksityiset yritykset eivät välttämättä avaa toimitusketjujaan ja tietojärjestelmiään kovinkaan helposti.

Automaatio ja robotiikka ovat tekniikoita, joiden oletetaan tuottavan laadukkaampaa tuotantoa ja laskevan tuotantokustannuksia.

1. Millä tavoin näette, merikuljetukset voidaan integroida muihin kuljetusmuotoihin, tarvitaanko yhteistä lainsäädäntöä?

2. Parantaako digitalisaatio satamien kilpailukykyä vai onko se vaatimus tulevaisuudessa?

3. Kuinka logistiikkasektorin digitalisaation kehitystä ja tiedon hyödyntämistä voidaan edistää?

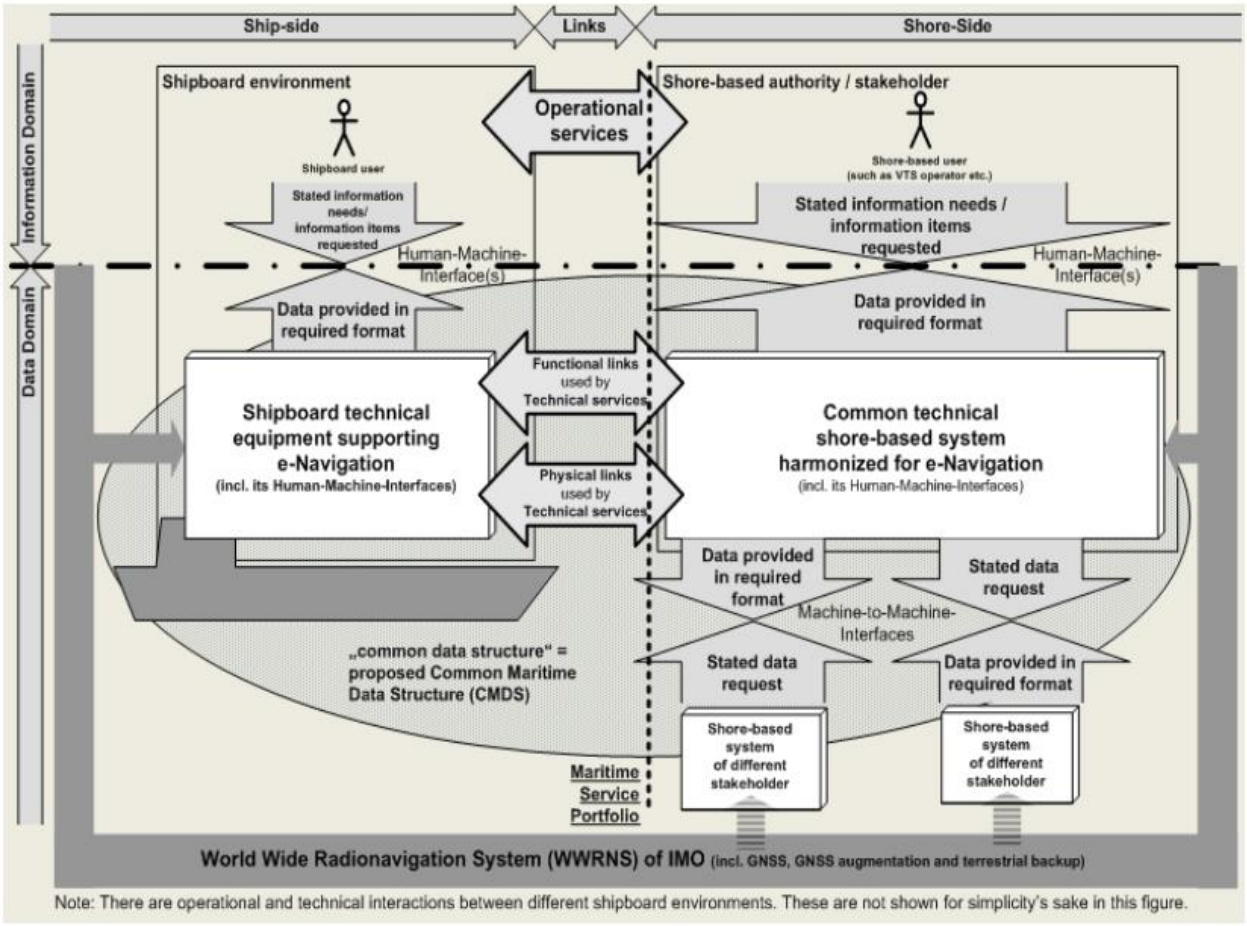
4. Yritysten logistiset prosessit ja tietojärjestelmät perustuvat dokumenteista pohjautuvan tiedon käsittelyyn.
   4.1. Kuinka voidaan varmistaa tallennetun tiedon oikeellisuus?

   4.2. Kuinka yritykset voivat siirtyä dokumenteista datamalleihin ja hajautettuihin, sekä integroituihin ratkaisuihin?

5. Näettekö, että digitalisaation avulla saadaan kustannussäästöjä?

Kansainvälisen merenkulkujärjestön mukainen E-navigointi

IMO:n määritelmän mukaan e-navigointi (MSC94, marraskuu 2014) määritellään seuraavasti:
"the harmonized collection, integration, exchange, presentation and analysis of marine information on board and ashore by electronic means to enhance berth to berth navigation and related services for safety and security at sea and protection of the marine environment."



6. Uskotko tällaisten navigointitarpeiden tuovan satamille ja niissä toimiville operaattoreille vaatimuksia? Perustele.

7. Kuinka tieto siirretään, millaisia avoimia rajapintoja (Open API) jatkossa tarvitaan aluksien ja satamien välille?

8. Mitä hyötyä ja kenelle näet digitalisaation tuovan satamien operaatioille?

9. Miten näet toimintavarmuuden, työ- ja lastiturvallisuuden suhtatuvan uusiin tavoitteisiin?

10. Millä tavalla datan jakamista voisi lisätä yksityisten toimijoiden ja julkisten sektorien yhteisellä toiminnalla?

Muita ajatuksia ja vapaita kommentteja kyselystä?

Paljon kiitoksia, arvostamme todella paljon apuanne ja vastauksianne!

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