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Ships' Waste Discharge Sources and Incentives for Preventing Waste Discharges to Sea

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Master's Thesis for Marine Engineering/Technology

Maritime Management - Master of Marine Engineering/Technology

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EXAMENSARBETE

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Titel: Fartygets avfallskällor och incitament för att förhindra avfallsutsläpp till havet

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Abstrakt

Denna studie har två syften. Först att upptäcka avfallskällor från fartyg till havet och det andra att studera incitamenten som kan användas för att förhindra avfallsutsläpp till havet och förbättra avlämningen av avfall till hamnarnas mottagningsanordningar. Studien genomfördes som en litteraturöversikt och kompletterades av intervjuerna. Litteraturmaterialet består av internationell och nationell lagstiftning och studier som utförts av de internationella organisationerna och samfälligheterna. Intervjumaterialet består av intervjuerna från rederiers tekniska- och miljöexperter, fartygspersonal och tjänstemän som arbetar med olika sektorer i administrationen.

Enligt intervjuerna är olagliga avsiktliga utsläpp och oavsiktliga utsläpp relativt sällsynta i Östersjön. Vissa utsläpp sker dock fortfarande från särskilda fartygsbaserade källor. Dessutom tillåts vissa utsläpp enligt lagstiftningen, såsom toalettavfall, grått vatten, matavfall, icke-HME lastrester och avgasreningssystemets avloppsvatten. Dessa utsläpp inträffar också i praktiken, även om många rederier följer striktare miljöstandarder som lagstiftningen kräver. Det 100% indirekta avgiftssystemet (dvs. no-special-fee) sågs som ett funktionellt incitamentssystem som främjar avfallsavlämningen från fartyg till hamnarnas mottagningsanordningar. Det erkändes dock att systemet ytterligare borde uppmuntra fartyg att minska sin avfallsproduktion.

Som en kortvarig åtgärd kan avlämningen av avfall till mottagningsanordningar för hamnar förbättras genom att informera om tillämpade incitamentssystem och utveckla hamnarnas möjligheter för avfallsmottagningen. Som en långsiktig åtgärd bör den internationella MARPOL-konventionen revideras genom att utveckla kraven för de avfallsutsläpp som i dag tillåts att släppa ut i havet.

Språk: Engelska Nyckelord: fartygsavfall, marint avfall

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Tiivistelmä

Tällä tutkimuksella on kaksi tavoitetta. Ensimmäiseksi, löytää aluksista mereen aiheutuvat päästölähteet ja toiseksi tutkia kannustimia, joilla voitaisiin estää jätteiden päästäminen mereen ja tehostaa jätteiden toimittamista satamien vastaanottolaitteisiin. Tutkimus tehtiin kirjallisuuskatsauksena, jota täydennettiin haastatteluilla. Kirjallisuusmateriaali koostui kansainvälisestä ja kansallisesta lainsäädännöstä sekä kansainvälisten järjestöjen ja yhteisöjen suorittamista tutkimuksista. Haastatteluaineisto koostui varustamoyhtiöiden teknisten- ja ympäristöasiantuntijoiden, laivan henkilöstön ja hallinnon eri aloilla työskentelevien virkamiesten haastatteluista.

Haastattelujen perusteella sekä laittomia tahallisia päästöjä että tahattomia päästöjä tapahtuu Itämeren alueella harvoin mutta tiettyjä tahallisia päästöjä tapahtuu kuitenkin edelleen. Lisäksi osa päästöistä, kuten käymäläjäteveden, harmaan veden, ruokajätteiden, muiden kuin HME-lastien jäämät ja pakokaasujen puhdistusjärjestelmien poistovesien päästöt, ovat lainsäädännön mukaan sallittuja. Näitä päästöjä tapahtuu myös käytännössä, vaikka monet varustamot noudattavat tiukempia ympäristöstandardeja, mitä lainsäädäntö edellyttää. 100% epäsuoraa maksujärjestelmää (no-special-fee) pidettiin toimivana kannustinjärjestelmänä, joka edistää jätteiden toimittamista aluksilta satamien vastaanottolaitteisiin. Vaikka järjestelmä on toimiva, tämän tulisi myös kannustaa aluksia vähentämään jätteiden syntymistä.

Lyhytaikaisena toimenpiteenä jätteiden toimittamista satamien vastaanottolaitteisiin voidaan parantaa lisäämällä tiedottamista satamissa sovellettavista kannustusjärjestelmistä ja kehittämällä jätteiden toimitusvaihtoehtoja satamissa. Pitkäaikaisena toimenpiteenä kansainvälistä MARPOL-yleissopimusta olisi uudistettava asettamalla vaatimuksia jätepäästöille, joiden päästäminen mereen on nykyään sallittua.

Kieli: Englanti Avainsanat: Alusjäte, meriroska

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Abstract

This study has two objectives. First, to discover waste discharge sources from ships to sea and second, to study incentives that could be used to prevent waste discharges to the sea and enhance the waste delivery to the port reception facilities. The study was conducted as a literature review and complemented by the interviews. The literature material consist the international and national legislation and studies conducted by the international organizations and entities. The interview material consist the interviews of the ship-owner companies' technical and environmental experts, ship personnel and civil servants working on different sectors in the administration.

Based on the interviews, illegal deliberate discharges and unintended discharges, are relatively rare in the Baltic Sea area. However, some deliberate discharges still happen from particular ship-based sources. In addition, certain discharges are allowed by the legislation, such as the sewage, grey water, food waste, non-HME cargo residues and exhaust gas cleaning systems' discharge waters discharges. These discharges happen also in practice, although many ship-owner companies follow stricter environment standards what the legislation requires. The 100 % indirect fee system (i.e. no-special-fee) was seen as a functional incentive system that promotes the waste delivery from ships to port reception facilities. However, it was recognized that the system should further encourage ships to reduce their waste generation.

As a short-term measure, waste delivery to port reception facilities can be improved by increasing the informing of the applied incentive systems and developing waste delivery options at ports. As a long-term measure, the international MARPOL Convention should be improved by developing the requirements for those waste discharges, which are today allowed to be discharged to the sea.

Language: English Key words: Ship generated waste, marine litter

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1 Introduction

The garbage pollution and especially the marine litter from ships have been recognized as a significant threat to the marine environment, human life and economy. Marine plastic litter is a global problem and it exists both in the oceans and in the regional sea areas. (UNEP 2009)

Marine mammals, fish and birds may ingest plastic litter or can stuck by the lost fishing gear, which may cause death to exposed animals. Microplastics may find its way along the food chain to human organs. For the shipping industry, marine litter may cause safety and navigational hazard when ropes or fishing nets may stuck the ship's propellers or ship can collide with drifting containers. Aesthetic harm will most certainly affect to tourism and further cause economical losses. (IMO 2018, UNEP 2009)

Although, the shipping is not the main vector of the marine litter discharges in the Baltic Sea area, the 5 % of the marine litter discharges in the Baltic Sea are from shipping industry (Arcadis 2012). It is important to intervene the marine litter discharges from ships also here as the discharges affect directly to outer archipelago and concentrate in the fairways (GESAMP 2015, Arcadis 2012).

Purpose of this study is to find out shipping related waste discharge sources focusing especially on the marine plastic litter. Furthermore, the purpose is to discover possible incentives, which could provide help for preventing the waste discharges from ships to the sea.

The Finnish Transport and Communications Agency has conducted this study for the Finnish Environment Institute as a part of the national research project, which name is *RoskatPois!*. The intention of the national research project is to chart possible sources of the marine plastic litter entering in the Finnish sea areas. Research project *RoskatPois!* is based on the Finnish national programme of measures which is established in accordance with the Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy.

The goal of this study is to provide necessary information from the shipping related waste discharge sources for the above mentioned national research project. This study will also give baseline information for the future development of the both national and international regulations as it considers also the feasibility of the different incentive systems.

2 Purpose and definition

The scope of this study is to research ships' pollution sources concerning the waste pollution to sea and consider incentive systems, which may prevent such pollution from ships to sea.

The study's target is to provide relevant information for the Finnish national research project *RoskatPois!*. The study may also provide information for future development of the pollution prevention legislation both nationally and internationally.

As mentioned before, this study is part of the national research project managed by the Finnish Environment Institute. The overall target for this national research project is to chart the marine litter pollution sources, which cause the marine litter pollution in the Baltic Sea. The purpose of the TRAFICOM part of the research project is to encompass shipping related waste sources of the marine litter in the Baltic Sea. Other studied areas on the national research project are the land based sources of marine litter, and aquaculture and fishing as a source of marine litter. Land based sources were studied by the Finnish Environment Institute and aquaculture and fishing by the Natural Resources Institute Finland.

Consequently, the research questions were formulated based on the task given by the national research project and issues found by the TRAFICOM, which are related to prevention of pollution from ships to sea.

The research questions for the study are:

1. What are the ships' waste discharge sources?

2. What incentives could be used as preventing measures for ships not to discharge wastes to the sea and deliver wastes to port reception facilities?

The purpose of the first research question is to find the ships' waste discharge sources. In other words, where the ships' waste discharges originates from and to contribute this information for the national research project *RoskatPois!*. The focus of the *RoskatPois!* project is on those ships' waste discharges, which may be source of marine plastic litter discharges to the sea. However, also other onboard waste discharge sources than just marine plastic litter are researched in this study, as this information is of great interest for the TRAFICOM. In summary, the purpose of the first research question is to find all possible ships' waste discharge sources where the wastes could end up to sea.

The second question is concerning the incentives for preventing waste discharges from ship to sea. This question is not part of the national research study *RoskatPois!* but it is of interest for the TRAFICOM to study incentives, which would encourage efficient waste delivery from ship to port reception facilities. Incentive in this content includes both economic incentives and incentives, which in practice makes the waste delivery from ship to port reception facilities more attractive. The second research question would provide information for upcoming amendments of the Finnish national Act on Environmental Protection in Maritime Transport 1672/2009. The act in question will be revised in the near future due to implementation of recent revision of the Directive 2000/59/EC of the European Parliament and of the Council of 27 November 2000 on port reception facilities for ship-generated waste and cargo residues (later PRF-directive).

3 Theoretical starting points

3.1 Essential Concepts and Definitions

For avoiding factual errors in this study, essential definitions are described in the below paragraphs. Definitions for terms: ship, waste and pollution prevention are taken from the MARPOL and SOLAS Conventions, which are developed in the International Maritime Organization (IMO). The definition for marine plastic litter is from the United Nations Environment Programme's (UNEP) report *A Marine Litter: A Global Challenge*. Definitions for micro- and macroplastic are taken from previous studies. For the term incentive, the definition given in the Cambridge English dictionary is used as a basis.

For all other terms, which are not defined in the below paragraphs and would require definitions, the definitions in the MARPOL Convention are used.

3.1.1 Ships

In this study, passenger ships' and cargo ships' waste discharge sources are researched. The International Convention for the Prevention of Pollution from Ships (MARPOL Convention) is defining the ship as follows:

> *'"Ship" means a vessel of any type whatsoever operating in the marine environment and includes hydrofoil boats, air-cushion vehicles, submersibles, floating craft and fixed or floating platforms."*

The International Convention for the Safety of Life at Sea (SOLAS Convention) further defines a passenger ship and a cargo ship as follows:

"A passenger ship is a ship which carries more than twelve passengers."

"A cargo ship is any ship which is not a passenger ship."

3.1.2 Waste from ships

This study focuses on ship generated waste, concentrating especially on marine plastic litter from ships. Consequently, definitions for waste and garbage are essential.

Directive (EU) 2019/883 of the European Parliament and of the Council of 17 April 2019 on port reception facilities for the delivery of waste from ships, amending Directive 2010/65/EU and repealing Directive 2000/59/EC defines the waste from ships as follows:

"'waste from ships' means all waste, including cargo residues, which is generated during the service of a ship or during loading, unloading and cleaning operations and which falls within the scope of Annexes I, II, IV, V and VI to MARPOL Convention, as well as passively fished waste."

The Annex V of the International Convention for the Prevention of Pollution from Ships (1997) gives definition for garbage:

"Garbage means all kinds of food wastes, domestic wastes and operational wastes, all plastics, cargo residues, incinerator ashes, cooking oil, fishing gear, and animal carcasses generated during the normal operation of the ship and liable to be disposed of continuously or periodically except those substances which are defined or listed in other Annexes to the present Convention. Garbage does not include fresh fish and parts thereof generated as a result of fishing activities undertaken during the voyage, or as a result of aquaculture activities which involve the transport of fish including shellfish for placement in the aquaculture facility and the transport of harvested fish including shellfish from such facilities to shore for processing."

Below the definition for marine litter as it is defined in UNEP's report Marine Litter: A Global Challenge (2009).

"Any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment.

Marine litter consists of items that have been made or used by people and deliberately discarded into the sea or rivers or on beaches; brought indirectly to the sea with rivers, sewage, storm water or winds; accidentally lost, including material lost at sea in bad weather (fishing gear, cargo); or deliberately left by people on beaches and shores."

This study focuses especially on marine plastic litter and it can be further divided into macro- and microplastics. In the IMO's Action Plan to Address Marine Plastic Litter from Ships microplastic and in several studies and reports (i.e. UNEP 2009, GESAMP 2016, ARCADIS 2012) microplastic is usually considered as a small plastic particle, which diameter is 5 mm or less. Macroplastic is considered usually as a plastic particle with a diameter more than 5 mm (UNEP 2009, Eriksen et al. 2014). Some studies also define a mesoplastic size category. This usually means a plastic particle, which diameter is between 5 mm and 250 mm (GESAMP 2016, Eriksen et al. 2014). However, this

size category is not relevant for this study and mesoplastic is included in the macroplastic size category.

3.1.3 Pollution Prevention

Requirements for pollution prevention are given in the International Convention for the Prevention of Pollution from Ships (MARPOL) (1997). For this study, the Annexes I, IV and V of the MARPOL Convention are relevant. The MARPOL Convention gives pollution prevention regulations for oily waste, sewage and garbage discharges from ships. These requirements are explained in more detail in the paragraph 4.1.1 but the principal requirement is that all garbage discharges to sea are prohibited. However, the MARPOL Convention provides certain exceptions from this main requirement. (IMO 1997)

3.1.4 Incentive

The Cambridge English dictionary defines an incentive as follows:

> *"something, especially money, that encourages a person or organization to do something"*

In this study, *incentive* means actions and procedures that encourage ships to leave all their wastes to port reception facilities and not discharging wastes to the sea. Incentive in this content means both economic incentives and incentives, which make the waste delivery from ship to port reception facility more attractive.

4 Theoretical background

The international conventions, EU regulations and directives, regional conventions and national acts regulate the pollution prevention in maritime shipping. In this section each convention, regulation or act, which is related the ships' waste discharge sources are scrutinized. In this section different ship types, which are subject of this study are also described.

4.1 International Conventions

In this section, international and Finnish national regulations are explained, which are directly related to ships' waste discharges. For example, the MARPOL Convention contains six Annexes, which are regulating pollution from ships but only its first, fourth, fifth and sixth Annexes regulate

waste discharges that are relevant for this study. Thus, the Annexes II and III are not explained below.

4.1.1 MARPOL Convention

International Convention for the Prevention of Pollution from Ships (MARPOL 73/78/97) and its Annex I, Regulations for the Prevention of Pollution by Oil, issues the requirements for ships, which are related to the oily wastes. The Annex IV, Regulations for the Prevention of Pollution by Sewage from Ships, gives regulations for sewage discharges and Annex V, Regulations for the Prevention of Pollution by Garbage from Ships, for garbage discharges. The Annex VI, Regulations for the Prevention of Air Pollution from Ships, regulates the air emissions but it contains also discharge requirements for ozone depleting substances and regulates equivalent compliance methods such as exhaust gas cleaning systems (EGCS) (i.e. scrubbers).

In general, the MARPOL Convention prohibits waste discharges to the sea. However, the Convention allows discharge of particular waste categories with certain requirements. These discharge requirements are divided to two different type of requirements. These are discharge regulations for sea areas outside of special areas and discharge regulations for special areas. However, certain requirements apply for all sea areas, e.g. discharge of plastic waste to sea is generally prohibited in all sea areas without any moderations. (IMO 1997)

According to Annex I, Annex IV, Annex V and Annex VI of the MARPOL Convention, waste discharges are allowed outside of special areas to sea as explained in the table 1.

Table 1. Garbage discharges outside special areas (IMO 1997).

Waste category	Conditions for discharge waste to sea
Oily bilge waters	• Oil content not exceeds 15 ppm (parts per million)
Sludge	• Discharge to sea prohibited
Sewage (treated with sewage treatment plant)	• No limitations
Sewage (comminuted and disinfected)	• 3 NM from nearest land
Sewage (untreated)	• Holding tank, • 12 NM from nearest land, • ship is en route, and

	• approved discharge rate
Food waste (comminuted/grinded)	• Ship is en route, • 3 NM from nearest land, and • comminuted/grinded
Food waste (not comminuted/grinded)	• Ship is en route, and • 12 NM from nearest land
Cargo residues	• Ship is en route, • 12 NM from nearest land, and • only substances, which are not classified as harmful to the marine environment are allowed
Animal carcasses	• Ship is en route and as far form the nearest land as possible
Wash water (cargo hold, deck or external surfaces)	• Substances not harmful to marine environment
Exhaust gas cleaning system (EGCS) discharge waters	• pH, turbidity and PAH limits set in the 2015 Guidelines for EGCS, MEPC.259(68)

According to Annex I, Annex IV, Annex V and Annex VI of the MARPOL Convention, waste discharges are allowed within special areas as explained in the table 2.

Table 2. Waste discharges within special areas (IMO 1997).

Waste category	Conditions for discharge to sea
Oily bilge waters	• Oil content not exceeds 15 ppm (parts per million)
Sludge	• Discharge to sea prohibited
Sewage, cargo ships (treated with sewage treatment plant)	• No limitations
Sewage, cargo ships (comminuted and disinfected)	• 3 NM from nearest land
Sewage, cargo ships (untreated)	• Holding tank, • 12 NM from nearest land, • ship is en route, and

	• approved discharge rate
Sewage, passenger ships	• Treated with sewage treatment plant, which is approved for special areas. • Otherwise no allowed.
Food waste (comminuted/grinded)	• Ship is en route • 12 NM from nearest land • Comminuted/grinded
Food waste (not comminuted /grinded)	• No allowed
Cargo residues	• Ship is en route • 12 NM from nearest land, • cargo residues in hold washing water and cleaning agents shall not contain substances, which are classified as harmful to marine environment • Departure port and next port are within special area • No adequate reception facilities available
Wash water (cargo hold, deck or external surfaces)	• Substances not harmful to marine environment.
Exhaust gas cleaning system (EGCS) discharge waters	• pH, turbidity and PAH limits set in the 2015 Guidelines for EGCS, MEPC.259(68)

According to the Convention, Parties shall ensure that their ports have adequate reception facilities for ships visiting in those ports. In addition, discharging wastes to port reception facilities shall not cause undue delay to ships. (IMO 1997)

The Convention also sets an obligation for Parties to inspect foreign ships, which are visiting their ports. This is called a port State control (PSC) inspection. If there are clear grounds that the ship is not following the requirements of the Convention, the Party shall prevent the ship to sail until the deficiency is rectified and there are no unreasonable threat or harm for the marine environment. (IMO 1997)

To prevent garbage discharges from ships, the Convention sets three main operational requirements. First, the ship needs to have placards onboard, which inform the garbage discharge requirements for the ship crew and passengers. This applies to all ships of 12 meters or more in length overall. The second requirement is a garbage management plan, where the ship's garbage management procedures are described. Procedures for minimizing, storing, collecting and disposing garbage shall be provided in this plan. Every ship with a gross tonnage (GT) of 100 or more or certified to carry 15 or more persons shall have a garbage management plan onboard. Third, there is a record keeping requirement for ships. Each garbage discharge shall be recorded in the garbage record book. Ships shall also keep onboard receipts received from reception facilities. The garbage record book requirement applies to each ship of 400 GT and above and each ship, which is certified to carry 15 or more persons onboard. (IMO 1997)

4.1.2 AFS Convention

The AFS Convention, officially the International Convention on the Control of Harmful Anti-Fouling Systems on Ships, 2001, sets obligations for reducing the negative effects of ships' anti-fouling systems to marine environment and human health. Annex 1 of the AFS Convention prohibits the use of organotin compounds in ship's anti-fouling paints. (IMO 2001) There is also ongoing work at the IMO to revise Annex 1 of the AFS Convention and include Cybuthryne to the list of prohibited biocides in ships' antifouling systems (IMO 2020).

4.2 EU Regulations and Directives

4.2.1 Marine Strategy Framework Directive

The purpose of the Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) is to create a framework for the EU member States for the actions, which are required to establish and maintain the good status of the marine environment by the year 2020. The main element of the Directive is the requirement for member States to develop marine strategy for its marine waters. The national marine strategy shall include both the preparation and the programme of measures. By the programme of measures, member States define the measures, which are needed to achieve good status for their sea areas. (Directive 2008/56/EC)

4.2.2 PRF Directive

The Directive 2000/59/EC of the European Parliament and of the Council of 27 November 2000 on port reception facilities for ship-generated waste and cargo residues, also called as the PRF Directive, aims to reduce ship garbage discharges. The directive sets additional requirements for garbage discharges above the MARPOL Convention. These additional requirements are waste reception and handling plans for ports, garbage notification 24 hours before arrival to destination port, mandatory delivery of ship generated waste to port with certain exceptions, requirements for waste fees, exemptions for ships with scheduled traffic and more stringent enforcement than in the MARPOL Convention and penalties. (Directive 2000/59/EC)

4.2.3 AFS Regulation

The purpose of the Regulation (EC) No 782/2003 of the EUROPEAN PARLIAMENT and of the Council of 14 April 2003 on the prohibition of organotin compounds on ships (AFS Regulation) is the same as the IMO's AFS Convention to prohibit the organotin compounds in ship antifouling systems. By issuing the AFS Regulation in 2003, the EU's intention was to speed up the States' ratification process, which would further assist the entry into force of the international AFS Convention. (Regulation (EC) No 782/2003)

4.3 Regional Conventions

4.3.1 HELSINKI Convention

The Baltic Sea States and the EU has signed the Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992 (HELSINKI Convention). Annex IV of the HELSINKI Convention issues requirements for the Prevention of pollution from ships. The structure of the Helsinki Convention is similar than the MARPOL Convention. The Helsinki Convention covers the Annexes I – V of the MARPOL Convention for consistent application and implementation of these Annexes between the contracting Parties. In the Annex IV of the Helsinki Convention, it is included some more stringent requirements above the MARPOL Convention. These are for example, prohibition against incinerating garbage and waste oils within territorial waters of the contracting Parties (i.e. 12 nautical miles from nearest land), toilet retention system requirements for pleasure boats and mandatory delivery of waste (i.e. oily residues, sewage and garbage) to port reception facilities. (HELCOM 1992)

Related to the waste delivery to port reception facilities, the HELCOM has issued the recommendation 28E/10 Application of the No-Special-Fee System to Ship-Generated Wastes and Marine Litter Caught in Fishing Nets in the Baltic Sea Area. The idea of the no-special-fee system is that the waste fee is included in the port fees and ships will pay the fee each time whether the ship delivers waste to port or not. Oily residues, sewage, garbage and marine litter caught in fishing nets are included in the no-special-fee system. The purpose of the no-special-fee system is to encourage ships to deliver its waste to port reception facilities and to promote the equal sharing of waste burden between ports. (HELCOM 2007)

4.4 National Acts

4.4.1 Act on Environmental Protection in Maritime Transport 1672/2009 and Government Decree on Environmental Protection in Maritime Transport 76/2010

Act on Environmental Protection in Maritime Transport 1672/2009 and Government Decree on Environmental Protection in Maritime Transport 76/2010 implements all above mentioned international maritime environment regulations, except the Marine Strategy Framework Directive, nationally in Finland. Many HELCOM recommendations like recommendation 28E/10 for no-special-fee have been implemented by this act and decree. The Act on Environmental Protection in Maritime Transport 1672/2009 also defines the responsible administrations and lists their roles. The Decree on Environmental Protection in Maritime Transport 76/2010 defines also the minimum amount of oily residues, which a ship can have in its tanks, without requirement to deliver it to shore reception facilities. In general, the act and decree in question do not set any additional requirements for waste discharges above Annexes I, IV, IV and VI of the MARPOL Convention, the PRF Directive and the Helsinki Convention. (Act on Environmental Protection in Maritime Transport 1672/2009 and Government Decree on Environmental Protection in Maritime Transport 76/2010)

4.4.2 Act on the Organisation of River Basin Management and the Marine Strategy 1299/2004 and Government Decree on the Organisation of the Development and Implementation of the Marine Strategy 980/2011

The Marine Strategy Framework Directive has been implemented to national legislation by the Act on the Organisation of River Basin Management and the Marine Strategy 1299/2004 and by the Government Decree on the Organisation of the Development and Implementation of the Marine Strategy 980/2011. The act and decree sets national requirements for the preparation and the programme of measures for the Finnish marine strategy. The act also defines the responsible administrations for implementing and monitoring of the marine strategy.

4.5 International Action Plans and Strategies

For addressing the issue of the marine plastic litter, international and regional organizations have adopted action plans.

4.5.1 The IMO Action Plan to Address Marine Plastic Litter from Ships

Despite of international conventions, it is recognized in the IMO that discharges of marine plastic litter from ships to sea still occur. The international regulations, which prohibits the plastic discharges are Annex V of the MARPOL Convention, which sets regulations for preventing garbage pollution from ships to sea, and the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 (London Convention and Protocol), which prevents the dumping of plastics to the sea. The intention of the IMO Action Plan is to offer solutions to prevent the entering of the plastic litter to seas by ship-based activities. (IMO 2018)

The IMO action plan to address marine plastic litter from ships proposes several measures concerning the fishing vessels, commercial shipping, port reception facilities and public awareness and education. These measures, which will be considered in the future when legislation is developed, consist inter alia, mandatory marking of fishing gear, better enforcement of the fishing vessels and enforcement of all ships regarding to requirements of the MARPOL Annex V. The action plan contains also establishment of system for reporting of lost containers, instruments to address the responsibility and liability for plastic consumer goods lost at sea from ships, plastic waste collection requirement for port reception facilities, including fishing gear, and incentive systems for ships to deliver wastes to port reception facilities. In addition, the IMO action plan for marine plastic litter addresses the training of ships' and fishing vessels' crew on marine environment awareness.

For better understanding of the ships' role on marine litter, the action plan proposes to conduct a study on marine plastic litter from ships. This study will include both macro- and microplastics. Additionally the action plan encourages Member States and international organizations to conduct studies and share the results of these studies. (IMO 2018)

4.5.2 HELCOM Marine Litter Action Plan

In 2015 the HELCOM Member States and the EU adopted the Regional Action Plan for Marine Litter (i.e. HELCOM Recommendation 36/1). This regional action plan addresses the recommended actions for preventing and cleaning of the marine litter. HELCOM marine litter action plan consists

two different action groups. First, collective actions, which are jointly implemented by Contracting Parties and second, voluntary national actions, which the Contracting parties may voluntarily implement as they consider actions applicable. Both action groups include actions for 1. Land-based sources of marine litter, 2. Sea-based sources of marine litter, and 3. Education and outreach on marine litter. (HELCOM 2015)

As a regional Committee the HELCOM cannot issue mandatory regulations and therefore the action plan consists of proposals for recommendations and guidelines. Actions address the inspections of the ships, implementation and harmonization of the no-special-fee incentive system, implementation of the ISO standard (201070:2013) for port reception facilities, best practices for fishing vessels and initiate removal measures for ghost nets and encourage passive fishing for litter. (HELCOM 2015)

Contrary to the IMO action plan, which proposes the measures for later amendments to Conventions, which have mandatory nature, the HELCOM action plan proposes the development of recommendations and guidelines, which are not mandatory. HELCOM Contracting States may implement these actions to their national legislation as appropriate.

4.6 Studied ship types

This study focuses on commercial ships, which are further divided into cargo ships and passenger ships. Definitions for these ship types are given above in paragraph 3.1.1.

Depending on the cargo, which the ship is constructed to carry, cargo ships can be further divided into sub categories like oil tankers, bulk carriers, general cargo ships and ro-ro cargo ships. Passenger ships can be divided into ro-ro passenger ships and cruise passenger ships. Definitions for different ship types are given in the Annex VI of the MARPOL Convention and in the SOLAS Convention. (IMO 1997)

5 Previous research

Several international studies and reports concerning the waste releases in shipping and especially related to the marine litter have been published in past years. Many of these studies and reports have been issued by international organizations or working groups, like the United Nations Environment Programme (UNEP), Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP), European Union (EU) and European Maritime Safety Agency (EMSA). In addition to above organizations and working groups, Universities and institutions have conducted

several studies related to ship waste discharges. In Finland, the Finnish Transport and Communications Agency have commissioned a few studies, where four of these studies were considered in this study.

Previous research concerning the research questions of this study are examined below. In the first section 5.1 previous research concerning the first research question (i.e. ship waste discharge sources) are examined. The second section 5.2 examines previous research related to second research question (i.e. incentive systems).

5.1 Ships' waste discharge sources

Many of the previous studies, which were examined for this study, were focusing on marine litter itself and its impacts from sea-based sources (e.g. shipping, fishing, offshore operations, boating, etc.) and not specifically individual waste and marine plastic litter sources onboard ships. In other words, from where onboard ships waste and marine plastic litter will end up to sea. (EUNOMIA 2016, Eriksen et al. 2014 RPA 2013, Arcadis 2012, UNEP 2009)

In 2009 UNEP published the report "*Marine Litter: A Global Challenge*". On that report sea-based sources of marine litter is divided on a general level into different source categories. These sea-based source categories are shipping (e.g. merchant, public transport, pleasure, naval and research vessels), fishing activities (e.g. vessels, angling and fish farming), offshore mining and extraction (e.g. vessels, and oil and gas platforms), legal and illegal dumping at sea, abandoned, lost or otherwise discarded fishing gear (ALDFG), and natural disasters.

For this study, waste discharges from merchant shipping, containing only discharges from cargo and passenger ships are studied. Waste discharges from merchant ships are further divided into discharges under the Annex I (i.e. oil), Annex IV (i.e. sewage), Annex V (i.e. garbage) and Annex VI (i.e. air emissions related discharges) of the MARPOL Convention.

5.1.1 Shipping

Many studies recognizes peoples' attitudes and behavior as a significant contributor of plastic discharges to sea (UNEP 2018, GESAMP 2016, GESAMP 2015, Arcadis 2012 UNEP 2009, UNEP 2006). In addition to these studies, human element is also recognized in the IMO and HELCOM marine litter action plans (IMO 2018, HELCOM 2015). GESAMP 2015 states as well that plastic waste is concentrated in shipping routes and population centers.

Studies (EUNOMIA 2016, Arcadis 2012) divides marine litter discharges from ships' into deliberate/illegal discharges and accidental discharges. Base on that study, illegal discharges are the major source but accidental discharges also happen (EUNOMIA 2016). Shipping disasters and accidents have also been recognized as a source for waste discharges. These may result in release of cargoes, such as loss of containers, release of fuel oil and loss of life. Released cargoes may even be toxic to the marine environment and toxicity may vary from non-toxic to severe toxicity. (UNEP 2019)

Cargo residues are also named as a source of discharge (GESAMP 2016, Carl Bro a/s 2005). Previous studies addresses difficulty of delivering the cargo residues to ports as main reason for cargo residue discharges to sea (GESAMP 2016, Carl Bro a/s 2005, Ohlenschlager et al 2012). In addition, chemical carriers, which carry the raw materials for plastics manufacture, may cause microplastics discharges to sea due to operational or accidental discharge. However, more research is needed to assess the quantity of this discharge. (GESAMP 2016)

Several studies mentions sewage (UNEP 2019, TRAFICOM 2019, Jalkanen et al 2019, Ohlenschlager et al 2012) and grey water (UNEP 2019, TRAFICOM 2019, Ytreberg et al 2019, Jalkanen et al 2019) as a pollution source from ships to sea. In accordance with the MARPOL Convention, it is allowed to discharge untreated sewage 12 nautical miles from nearest land and grey water discharges are not regulated in the MARPOL Convention (IMO 1997). It is also recognized that old sewage treatment plants are not working very well and consequently, effluent do not comply the standards set in the IMO sewage treatment plant type approval guidelines (Netherlands 2017).

Food waste is recognized as a waste discharge source from ships (TRAFICOM 2019, Jalkanen et al 2019). As sewage and grey water, food waste is also allowed to be discharged into the sea. Inside special areas, food waste may be discharged 12 nautical miles from nearest land when comminuted or ground. Outside the special areas, the equal limit is 3 nautical miles or 12 miles without any treatment. (IMO 1997)

One study (GESAMP 2016) names two main reasons why waste disposals on many ships may be handled inadequately. These are inadequate storage facilities on board ships and lack of reception facilities in ports.

Studies mention several reasons for difficult waste delivery from ships to port reception facilities, which may lead waste discharges to sea. For example the study (Carl Bro a/s 2005), mentions following reasons, waste notifications are not controlled, waste handling is outsourced and port may

not have central management over waste handling and ports may miss the cargo residue reception facilities. In addition, there may be lack of transparency concerning the pricing, waste operators may have monopoly status, and ports may lack competence related to ship waste handling, which may further lead to illogical waste handling systems in ports. Ohlenschlager et al 2012 mentions reasons as lack of communication between port operator and waste operator, communication between port and PSC is insufficient, majority but not all ports have reception facilities for sewage, ports do not know when the ships have exemptions issued in accordance with PRF Directive and ports are not involved in enforcement.

Some studies are examining direct microplastic releases from ships. The IMO has conducted a study "*Hull Scrapings and Marine Coatings as a Source of Microplastics*", which introduces that ship paints, especially anti-fouling paints, may cause microplastic pollution to sea. Same study raises the concern that ships' hull cleaning activities may cause microplastic releases to the sea. However, the study mentions that proper research is missing (IMO 2019). In addition to anti-fouling paints and hull cleaning, plastic abrasives, when used on cleaning ship hulls may cause microplastic releases (GESAMP 2016).

The London Convention and Protocol (LC&P) and the IMO have conducted a study "*Marine Litter in Wastes Dumped at Sea Under the London Convention and Protocol*". Although the study examines the dumped waste it recognizes that domestic waste onboard ships and especially grey water, are major sources of micropalastics. (LC&P and IMO 2016)

Table 3. Summary of shipping related discharge sources from previous research

Waste discharge source	Type of waste	Reason for discharge
Illegal discharges, dumping	Any	Human elements like attitudes and behavior. Difficulties in waste delivery to ports. Inadequate storage facilities on board.
Accidental discharges	Any	Disasters, accidents, storms.
Cargo spaces	Any cargo residue, cargo wash waters	Difficulties in cargo related waste delivery to ports.
Sewage systems	Sewage	Legal to discharge to sea. Human elements like attitudes and behavior. Difficulties in waste delivery to ports. Inadequate storage facilities on board. Onboard treatment plants do not meet discharge standards.
Grey water systems	Grey water	Legal to discharge to sea. Human elements like attitudes and

		behavior. Difficulties in waste delivery to ports. Inadequate storage facilities on board.
Food waste management/systems	Food waste	Legal to discharge to sea. Human elements like attitudes and behavior. Difficulties in waste delivery to ports. Inadequate storage facilities on board.
Hull scraping and coating	ship paints (e.g. anti-fouling paints)	Ship maintenance.
Hull cleaning	ship paints (e.g. anti-fouling paints), plastic abrasives	Ship maintenance.

Waste quantities from shipping

Average waste generation rates have been studied by the CE Delft 2017. Ship's waste generation rates given in the CE Delft 2017 have been compiled in the following table 4. It should be noted that these are the generation rates for wastes that are generated on board ship and not the quantities, which are discharged from ships to the sea.

Table 4. Ships' waste generation rates according to the CE Delft 2017

Regulation	Waste category	Quantity
MARPOL Annex I	Oily Bilge Water	0.01-13 m3 / day
	Oily residues (sludge)	0.01 to 0.03 m3 of sludge / tonne of HFO. 0 and 0.01 m3 / tonne of MGO.
MARPOL Annex I and II	Tank washings (slops)	20 to hundreds of m3
MARPOL Annex IV	Sewage	0.01 to 0.06 m3 / person / day. Sewage is sometimes mixed with other waste water. The total amount ranges from 0.04 to 0.45 m3 / day / person.
MARPOL Annex V	Plastics	0.001 to 0.008 m3 of plastics / person / day.
-"-	Food wastes	0.001 to 0.003 m3 / person / day.
-"-	Domestic wastes	0.001 to 0.02 m3 / day / person.
-"-	Cooking oil	0.01 to 0.08 litres / person / day.
-"-	Incinerator ashes	0.004 and 0.06 m3 / month.
-"-	Operational wastes	0.001 to 0.1 m3 / person / day.
-"-	Cargo residues	0.001–2 % of cargo load.

The Finnish Meteorological Institute have together with assist of the Chalmers University of Technology, IVL Swedish Environmental Research Institute and Tallinn Technical University (Jalkanen et al. 2019) assessed the waste quantities, which are discharged to sea in the Baltic Sea area. Assessed waste categories are those categories that ships can discharge to sea according to the MARPOL Convention or alternatively waste categories are not regulated in the MARPOL Convention.

Waste discharges from ships are based on the model called the Ship Traffic Emission Assessment Model (STEAM) and as a base data, the model uses the AIS data submitted by ships. As a metadata (i.e. ships' waste discharge factors), the model uses data from previous studies. In the following table 5, it is presented the quantities, which are discharged from ships to the Baltic Sea in the year 2018.

Table 5. Assessment of the discharged waste quantities (Jalkanen et al. 2019)

Regulation	Waste category	Quantity
MARPOL Annex I	Oily bilge water	360 000 m3
	Stern tube oil leakage	3 700 m3
MARPOL Annex IV	Sewage	1.4 million m3 containing 573 t of Nitrogen. 86% of Nitrogen from passenger ships.
	Grey water	5.4 million m3. 89 % of discharges from passenger ships.
MARPOL Annex V	Food waste	Nitrogen in food waste 90 t. 91 % from passenger ships.
MARPOL Annex VI	Exhaust gas cleaning system (scrubber) discharge waters	77 million m3. 99,9 % is originated from open loop systems.
AFS Convention	Antifouling paints releases from ships' underwater hulls. Pleasure crafts not included.	440 t 80 % is Copper(II)oxide (CuO)

Marine Litter study to support the establishment of an initial quantitative headline reduction target (Arcadis 2012) have examined the marine litter sources and waste quantities released to sea. Results

of this study are based on the beach litter survey. This means that number of the found items per 100 meters were registered in different beach sites. Items were sorted to different categories and average item quantity per 100 m per category were calculated. When the length of the Baltic Sea coastline is known, total quantity of the marine litter can be calculated. It should also be noted that Arcadis 2012 estimates the number of marine litter items, not the weight of litter.

The study (Arcadis 2012) assesses that 5 % of all marine litter in the Baltic Sea, originates from the shipping sector. All sea-based sources are responsible for 29 % of the marine litter in the Baltic Sea and remaining 71 % are from land-based sources. Proportion of marine litter from different sea-based sources is presented in the figure 1.

According to the Arcadis 2012, main waste category for the marine litter in the Baltic Sea is plastics, 58 % of all marine litter are plastic items. Other categories are paper/cardboard (17 %), metal (7 %) and ceramic (6 %). Most common single marine litter pieces are plastic pieces with sizes between 2,5 cm and 50 cm. These represent 24 % of all found pieces and means that there is on average 34 plastic pieces per 100 m coastline. Other items are cigarette butts (10 %) and plastic bottle caps (5 %) and foam sponges (5 %), ceramic/pottery items (5%) and plastic (shopping) bags (4%).

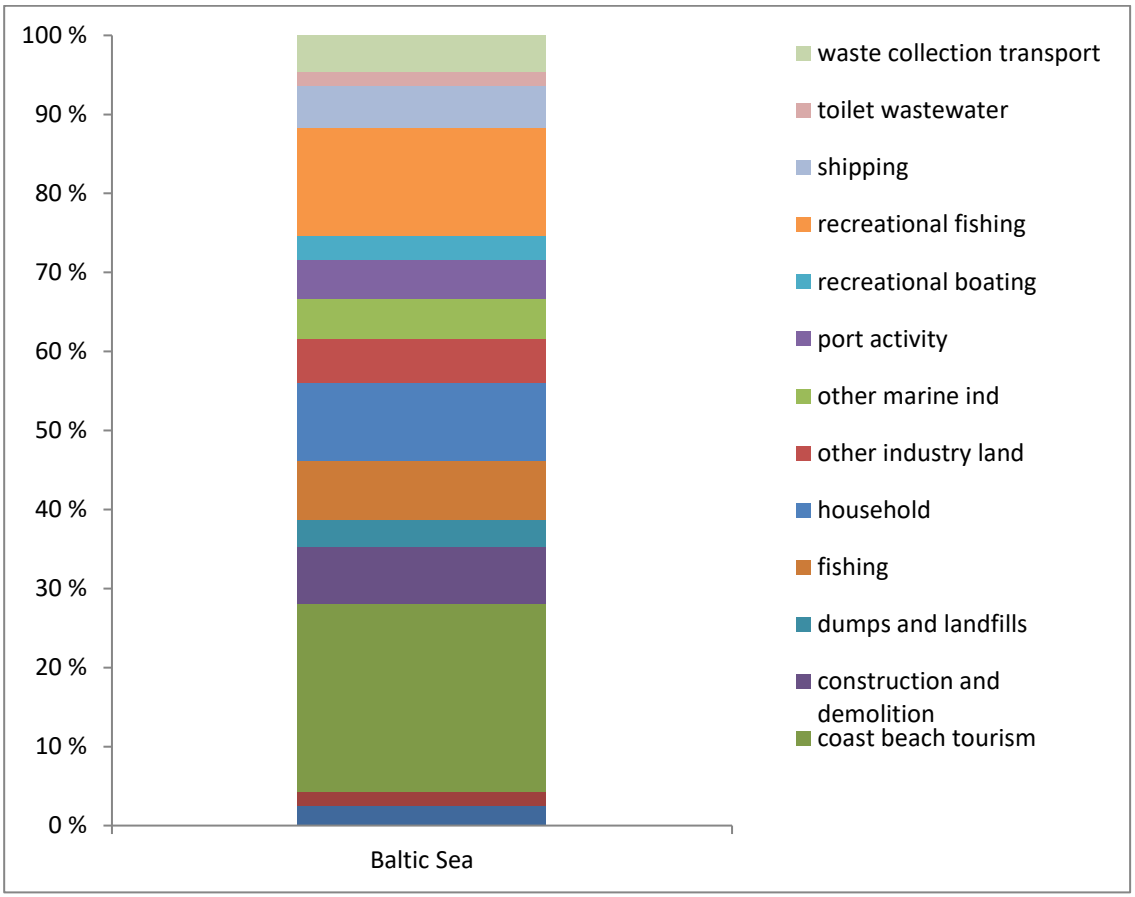

Figure 1. Proportion of marine litter sources in the Baltic Sea (Arcadis 2012)

5.2 Incentive systems

Several studies have assessed the incentives for ships to deliver their wastes to shore reception facilities (Traficom 2019, UNEP 2018, ECORYS 2017, EUNOMIA 2016, GESAMP 2016, GESAMP 2015, RPA 2013, Arcadis 2012, Ohlenschlager et al 2012, UNEP 2009, Carl Bro a/s 2005, HPTI Hamburg Port Training Institute GmbH 2005).

For this study, not only economic incentives are assessed but also incentives, which may affect human behavior and attitudes to deliver ship generated waste to shore are studied. Most of the above mentioned reports are dealing with incentives from an economic perspective but many these studies deal also with methods how to affect behavior, attitudes and public awareness (UNEP 2018, GESAMP 2016, GESAMP 2015, Arcadis 2012, UNEP 2009, UNEP and FAO 2009, UNEP 2006). EUNOMIA 2016 also finds that cost recovery systems have no influence for individual littering behavior. In addition to reports and studies, the IMO and HELCOM action plans recognize the need for incentive systems (IMO 2018, HELCOM 2015).

Five studies ECORYS 2017, EUNOMIA 2016, Panteia 2015, Ohlenschlager et al 2012 and Carl Bro a/s 2005 are especially assessing different economic incentives and cost recovery systems. In the below table 6 different cost recovery systems are explained as they are described in the EUNOMIA 2016. Information of cost recovery systems in the EUNOMIA 2016 is based on the previous studies above.

Table 6. Different type of cost recovery systems presented in the EUNOMIA 2016

Economic incentive systems	Explanation
Direct fee	"*A 100% direct fee is one where all of the cost of collection and treatment of a port user's waste is borne by the individual user. Charges vary in proportion to the amount of waste delivered by the user, and there are no charges if the user delivers no waste.*"
Indirect fee	"*A 100% indirect fee is a standard charge paid irrespective of the amount of waste delivered, including if no waste is delivered. Indirect fees can either be applied equally to all vessels, or they can be banded according to size thresholds (e.g. gross tonnage/engine power) and/or vessel types. Indirect fees can be included in port dues or as a separate waste fee.*"
Reverse fee	"*The reverse fee system is very closely related to indirect fee. An indirect fee is paid upfront but this confers no discharge rights; the user then pays the waste operator direct fees, and then claims back all or some of the direct fees from the port authority."*

Partial indirect fee	"*Partial indirect fees are where a standard charge is applied (indirect fee component) and is combined with a proportional charge (direct fee component) e.g. for waste delivered over a certain volume/tonnage or a certain vessel size threshold.*"
Rights Conferred by Indirect Fee Component and Calculation of Direct Fee Component	"*The standard charge confers the right to deliver an amount of waste up to a certain threshold. Where the charge does not confer the right of any waste delivery it is sometimes termed an 'administrative fee' (ADM). This increases the number of different methods that can be used for calculating the direct fee component of a partial indirect fee. It may simply be calculated based on the total quantity of waste. Alternatively, where the standard charge gives delivery rights, the direct fee can still be calculated either based on the total quantity of waste, or the remaining quantity of waste.*"
Deposit Refund Systems	"*A deposit refund system is where a deposit is returned in full on proof of delivery of waste at that or another port, whether to an in-house or external operator.*"
Penalties	"*Penalties can be imposed for non-delivery of waste, or non-notification and non-delivery of waste. They are charged unless proof of delivery at that or another port can be demonstrated. These can be administered alongside direct or indirect fee systems.*"
Voucher Systems	"*A voucher system is where a ship entering a port must pay for a voucher that is redeemable, at that or another port, against the cost of waste disposal, at that or another port. Its value is determined by the estimated amount of waste disposal required for the ship based on ship attributes. It can be a way of ensuring payment (because it is upfront) under a direct fee system, and thus removing the cost saving from discharging waste at sea, whilst providing flexibility for vessels that prefer not to deliver waste on every port call. It could also be implemented alongside an indirect fee system, to provide the same flexibility, although as upfront payment is already provided for in the indirect fee system it would be redundant with respect to ensuring payment.*"
Restriction by Waste Type	"*Cost recovery systems are often restricted to particular waste types, so that for any particular port, multiple fee structures are in use.*"
Exemptions	"*All fishing vessels and all small recreational vessels (<12 passengers) are exempt from notification and mandatory i.e. indirect charges, (though delivery of waste is still mandatory and fees charged to these types of vessels should cover the waste reception and disposal costs, leaving direct charging an option in addition to indirect charging);*

	Ships with frequent, regular scheduled stops and with sufficient evidence of arrangements to ensure delivery of waste and payment of fees in another port on the ship's route may be exempted from notification, mandatory delivery, and/or mandatory charges. *Favourable fees may be applied to ships producing reduced quantities of waste.*"

Reduced fee as an incentive to reduce generation of waste is mentioned in several studies, which have been made for the EC or the EMSA (ECORYS 2017, EUNOMIA 2016, Panteia 2015, Carl Bro a/s 2005). Ports may issue reduced waste fees if the ship can provide evidence that it generates less waste. Usually evidence documentation or a certificate issued by competent authority or organization is needed. Implementation of green technology, an environment management system or use of certain equipment may be required for this kind of certification. (ECORYS 2017, EUNOMIA 2016, Panteia 2015, Carl Bro a/s 2005)

Calculation examples for waste fees within 100 % indirect fee system (i.e. no-special-fee)

Charges given in the price list of the port of Helsinki has been used as starting values in the following examples. In the Port of Helsinki, ship waste management fee contains the delivery of solid waste, oily waste from the engine room and wastewater (i.e. sewage and grey water). The ship will pay that waste fee each time it visits in the port despite the ship delivers its wastes or not. (Port of Helsinki 2020b)

Example 1 – waste fee

Cargo ships' waste management fee is calculated by the following formula:

Ship net tonnage (NT) / 100 * 13,60 €

Min. fee per cargo ship's visit is 251,00 € and max. 3 132,00 €.

When general cargo ship, which NT is 5 500 visits in the port of Helsinki, waste fee is:

5 500 NT / 100 * 13,60€ = 748 €

Example 2 – fee reduction

Passenger ships' waste management fee is calculated by same formula but coefficient for € is 17,04

Min. fee per passenger ship's visit is 318,00 € and max. 4 020,00 €.

When cruise passenger ship, which NT is 45 000 visits in the port of Helsinki, waste fee is:

45 000 NT / 100 * 17,04 € = 7 668 €

When 7 668 € > 4 020 €, the waste fee for cruise passenger ship is 4 020 €

For reducing nutrition load and eutrophication in the Baltic Sea, the port is offering 20% fee reduction when the ship delivers its waste waters (i.e. sewage and grey water) to port reception facility.

So the waste fee is: 4 020 € * (1 - 0,2) = 3 126 €

Example 3 – fee reduction by environment discount

Ships in liner traffic, which have low environmental impact in port, or have significantly reduced their environmental impact with development measures, may apply environmental discount for its port charges. Maximum discount is 6 % and the port of Helsinki lists the following criteria:

"- Low emissions (based on vessel's ESI- or CSI-certificate score).

- Output noise level of less than 105 dB while docked, of vessels in the passenger harbours (based on confirmed and measured output noise levels while docked).

- Investments/innovations that improve in-harbor environmental efficiency, energy efficiency or noise abatement, for example (based on a report on the change with calculations/measurements of its impact)."

Ship's port charge for certain quay in the port of Helsinki is calculated by the following formula:

Net Tonnage / 100 * 24,85 €

Ship's port charge for the above mentioned cruise passenger ship is:

45 000 NT / 100 * 24,85 € = 11 182,5 €

If the ship is entitled for the full 6 % environment discount, the discount would be 670,95 €

6 Methods and procedures

This study is a qualitative study where the material is collected by the thematic half structured interviews. Configuration of this study is described in the figure 2 below.

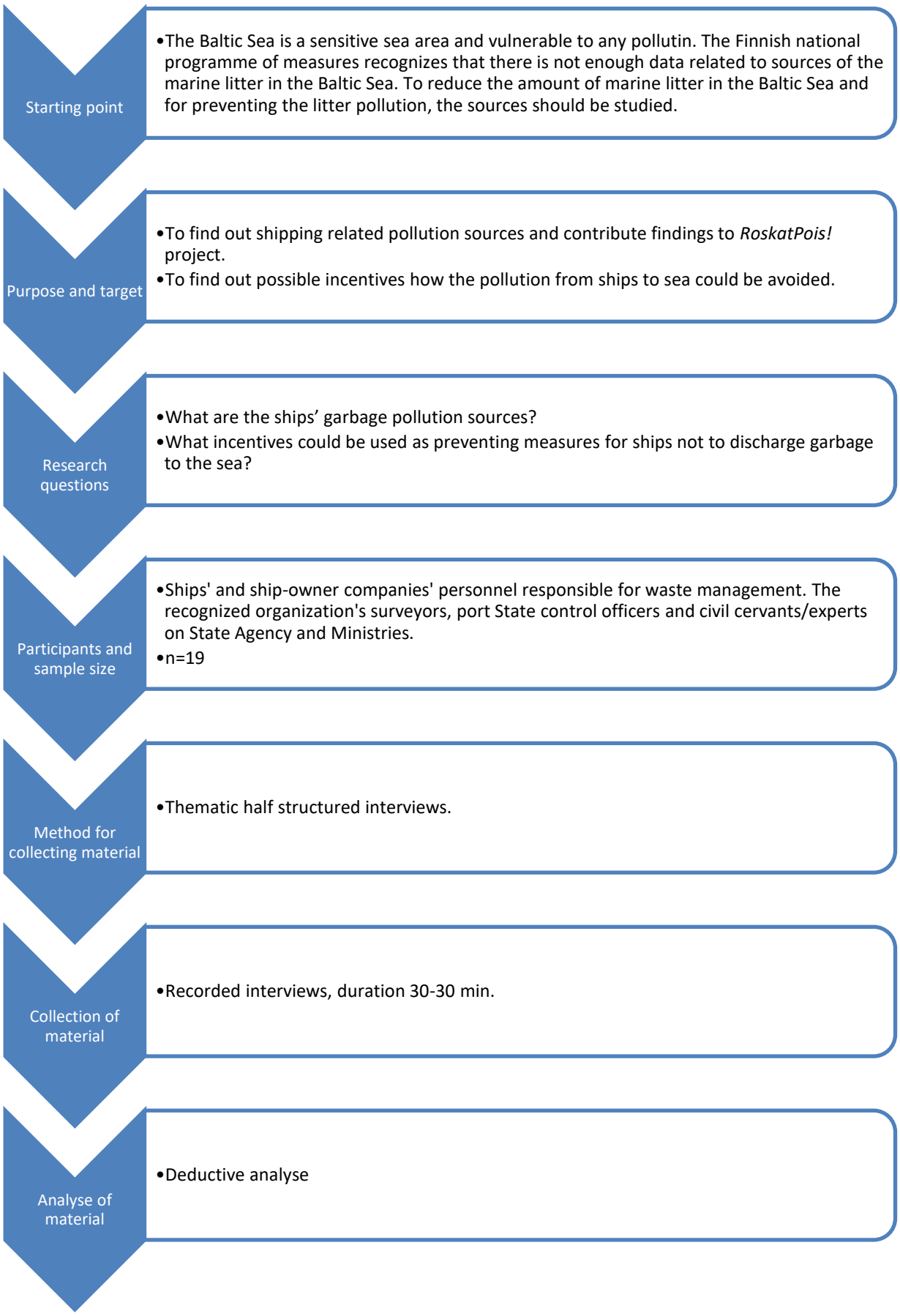

Figure 2. Study configuration

The purpose of a qualitative study is to describe the studied subject and achieve better understanding of that subject. Material sample for qualitative study is relatively small and instead of quantity, it concentrate on the quality of the collected material. Therefore, persons that were assumed to give most accurate and recent information of the studied subject were asked for interviews. The intention was to collect thorough knowledge from these interviewed persons.

This study is conducted as a literature review supplemented by interviews. The interviewed personnel worked with environmental issues for ship-owner companies and as ship personnel on board the ships. In addition, surveyors working for Recognized Organizations, port State control officers and administration's experts were interviewed.

Questions presented for the personnel working onboard ships, ship-owner companies' workers, recognized organizations' surveyors, port State control officers and administrations' experts are based on the issues found in the literature review. These found issues needed further clarification or verification from selected interviewed persons.

6.1 Participants and sample size

The literature used in this study consists of total 50 literature sources. 15 of the used sources were the international conventions given by the IMO, legislation from the EU and Finnish national acts and degrees. 4 of the used sources were guidelines and guidance documents issued by the IMO and HELCOM. 28 of the 48 sources were studies and reports. These studies were conducted by the EU (9), GESAMP (2), IMO (2), jointly IMO and LC&P (1), UNEP (2), jointly UNEP and FAO (1) and others (11). Rest of the literature sources were specific information retrieved from the internet, such as information of price reduction systems, price lists, guidance from state agencies etc.

For this study, in total 19 persons were interviewed. Three of those worked onboard ship and five persons were working for environmental issues in different ship-owner companies. From the industry side also 3 interest group representatives were interviewed. From recognized organizations 2 surveyors, 2 port State control officers and 4 administration's experts were interviewed.

Careful consideration were used for selecting the persons to be interviewed for this study. Appropriate selection of interviewed persons would enable that a smaller number of interviewed persons would be adequate because those persons will probably have most accurate information concerning the subject of this study.

The interviewed persons were selected based on their working position, knowledge and experience on environmental issues. Interviewed persons working onboard ships were those persons who were responsible for ships' waste management. These included environmental officers, captains, chief engineers and engineers. The persons who worked on ship-owner companies' offices were responsible for the company's environmental issues or otherwise were at work on environmental issues. The interviewed persons of the recognized organizations were the surveyors who conducted ship surveys. For this study, it is relevant that these persons conduct surveys according to the MARPOL Convention. The same principle applies to interviewed port State control officers. Persons selected for interview are conducting the PSC and the PRF-directive's inspections. In these inspections, ship compliance against the requirements of the MARPOL Convention and the PRF-directive is checked. For this study, also a few administration's environmental experts were interviewed. These experts are responsible for the development of the environment regulations in the IMO and the EU level. They are also involved in the implementation work of these regulations nationally. The interviewed port State control officers and the administration's experts were working for the Finnish Transport and Communications Agency, the Finnish Transport and Communications Ministry and the Ministry of Environment. It was reasonable to select persons from all these entities so that aspects and information would be gathered from as many different perspectives as possible.

6.2 Method for collecting material

Material for this study were collected by thematic interviews with half structured questionnaire form. The questionnaire form for the interviews included relatively open questions to guide the interviews and consequently, it was possible to divert from the questionnaire when relevant issues related to this study were found during the interviews. Questionnaire form as an appendix 1.

Persons participating for thematic studies are usually relatively small in number as it was also in this study. However, the amount of needed work is relatively huge, when the analyse of the material is demanding. (Braun and Clarke 2012)

Questionnaire form contained questions from three different categories related to research questions. These are ship waste discharge sources, waste delivery to port and incentives. Questions 1 to 5 are concerning ship waste discharge sources, where the wastes are discharged and does the deliberate or accident discharges to sea happen. Questions 6 to 9 consider the waste delivery from ship to port reception facilities and possible deficiencies in delivery. Questions 10 and 11 consider the incentives and attractiveness of waste delivery to port.

As a summary, the questions 1 to 5 are related to first research question concerning the ship waste discharge sources. Questions 10 and 11 are related to the second research question, which considers the incentives. The questions 6 to 9 have point of resemblance to both research questions.

6.3 Collection of material

The literature for this study was searched from the different international and regional organizations' Internet sites. These international and regional organizations were the UNEP, IMO, EU, EMSA and HELCOM. In addition, national studies conducted by the TRAFICOM and Finnish Meteorological Institute were used as literature sources.

Most of the literature sources contained a lot more issues than just shipping related garbage and marine litter sources. From these literature sources, only shipping related sources of garbage and marine litter were researched. After finding the relevant content from the studied material for this study, the ship garbage and marine litter discharge sources were analysed.

Empirical material was collected by interviewing the persons working on different shipping related entities as described above in paragraph 6.1. As the personal interviews of the personnel working on board ship and in ship-owner companies' offices would have required a lot of travelling and consequently would have been time consuming, these interviews were carried out over telephone. Interviews of the port State control officers and administration's experts were done in their offices in Helsinki and Turku. Some of the interviews, like interviews of the recognized organizations' surveyors whose work is hectic and mobile, were conducted also over telephone.

Before the interview, the interviewed person were shortly briefed for the study and its subject. Interviews were recorded and written up, and they were planned to last 30-60 minutes.

Chronological progress of the study is described in the figure 3 below.

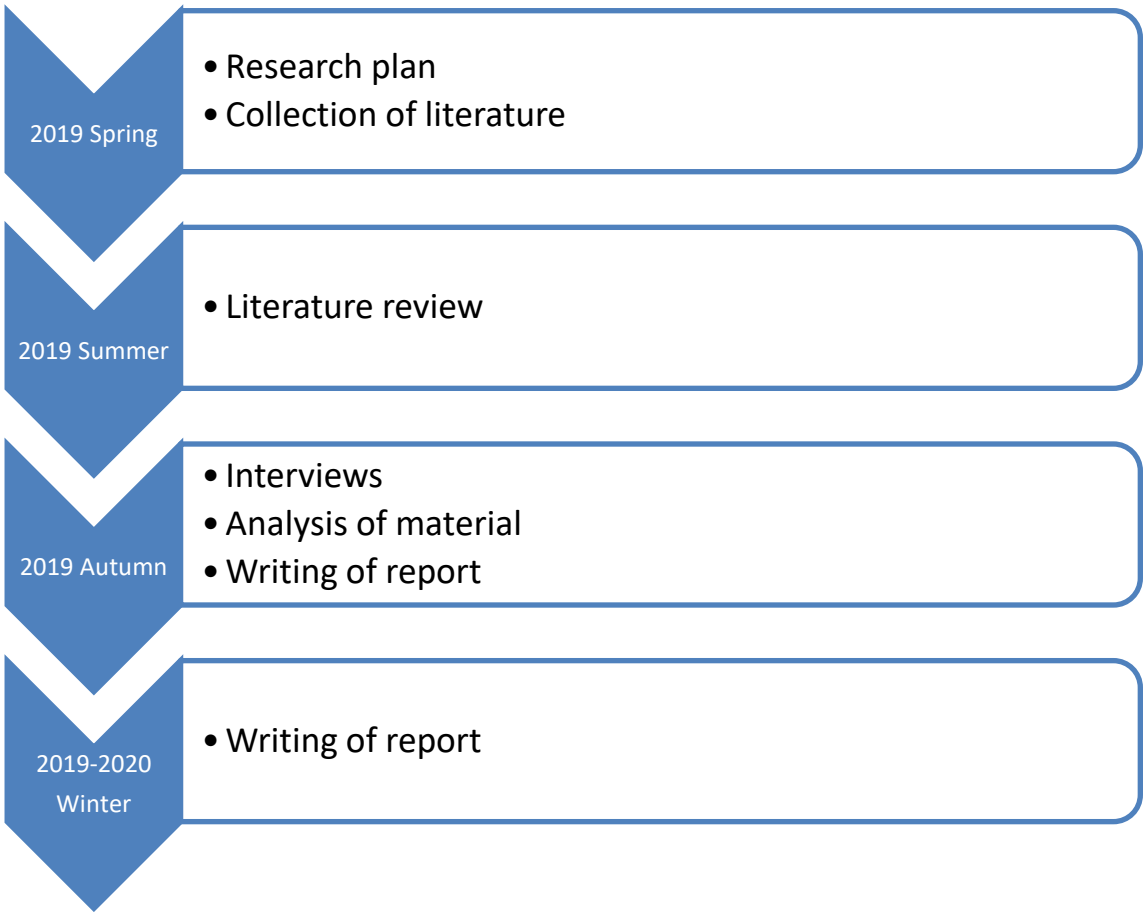

Figure 3. Chronological progress of the study

6.4 Analysis of material

The main elements of the each interview were written up in order to make structuring and analysis of answers possible. For the first research question, elements in the answers were structured according to the Annexes of the MARPOL Convention. This means that answers concerning the same waste type were collected and analysed together. E.g., all answers concerning sewage discharges from cargo ships were first collected together and then analysed. This same structuring was made for each ship type, which was involved in this study. Below table 7 illustrates how the structuring of answers were made. The questionnaire form was prepared so that it supported this structuring.

Table 7. Structuring of answers for ship waste discharge sources

Ship type	Waste category	Waste type
Cargo Ships	MARPOL Annex I	Oily bilge waters
		Oil residues (sludge)
		Others
	MARPOL Annex IV	Sewage

		Grey water
	MARPOL Annex V	Food waste
		Plastic
		Domestic waste
		Cooking oil
		Operational waste
		E-waste
		Cargo residues (non-HME)
		Cargo residues (HME)
		Hazardous/dangerous waste
Passenger ships	MARPOL Annex I	Oily bilge waters
		Oil residues (sludge)
		Others
	MARPOL Annex IV	Sewage
		Grey water
	MARPOL Annex V	Food waste
		Plastic
		Domestic waste
		Cooking oil
		Operational waste
		Electronic waste
		Hazardous/dangerous waste

For the second question concerning the incentives, information of the existing incentive systems were used as a base material for interviews. The interviewed persons were asked to express their views on these existing systems and propose any development ideas. Incentive systems were divided to different categories in accordance with the table 8 below.

Table 8. Structuring of answers for incentives

Direct fee - no incentive
100% indirect fee (for all waste categories)
Reverse fee
Partial indirect fee (e.g. only certain waste types covered)
Rights Conferred by Indirect Fee Component and Calculation of Direct Fee Component
Deposit Refund Systems

Penalties
Voucher Systems
Restriction by Waste Type
Exemptions
Reduced fee (e.g. when ship demonstrates improved waste handling onboard)
Any other incentive

Material of the both research questions was analysed in accordance with deductive analyse method. A lot of earlier studies and legislation exists concerning the ship waste sources and incentives. Based on this literature, the questionnaire form was developed. After the interviews, results were compared to existing studies and legislation.

7 Results and their interpretation

7.1 Background information of participants

In total 19 persons were interviewed. 8 persons were working for the ship-owner companies where 3 of these on board ships in different positions. Rest (5) of the interviewed persons were working on ship-owner companies' offices in such positions that they were responsible or involved for the company's environmental issues. Ship types, which the ship-owner companies operated, comprised general cargo-, ro-ro- and ro-pax ships, bulk carriers, oil tankers, cruise passenger ships and pusher tug-barge combinations. Most of these ships' trading area were the Baltic Sea and the North Sea but some ships operated also in the European and worldwide traffic. Interviewed ship personnel worked in the general cargo ships, cruise passenger ships and oil tankers. Trading area of these ships were the Baltic Sea, the North Sea, the Europe and worldwide.

The interest group representatives who were interviewed for this study, total three persons, represented three different interest groups (i.e. ship-owner companies, ports and fishing vessels).

In total 6 civil servants were interviewed for this study. Four of the Civil servants represented the Finnish Transport and Communications Agency, which is the flag State Administration of the Finnish ships, the Ministry of Transport and Communications, Ministry of Environment and Ministry of Agriculture and Forestry of Finland.

Two PSC officers who were working for the Finnish Transport and Communications Agency and two recognized organizations' surveyors were interviewed. These interviewed PSC Officers and

ROs' surveyors conduct inspections and surveys for all ship types, which are trading in all trading areas.

Table 9. Summary of background information

Background information	Number	Represented ship types	Represented trading areas
Ship-owner company personnel	5	General cargo- (2*), ro-ro- (2*), ro-pax ships (2*), bulkers (1*), tankers (1*), cruise ships (1*), pusher tug-barge combinations (1*)	Baltic Sea, North Sea, Europe, Worldwide
Ship personnel	3	General cargo (2), container ships (1), tankers (1), cruise ships (1)	Baltic Sea, North Sea, Europe, Worldwide
Interest group representatives	3	General cargo, ro-ro, ro-pax, bulkers, tankers, Cruise ships, fishing vessels	
Civil servants	4	-	-
PSC officers	2	All ship types	Baltic Sea, North Sea, Europe, Worldwide
RO surveyors	2	All ship types	Baltic Sea, North Sea, Europe, Worldwide

**Number of ship-owner companies operating these ship types. Note that one company may operate several ship types.*

7.2 Ships' waste discharge sources

In this study, the cargo and passenger ships discharges were divided into different main- and sub-categories in accordance with the Annexes of the MARPOL Convention. Although, the hazardous/problem waste is not recognized in the MARPOL Convention as own waste type, in this study, it was categorized as separate waste category to better encompass issues with this waste category. The MARPOL Annex VI emissions to air and the MARPOL Annex II noxious liquid substances, which are carried with chemical tankers are excluded from this study. Ship waste discharge sources are summarized in the below table 10.

Table 10. Categorizing of waste discharges from cargo and passenger ships

Waste category	Waste type
MARPOL Annex I: Oil	Oily bilge water
	Oily residues (sludge)
	Other oily residues
MARPOL Annex IV: Sewage	Sewage
	Grey water
MARPOL Annex V: Garbage	Plastics
	Food Waste
	Domestic waste (e.g. paper products, rags, glass, metal, bottles, crockery, etc.)
	Cooking Oil
	Incinerator ashes
	Operational waste
	Animal carcass(es)
	E-waste
	Cargo residues (Harmful to the Marine Environment – HME)
	Cargo residues (non-HME)
	Hazardous/dangerous waste (not categorized in the MARPOL Convention)
MAPROL Annex VI: Air pollution related wastes	Ozone depleting substances and equipment containing such substances
	Exhaust gas cleaning systems' residues and discharge waters

7.2.1 MARPOL Annex I - Oil

All of the interviewed persons working for the ship-owner companies mentioned that their ships were generating the MARPOL Annex I oily wastes. These are oily bilge waters and oily residues (sludge). In accordance with the MARPOL Convention, oily residues shall be delivered to shore.

Oily bilge waters may be discharged to sea through the oil filtering equipment and the oil content shall not exceed 15 ppm (parts per million) during the discharge (IMO 1997).

All of the interviewed persons answered that sludge is always delivered to port reception facilities from their ships. Oily bilge waters were also mainly discharged to shore, although many ships have the oil filtering equipment installed on board. Only two of the participated ship-owner companies used the oil filtering equipment and discharged the oily bilge water to the sea. One of these companies had oil filtering systems, which filter the oily water so that it does not exceed 5 ppm.

In addition to oily bilge water and sludge, questions were asked if the ships are generating other oily wastes, such as oily tank washings, scale and sludge from tank cleaning. All the persons who answered these questions stated that their ships are generating these oily wastes very seldom. According to answers, ships' tanks are usually cleaned before the dry docking or when the ship is changing its fuel oil type. Many participants mentioned that their ships' tanks were cleaned last time when the Sulphur emission control area (SECA) requirement entered into force in the January 2015. Based on the answers, cleaning work of the ships' fuel oil tanks were outsourced and conducted by the cleaning companies. Consequently, the cleaning company took care of these oily wastes.

7.2.2 MARPOL Annex IV – Sewage

Cargo ships

All the five ship-owner companies, which operated the cargo ships, answered that they have sewage treatment plants installed on board their ships and discharged the treated sewage to the sea. One of these companies had also few ships, which do not have sewage treatment plants on board. Two of the five companies answered that they are following companies' own stricter environment policies and discharge treated sewage at outside of the 12 nautical miles from the nearest land, when the MARPOL Convention sets no discharge limits for the treated sewage (IMO 1997). In addition, one cargo ship company answered that their policy is to discharge all sewage and grey water to the port reception facilities. However, the company mentioned that there has been restrictions for delivery or it has not been possible to deliver sewage or grey water to some ports at all. Encountered delivery restrictions have been related to limitations for the delivered volume or delivery has not been included to the no-special-fee system. Consequently, company's ships need to discharge part of their sewage and grey water to sea.

The same company mentioned also that sewage is more often accepted in the Baltic Sea ports than in the North Sea ports and according to that company, if the sewage is accepted in the North Sea

port, delivery is more expensive than in the Baltic Sea ports. In addition, that company mentioned that their intention is to avoid the sewage discharges to the Baltic Sea where the sea is vulnerable for eutrophication and if needed, the sewage is discharged to sea when their ships are sailing in the North Sea area.

The MARPOL Convention do not recognize the grey water but in this study, the grey water was examined in the same content than sewage as those are related to each other. Two of the five ship-owner companies answered that grey water is treated with the sewage treatment plants, which after it is discharged to the sea. One company answered that some of their ships have possibility to treat the grey water with sewage treatment plant and rest of the company's ships are discharging grey water directly to the sea. One company answered that all grey water is discharged as untreated into the sea.

Passenger ships

All three ship-owner companies, which operated the passenger ships and were interviewed for this study, answered that they are delivering all their sewage and grey water to shore reception facilities in the Baltic Sea region. Two of these companies have sewage treatment plants installed on their ships. One of these companies is cruise passenger ship company and have advanced wastewater treatment plants installed on its ships. The cruise ship company's ships are operating worldwide and when the company's ships are operating outside of the Baltic Sea, they discharge the sewage and grey water to sea after the treatment in that advanced wastewater system. Same company answered that swimming pool waters are varyingly discharged both to sea and to shore reception facilities. When swimming pool waters are discharged to sea, waters are discharged at outside of the 12 nautical miles from nearest land. If that is not possible, the swimming pool waters are pumped to advanced wastewater treatment plant and then discharged to sea. De-chlorination is included to treatment before the swimming pool waters are discharged to sea. Some of the company's ships have seawater pools and these are discharged to sea without any treatment.

7.2.3 MARPOL Annex V – Garbage

Plastics - cargo ships

All cargo ship companies answered that their ships are sorting the plastic waste on board according to requirements of the MARPOL Convention. All plastics are also delivered to shore reception facilities. However, all interviewed cargo ship-owner companies mentioned that often plastics are

not collected separately in the port's waste station but mixed with domestic waste and delivered to one energy waste container.

Plastics - passenger ships

Two of the companies, which operated the ro-ro-passenger ships in liner traffic answered that plastics are collected on board separately and delivered to shore reception facilities. All ships of these two companies were exempted according to the EU PRF Directive and the Finnish Act on Environmental Protection in Maritime Transport 1672/2009. Other of these companies told that after the delivery to shore, plastics are sorted as energy waste. Second company announced that plastics, which are contaminated with food, are sorted on shore as domestic waste. That company mentioned also that clean plastic foil is sorted on board separately and delivered to plastic bag producer for recycling. In addition, plastic bottles are sorted on board and delivered to separate container on shore. Cruise ship company answered that plastics are either incinerated on board or delivered to shore, depending where the ships are operating. In the Baltic Sea area, plastics are delivered to port reception facilities.

Food waste – cargo ships

Two of the five cargo ship companies answered that their ships are delivering their food wastes to shore reception facilities. Other of these companies have their ships installed separate refrigerator for the food waste. That company mentioned also that when the food waste is delivered to port, it is sorted as mixed waste according to the agreement with waste management company.

One cargo ship company answered that they deliver most of their food waste to shore and when the food waste is discharged to sea, it is grinded. Same company also answered that ship personnel have significant effect if the ship is delivering its food wastes to shore or discharging it into the sea.

One of the cargo ship companies answered that they are discharging almost all their food waste to sea. However, the company also told that their ships are usually discharging food waste through the sewage treatment plant and grease is also separated from the food waste on this process. In addition, that company answered that when their ships are visiting in the Russian ports, the international catering waste, (i.e. food waste and contaminated material generated during the operation in non-European waters) is collected to the dedicated waste barrels and delivered to port reception facility.

Food waste – passenger ships

Both of the liner traffic ro-pax ship-owner companies answered that all their ships are delivering their food wastes to port reception facilities. Handling and storing of food waste is varying between these ro-pax ships. Some of the ships have separate food waste tanks where the food waste is pumped after the grinding. Some ships have separate collection for food waste where the food waste is first pressed on board, so that the water is removed. One of these companies mentioned that after the delivery to shore, food waste is incinerated. The second company replied that they have agreement with waste management company, which is delivering the food waste to biogas plant.

Cruise ship company answered that their newer ships have advanced waste water treatment plants on board and after the treatment, the residues are dried and incinerated. The incinerator heat is collected and re-used on board ship. Company's older ships are discharging the food waste to sea or deliver it to shore reception facilities depending where the ships are operating. In the Baltic Sea area, food wastes are delivered to port reception facilities.

Domestic waste – cargo ships

All cargo ship companies, which answered to this study, mentioned that they are delivering all domestic waste to port reception facilities. Companies' ships are also sorting domestic waste according to the MARPOL Annex V Guidelines (i.e. paper, cardboard, glass, metal, rags and wood are collected separately). One ship-owner company answered that they are sorting domestic wastes onboard but according to the agreement with waste management company, some waste types, such as plastics, wood and paper are delivered to one energy waste container in port.

Domestic waste - passenger ships

Like cargo ships, also all ro-pax ships deliver all their domestic waste to shore reception facilities. Likewise, domestic waste is sorted according to the MARPOL Annex V Guidelines. Other of the ro-pax ship-owner companies told that part of the domestic waste, such as crockery and porcelain are delivered to mixed waste container on shore although these wastes are sorted on board as own waste category. Other ro-pax company answered that after the delivery to shore, some domestic wastes, like wood and rags, are incinerated in the waste burning plant.

Cruise ship company answered that domestic waste is sorted on board according to the MARPOL Annex V and some ships have even robots for sorting. The domestic waste is mainly delivered to port reception facilities but sometimes certain domestic waste categories are incinerated on board. That company mentioned also that glass has own treatment on board, it is first crashed and collected separately, before its delivery to port reception. Company mentioned also that some ports are even

paying for the delivery of certain waste types. For example, the port of Hong Kong is paying for ship when it delivers cardboard.

Cooking oil – cargo ships

Cooking oil was collected separately in each cargo ship company's ships and delivered to shore. However, management of the cooking oil on board ships varied between the different companies. Three of the five ship owner companies stored the cooking oil in canisters and delivered those canisters to shore. One of these companies used 20 litres canisters for storing. Other company used smaller canisters and according to the agreement with waste management company, these canisters are delivered to the mixed waste container on shore. This mixed waste is later incinerated in the local waste burning plant.

Two of the cargo ship companies also collected the cooking oil separately but collected cooking oil was drained to ships' sludge tanks and the sludge was later discharged to the port reception facilities. Other of these companies has consulted waste management company, which receipts ships' sludge and the waste management company has answered that there is no harm for mixing cooking oil with sludge.

Cooking oil – passenger ships

Both ro-pax companies and cruise ship company answered that cooking oil is sorted separately and delivered to port reception facilities. Other of these ro-pax companies answered that they have agreement with waste management company, which is specialized for the management of vegetable oil products. This company produces fuel oil and lubricating oil from the recycled cooking oil. Cruise ship company answered that some ports even pay for ships when they deliver cooking oil.

Incinerator ashes – cargo ships

Two of the cargo ship companies have incinerators installed on board their ships. Both these companies answered that their ships are using incinerators very seldom, if not at all. Both companies replied that incinerator ashes are delivered to port reception facilities. Other of these companies answered that ash is not accepted in each port and it is mainly delivered to shore when ships are visiting in bigger European ports.

Incinerator ashes – passenger ships

Only the cruise ship company used the incinerators in their ships and answered that ash is always delivered to port reception facilities.

Operational waste – cargo ships

All the cargo ship companies answered that operational wastes, except the deck wash waters containing cleaning agents, which are non-hazardous to marine environment (non-HME), are delivered to port reception facilities. All these companies answered that operational wastes are sorted on board according to the MARPOL Convention and the MARPOL Annex V Guidelines. For most of the ships operated by these companies, it is not possible to drain or collect deck wash waters to ships' holding tanks (e.g. bilge or sludge tanks). Consequently, wash water discharge into the sea is the only option in practice.

Operational wastes – passenger ships

All passenger ship companies answered that similarly as cargo ships, all operational wastes, except deck washing wasters containing non-HME cleaning agents, were delivered to port reception facilities. The cruise ship company answered also that their ships are operating in the US waters and their ships are using cleaning agents and rust removal substances that are accepted and certified by the United States Environment Protection Agency (US EPA).

One ro-pax company replied that they are using outsourced cleaning company for their ships cargo deck washing. Ro-ro lanes are washed with dedicated washing truck, which is collecting the main part of the used washing water back to truck.

Animal carcass(es)

All cargo ship companies and the cruise ship company replied that they do not transport animals on their ships. However, both ro-pax companies answered that animals are transported but animal deaths and accidents are encountered very seldom. One of these two ro-pax companies replied that animals have usually high economic value for its owner (e.g. horses) and consequently very good care is taken for the animal health during the sea transport.

E-waste – cargo ships

All cargo ship companies answered that e-waste is generated on board and sorted according to the MARPOL Convention and the MARPOL Annex V Guidelines. One company, which have waste

agreement with the waste management company, replied that they are delivering e-waste to problem waste container located in port where is own waste bin for e-waste.

E-waste – passenger ships

Both ropax companies and cruise ship company replied that they sort e-waste on board. One ropax company replied that many waste management companies are sorting e-waste as a metal on shore. Other ropax company answered that they are delivering the e-waste to the problem waste container, which contains separate bin for the e-waste. The cruise ship company replied that some ports are even paying for ships for the e-waste delivery.

Cargo residues (Harmful to the Marine Environment – HME) – cargo ships only

Two of the five companies carried solid bulk cargoes on their ships and only one of these two companies answered that they are carrying the HME cargoes. However, the ratio of HME cargoes, compared to all carried cargoes, were very small, only 1-2 % of all cargoes. That company announced that all the HME cargo residues were delivered to the port reception facilities.

Cargo residues (non-harmful to marine environment - non-HME)

As mentioned on the above paragraph, two companies which participated to this study, carried the solid bulk cargoes. Both of these companies carried the non-HME cargoes. One company answered that based on the company's own accounting, 86% of their non-HME cargo residues, contained in the cargo room wash waters, are discharged to the sea. Other company answered that the ratio between the non-HME washing waters delivered to shore and discharged to the sea is 50:50.

Hazardous/problem waste – cargo ships

According to the answers, the most common hazardous/problem wastes that ships generate are the batteries, used chemicals, fluorescent tubes, solid oily wastes, paint residues, pyrotechnic equipment and medicines. All these wastes are sorted on board and delivered to port reception facilities. One company, which have agreement with the waste management company, replied that the waste management company has provided a container in port where all above mentioned wastes have own bins.

All cargo ship companies answered that the pyrotechnic equipment are returned to the vendor same time when the new pyrotechnics are bought. In Finland, the manufacturer, seller or importer have agreed to accept the outdated or used pyrotechnics when the pyrotechnic equipment are bought

(Finnish Border Guard 2020). Each cargo ship company also replied that for the outdated medicines, they have agreement with the pharmacies and that pharmacies receives their ships' outdated medicines.

Hazardous/problem waste – passenger ships

According to the answers, similar hazardous/problem wastes are generated on board passenger ships than in cargo ships. All different hazardous/problem waste types are sorted on board and both ro-pax companies answered that they have agreement with the waste management companies, which provide problem waste container where different hazardous/problem waste types are sorted to own bins.

One ro-pax company and cruise ship company answered that ships' pyrotechnic equipment are returned to vendor when the new products are delivered. Similar as cargo ship companies, both ro-pax companies have agreements with pharmacies, which are taking care of ships' medicines. The cruise ship company replied that outdated medicines are incinerated on board under the supervision of the ship security officer and this incineration is recorded to the ship's garbage record book.

7.2.4 MARPOL Annex VI – Air Pollution related waste

Ozone depleting substances – cargo ships

All cargo ship companies answered that the refrigerants are used on board (e.g. in air-condition systems and refrigerating machines) but no old ozone depleting substances, such as hydro-chlorofluorocarbons, which are prohibited according to the MARPOL Annex VI, Reg. 12, are used in any ships. All companies replied that used refrigerants are delivered to shore and one company mentioned that the refrigerant replacement bottles are always returned to vendor.

Ozone depleting substances – passenger ships

Similarly as cargo ship companies, both the ro-pax companies and the cruise ship company replied that they are not using the old prohibited ozone depleting substances and all used and replaced refrigerants are delivered to shore. The ro-pax companies answered that they have an agreement with the service companies, which are maintaining the refrigerant machines. The service company collects the refrigerant substances and delivers those to shore when the machines' are maintained.

Exhaust gas cleaning residues – cargo ships

Two of the five companies replied that the exhaust gas cleaning systems (EGCS) (i.e. scrubbers) are in use on board their ships. One company replied that they are using only closed loop system and all wash water and residues are delivered to the port reception facilities. One ship is discharging approx. 20 m3 exhaust gas cleaning residues once per week to shore. This company has an agreement with the garbage management company, which is specialized for handling of the oily wastes and exhaust gas cleaning residues. Second company uses open loop EGCS, which discharges wash water back to the sea. According to the company, the open loop EGCSs collect only minor amount of residues and that residue is delivered to the port reception facilities.

Exhaust gas cleaning residues – passenger ships

One of the two ro-pax companies had the EGCSs installed on board its ships. These EGCSs were open loop systems and the exhaust gas cleaning system wash waters are discharged into the sea. The company replied also that these systems have water treatment and minor amount of residue is generated, which is mainly ash. This residue is delivered to the port reception facilities. This was the case also with the cruise ship company. The company have the open loop EGCSs installed on board their ships and wash waters are discharged into the sea. Similarly there is treatment for the wash waters but both the ro-pax and cruise ship companies assessed that this treatment have only minor treating effect because the water volume and discharge rate are very high and only minor amount of residue is generated.

7.2.5 Other comments related to wastes or waste management

Three of the cargo ship companies operated the ships, which are exempted in accordance with the EU PRF-directive 2000/59/EC and the Finnish national Act on Environmental Protection in Maritime Transport 1672/2009. One company answered that their ships are exempted in all those ports, where it is possible to apply the exemptions and not exempted in those ports, where the Administrations are not issuing the exemptions.

One cargo ship company also highlighted that although, plastic is collected on board, sorted and recorded in the garbage record book as a separate waste category according to the MARPOL Convention, almost in every port, it is delivered to the one common mixed waste or domestic waste container. Based on the answers, only the few Finnish ports are sorting the domestic waste to different categories according to the MARPOL Convention (i.e. plastic, paper, cardboard etc). That company is operating its ships mainly in the Baltic Sea and the North Sea regions.

One ro-pax company also answered similarly that the furniture, mattress, ropes, plastic pipes, wood pallets, chipboard and cover papers for the wood cargoes are delivered to shore as mixed waste. That company had waste agreement with the waste management company and sorting on shore is based on that agreement. Other ro-pax company had also agreement with the waste management company but they mentioned that the wood waste is collected separately at port and only the plastic waste, which is contaminated by food waste, is delivered to port as domestic waste. All clean plastics and plastic bottles are sorted separately on shore as described in the paragraph 7.2.3. This company had also established own plastic strategy and one goal is to replace all single use plastic products on board. That company also mentioned that this is not an easy task because the biodegradable products are not necessary environment friendly and consequently, replacing products are difficult to find. In addition, same company mentioned that waste sorting in the ports is varying significantly between different countries. E.g. in Sweden, there is more stringent recycling requirements than in the Finland and even colored glass is sorted separately in ports.

Both ro-pax companies mentioned that a lot of feedback concerning the ships waste management is given both from the passengers and from the ship crew. In addition, the passengers are often asking do the companies have environmental policies and how the policies are implemented. Other company told that the questions and feedback related to the CO_2 emissions are most common but their ships' waste management is the second.

One ro-pax company and cruise ship company had established own incentive system for the ship personnel to enhance waste management onboard their ships. The ro-pax company mentioned that all income from recycled waste is invested to crew recreation fund. The cruise ship company answered that money, which is received from the recycling, is dealt so that 85% of the received money is invested to the crew welfare fund and 15% is dealt directly to persons who are sorting the waste and using the incinerators. According to the cruise ship company, this incentive has proven to be efficient for improving sorting on board.

7.2.6 Anti-fouling paints

Cargo ships

All the interviewed cargo ship companies operated in the wintertime in the Baltic Sea area and sailed in the ice conditions. Majority of the ships were painted with the hard coating paints, which are not containing biocides and only the ships' sea chests are painted with the anti-fouling paints. Only one company answered that their ships are using the anti-fouling paint also in their ships' hulls.

All the companies answered that the painting is renewed in the five years interval when the ships' are docked. Level of the paint removal and re-painting depends on the condition of the painted surface. All the different alternatives (i.e. overpainting of the old paint, removal of old paint and painting, and respraying) were applied in the case by case.

Five cargo ship companies answered that they are conducting in-water cleaning of their ships' hulls for the removal of the underwater growth i.e. (biofouling). The companies mentioned that their ships' hulls are cleaned when they find it necessary. One company replied that they have established the monitoring plan for the biofouling accumulation.

Passenger ships

Both ro-pax companies answered that their ships are operating each winter in the ice conditions and therefore, their ships are painted with the hard coating paints. The ships' sea chests are painted with the anti-fouling paints. Similarly as cargo ships, hull painting is renewed in the five years interval when the ships are docked.

Both of the ro-pax companies replied that they conduct in-water cleaning during their ships' port stay. One ro-pax company mentioned that they have established plan for ships' hull cleaning and their ships' hulls are cleaned regularly in every three weeks. Based on the answers, the in-water cleaning of the ships' hulls begin in the spring and ends at late autumn.

The cruise ship company replied that they are using the anti-fouling paints on their ships' hulls. The anti-fouling paints, which contain silicone, are used in the ships' bow and side areas and the normal anti-fouling paints in the ships' flat bottom area. The painting is renewed when the ship is docked (i.e. in the five years docking interval). The company mentioned that the silicone paints' antifouling effect lasts about three years and then the anti-fouling effect is worn out. The anti-fouling paint in the ship's flat bottom area may be renewed only in ten years interval. The company replied also that the hard coating paints are not used today in their ships. However, the intention is to use more hard coating paints in the future. There is even plan to start a project where the purpose is to paint the ship's hull with the certain hard coating paint and install ultrasonic systems to prevent the biofouling accumulation. The company had good experiences from that arrangement when it is used in their ships' cooling systems.

7.2.7 Deliberate and unintended discharges

Unintended discharges

Both the cargo and passenger ship companies answered that unintended or accidental waste releases happen very seldom. One cargo ship company answered that they have not had any accidental waste releases and other cargo ship company answered that they have not had any accidental releases into the sea in five previous years.

One cargo ship company answered that they had once accident with the sludge barge when the ship was discharging sludge. The sludge barge was accidentally released from the ship's side and that sludge, which were remaining in the discharging hose, were spilled to the sea. The same company also mentioned that once they had crack in the ship's heavy fuel oil (HFO) tank, which caused the HFO spill to the cargo room. Although, this was accidental release, it was not actual waste release. The cruise ship company reported similar case. They had accident, when the oily bilge water were discharged to tank truck, which stayed on the quay and overfill of the tank truck happened on the shore side.

Two cargo ship companies and the cruise ship company replied that if accidental discharges happen on board, these are often related to the hydraulic hose disruptions on the ships' decks. In addition, two cargo ship companies and one ro-pax company answered that the overfill of the ships' tanks is potential source of the unintended waste release. The ro-pax company also mentioned that overfills are mainly related to the bunkering operations. Similarly, during the bunkering operations, they had sometimes encountered leaks with bunker hose connections. This company mentioned that these leaks are mainly minor and usually do not end up to sea, as these accidents happens often on the ships' deck or on the quay.

The hydraulic winches on the ships' deck areas were named by one cargo ship company and the cruise ship company as most common reason for the unintended release. That cargo ship company named also ships' cargo systems, such as pumps and cranes, as common source of the accidental release of hydraulic oil. To prevent such releases into the sea, that company had established a monitoring program for the accidental releases. All leaks with more than zero volume is reported to the company. In addition, the company had established incentive system for their ships' crew to ensure that all leaks are reported.

The cruise ship company mentioned that emergency drills and rescue boats may sometimes be the source of accidental pollution to the sea. For example, the rescue boats' bottom plugs are sometimes left open when the boats are stored on the ship's deck. This may result to minor oil leaks to deck and further to the sea. In addition, during the emergency drills, rescue boats' bilge pumps are sometimes accidentally or negligently used and result may be a minor oil pollution to sea.

One ro-pax company and the cruise ship company recognized a potential risk that passengers may take plastics (e.g. the plastic bags, bottles, wrappings, pints which are bought from ship's shops) to ships' weather decks and these may accidentally or deliberately released to sea. Although, discharging of the waste to sea may be deliberate from the passengers' side, in principle, it is unintended form the shipping company's perspective.

The companies were also asked, if they had experienced any other accidental releases to the sea, such as broken structures or cargo releases (i.e. due to adverse weather, disaster etc.). None of the companies answered that they would have experienced such a release. However, majority of the interviewed companies recognized the risk for accidental releases caused by adverse weather or disasters.

Deliberate discharges

All participants of this study were of the view that discharge of any waste into the sea is not acceptable behaviour. Similarly, all participants answered that attitudes have improved significantly from the previous days. One cargo ship company also reported that it is very rare to encounter waste dumping from ships to sea.

The cargo and ro-pax companies and the cruise ship company had named dedicated environment officers on board their ships, which are responsible for ships' environmental issues and waste management. The majority of the companies answered also that crew awareness of environmental issues have increased and more and more questions concerning the recycling and sorting of wastes are received from the ships' crew. The sorting of plastics were especially highlighted by the cargo and ro-pax companies and it was addressed that plastics are sorted on board according to the MARPOL Annex V requirements but in the ports, it is often collected to same container as domestic waste. The cruise ship company replied that although attitudes have significantly improved, there has been case in the recent history where ship's bilge water and grey water lines were connected for purpose and bilge water was discharged to the sea. In addition, the cruise ship company reported that differences in attitudes still exists between the crew members, which are coming from the different geographical locations. For example, the crew members' who are coming from the Asia and China, attitude have improved significantly during the last years. Today they have better attitude for environmental issues than many other nationalities have.

Almost all the interviewed companies had established environmental policies or applied the ISO 14001 environment management system. Two companies replied that they have noticed that waste reporting accuracy have become more accurate than in previous days. One cargo ship company

answered that they have encouraged the ship crew to report all leaks. In addition, one ro-pax company and the cruise ship company had established incentive system for the ship crew to enhance the waste sorting and recycling. The cruise ship company answered that their environment policy is strict and even minor littering by the ship crew may lead to employee's dismissal.

One ro-pax company and the cruise ship company answered that passengers environment awareness have also been improved from previous days. Ship owners are receiving more and more questions also from passengers. According to these companies, the questions and feedback is very often concerning the waste recycling and collection of cigarette butts. The ro-pax company told that based on the feedback, they have installed more ashtrays and placards on the ships' weather decks. In some of their ships, the company had also increased the recycling possibilities for the passengers.

Although, passengers environment awareness have increased, both ro-pax companies and the cruise ship company had recognized the risk that passengers may throw garbage to the sea. All these companies mentioned that this is something, which is very difficult to control. According to the companies, the waste, which is thrown to the sea, originates from ships' own shops and restaurants. The companies mentioned that this waste consists most often of bottles, plastic bags, wrappings, plastic pints, disposable plates and cups, and cigarette butts. The cruise ship company replied that they have noticed that passengers may throw even the deck chairs to the sea. All the companies mentioned that although littering by passengers happen, this happens relatively seldom.

7.2.8 Waste delivery to port reception facilities

Issues with waste delivery to port reception facilities

In general, the waste delivery from ships to port reception facilities works well in accordance with answers. The companies replied that they have always managed to deliver their wastes to port reception facilities. However, all companies had encountered at least some issues with the waste delivery. One of the main issue was the varying standards for sorting. The ships are sorting wastes according to the MARPOL Convention and the MARPOL Annex V Guidelines but the same standard does not apply in the ports. Often sorted waste is delivered to one and same container on shore. In addition, sorting standards are varying between ports. Issues with sorting were mentioned by two cargo ship companies, one ro-pax company and the cruise ship company.

Volume restrictions were also mentioned as an issue by several companies. Two cargo ship companies answered that some ports set restrictions for delivery of the sludge and oily bilge water. One company had encountered volume restrictions with the sewage delivery to the port reception

facilities and one company answered that they have had difficulties to deliver the exhaust gas cleaning system (EGCS) residues due to both volume restriction and packing requirement. For example, one port requires that the EGCS residues should be packed in the 1 m^3 plastic containers. In addition, two cargo ship companies replied that time to time, they encounter delay issues with waste reception (e.g. trucks or barges have been late).

One company, which is carrying non-HME bulk cargoes on its ships, answered that port reception facilities for the cargo residues and wash waters are not adequate in any port. The company mentioned that only possibility to deliver cargo residues is to order tank truck and that is really expensive, especially when there may be hundreds of cubic metres tank washing water and tank truck volume is 30 m3. The company mentioned that in practice, this means that most of the non-HME cargo residues contained in wash water are discharged to the sea outside of the 12 nautical miles from the nearest land.

One company replied that they have encountered cases where the ports have not accepted the sewage delivery and other cargo ship company mentioned that not all ports accept the hazardous or problem waste. Difficulties to deliver problem waste to port reception facilities was mentioned also by one ro-pax company and the cruise ship company. The ro-pax company mentioned that they have had difficulties to deliver problem waste to shore in the Mediterranean ports and the cruise ship company mentioned that problem waste is not accepted in the many Asian ports.

The cruise ship company mentioned that cruise ships usually deliver large quantities of garbage to port and port's garbage stations are often full after the delivery. If there are more than one cruise ship visit in port in short time interval, it may lead to case where the garbage station is full when the second cruise ship intends to deliver its garbage. The company mentioned that this happens time to time.

Related to previous, the company mentioned as an example that when there has been e.g. construction work on board, there may be even several hundreds of cubic metres construction waste. This sets challenges to ports waste reception and ports are often not prepared for such waste delivery cases.

Those companies, which operated ships in liner traffic, had encountered less problems with waste delivery. These ships are often exempted according to the EU PRF Directive and the Act on Environmental Protection in Maritime Transport 1672/2009, which means that they have a waste agreement with the waste management company. The companies answered that the agreement with the waste company enables comprehensive waste planning. For example, locations for the

ships'own waste stations have been agreed with ports and detailed waste sorting arrangements can be agreed with the waste management company.

Issues with no-special-fee

According to the ship-owner companies' answers, the no-special-fee system works quite well and the companies have had very few issues with the system. The main issue, which was mentioned by the ship-owner companies, was that all waste categories were not included to the no-special-fee system. One cargo ship company answered that in some ports, the hazardous/problem waste is not included and the other cargo ship company replied that in the some ports, sewage discharge is not included to no-special-fee. In these cases, ports are collecting the fee based on the delivered volume.

According to the ports' interest group representative, some ports, especially the cargo ship ports have not included the no-special-fee system to cover the sewage. Reason for this is that cargo ships deliver sewage to port reception facilities very seldom. Consequently, when the port do not include sewage in the no-special-fee system, the port can reduce its waste fees, which are charged from the visiting ships.

All five cargo ship companies replied that some ports have volume limits included in the no-special-fee system. After certain volume limit, direct waste fee is applied, which is based on the delivered volume. According to the answers, delivery limits are mainly applied for oily wastes, like sludge and bilge water but also sewage was mentioned. One cargo ship company also mentioned that delivery limits are usually applied in small ports. According to answers, limits do not set practical problems for ships as the ships can discharge the remaining waste to the ship's next port of call.

Representative of the port's interest group explained that volume limits in the no-special-fee system are related to the method how the waste is transported from the port. For example, the oily wastes are mainly transported from port to waste treatment plant with tank trucks. If the volume of the tank truck is 20 m^3, the volume included to the no-special-fee is also 20 m^3. When the ship wants to deliver more than 20 m^3, the cost of the exceeding volume is based on the actual cost caused to the port.

Ports' involvement

The shipping companies were asked, do the ports supervise their ships' waste delivery to the port reception facilities. According to the answers, ports' involvement is varying between the ports. Only one cargo ship company answered that they have not noticed that ports would supervise ships' waste delivery. All other shipping companies replied that ports are at least somewhat interested in the

ships' waste delivery and some ports even inspect the ships' garbage rooms. According to the answers, inspections carried out by ports are happening today in the German ports and in the port of Rotterdam. Some ports, such as the port of Klaipeda requires that ship shall show its last waste delivery receipt given by the previous port. One of the cargo ship companies, which operates exempted ships, answered that sometimes ports ask why their ships do not deliver their wastes to ports. In these cases, ship's exemption certificates issued by the administrations are shown.

All except two cargo ship companies replied that ports are often supervising the waste stations in the port area. The ports are even giving feedback to ships, if the garbage is not sorted properly in port's garbage station, garbage station is not clean after the ship's visit or garbage is delivered to elsewhere than to the port's garbage station. The cruise ship company mentioned that in those ports, which they are visiting, there is often person from port who checks that the waste is delivered and what is the content of the delivered waste.

All shipping companies answered that generally ports are giving waste delivery receipts after the waste delivery but not always. The companies mentioned also that the waste receipts from ports are usually issued according to the ship's pre-arrival waste notification. By the waste notification, the ship informs the port for its intended waste delivery. In those cases, where the port does not issue waste receipt, the ship's agent usually signs the printed version of the ship's pre-arrival waste notification and this acts as a receipt. One company highlighted that it is important that the waste volumes in the ship's notification form and in ship's garbage record book and in the waste delivery receipt given by port, should be same. It is difficult to estimate garbage volumes and if there is mismatch with the delivery receipt and ship's garbage record book, the ship may encounter difficulties in its future port State control inspections.

7.3 Incentive systems

Persons who were interviewed for this study was asked what sort of incentive system or combination of different systems would work best that the ships would deliver all their wastes to port reception facilities and that ships would not discharge their wastes into the sea. Opinions were asked in relation to ten different economic incentive systems or variations of these incentive systems. In addition, opinions were asked related to the exemptions, which can be issued for ships according to the EU PRF Directive and the Act on Environmental Protection in Maritime Transport 1672/2009.

7.3.1 Direct fee – no incentive

All the interviewed ship-owner companies and the civil servants, which had the opinion for the direct fee system, were of the view that this system do not incentivize ships to deliver their wastes to the port reception facilities. However, it was mentioned that this cost recovery system may incentivize ships to reduce their waste generation when the fees are based on the delivered waste quantities. It was also recognized that to be applicable in practice, this cost recovery system would require a lot of monitoring by the administration.

7.3.2 100% indirect fee for all garbage (cargo residues excluded) – no-special-fee

This system were most liked among the ship-owner companies. As a positive thing, the no-special-fee system was considered simple to apply and understand. Low bureaucracy were mentioned as a good thing from both administrations and ship-owners perspective. However, the representative of the ports' interest group mentioned that the upkeep of this system causes some administrative burden for ports.

As a negative thing, the ship-owners companies mentioned that no-special-fee system do not actually incentivize ship to reduce its waste generation. When the waste fee is based on the ship's size, the system is not motivating ship to reduce its waste volumes. To reduce ships' waste volumes, many ship-owner companies are doing more than the legislation requires and the system do not incentivize those companies. Consequently, many companies mentioned that in addition to 100% indirect fee, there should be additional incentive (e.g. discounts) to further incentivize those ships who are doing more than what is required. Other issue, which was mentioned by the interviewed ship personnel and ship-owner companies, was that the no-special-fee system do not incentivize ship personnel to deliver wastes to shore. In other words, the system incentivizes the ship-owner but it doesn't incentivize ship crew to do its best that all waste would be delivered to port reception facilities.

It was also mentioned by ship-owner companies that that the no-special-fee system favors those ships that are in the tramp shipping with few port visits but not for those ships, which are in the liner traffic with several and frequent port visits on its route. The reason is that the no-special-fee is based on the ship size and it is charged each time the ship visits in port. The system does not take into account frequency of the ship's port visit.

7.3.3 Reverse fee

Both from the ship-owners and administrations side almost all participants answered that reverse fee system is bureaucratic and causes additional administrative burden. From the ship-owners' perspective this means that both the ship-owner company and its ships need to know how the system works and applying back the paid direct fee requires effort. If the system is too complicated, requires too much effort or the ship personnel do not know how the system works, the system is not incentivizing ship to deliver its wastes to shore. According to the answers, this may even lead to situation where the ship is not using waste services at all.

The ship-owner companies also mentioned that there is often charterer or agency between the port and ship-owner company, which is taking care of the port's costs and therefore, there may not necessary be any incentive for the ship-owner company.

It was mentioned also that, similarly as 100% in direct fee (i.e. no-special-fee) system, this system do not incentivize ship to reduce its waste generation. Two ship-owner companies also answered that different incentive systems may lead to beforehand planning for best waste delivery options or waste shopping. This means that ships are delivering only minimum volume or only particular waste categories to certain ports, where it is cheapest to deliver.

7.3.4 Other Incentive systems

Opinions were asked to several other cost recovery systems as well. These were the partial indirect fee (e.g. only certain waste types covered), the rights conferred by indirect fee component and calculation of direct fee component (i.e. administrative fee system), deposit refund systems, penalty system, voucher systems and cost recovery system restricted by waste type.

Most of the participants answered that these systems are more or less complicated, bureaucratic and would cause additional administrative burden. Many ship-owner companies replied that it is difficult to know what sort of cost recovery system is applied in which ports. In addition, the ship's agent or charterer often manages the ship's waste fees and consequently, incentive system may have no effect. Thus, interviewed ship personnel answered that they need instructions and guidance of the applied cos recovery systems from their agent or ship-owner company. Otherwise, the ship may not deliver any waste to port and the cost recovery system may not have its intended effect.

It was also mentioned by the interviewed ship personnel that, as the cost recovery systems in general, these systems incentivize the ship-owner company but not the ship's crew to deliver wastes to port

reception facilities. Especially, if the crew or ship captain do not even have information concerning the applied system.

The ship-owner companies replied that when several different systems are applied in different ports in ship's route, this encourages waste shopping. Waste is delivered to port there, where it is most inexpensive. According to the ship-owner companies, some of the systems, like administrative fee system and penalty system, may lead to situation where the ship is forced to deliver at least minor amount of waste to port just to avoid additional fees or to receive reimbursement. It was also mentioned that often incentive systems favour ships, which are in tramp shipping and disfavour liner traffic where the ships have several and frequent port visits on its regular route.

In relation to the administrative burden, interviewed ship-owner companies and civil servants mentioned that there may be possibilities to misuse cost recovery systems e.g. ports may favour some waste management companies, fees may not be transparent or information concerning the applied system is not distributed. Therefore, to work as intended, these cost recovery systems need supervision from both the administrations and ports side.

7.3.5 Exemptions

General opinion of the interviewed persons were that the exemptions do not give financial incentive for ships to deliver their wastes to port reception facilities. Instead, several ship-owner companies and ship personnel answered that exemptions make the practical waste delivery from the ship to the port reception facility easier. In addition, the exemptions offer better possibilities for the ship-owner companies to improve their ships' waste management. According to the answers, the exempted ships had better sorting arrangements in ports than those ships, which delivered their wastes to the ports' own waste stations and paid the ports' waste fees.

It was mentioned by the ship-owner companies that exemptions reduce the workload of the ship personnel when waste delivery is arranged only in one port or certain ports on ship's route. According to the interviewed ship personnel and ship-owner companies, the exemptions' influence emphasises when the ship has several port visits on its route. The ship-owners and ship personnel mentioned following reasons, why the exemptions make practical waste management work is easier: There is clear rules for ship-owner company and for ship how the waste will be sorted on board and delivered to port. Sorting standard is same on board the ship and in the waste station located in the port. Waste sorting and delivery arrangements may vary significantly between the different ports, when the ship delivers its wastes always to same port, delivery arrangements are staying same. In addition, interviewed persons answered that the contact point to waste management company is

clear. This helps the communication between the ship or ship-owner company and the waste management company.

Direct fees based on the delivered volume were also mentioned by the ship-owner companies as a factor, which is motivating for sorting and reducing waste volume. One company mentioned that they have improved their waste sorting and delivery far above the MARPOL Convention (e.g. different plastics, such as clean plastic, plastic bottles and contaminated plastic were collected and delivered separately). That ship-owner company has agreement for the recycling of these plastics and also other waste categories (e.g. the cooking oil, used lubrication oil, sewage, grey water) and different domestic waste categories (e.g. glass, metal, paper, cardboard, rags, e-waste etc.) with few different waste management companies.

It was mentioned by two ship-owner companies that it is not possible to apply exemption to each port due to different national legislations. In addition, the conditions for exemptions are varying between the different states. One company explained that in certain ports, the exemption may be applied only if the waste management agreement between the ship and waste management company is made with the waste management company, which is owned by that port.

7.3.6 Fee reductions

Fee reduction means the system, where the ship have possibility to get reduction from its waste fee with certain conditions. This means that the ship needs to demonstrate that it produces less waste or is more environment friendly than similar ships in average. The clean ship index is one example of the reduced fee system.

Reduced fees divided the participants' opinions, part of the ship-owner companies liked these systems and some did not. The interviewed civil servants also raised some doubts concerning the fee reduction systems. Those participants who were in favour of the fee reductions, mentioned as a good thing that the fee reduction systems encourage to reduce waste generation on board and also incentivize ship-owner to enhance its ships garbage management and environment technologies.

According to the answers, it is a matter of cost if the ship-owner will apply the free reduction systems. The ship-owner companies mentioned that applied system needs to pay itself back to be worth of using. It was also mentioned by ship-owners that upkeep of the fee reduction system requires some effort, which may be costly. For example, the system may have requirements that ship is inspected by the recognized organization or by the organization, which manages the fee reduction system.

Those ship-owners, which supported the fee reduction system, mentioned that systems should be applicable in all ports, because this would give more economic benefit for the ship-owner. When fee reduction systems are applied only in very few ports and if the ship is visiting only seldom in those ports where the fee reductions are applied, it is not cost-effective for the ship-owner to upkeep expensive fee reduction system. In other words, the system is not paying itself back in those cases.

As a negative thing, it was mentioned by the ship-owners that the fee reduction systems do not incentivize ship personnel to deliver wastes to port reception facilities. There may even be temptation to get rid of ships' wastes by doubtful way. It was mentioned by both ship-owners' and civil servants that there should be method how to verify that the fee reduction system is applied properly so that the waste generation is not reduced by illegal ways (e.g. disposing the waste during the ship's sea voyage).

It was also mentioned by the ship-owners that it is difficult, especially for older ships, to achieve the fee reduction systems' requirements. The fee reduction systems may contain several requirements for ship, e.g. use of certain chemicals, air emission limits and change of hydraulic oils, etc. One system, called Environmental Ship index (ESI), requires ships to use the LNG as its fuel or shore electricity during ships' port stay (WPSP 2020). According to the interviewed ship-owner companies, these requirements may be too demanding for old ships.

7.3.7 What could make the waste delivery to port more attractive?

Each interviewed ship-owner company and ship personnel mentioned that easy accessibility to port's waste station is important element to make the waste delivery from ship to port reception facility more attractive. Barges were mentioned by many ship-owner companies and ship personnel as the best method to deliver wastes from ship to shore. It was mentioned that barges are used usually in the big ports in the central Europe. The port of Rotterdam was named as one good example. Mobile garbage stations in quay such as trucks were also mentioned as good method to make garbage delivery from ship to shore easier. According to the answers, garbage trucks are in use today, e.g. in the port of Riga. The garbage barges and trucks were mentioned by several ship-owners as a method, which could be applicable also in the Finnish ports. Many ship-owners and ship-personnel answered that this could be for example a service, which the port could offer for visiting ships. However, many ship-owners recognized that in Finland, seasons may restrict the use of barges e.g. in wintertime, ice conditions may prevent the using of barges.

According to the ship-owner companies and ship-personnel, garbage station, which are located far from the ship's quay, impedes efficiently the garbage delivery from ship to shore. According to the

ship-owners and ship personnel, the garbage is often delivered to port's garbage station by hand and thus, requires a lot of labour force. Additional working hours may lead to break of resting hours and further to accidents, which may result discharges to the sea.

One element, which was mentioned by the ship-owner companies and ship personnel that makes the garbage delivery to port less attractive, was low sorting possibilities in the port's garbage station. In general, ships are sorting their wastes according to the MARPOL Convention and the MARPOL Annex V Guidelines. This same sorting requirement does not apply in ports. In some cases, the different MARPOL Annex V waste categories are delivered to the one domestic waste or general waste container. Based on the answers, this frustrated many participants of this study.

Representative of the ports' interest group assumed that main reason, which defines the waste sorting level in the port, is the method of the waste handling in the local waste treatment plant. For example, if the local waste treatment is managed in the waste burning plant, ports are collecting the different waste categories from ships to one domestic or energy waste container.

Several participants from the ship-owners' and administrations' side answered that guidelines, which give information of the port reception facilities and waste management in ports, would help practical life on board ship and in the ship-owner company's office. It was also mentioned in the interviews that ports' waste management information should be in the same standard format among the Baltic Sea ports. In addition, it was mentioned that garbage related information should be found from the ports' web sites.

According to the interviewed port State control inspectors, it happens often that the ships do not know which sort of cost recovery system is applied in ports where they visit. For example, ships that are visiting seldom in the Finnish ports, such as oil tankers and bulkers in tramp traffic, do not know that the no-special-fee system applies or what the no-special-fee system means. According to the PSC inspectors, in many cases this may lead to the situation that the ship is not delivering its wastes to port reception facilities when the ship assumes that direct waste fees based on the delivered waste categories and quantities are charged. This means that there is increased risk that ship discharges its wastes illegally. It was mentioned also by the ship-owner companies that it is very important to inform ships, which cost recovery system is applied in port (e.g. if no-special-fee system is applied).

8 Critical examination and discussion

8.1 Reliability and relevance

Under this paragraph, it is assessed how reliable and relevant the study methods, analyse and achieved results are.

This study is descriptive qualitative study and the material has been collected by the thematic interviews. The intention of this study was to find out in-depth and thorough knowledge from the interviewed persons. The target group of the study was considered carefully, in order to find out those experts who have detailed knowledge regarding the studied subject (i.e. ship waste discharge sources and incentive systems). The study's sample size was relatively small but when it covered the relevant shipping industry and administrations, it can be considered as adequate.

The interviewed persons were working for the ship-owner companies as technical and environmental professionals, ship captains and engineers. All of the interviewed ersons had Finnish nationality. However, only three of the ship-owner companies, which the interviewed persons represented, had the Finnish ownership. From the industry side also different interest groups' (i.e. ship-owner companies, ports and professional fishing) representatives were interviewed. The interviewed ship-owners consisted companies, which operated the general cargo ships, bulk carriers, oil and chemical tankers, ro-ro and ro-pax ships and cruise passenger ships. These ship types represent those ship types, which are generally operating in the Baltic Sea area (HELCOM 2018). Therefore, the interviewed persons working for the ship-owner companies' offices, on board ships and for interest groups can be considered as both relevant and reliable for this study.

Interviewed persons from the administrations were the PSC inspectors who are conducting the PSC and PRF inspections for ships, and experts from the Finnish Transport and Communications Agency who are responsible for national implementation of these regulations (Act on Finnish Transport- and Communications Agency 935/2018). In addition, the civil servants from the Finnish Transport and Communications Ministry, the Finnish Ministry of Environment, and Ministry of Agriculture and Forestry of Finland were interviewed. The Finnish Transport and Communications Ministry and the Finnish Transport and Communications Agency are the Finnish maritime administrations, where the Agency is competent authority in substance level and responsible for the ship surveys and certification of the Finnish flagged ships and responsible for the inspections of the foreign ships visiting in Finland (Act on Finnish Transport- and Communications Agency 935/2018). The Finnish Transport and Communications Ministry is responsible for the shipping in the legislation and

political level and also responsible for the port related issues (Prime Minister's Office's Decree on the Finnish Transport and Communications Ministry 405/2003). The Finnish Ministry of Environment is responsible for the protection of the marine environment in general level (Prime Minister's Office's Decree on the Finnish Ministry of Environment 1286/2015). The Ministry of Agriculture and Forestry of Finland is responsible for the Finnish fishing policy and legislation (Prime Minister's Office's Decree on the Ministry of Agriculture and Forestry of Finland 1267/2014). Material collected by the interviews of the civil servants can be considered both relevant and reliable for this study, as these administrations are regulating and supervising those waste issues, which are in the scope of this study.

The first research question of this study was "What are the ships' waste discharge sources?". To answer this question, the first part of the questionnaire was aimed to find out what different wastes categories are generated onboard and how these wastes are managed on board ships. The second part of the questionnaire was aimed to find out how the wastes are delivered to shore, what are the current attitudes onboard ships and in the ship-owner companies' offices, and do the accidents happen today. Intention of these questions were to find out if the deliberate or unintended waste discharges to sea happen today. For finding of the possible ships' waste discharge sources, these questions can be considered as relevant.

For ensuring that given answers would be reliable for this study, it was made clear for the interviewed persons that their identity cannot be discovered from their answers. This applies also for the companies, which the interviewed persons represented. Although, names of the participated companies are mentioned on this study, answers given by one certain company cannot be connected to that specific company.

During the interviews, it proved that all participants, both from the industry's and administration's side, were very environmentally aware and exited to answer the questions. Many participants also mentioned that their names or their company names, which they represent, can be referred in their answers. Consequently, it can be concluded that given answers are relatively reliable.

The second research question was "What incentives could be used as preventing measures for ships not to discharge wastes to the sea and deliver wastes to port reception facilities?". Third part of the questionnaire lists the different incentive system models and asks the participant's views on these systems. As this question is related to opinions and not how the participant acts or behave in pracctice, it can be assumed that answers are reliable (i.e. it can be trusted that participant's answer is the same what he or she thinks of the issue). For this second research question, the relevance is

important aspect. This means that it is important to find the relevant participants, which have enough experience and knowledge to form their opinions for the different incentive systems. It can be considered that ship-owner companies technical and environment experts who are using the incentive systems in practice and administrations, which impose these systems, are both relevant participant groups. When the participant has knowledge and experience from the different incentive systems, the answers can be considered as reliable.

8.2 Ethicality

Although, this study was conducted by the civil servant of the maritime administration, the participation for this study was voluntary. It was also mentioned for the participants that their identity is protected so that their names are not published and their answers cannot be connected to companies, which they are representing. Names of those companies, which participated to this study, are not mentioned and consequently given answers cannot be combined to any particular company. In addition, it was told to the participants that their answers are only for the research purpose and there will not be any criminal implications if any such actions would turn up in the answers.

All interviews were tape-recorded and documented. On average, one interview lasted from 30 to 60 minutes. The material contains also personal information of the interviewed persons (i.e. name, title, position and task in the company, and company's name). This interview material and recordings are archived in the Finnish Transport and Communications Agency's data management system and it is not available in public.

8.3 Quality of former studies

Former studies, which were used for the literature review of this study, were mainly studies ordered by the EU, IMO, UNEP and FAO, and conducted by the private consultancy companies or science groups (e.g. GESAMP). Studies ordered by above entities and organizations are often put out to tender in public. In addition, these studies are steered by the steering committees. The steering committees are often comprised of the EU or IMO member States' administrations, relevant secretariat and the non-governmental organizations. These studies are often intended to give background information for the development of the new international regulations. For example, several previous studies were used for the preparing of the EU PRF-directive's revision (ECORYS 2017). The studies conducted by the EU and IMO were emphasized on this study's literature review

as the results of these studies are most relevant for the shipping industry's waste discharges and consequently also for this study.

8.4 Examination and discussion of results

8.4.1 Ships' waste discharge sources

The primary aim of this study was to find out possible waste discharge sources of the merchant ships operating in the Baltic Sea area. The participants of this study were chosen in the view that they would represent as wide scale of the different ships and ship owner companies as possible. The interviewed participants represented general cargo ships, bulk carriers, oil and chemical tankers, container ships, ro-ro- and ro-pax-ships and cruise passenger ships. It can be considered that this variety of ships would cover the ships, which most commonly operate in the Baltic Sea area (HELCOM 2018) and consequently would give good starting point to discover ships' waste discharge sources. In order to make conceptualization of ships' waste discharge sources easier, the waste categorization in accordance with the MARPOL Convention is used. This means that the ships' wastes are divided to the following main categories: oily wastes, sewage, garbage and air emissions related waste.

In former studies, the marine litter were often divided to two main sources, land- based sources and sea-based sources (EUNOMIA 2016, Eriksen et al. 2014 RPA 2013, Arcadis 2012, UNEP 2009). The sea-based sources contain waste sources, which origin is in the sea e.g. merchant shipping, commercial- and recreational fishing, offshore operations, marine research, sea building and recreational boating (EUNOMIA 2016, Eriksen et al. 2014 RPA 2013, Arcadis 2012, UNEP 2009). Based on the study Arcadis 2012, about 20 % of the all marine plastic litter is from the sea-based sources. In the Baltic Sea this ratio is significantly smaller, i.e. 5 % (Arcadis 2012). The scope of this study was to find out the waste discharge sources, which originate from the merchant shipping. In other words, part of the sea-based sources, such as the recreational boating, offshore operations, marine research and sea building were out of the scope of this study.

Deliberate discharges

In the previous studies (EUNOMIA 2016), the sea-based waste sources were divided to two categories, based on how the wastes are ending up into the sea. These are deliberate discharges and unintentional discharges. Deliberate discharge means that the ship is discharging its wastes into the sea on some purpose. Unintentional discharge means that wastes are discharged to sea by the

accident or otherwise unintentionally. The deliberate and unintentional discharges can be further divided to legal and illegal discharges. (EUNOMIA 2016)

Deliberate discharges may often be legal. For example, in accordance with the MARPOL Convention and the Finnish Act on Environmental Protection in Maritime Transport 1672/2009, ships are allowed to discharge certain waste categories, such as oily bilge water, sewage, food waste, and exhaust gas cleaning system discharge waters into the sea. Standards for these discharges are set in the MARPOL Convention and relevant guidelines referred in the MARPOL Convention (IMO 1997). Other example is the exceptional circumstances, like emergencies, where the ships' wastes need to be purposely discharged to sea for securing the ship safety or saving life at sea (IMO 1997). It should be also taken into account that accidental discharge may be illegal. For example, if the reason for accident is negligence or omission. (EUNOMIA 2016)

Based on the results of the interviews, which are described in the section 7.2, ships are generating various categories of wastes, which are defined in the Annexes of the MARPOL Convention. Consequently, possibility exists that all these ship generated wastes may end up to the marine environment.

All the participants answered that it is very rare that wastes would be discharged to sea deliberately, except those waste categories, which are allowed according to the MARPOL Convention. In addition, all participants who worked for the ship-owner companies or as ship personnel answered that unintended waste releases from ships happen very seldom and if those happen, volumes are relatively small. Based on the given answers, the conclusion can be drawn that illegal or accidental waste discharges to sea are relatively rare in the Baltic Sea area.

According to the previous studies (EUNOMIA 2016, Ohlenschlager et al 2012, UNEP 2009, Carl Bro a/s 2005), there are several reasons, which may lead to deliberate waste discharges to sea. These studies address the reasons such as the inadequate port reception facilities, inadequate storage capacity onboard, attitudes of ship crew and crew's unawareness. There may be further underlying reason for these, e.g. defective waste management onboard, which may lead to unnecessary filling of ship's waste storages, indiscriminateness of waste management, negligence, accessibility to port reception facilities and unreasonable costs for garbage delivery to port. (EUNOMIA 2016, Ohlenschlager et al 2012, UNEP 2009, Carl Bro a/s 2005).

Based on the answers given for this study, above reasons for deliberate discharges are seldom encountered in the Baltic Sea area. Regarding to the attitudes, several answers from the ship-owner companies and ship personnel mentioned that attitudes have improved significantly during the last

years. According to the answers, the ship personnel and passengers are today very aware of the existing environmental issues, especially issues related to the marine plastic litter. The participants working in the ship-owner companies' offices replied that more and more references are received from both their ships' personnel and passengers.

It may also indicate the raised awareness that almost all interviewed ship-owner companies had established environmental policies and certain companies had also own rewarding systems and incentives for the ship personnel to improve the waste management on board ship. Ship-owner companies had also established own sanctioning systems for pollution and within certain companies, even small littering may lead to employee's severance.

Despite of the increased awareness, all ship-owner companies, which operated passenger ships, mentioned the existing risk that passengers may throw garbage to the sea. According to the answers, this garbage contains mostly cigarette butts and items which may be bought from the ships' shops and restaurants (e.g. plastic pints, disposable plates and cups and wrappings) but it is not uncommon that even deck furniture are thrown to sea by passengers. In addition, all above participants replied that littering by passengers is very difficult to control. However, one company had experience that by adding the ashtrays, garbage bins and placards on the ship's weather decks, the deliberate throwing of garbage to sea by passengers had decreased. By applying this sort of actions, the ship-owners companies would probably reduce the volume of the garbage, which is discharged from ships to the sea.

One element, which could reduce the deliberate littering either by passengers or by ship crew, could be improvement of the awareness and attitudes. Based on the result of this study, this could be helped by enhancing the informing of the company's environment policy, waste handling onboard ship and explaining consequence of the marine littering. As mentioned above, many ship-owner companies mentioned that both the ship personnel and passengers are increasingly asking the companies' environmental policies and possibilities for garbage sorting and recycling on board ships. Reduced littering after placing more placards and garbage bins on passenger ships' weather decks is good example of succeeded informing and improved attitudes.

When all the ship-owner companies mentioned that it is difficult to control their passengers behavior, one option to reduce marine plastic litter could be to change the material of the plastic pints, disposable plates and cups, and wrappings. When the origin of these wastes are ships' stores and restaurants, the ship-owner companies have possibility to influence this issue. Ship-owner companies mentioned that using of the disposable plates and cups is reduced as far as possible but

in some cases, like with takeaway products, it is difficult to reduce disposable materials. In these cases, replacing of the disposable material with biodegradable material could solve some issues. As one example, plastic wrappings in dry products could be replaced with materials, such as paper or cardboard. One company mentioned that they have ongoing process to replace all plastic pints with biodegradable pints. However, according to that company, it has shown to be difficult to replace plastic materials due to reason that they have not yet found such biodegradable material that would also be environment friendly. According to that company, the biodegradable products exists in market but it has not been possible to demonstrate that these products would not cause harm to the marine environment.

The ship-owner companies and ship personnel mentioned that littering by the passengers is often related to the alcohol consumption and almost everything from the deck furniture to cigarette butts can be thrown overboard. It can be assumed that ship-owner companies are not willingness to reduce the alcohol sale on board ships, as this is income for the company. One option to reduce this sort of littering would be to make arrangements on board such that littering is not possible at first place. As an example could be to prevent unnecessary access to ships' weather decks at nighttime. Other option would be to make the weather decks free of any movables or using of built-in furniture. However, this second option do not prevent passengers for bringing items with them to the ship's weather deck.

Deliberate waste discharges allowed in legislation

As it was mentioned above, some waste categories can be legally discharged to the sea in accordance with the MARPOL Convention and the Finnish Act on Environmental Protection in Maritime Transport 1672/2009. These waste categories are inter alia:

- oily bilge waters through the oil filtering equipment when the oil content is max. 15 ppm,
- untreated sewage from cargo ships outside of 12 nautical miles from nearest land,
- treated sewage without limitations,
- grinded/comminuted food waste outside of 12 nautical miles from nearest land,
- non-HME cargo residues contained in cargo hold wash water outside of 12 nautical miles from nearest land,
- deck wash waters containing the non-HME cleaning agents without limitations, and

- EGCS discharge waters with standards set in the IMO Guidelines MEPC.259(68).

These waste categories and detailed conditions for discharges are explained in the tables 1 and 2, on the paragraph 4.1.1.

According to the answers, majority of interviewed ship-owners mentioned that all oily bilge waters are delivered to shore and only few ship-owner companies replied that they use the option in the Annex I of the MARPOL Convention to discharge oily bilge waters to sea by using the oil filtering equipment. Based on the given answers that oily bilge water is in many cases delivered to port reception facilities, we can reach a conclusion that ship-owner companies are following more stringent environmental policies than what the MARPOL Convention requires.

One reason for this voluntary delivery of oily bilge waters is most certainly the applied no-special-fee incentive system. When the no-special-fee system (i.e. 100 % indirect fee cost recovery system) is applied in the Finnish ports and generally in the Baltic Sea area (HELCOM 2007, Act on Environmental Protection in Maritime Transport 1672/2009), it can be concluded that this incentive system have strong effect that oily bilge waters are delivered to port reception facilities and not discharged into the sea. Other reason for improved oily bilge waters delivery is most probably the enhanced awareness and attitudes. Many ship-owners mentioned that they have applied strict environmental policies and especially for those ship-owner companies, which operate passenger ships, this is the matter of reputation, which may lead to losing of passengers.

The Annex IV of the MARPOL Convention allows sewage discharges to the sea with certain conditions. In addition, the MARPOL Convention do not regulate the grey water discharges at all. Except the passenger ship-owner companies, the ship-owner companies and ship personnel replied that the sewage and grey water, either treated or untreated, is usually discharged from cargo ships to sea. Almost all ship-owner companies answered that they have sewage treatment plants installed on board their ships and only one ship-owner company replied that they have some ships, which do not have sewage treatment plants.

Ship-owner companies, which operated passenger ships, replied that sewage and grey water are delivered to port reception facilities. Based on the given answers and also on previous studies (Jalkanen et al. 2019, Traficom 2019), the sewage is often deliberately discharged to sea. Based on the results of Jalkanen et al. 2019 1,4 million cubic meters are discharged to the Baltic Sea. Based on the previous studies, the sewage discharges are harmful to the marine environment because it contains nutrients, especially phosphorous and nitrogen (Hänninen and Sassi 2009). Grey water may contain also microplastics and cleaning agents (Ytreberg et al. 2019, LC&P and IMO 2016).

According to the answers, it seems that some cargo ship companies and especially the passenger ship companies are following more stringent voluntary actions to prevent the sewage and grey water discharges to the sea than what the Annex IV of the MARPOL Convention requires. For the passenger ship companies, the image of the company is probably significant aspect why they deliver all sewage and grey water to port reception facilities in the Baltic Sea area. In addition, delivery of the sewage is often included to no-special-fee system in the Baltic Sea area, which probably incentivizes ship-owners to deliver sewage and grey water to shore. To further incentivize ship-owners to deliver sewage and grey water to port reception facilities, at least one port, port of Helsinki have issued price reduction for waste fee when the ship delivers its sewage and grey water to port reception facility (Port of Helsinki 2020a).

Considering the given answers, there may be two possibilities to reduce or prohibit the sewage and grey water discharges into the Baltic Sea. The first is better implementation and enforcement of the no-special-fee incentive system. Based on the answers, the no-special-fee system seems to be effective method for preventing the MARPOL Annex I oily bilge water discharges to sea. If the existing barriers, such as inadequate sewage reception facilities for cargo ships, volume restrictions for delivery and direct fees, would be removed, the no-special-fee system would be effective method for reducing sewage discharges to sea. Better implementation and enforcement could be put into practice in relatively small effort and would not even need amendments to present legislation. If the grey water would be included to the no-special-fee system the amendment to legislation would be needed.

The second possibility to prohibit the sewage and grey water discharges would be to amend the discharge requirements in the Annex V of the MARPOL Convention. These amendments should contain the prohibition of untreated sewage discharges from cargo ships and prohibition of untreated grey water discharges from cargo ships and passenger ships. These discharges are allowed today as explained in the section 4.1.1. This second possibility is the long-term measure, it requires international cooperation between the HELCOM and the IMO member States and more background studies for the amendment's feasibility. These two options do not exclude each other and both measures should be promoted.

Based on the answers, waste categories in the MARPOL Annex V, which are discharged to sea, are:

- food waste,
- non-HME cargo residues, and

- deck wash waters containing non-HME cleaning agents.

Most of the interviewed ship-owner companies and ship personnel mentioned that they are delivering the food waste to port reception facilities. However, few ship-owner companies replied that food waste is also discharged to the sea. Either directly to the sea through the comminuter and outside of 12 nautical miles from nearest land or through the sewage treatment plant.

None of the answers indicated any issues with the no-special-fee system or port reception facilities on this matter so we can assume that these are not reasons why the food waste is still discharged to sea. Instead, the reasons may be related to the difficult storage of food waste on board ships and easy discharge to the sea with comminuter. One company replied that for storing of the food waste on board, they have purchased separate refrigerator, other companies replied that they have applied airtight containers, waste press and separate holding tank for food waste. Especially, if the ship has seldom port visits, the storing of food waste may be challenging.

In accordance with the MARPOL Convention, the cargo residues, which are non-hazardous to the marine environment and contained in cargo room wash water, can be discharged to sea outside of 12 nautical miles from the nearest land, if the ship's loading or unloading port do not have adequate port reception facilities for cargo residues. Two ship-owner companies, which participated on this study, mentioned that adequate port reception facilities for the non-HME cargo residues are mainly missing in the Baltic Sea area. One company answered that they are discharging to sea about the half of their non-HME cargo residues. The other company mentioned that about 86% of their non-HME cargo residues are discharged to sea. One of the root causes, which has led to this situation, is the above mentioned regulations of the MARPOL Convention. When there is legal possibility to discharge the non-HME cargo residues to sea, there are no interest to develop or improve port reception facilities. Cargo residues do not belong to the no-special-fee system either (Act on Environmental Protection in Maritime Transport 1672/2009) and consequently, this incentive system do not help to enhance cargo residues' delivery to the reception facilities.

All the ship-owner companies, which participated to this study, answered that deck washing waters, which may contain the non-HME cleaning agents, are discharged always to sea. These deck wash waters may contain residues from ship's maintenance work, such as paint flakes from hull scraping work (IMO 2019).

Although, deck wash waters belong to the no-special-fee system as this waste is categorized in the MARPOL Annex V as a garbage, the incentive system do not enhance the delivery of the wash waters to port reception facilities. The ship-owner companies and ship personnel replied that reason

for this is that the collection of the wash water is either not possible or at least burdensome. Thus, to prevent deck wash water discharges to sea, the methods for wash water collection should be developed. For example, one ship-owner company, which operated ro-ro and ro-pax ships, used the dedicated cleaning trucks for cleaning their ships' ro-ro lanes. This dedicated cleaning truck collects the most of the used wash water. Based on the answers, some ship types, such as oil and chemical tankers have deck wells on their cargo area for preventing oil pollution. On these ships, the wash water can be drained from deck wells to residue tanks. However, this applies only for certain ship types and only wash waters generated on the cargo deck area. Deck wash waters outside of the cargo deck area are yet discharged to the sea also from these ship types.

Three ship-owner companies, which participated this study, mentioned that they are using the exhaust gas cleaning systems (i.e. scrubbers) on board their ships. Two of the three answered that they are using the EGCSs in open loop mode and wash water from EGCS is discharged to sea according to the discharge water standards set in the guidelines for exhaust gas cleaning systems MEPC.259(68). This guideline sets limits for the discharge water's pH, PAH and turbidity. In principle, for the open loop EGCS this means that adequate amount of sea water is pumped to ship's scrubber unit, so that pH, PAH and turbidity values are diluted under the required discharge limits. Ship-owner companies mentioned that their open loop EGCSs have water cleaning units but they also questioned the efficacy of those cleaning units because only small amount of soot is collected on the water cleaning process. They mentioned also that this soot is always delivered to port reception facilities. The EGCS residues are not included to the no-special-fee system (Act on Environmental Protection in Maritime Transport 1672/2009) but this would not anyway help to increase discharge water delivery to port reception facilities because used water volumes with the open loop EGCS are so high that ships would not have such holding tank capacity.

Probably the only way to restrict the EGCS discharge water releases to the sea would be to develop the international requirements for these discharges. Developing of these discharge requirements at the IMO would need comprehensive background studies. For the present, there are impact assessments for the EGCS discharge water from the Japan (Japan 2018) and by the CE Delft in Europe (2019). However, both of these studies are not directly comparable to the Baltic Sea's marine environment, as the sea areas covered by these studies (i.e. the coastal waters of Japan and modelled ocean, North Sea, Baltic Sea and river port) do not correspond directly to the Baltic Sea. The CE Delft 2019 uses model of the commercial Baltic port but as this is a model, more studies are needed to assess the impacts of EGCS discharge waters in the Baltic Sea area. The harmful substances contained in the EGCS discharge waters are yet studied in the Germany (Beate et al. 2014) and by the CLIA (Cruise Lines International Association) (CLIA 2019) and based on these studies the

EGCS discharge waters may contain several harmful substances, such as PAH compounds, Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Selenium, Vanadium and Zinc.

When the development of the new IMO requirements is relatively slow process, one option would be the setting of the national restrictions for the EGCS discharge waters. This could be done e.g. by amending the Act on Environmental Protection in Maritime Transport 1672/2009. Although, the process for amending the national legislation is faster and less burdensome than amending the international regulations, it still requires preparation and assessments. In addition, compared to the international regulations, the environmental benefits achieved by the national legislation would be much lower because the national legislation would be applicable only in the waters under the Finnish jurisdiction.

8.4.2 Incentive systems

Incentive systems were collected from the previous studies ECORYS 2017, EUNOMIA 2016, Panteia 2015, Ohlenschlager et al 2012 and Carl Bro a/s 2005. These incentive systems were introduced and explained to the participants, which after the opinions were asked for these systems.

In principle, participants raised one general concern. It was mentioned that the applied incentive system should be easy to apply in practice. This means that the system should be easy to understand for both the ship-owner company and ship personnel, and it should contain as less bureaucracy as possible. Majority of the participants mentioned that many of the introduced incentive systems were difficult to understand and would cause additional administrative burden. The interviewed ship-owner companies and ship personnel replied that this appears in practice so that they do not know which system is applied in that port where the ship is visiting. According to the answers, it is often charterer or agent on behalf of the ship-owner company, which is taking care of the ship's waste fees. In those cases, the intended effect of the incentive system may be lost.

All the interviewed participants mentioned that the 100 % indirect fee (i.e. no-special-fee) cost recovery system would be the best available economic incentive system for ships. However, many participants also raised some concerns regarding the system. When the ship is always paying the same amount of waste fee, despite if the ship delivers its wastes or not, the system do not encourage ship to reduce its waste generation. In addition, no-special-fee is usually based only on the ship's size. Consequently, some ship-owners mentioned that there should be additional rewarding system for those ships, which are doing more than what the MARPOL Convention or PRF-directive requires, e.g. if the ship can prove that it generates less waste than similar ships on average. In the

other hand, this sort of additional element would increase the bureaucracy and administrative burden, which were unwanted features of the incentive system.

As mentioned above many ship-owner companies answered that they are often unaware of the applied incentive system in those foreign ports where their ships are visiting. Similarly, the interviewed inspectors mentioned that foreign ships are unaware that the no-special-fee system is applied in the Finnish ports or they do not know what the no-special-fee system means. According to the interviewed inspectors, this is also the main reason why the foreign ships are not delivering their wastes to the Finnish ports. They mentioned that when the ship is informed during the inspection that the port charges its waste fee anyway, delivers the ship its wastes or not, the ship is always delivering its wastes after that. This demonstrates that informing of the applied incentive system is important, otherwise the intended effect of the incentive system may be lost. This may even lead to situations where the ship's waste storages are filled up and consequently, the risk for deliberate discharge to the sea increases. The ports' and agents' role as informing entities, were recognized by the inspectors as utmost important. However, it was also mentioned by inspectors that there might be economical benefit for ports not to inform the ships because the ports would get the economic benefit without obligation of the waste management. In the other hand, the waste fees are generally relatively small compared to all other port fees, so the risk for this is also relatively small.

Based on the ship-owner companies and ship personnel answers, the economic incentives do not encourage ship personnel to deliver wastes to port reception facilities. The similar issue was also found in the EUNOMIA 2016 as the study mentions that the cost recovery systems have no influence for individual littering behavior. Instead, the incentive systems encourage ship-owner companies, which further order their ships to deliver wastes to port reception facilities. Majority of the ship-owner companies and especially ship personnel mentioned that it is the attractiveness of the waste delivery to the port reception that matters most that the waste is delivered to shore.

Several participants mentioned the easy access to the port reception facility as an important factor that wastes are delivered from ship to the port reception facilities. Ship-owner companies and ship personnel mentioned that garbage stations are often located far from the ship's quay. Thus, it is not attractive for the ship crew to deliver wastes to shore when it requires additional effort. Based on the given answers this issue is especially related to certain ship types, such as oil tankers, bulk carriers and container ships. Location of the garbage station is not so relevant for the ro-ro and ro-pax sips as the ships have usually possibility to use forklift trucks or alternatively the garbage truck may drive directly to ships ro-ro deck to receive the ship's wastes.

Probably the best solution to improve the garbage stations' accessibility would be the applying of the mobile garbage collection. Several participants mentioned this as a method for making the waste delivery more attractive for the ship crew. It was mentioned that already today many ports are applying garbage trucks, which are driving next to ship for receiving the ships' garbage. The big ports are often using barges, for waste collection. Consequently, the ship-owner companies and ship personnel mentioned that ships strive to deliver wastes to such ports where it is most convenient. Except the reception of the oily wastes and cargo residues, the waste reception with trucks is not often applied in the Finnish ports and waste barges are not used at all. Ship-owner companies were of the view that using of the trucks and barges could be applicable also in the Finnish ports, at least in the bigger ports, and that would enhance waste delivery from ship to shore. However, it was also recognized that it would not probably be possible to use barges on wintertime in the ice conditions. Participants were also of the view that this mobile waste reception services would most probably increase the waste fees charged by port.

Other element, which were mentioned by participants that would promote better waste delivery from ship to shore, was the port specific instructions or guidelines for ships' waste delivery to port reception facilities. It was mentioned that these instructions or guidelines should be publicly available and as the best option, these guidelines should be found from the one and same platform. For example, from one common web site. The ship-owner companies also mentioned that form of the instruction should be uniform to allow easier reading and understanding. According to ship-owner companies, the port specific guidelines would make the beforehand planning of the ships' waste delivery easier when they would have knowledge of the port's waste reception and applied incentive system.

One issue, which were raised by the ship-owner companies and ship personnel that would make the waste delivery to port reception facilities more attractive, was the better sorting at the port's garbage station. It was mentioned that many ports, especially bigger ports, have often arranged good sorting possibilities. Often in these ports, the sorting arrangements follow the same sorting standard as required by the MARPOL Convention and the MARPOL Annex V guidelines, which the ships are following. According to the interviewed ship-owner companies and ship personnel, there are also a lot of ports, which are hardly sorting the delivered waste at all. As an example, the ship-owner companies mentioned that sometimes there may be only one domestic or mixed waste container in port's waste station. Based on the interviewed representative of ports interest group, the reason is mainly the local waste treatment plant on shore. For example, if the waste is incinerated in the local waste burning plant, the waste will also be collected in the port as energy waste.

Lack of the sorting possibility do not necessary reduce the waste delivery to port but according the answers, this frustrates the ship personnel and may lead to situation where the sorting requirements of the MARPOL Convention and the MARPOL Annex V Guidelines are not followed on board ship. Insufficient sorting on board ship may further lead to situation, where the waste is not properly recycled or reclaimed in those ports, which are following the more accurate sorting.

Reduced fees are not cost recovery systems itself but can be used in addition to cost recovery system to further incentivize ships to deliver their wastes to port reception facilities or encourage ship-owner companies to invest more environmental friendly ships (EUNOMIA 2016). Reduced fees divided the opinions, part of the participants were in favour of reduced fees because these systems enhance ship-owner companies to promote their waste management and invest the environment friendly technologies. The second half of the participants were not in the favour of reduced fees. According to the answers, main reason was that the existing fee reduction systems, which are applied today in some ports, are very demanding and comprehensive. For example, Environmental Ship index (ESI) requires that the ship uses the LNG as its fuel or on-shore power supply during its port stay (WPSP 2020). When the requirements for ships are too high, there is risk that nothing is done and system is not applied. Many ship-owner companies mentioned that the fee reduction system needs to pay itself back that it would be applicable. Meaning that benefits gained from the system are greater than the costs. According to the answers, these systems may be difficult to be applied especially for the older ships. When the ship's value is low and it is in the end of its lifecycle, it may not be worth to install any new technologies. In these cases, probably nothing is done. In the other hand, this may be the purpose of the applying reduced fee systems, when reduced fee systems may accelerate the replacing of older ships with the new environmental friendly ships. One option would be to improve existing reduced fee systems so that there is more application levels and the even older ships could get partial reduced fee when they can e.g. prove that ship generates less waste than similar ships on average.

As a negative thing, it was mentioned by the ship-owner companies that reduced fee systems are applied today only in few ports. When the upkeep of the system requires effort and costs for the ship-owner, in order to system to be cost-effective, the ship should visit in those ports regularly where the reduced fee system is applied. Many participants raised also concerns that in order to work properly, the reduced fee system requires regular monitoring, which further causes additional administrative burden and costs.

Exemptions are not cost recovery systems (EUNOMIA 2016) but those were considered in this content because according to the previous study (EUNOMIA2016) and answers given to this study,

exemptions affect the ship's waste delivery to port and may make it even more attractive. According to the PRF-directive and Act on Environmental Protection in Maritime Transport 1672/2009, ship can apply the exemption from mandatory waste delivery, waste notification and waste fee, when the ship has regular route where it visits in the one Finnish port fortnightly and have waste agreement with competent waste management company.

Based on the given answers, all those ship-owner companies, which operated exempted ships, had enhanced their ships' waste delivery to port. They used more detailed sorting in their waste management port than what the MARPOL Convention requires. When the ship-owner company has direct agreement with waste management company, it is easier to optimize the ship's waste delivery to shore and make it more cost-efficient. Based on the answers, it appears that waste sorting is more detailed when the ship-owner company have own agreement with waste management company (i.e. exempted ships) than when the port arranges waste reception by itself with waste management company (i.e. ships without exemptions).

Those ship-owner companies, which applied exemptions, neither claimed any problems with accessibility to the garbage stations located in port. Many ship-owner companies and ship personnel answered also that the exemptions make the practical waste management on board ship easier. The ship-owner companies also mentioned that when the waste management companies invoice direct fees based on the delivered volume, it also encourages reducing of the ship's waste generation. In the other hand from the administrative perspectives, concerns were raised that there might be risk that ships may have interest to get rid of garbage deliberately, either by illegally or using the options from the MARPOL Convention as explained in the section 4.1.1 to reduce the waste quantities, which would be otherwise delivered to port reception facilities.

Other issue, which concerned the participants from the administration side, was the competency of the waste management company. Ship, which is exempted in Finland, may have the waste management agreement with foreign waste management company in foreign port. It is very difficult for the Finnish administration to monitor foreign waste management companies and these companies' waste treatment in practice. The monitoring of the Finnish waste management companies is conducted according to the Finnish Environmental Protection Act 527/2014 and waste management companies are also certified according to the same act. When ship has the waste agreement with the Finnish waste management company, in principle, it can be assumed that the waste management company manages the delivered waste in proper way.

Those waste management companies, which are not following the standards on its waste management, may have possibility to offer lower prices for ship-owner companies. For the Finnish inspectors, it is also very difficult to monitor that the exempted ships are actually delivering their wastes to those foreign ports where the ship has its waste management agreement. This could be helped by increasing the international co-operation between the States. If there is suspicion that the ship is not following conditions of the exemption, there is e.g. possibility for inspector to make alert to ship's waste delivery port's national administration and request inspection in that port.

8.5 Conclusions

8.5.1 Ships' waste discharge sources

To ease the identification of the ships' waste discharges, the categorization of the waste types in accordance with MARPOL Convention was used. In principle, it is possible that all different waste types, which are generated on board ship, can be discharged to sea either intentionally or unintentionally, as described in the table 3 of the section 5.1.1. Based on the answers given to this study, illegal deliberate and accidental waste releases are relatively rare. Exception was the waste categories, which are allowed to be discharged into the sea according to the MARPOL Convention. In addition, passenger ship companies recognized the risk of littering by the passengers.

Unintentional discharges (e.g. due to accidents or bad weather), are very rare and based on the answers, accidents are often related to such as, hose disruptions or overfills caused by human errors during the oily bilge water or sludge discharges from ship to port reception facilities. Other accidental releases, which were mentioned on the interviews, were related to oily bilge water releases from rescue boats and hydraulic oil releases from ships' deck area.

In general, all interviewed persons were interested in the subject of this study and they were of the view that it is important to enhance ships' and ports' waste management. Based on the answers, ships crews' and passengers' attitudes are today in good level and knowledge of environmental issues has increased, more actions to prevent marine plastic littering and other releases to sea can be still done. To further reduce the intentional waste discharges, more attention should be paid to awareness rising of the ship personnel and especially the passengers. Littering by the passengers were mentioned by the each passenger ship-owner company and personnel working on board passenger ships as a source of littering. This sort of littering could be reduced for example by increasing the number garbage bins, ashtrays for cigarette butts and garbage placards on the passenger ships' weather decks. Several interviewed ship-owner companies had also named one

officer on board ship as responsible for the environmental issues and ship's waste management. Naming of the responsible persons most probably reduces the littering by the ship personnel and also increases the awareness. It was also noted by many interviewed persons that younger generations had better attitudes against the littering than older generations.

8.5.2 Incentive systems

Based on the answers, economic incentive systems (i.e. cost recovery systems) are varying significantly between the ports. This increases the risk that ship-owner companies or ships do not know, which system is applied in the ports where the ships visit. In these cases, the effect of incentive system may be lost. This was also confirmed by the interviewed port State control and PRF inspectors. In many cases foreign ships, especially ships in tramp traffic, which visit seldom in the Finnish ports, do not know that the no-special-fee system is applied. Consequently, it can be concluded that informing ships of the applied incentive system is very important. Otherwise, the effect of the incentive system may be lost, when the ships are not delivering their wastes to port reception facilities in the belief that they are gaining economic benefit.

Many participants also highlighted the ports' central role related to the ships' waste delivery to port. In general, ports' waste disposal is outsourced to the external waste management companies and ports may not have information of waste streams, which are going through the port. Especially when there are ships, which are exempted from the mandatory waste delivery and have own agreement for the waste delivery with the waste management company.

Improvement of the ports' waste management systems and improvement of the communication between ship and port were recognized in previous studies as important issues (EUNOMIA 2016, Ohlenschlager et al 2012, UNEP 2009, Carl Bro a/s 2005). In addition, previous studies (Ohlenschlager et al 2012, Carl Bro a/s 2005) mentioned that ports should be involved to that monitoring. Interviewed persons on this study recognized the importance of these issues as well and expressed the views that garbage management practices in ports may be complicated e.g. different waste operators may be required for the different waste categories or waste delivery to the port requires the ship's agent's involvement. Based on the interviews, monitoring of the ships' waste delivery by ports may be challenging due to reason that visiting ships are customers for the ports. However, majority of participants mentioned that several ports are today monitoring the ships' waste deliveries to port reception facilities. Regarding the monitoring conducted by administration, interviewed persons did not mention significant deficiencies and possible deficiencies were mainly related to lack of the resources.

Based on the answers, it can be concluded that existing economic incentive systems may be further developed. Majority of participants were of the view that 100 % indirect fee cost recovery system (i.e. no-special-fee) is easy to apply in practice and it require little administrative burden. However, it may still be enhanced by adding price reductions. The price reductions (i.e. fee reduction systems) divided the views of the interviewed persons. Part of the participants were of the view that the criteria for fee reduction within existing systems are generally too high. Systems may require massive investments from ship-owner company, which would mean that the ship-owner company do not apply fee reductions and consequently do not either enhance its ships' waste reduction. In the other hand, intention of the fee reduction systems may be to promote the use of the new ships, which are more environment friendly than older ships. For example, the new LNG-powered ships have significantly smaller oily bilge water and sludge generation rates than ships, which use the heavy fuel oil as its fuel (ECORYS 2017, HPTI Hamburg Port Training Institute 2007).

Many participants answered that the economic incentive systems do not incentivize the ship personnel but rather the ship-owner company. Based on the answers, it is the easiness of the waste delivery, which matters the most for the ship personnel that waste is actually delivered from ship to port reception facility. The mobile garbage stations like trucks and barges were mentioned as a best solution and in any cases, the port waste stations should not be located far from the quays. The port specific waste management instructions and guidelines were also mentioned as good tools, which increase the attractiveness of the waste delivery.

In addition, the interviewed ship-owner companies and ship personnel highlighted the importance of the sorting possibilities in ports' waste stations and demanded that sorting according to the MARPOL Convention should be followed also in ports. This is frustrating for the ship personnel and ship-owner companies when the waste is sorted on board ship but mixed in the port's waste station.

8.6 Proposals for further study

This study focused on the waste discharges from ships to sea and aimed to chart possible waste discharge sources from ship to the sea. Waste discharges were divided to deliberate and unintentional discharges. Consequently, logical scope for the further study would be to assess the impacts of these waste discharges to marine environment. These impact assessments should especially focus on the following discharges, food waste, grey water, sewage, and exhaust gas cleaning systems discharge waters. The reason is that these waste categories are allowed to be discharged to sea with certain conditions in accordance with the MARPOL Convention. Based on

the answers, these waste categories are also discharged to the sea in practice. It was also recognized on this study that some littering by the passengers is happening today. It would be useful to study further the quantities of plastic litter, which end up to sea by this way.

To find out the reasons behind the deliberate discharges from ships to the sea, it would be interesting to study the influence of the human behaviour and cultural differences for the deliberate discharges. Some of the answers given to this study indicated that the attitudes vary between the different generations. Some of the interviewed persons, which had longer history at sea mentioned that attitudes among people with certain cultural background have improved significantly only in past few years. Thus, it seems that also cultural differences might affect the attitudes.

The second research question of this study was to find out what incentives could be used as preventing measures for ships not to discharge garbage to the sea and deliver wastes to port reception facilities. Based on the answers, the 100 % indirect fee system (i.e. no-special-fee) were proven to be most liked and applicable economic incentive system. Many participants also answered that this system could be further improved and price reductions could be good option to improve this intensive system. However, requirements of the existing fee reduction systems were also criticized by some participants as those could be too demanding especially for older ships. Consequently, further study could be conducted for the improving of the existing fee reduction systems. The systems' should at same time promote the environment investments for ships, and enhance waste reductions, which can be achieved with older ships when the investments are not any more economically feasible.

Arrangements, which make the practical delivery of ship-generated waste to port reception facilities more attractive, were also studied under the second research question. Majority of the participants were of the view that mobile waste stations, i.e. use of trucks and barges, would be the most important element to increase attractiveness of waste delivery from ship to port. Therefore, further studies could be conducted to find out possible technical solutions for the mobile waste reception. In addition, economic feasibility of the mobile waste reception solutions could be further studied.

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Appendix

Questionnaire

Background information of the participant

Working position/title:	
Task in organization:	
Organization:	
Ship type/s which the answers concern:	
Ships' trading area(s):	
Any other information:	

Ship waste discharge sources

1. What are the waste types that your ship generates and how it is treated?

Waste type	Generated on board (yes/no)?	Discharged to sea or shore or both?	Waste managed before discharge to sea or delivery to shore? If yes, how managed?
MARPOL Annex I – Oil			
Oily bilge water			
Oily residues (sludge)			
Oily tank washings			
Dirty ballast water			
Scale and sludge from tank cleaning			
Other (please specify)			
MARPOL Annex II – NOXIOUS LIQUID SUBSTANCES (Annex II tankers only)			
Category X substance			
Category Y substance			
Category Z substance			
OS – other substances			
MARPOL Annex IV – Sewage			
Sewage			
Grey Water			
MARPOL Annex V – Garbage			
Plastics			
Food Waste			
Domestic waste (e.g. paper products, rags, glass, metal, bottles, crockery, etc.)			
Cooking Oil			

Incinerator ashes			
Operational waste			
Animal carcass(es)			
E-waste			
Cargo residues (Harmful to the Marine Environment – HME)			
Cargo residues (non-HME)			
Hazardous/dangerous waste (batteries, pyrotechnics etc.)			
MARPOL Annex VI – Air Pollution related			
Ozone depleting substances and equipment containing such substances			
Exhaust gas cleaning residues			

Any other comments related waste types or waste treatment.

2. Which kind of paints are used on your ship hull (e.g. antifouling paints, hard coating paints) and how often the painting is renewed? How the repainting is done (e.g. overpainting, first removing old paints and then painting, only flacking)?

3. Do you have experienced accidental garbage releases to the sea (i.e. due to adverse weather, disaster etc.)? If yes, is it possible to name examples and garbage categories released to sea?

4. Do you have experienced accidental other releases, like broken structures, parts of the ships or cargo to the sea (i.e. due to adverse weather, disaster etc.)? If yes, is it possible to name examples and what has been released to sea?

5. Deliberate (illegal/legal) discharge: Attitude today compared to previous days? Is it generally accepted behavior to discharge wastes to sea? Any examples?

Waste delivery and handling in port

6. Have you experienced any issues when ships are delivering their wastes to port (e.g. no reception for specific waste category, volume restrictions, waste sorting restrictions etc.)?

7. Do the port/s have waste categories that are not included in no-special-fee (indirect fee) system (excluding cargo residues)?

8. Do the port/s have limitations concerning waste volumes in its no-special-fee (indirect fee) system?

9. Does the port supervise that ships are delivering their waste to port reception facility? If yes, how? (e.g. ship notifies port but not deliver waste)

Incentives

10. What kind of incentive system or combination of systems would promote best for ships to deliver all their waste to shore and not to discharge waste to sea? (Below different incentive systems explained)

Incentive system	**Description**	**Comment**
Direct fee - no incentive	"*A 100% direct fee is one where all of the cost of collection and treatment of a port user's waste is borne by the individual user. Charges vary in proportion to the amount of waste delivered by the user, and there are no charges if the user delivers no waste.*"	
100% indirect fee for all garbage (cargo residues excluded)	"*A 100% indirect fee is a standard charge paid irrespective of the amount of waste delivered, including if no waste is delivered. Indirect fees can either be applied*	

	equally to all vessels, or they can be banded according to size thresholds (e.g. gross tonnage/engine power) and/or vessel types. Indirect fees can be included in port dues or as a separate waste fee."	
Reverse fee	"*The reverse fee system is very closely related to indirect fee. An indirect fee is paid upfront but this confers no discharge rights; the user then pays the waste operator direct fees, and then claims back all or some of the direct fees from the port authority."*	
Partial indirect fee (e.g. only certain waste types covered)	"*Partial indirect fees are where a standard charge is applied (indirect fee component) and is combined with a proportional charge (direct fee component) e.g. for waste delivered over a certain volume/tonnage or a certain vessel size threshold.*"	
Rights Conferred by Indirect Fee Component and Calculation of Direct Fee Component	"*The standard charge confers the right to deliver an amount of waste up to a certain threshold. Where the charge does not confer the right of any waste delivery it is sometimes termed an 'administrative fee' (ADM). This increases the number of different methods that can be used for calculating the direct fee component of a partial indirect fee. It may simply be calculated based on the total quantity of waste. Alternatively, where the standard charge gives delivery rights, the direct fee can still be calculated either based on the total quantity of waste, or the remaining quantity of waste.*"	
Deposit Refund Systems	"*A deposit refund system is where a deposit is returned in full on proof of delivery of waste at that or*	

	another port, whether to an in-house or external operator."	
Voucher Systems	"*A voucher system is where a ship entering a port must pay for a voucher that is redeemable, at that or another port, against the cost of waste disposal, at that or another port. Its value is determined by the estimated amount of waste disposal required for the ship based on ship attributes. It can be a way of ensuring payment (because it is upfront) under a direct fee system, and thus removing the cost saving from discharging waste at sea, whilst providing flexibility for vessels that prefer not to deliver waste on every port call. It could also be implemented alongside an indirect fee system, to provide the same flexibility, although as upfront payment is already provided for in the indirect fee system it would be redundant with respect to ensuring payment.*"	
Restriction by Waste Type	"*Cost recovery systems are often restricted to particular waste types, so that for any particular port, multiple fee structures are in use.*"	
Penalty	"*Penalties can be imposed for non-delivery of waste, or non-notification and non-delivery of waste. They are charged unless proof of delivery at that or another port can be demonstrated. These can be administered alongside direct or indirect fee systems.*"	
Exemptions	"*All fishing vessels and all small recreational vessels (<12 passengers) are exempt from notification and mandatory i.e. indirect charges, (though delivery of waste is still mandatory and fees charged to*	

	these types of vessels should cover the waste reception and disposal costs, leaving direct charging an option in addition to indirect charging); *Ships with frequent, regular scheduled stops and with sufficient evidence of arrangements to ensure delivery of waste and payment of fees in another port on the ship's route may be exempted from notification, mandatory delivery, and/or mandatory charges.*"	
Reduced fee (e.g. when ship demonstrates improved waste handling onboard)	*"Favourable fees may be applied to ships producing reduced quantities of waste."*	
Any other incentive		

11. What could make the delivery of waste from ship to port more attractive (e.g. port or region specific information of waste delivery, improved waste management in ports such as more accurate sorting, easier access to garbage stations, service availability etc.)?
