CHALMERS

An analysis of the blackwater handling from a port perspective

The different aspects of methods, expenses, and challenges

Bachelor thesis for International Logistics Program

JOHN FÄGERSTEN
FILIP HELMER

DEPARTMENT OF MECHANICS AND MARITIME SCIENCES

CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden, 2024

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Department of Mechanics and Maritime Sciences
Chalmers University of Technology
SE-412 96 Gothenburg
Sweden
Telephone: + 46 (0)31-772 1000

Cover:
A picture of rain falling over a lake. Raindrops create ripples on the water surface while clouds cover the sky. It illustrates the natural flow of water from rain to the lake, emphasizing the importance of water for the ecosystem (*Bakgrundsbilder - Wallhere*, n.d.)

Department of Mechanics and Maritime Sciences
Chalmers University of Technology
Gothenburg, Sweden 2024

PREFACE

Detta examensarbete har genomförts av skribenterna som studerar programmet Internationell Logistik på Chalmers Tekniska Högskola under våren 2024 på institutionen för mekanik och maritima vetenskaper. Programmet innefattar 180 högskolepoäng, varav 15 av dessa är ämnade för uppsatsen.

Vi valde ett ämne utifrån vad vi har lärt oss under studiernas gång samt vad som kändes aktuellt. Vi har under skrivandet av examensarbetet lärt oss mer om ämnet svartvatten, dels om hur hamnarna arbetar med det men också eventuella problem och konsekvenser det kan medföra.

Det har varit lärorikt men också utmanande att skriva en akademisk uppsats. Därför vill vi tacka de som har bidragit och hjälpt oss i skrivprocessen. Ett stort tack till de representanter från hamnarna som givit oss en djupare insyn i hur de arbetar med svartvatten samt tack till handledare som väglett oss i rätt riktning.

Efter att ha skrivit denna uppsats hoppas vi att den kan bidra till en ökad medvetenhet hos allmänheten om svartvatten och dess påverkan inom sjöfarten, för att fortsatt kunna bedriva forskning inom ämnet.

Göteborg, 2024,
John Fägersten, Filip Helmer

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SAMMANDRAG

Denna rapport fokuserar på hanteringen av svartvatten i två av Sveriges största hamnar. Syftet är att undersöka skillnaderna och likheterna i hanteringen av svartvatten samt att identifiera eventuella miljöegenskaper som skiljer sig åt. Resultaten visar att det finns betydande skillnader i antalet anlöpande fartyg, där passagerar- och fraktfartyg spelar en avgörande roll för svartvattenmottagningen. Genom att införa strängare lagstiftning, såsom krav på att fartyg lämnar in sitt svartvatten i hamn, skulle miljöskadorna kunna minskas. Rapporten belyser också brister i dagens lagstiftning som tillåter fartyg att släppa ut sitt svartvatten i haven och därigenom skadar miljön. Avgränsningar inkluderar endast de två största hamnarna i Sverige och utesluter tekniska och ekonomiska aspekter. Två intervjuer med representanter genomfördes för att öka förståelsen inför kommande förändringar.

Nyckelord: Svartvatten, gråvatten, IMO, MARPOL, hamnanlöp, lagstiftning, miljö, hamnar

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ABSTRACT

This report focuses on the handling of blackwater in two of Sweden's largest ports. The aim is to investigate the differences and similarities in blackwater management and identify any environmental characteristics that may differ. The results show significant differences in the number of visiting vessels, where passenger and cargo ships play a crucial role in blackwater reception. Introducing stricter legislation, such as requirements for ships to submit their blackwater in port, could reduce environmental damage. The report also highlights shortcomings in current legislation, which allows ships to discharge their blackwater into the seas, thus harming the environment. Limitations include only the two largest ports in Sweden and exclude technical and economic aspects. Two interviews with representatives were conducted to increase understanding for upcoming changes.

Keywords: Blackwater, greywater, IMO, MARPOL, port calls, regulation, environment, ports

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ACRONYMS AND TERMINOLOGY

Blackwater	Blackwater usually describes the organic waste-containing effluent from kitchen sinks and toilets that needs to be treated before being disposed of.
CSI	Clean Shipping Index
ESI	Environmental Ship Index
HELCOM	The Helsinki Convention
IMO	International Maritime Organization
NFSE	No Special Fee – System
MARPOL	The International Convention for the Prevention of Pollution from Ships

1. INTRODUCTION

As a result of increased travel in a world that is rapidly globalizing, enormous cruise ships as the "Icon of the Sea" (*Oasis Class | World's Largest Cruise Ships | Royal Caribbean Cruises*, n.d.) are becoming more common. At the same time that freight volumes are rising, the freight market is expanding more quickly. The needs of the over 10,000 passengers and crew members on board contribute to the production of sewage. This study investigates the methods used by ports to manage the waste from these massive cruise ships.

Blackwater and greywater are harming the oceans in multiple ways. It is a significant source of pollution in oceans (Xu et al., 2023). Untreated blackwater discharged directly into the environment will contaminate the land and water, endangering food, and drink safety. In certain areas it is not allowed to discharge, but not in all areas. Therefore, someone needs to take care of it and therefore this paper will focus on two major ports in Sweden. How they currently handle blackwater and grey water in these ports differs between them, and therefore we want to investigate the cost, services, and the overall management. There are regulations and guidelines according to blackwater, and therefore International Maritime Management (IMO) will be a foundation of the paper. Within IMO there is the International Convention for Prevention of Pollution from Ships (MARPOL) (*International Convention for the Prevention of Pollution from Ships (MARPOL)*, n.d.) which includes blackwater discharge from vessels.

One port is in Gothenburg (Port of Gothenburg) on the west coast of Sweden which is connected to Kattegat and an arm of the North Sea. The other port is in Stockholm (Port of Stockholm), which is connected to the Baltic Sea. The comparison between these two ports is interesting in the sense that the ports are connected to two different oceans and therefore have two different regulations. The Baltic Sea is a special area under The Baltic Marine Environment Protection Commission (HELCOM) as a sub convention under MARPOL and there is no clear regulation in Kattegat.

1.1 Aim of the report

The study aims to improve the understanding of the differences between Swedish ports and more specifically Port of Gothenburg and Port of Stockholm. The different ports are in separate regions, and they are two of the biggest in the region, so the aim of the report will also see if there are different factors that will be affected in their blackwater management.

By studying previous research, this paper will give the reader a deeper understanding of the different perspectives and initiatives from different ports. Furthermore, by conducting interviews, we will gain further knowledge of the current challenges and the effects of possible improvements in the ports today. The research seeks to investigate what the different ports offer, in terms of blackwater volumes per year, ship type and pricing for blackwater management and how to improve the operation.

1.2 Research questions

- What are the differences in the handling of blackwater in the ports of Gothenburg and Stockholm?

- What are the variations and similarities in methods, expenses, and environmental measures associated with maritime traffic handling in different ports?

1.3 Delimitations

This study investigates Port of Gothenburg and Port of Stockholm, since they are two of the biggest ports in Sweden. Except for the size of the ports, they operate in different oceans with different limitations which will enable the comparison. Hence, interviews with representatives in the respective ports will be held. The study will not go in-depth of economic, or technical parts of handling the blackwater, the main goal is to conclude future improvements.

2. THEORY

In addition to offering a guiding framework for research attempts, the theoretical framework comprises a thorough structure intended to clarify the phenomenon under inquiry and promote a greater comprehension of the paper's background and context.

2.1 Environmental impact of shipping

The shipping industry consist of several types of transportation modes such as cargo ships and cruise ships. This industry has the lowest environmental footprint in the transport segment on a per – ton basis (*Shipping and World Trade: Driving Prosperity | International Chamber of Shipping*, n.d.). Around 11 billion tons of goods are transported each year around the world, enabling countries to develop and change goods.

The biggest contributor to environmental impact in shipping is the cruise shipping industry (*STATE OF THE CRUISE INDUSTRY 2023*, n.d.). During 2022, there were 20,4 million travelers, and is forecasted to increase in the coming years to eventually reach a peak of 31,5 million. On the other hand, the oil industry has contributed in history to oil spills which pollute the oceans. However, there has been a significant decrease since the 1970s when there were more than 20 large oil spills per year (*Global Average Oil Spills per Decade 2023 | Statista*, n.d.). Grounding incidents represent the most common cause of large oil spills from tankers, accounting for 32 percent of such spills between 1970 and 2023. But there is also other pollutant such as ballast water and antifouling, ballast water contributes to environmental dysfunction because untreated water is released in a new part of the world. This introduces new invasive marine species in a new ecosystem.

2.2 IMO – International Maritime Organization

The International Maritime Organization was founded in Geneva 1948 (*Introduction to IMO*, n.d.) and they consist of 175 member states and 50 conventions. The United Nations is a specialized agency, responsible for the safety and security at sea as well as preventing pollution by ships (*Introduction to IMO*, n.d.). Creating a fair and effective regulatory framework for the shipping industry is its main role, to obtain maritime safety, security, garden marine environment.

There are multiple subdivisions and committee´s within marine environment division, and the focus is pollution prevention and response (PRP) (*Marine Environment*, n.d.). The focus was mainly to prevent the oil pollution, but later IMO could recognize that there is more to do, hence why they created the antipollution convention MARPOL adopted in year 1973.

2.3 MARPOL

IMO is a regulatory framework, which consists of different chapters and annexes. Blackwater contributes to environmental damages in the sea and therefore there are regulations for discharging it. The regulations for the prevention of pollution by sewage can be found in MARPOL Annex IV (International Maritime Organization, n.d.). Regulations surveys and certifications, facilities for sewage and ships' equipment are all examples of the content in Annex IV. The oceans are harmed by greywater and blackwater in many ways. It contributes significantly to ocean contamination (Xu et al., 2023). When untreated blackwater is released into the environment, it contaminates the land and water, putting the safety of food and drink at risk. Discharging is prohibited in some places, but not elsewhere. Annex IV was introduced 2003 but got revised in 2004 and entered into force in 2005.

Annex IV (International Maritime Organization, n.d.) specify the regulation of the convention towards the shipping industry:

> The revised Annex applies to ships, engaged in international voyages, of 400 gross tonnage and above or which are certified to carry more than 15 persons. The Annex requires ships to be equipped with either an approved sewage treatment plant or an approved sewage comminuting and disinfecting system or a sewage holding tank.

It also prohibits the discharge of sewage within a specified distance from the nearest land. In addition, it specifies Special Areas (International Maritime Organization, n.d.). Since January 2013, MARPOL Annex IV consists of relevant requirements for the discharge of sewage. In general, discharge of sewage is prohibited within a Special Area for passenger ships, with exemptions. If the ship has an approved treatment plant that has been certified by the Administration, it is not prohibited anymore.

According to MARPOL Annex IV (International Maritime Organization, n.d.) sewage includes drainage from toilets, drainage from medical premises, drainage from rooms with living animals and sanitary areas and other waste waters that are mixed with these drainages (*Ship's Sewage and Garbage (MARPOL Annex IV-V) — Home*, n.d.).

The only Special Area under MARPOL Annex IV is the Baltic Sea Areas (International Maritime Organization, n.d.):

> On 1 June 2019, for new passenger ships;
> On 1 June 2021, for existing passenger ships other than those specified; and
> On 1 June 2023, for existing passenger ships en route directly to or from a port located outside the special area and to or from a port located east of longitude 28˚10' E within the special area that do not make any other port calls within the special are.

Since Port of Stockholm is one of the ports that has been mentioned, and furthermore, investigated in regards with their blackwater management, Special Areas will have importance to the purpose of the paper. Because Port of Stockholm is adjacent to The Baltic Sea, which is the only Special Area under MARPOL Annex IV.

This is regulation that shipping companies must consider but also the ports need to be aware of the regulation regarding special areas.

Since the aim of the paper is to investigate ports and their blackwater management, the Directive (EU) 2019/883 is appropriate for use, because it handles port reception facilities for the delivery of waste from ships.

2.3.1 Power of European directives

In the 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 (*Directive - 2019/883 - EN - EUR-Lex*, n.d.), it states in article 4.1, regarding port reception facilities, Member States shall ensure the availability of port reception facilities adequate to meet the need of the ships normally using the port without causing undue delays to ships.

Furthermore, in article 4.2 (*Directive - 2019/883 - EN - EUR-Lex*, n.d.), Member States shall ensure that:

i. The port reception facilities have the capacity to receive the types and quantities of waste from ships normally using that port, considering:
ii. The formalities and practical arrangements relating to the use of the port reception facilities are simple and expeditious to avoid undue delays to ships;
iii. The fees charged for delivery do not create a disincentive for ships to use the port reception facilities; and
iv. The port reception facilities allow for the management of the waste from ships in an environmentally sound manner in accordance with Directive 2008/98/EC and other relevant Union and national waste law.

In article 4.4 (*Directive - 2019/883 - EN - EUR-Lex*, n.d.), it also states that the port authorities concerned or, failing them, the relevant authorities shall ensure that waste delivery or reception operations are carried out with sufficient safety measures to avert risks to persons and the environment at ports covered by this Directive.

In addition, in article 7.1, regarding delivery of waste from ships, (*Directive - 2019/883 - EN - EUR-Lex*, n.d.) it states that the master of a ship calling at a Union port shall, before leaving that port, deliver all of its waste carried on board to a port reception facility in accordance with the relevant discharge norms laid down in the MARPOL Convention.

Article 7.2 (*Directive - 2019/883 - EN - EUR-Lex*, n.d.) also states that upon delivery, the port reception facility operator or the authority of the port where the waste was delivered shall truly and accurately complete the form set out in Annex 3 (‘waste delivery receipt’) and issue and provide, without undue delay, the waste delivery receipt to the master of the ship.

2.4 HELCOM

HELCOM also known as Baltic Marine Environment Protection Commission (*HELCOM*, n.d.), is an intergovernmental organization bridging policy and science related to the environment of the Baltic Sea. The parties are the European Union, Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russia, and Sweden. This convention is signed and developed to ensure and protect the environment of the Baltic Sea area, and it is relevant and important for the region of Sweden. It is an inclusion of MARPOL but at the same time a convention with their own directives and convention in the nearby area of Sweden´s oceans.

This convention is to prevent and protect the Baltic Sea from the environmental challenges oceans are set for today. This convention was signed and contracted to mentioned countries. The past two years there has been an aggression invasion from Russia towards Ukraine. During last year 2023 there was an announcement from the commission in the European Union that no business or interaction with Russia should be further deliberated (*HELCOM and the Strategic Pause*, n.d.). This was something that the experts were upset about, but there was not a statement saying that Russia is no longer a part of Helcom, but there should not be any meetings in person and if so, they shall be postponed into the future. Hence, all of this, is Russia still a contracting part of Helcom, and they are a full member and contributing to the environment in the Baltic Sea.

2.4.1 The Helsinki Convention

The Helsinki Convention, also known as The Convention on the Protection of the Marine Environment of the Baltic Sea, was signed in 1974 by all the HELCOM parties (*The Helsinki Convention – HELCOM*, n.d.). At the time it was only signed by seven parties, but it was updated in 1992 and then all ten parties signed it. It was signed due to the increasing environmental effects industrialization resulted in. All sources of pollution are included in the convention, and it covers the whole Baltic Sea area, including inland waters.

2.5 No-Special-Fee System

When a vessel enters a port, shipowners shall pay harbor fees. There are different types of cost or fees that needs to be paid, all ranging from nautical services, such as towage, to services to vessels and cargo, such as waste disposal and customs (*Chapter 5.4 – Port Pricing | Port Economics, Management and Policy*, n.d.). In some ports, a charging system called "no-special-fee" system is used. The cost of reception, handling and disposal of ship-generated wastes are all included in the harbor fee (Helsinki Commission, n.d.).

The no special fee specifies the method of calculation for collecting the disposal in the port. This should be independent and per ship. The calculation includes the gross tonnage, to the fairness the calibration is based on the vessels data sheets. Hence the difference id disposal oil, sewage, or other disposal. Considered is also number of crew personnel and passengers. One of the goals to have in mind is the general aim of minimization of waste production, and the benefit of waste separation.

3. METHODS

The research involves several steps to gain a holistic understanding and formulate action proposals. We began with a literature review to find relevant scientific articles and reports to get a deeper understanding in the field. Also, professors in the relevant department at Chalmers University of Technology provided important inputs. This was the basis of our analysis. The subsequent step in the paper was a deep dive into the differences between the ports blackwater management, and more in detail, the similarities and differences in handling methods, expenses, environmental challenges, and measures.

Given that (Denscombe, 2018) recommends using interviews for smaller research projects with a limited budget, interviews with representatives from the ports was conducted. The interviews were used as additional strengthening information, also data from organizations and regulations such as MARPOL and HELCOM were important. Denscombe also states that it is time effecting, environmentally friendly as well as reducing time for data management.

3.1 Semi structured interview

A semi structured interview allows the interviewer to express their ideas more freely which gives more information to analyze in the paper (Denscombe, 2018). We investigated what and why there are differences between ports and their respective blackwater management. We also discussed the negative effects of blackwater discharge in the oceans as well as providing proposals for future improvement.

3.1.1 Primary data

The primary data that we have chosen was to conduct semi structured interviews in terms of an open survey using Microsoft Forms. The survey was shared with representatives from the ports using strategic selection. That gave us direct particular and distinct perspective from individuals involved in the operations of the Port of Gothenburg and Port of Stockholm. This approach is considered the most appropriate method to gain the knowledge that might not have been studied before or published before. This is a necessity to get a better comprehension of the operational dynamic of the ports of choice.

3.1.2 Secondary data

The secondary data is the founding of the background and theory chapter, based on earlier research and observations. The secondary data is crucial and therefore the collection came from trustful databases and publications. The literature is mainly from Chalmers library and the database Scopus. There are multiple ways to gain literature, but we have searched for key word such as shipping AND blackwater, “ship discharge blackwater”, and the AI tool in Scopus where the AI search for the words for you “blackwater from shipping industry”. Peer reviewed publications is important to gain trust for the reader and the overall quality.

The variety of sources include government publications, industry reports, and scholarly journals, to supplement our primary data and be sure that information and regulation align. Hence, the secondary data is also as mentioned government publications and industry reports. The secondary data is an important part of the report, and as stated in the Swedish Environmental Agency, the need of true and accurate statistics as stated in their new report regarding new legislation of disposal (*Nya Regler För Avfallsförebyggande*, n.d.).

Government publications such as IMO, MARPOL, HELCOM are important to gain an understanding of what the ports must do. But industry reports and news articles have a risk of being biased, and that there are certain stakeholders involved, so source criticism is important because the information is not validated or peer reviewed.

We can place our findings in the perspective of the larger body of knowledge already known about port operations thanks to this methodology. To adopt this dual method approach we aim to enrich the research because of the firsthand data and the secondary data.

3.2 Selection method

As stated previously, semi-structured interviews was used as it allows the interviewed to express themselves more freely due to its structure of an open survey (Denscombe, 2018). The answers from the semi-structured interviews can thereafter be followed up easily as the initial contact already have taken place and from there the collaboration will be easier.

When selecting sources, and furthermore, selecting representatives from the ports, we consciously chose them which can be negative in terms of reliability and validity of the paper. However, the concerned participants of the interviews have been recommended to us by our program director Martin Larsson due to their expertise within the area. In addition, the port representatives may answer to their advantage, but that will be considered when analyzing the data. The participants and representatives from the port side will remain anonymous and referred to as “Port of Gothenburg”, and “Port of Stockholm”. This is a request of one of the participants, that we in this paper will respect.

3.2.1 Choice of organization/port

The ports have been chosen because of their locations, with regards to their different connecting waters. In addition, the ports were chosen as a delimitation act to be able to compare them as well as being concrete.

3.2.1.1 Port of Gothenburg

Port of Gothenburg was chosen due to its size, location, and traffic. As stated earlier, we wanted to delimit the paper to be able to answer the research questions and provide useful research. Therefore, Sweden was chosen as our main area to conduct research within and because of that, Port of Gothenburg as one of the two ports to be studied.

3.2.1.2 Port of Stockholm

Just as Port of Gothenburg, Port of Stockholm was chosen by similar reasoning. Port of Stockholm have various types of traffic, both cargo and passenger vessels operate in the area and therefore blackwater handling can be studied in the port. It was also chosen because of the port being adjacent to the Baltic Sea, which is a special area according to MARPOL Annex IV (International Maritime Organization, n.d.).

3.3 Analysis of interview

The interview was conducted on an online platform called Microsoft Survey, and more specifically Google Forms. This is a website that helped us create a form that we sent out to the interviewees, and we can extract the information easily.

We chose this method due to the flexibility to make the interview possible for all participants (Denscombe, 2018). The use of an online platform will help us with this. Next step was to categorize and code the interview, where we looked for patterns, themes, and significant elements from the interviews. Specific questions and topics were addressed in the interview so it was easier to categorize and code the material. This helped us get a code overview and a pattern so the main content and focus on the most important aspects could be highlighted. A deeper interpretation and understanding of the material helped us understand the significance of the identified themes (Denscombe, 2018). After conducting this method assisted us to draw conclusions that helped us in the research. We also presented the data to illustrate and substitute the findings from the interview.

3.4 Ethic – Interview

Conducting an interview comes with responsibility. The interviewed should not be harmed and shall be protected for participating in the research (Denscombe, 2018). The interviewed should not feel uncomfortable or have a feeling of being interfered in their personal life. The researcher has good intention of the research and follows good research ethics. The purpose of the research is not to ignoble personal details, or opinions outside of the research. Therefore, it is important to handle the information, consent, and a confidential agreement. The consent, confidentiality, and utilization requirements are addressing the researchers clearly for permission, and the ethical guidelines from (Denscombe, 2018) in the following manner before interviews.

4. RESULTS

In the results chapter, background information about Port of Gothenburg and Port of Stockholm will be presented below. This is to give a better understanding of the ports characteristics and features.

Port of Gothenburg is the biggest cargo hub in Scandinavia, they are connected to Göta Älv and the river runs into the North Sea with the connection to the continent (*Services of Port of Gothenburg*, n.d.). The port wants to meet the demands from the market, therefore they are equipped with rail, road, and sea. Half of all container traffic in Sweden goes through the Port of Gothenburg's quays, where over 30% of it passes through. Within a 500 km radius are three capital cities, as well as 70% of Scandinavia's population and economy. The port transport over 36 million tons of cargo each year and the port of Gothenburg also receives 1,4 million passengers every year (*Ropax Terminals Port of Gothenburg* , n.d.).

In Port of Stockholm which is in the Baltic Sea across from Finland. The port is associated as one of the world's largest passenger ports and one of Sweden's largest freight ports (*Port of Stockholm Terminals* , n.d.). A normal year the Port of Stockholm transport around 16 million passenger and a total of 9 million metric tons of goods. The port is also facilitating 1100 jobs in the Stockholm region and the international cruises often visit port of Stockholm which generate EUR 176 million.

4.1 Concerned ports work with blackwater management and the service included

Port of Gothenburg and Port of Stockholm are actively working with blackwater management. The following chapter will describe the two ports handling methods, received blackwater, regulations and environmental aspects.

4.1.1 The ports handling methods

Port of Gothenburg are receiving and handling it by connecting a hose to the ship, and that specific hose is also connected to a sewer. Port of Stockholm are using a similar procedure. The blackwater is handled mostly through the municipal wastewater treatment plant. However, sometimes a truck is used for the transport of the blackwater.

In terms of what services are included in respective ports blackwater management, Port of Gothenburg are offering connecting and receiving for sewage, whereas Port of Stockholm is offering handling for removal to wastewater treatment plant. This is possible due to their collaboration with the municipality of Stockholm and their instances, more specifically Stockholm Water and Waste. Port of Stockholm is also collaborating with shipping lines to receive feedback to offer more attractive services. On the other hand, Port of Gothenburg is closely working with the reception facility Gryaab. Gryaab are not only collaborating with Port of Gothenburg, but they also have several stakeholders including industries as well as individuals(*Kort Om Gryaab - Gryaab*, n.d.). Today, they are handling sewage from approximately 800 000 people in the Gothenburg Area. The sewage is transported to Ryaverket in Gothenburg, where they clean the water and convert it back into the water in forms of biogas and treated sludge.

4.1.2 Amount of sewage received

Both ports are united regarding the differences in amount of sewage the different ship types deliver. They can conclude it is almost only passenger vessels that are delivering sewage. However, another aspect of sewage is what it consists of. Because if the ship mixes food waste with the sewage it affects the operational efficiency since it may clog the treatment systems. In terms of how much sewage the ports are receiving, the representative from Port of Gothenburg says: “We cannot answer that, since there is not a requirement to report the amount of blackwater and greywater”. Hence, they are not separating black and grey water, table 1 shows the amount of black and grey water in total.

The amount of received sewage have a strong correlation with the amount of cruise ships arriving at the port. In 2023, Port of Gothenburg said they had a record-breaking year regarding calls, which generated 13 500m3 sewage as shown in table 1 below. However, Port of Gothenburg also states that this amount should not be used, since sometimes it only was greywater, which therefore can be misleading. Port of Stockholm received 284 000m3 2023.

Even though Port of Gothenburg states that they had a record-breaking year regarding calls in 2023, they received higher volumes in the two previous years. However, as they stated in the interview, these numbers can be misleading in a way since it may be only greywater.

Comparing the ports received amount of blackwater clearly indicates the impact cruise vessels have. Despite the size of Port of Gothenburg, they do not receive the same amount of cruise calls that Port of Stockholm does and therefore the amount of blackwater received differs drastically. The covid-19 pandemic is one clear contributing factor to the low amounts received in 2020 for both ports, since travelling on cruise ships got affected hugely. Comparing 2019 and 2020 of Port of Gothenburg is not as remarkable as for Port of Stockholm, since a decrease of approximately 3000 metric tons is not huge as almost 440 000 metric tons which was the difference for Port of Stockholm between the years.

Table 1

Amount of black and greywater received from vessels in the ports, in metric to*ns.*

Received black and grey water from vessels, m³	**Port of Stockholm**	**Port of Gothenburg**
Year	**m³**	**m³**
2018	592 759	Missing data
2019	581 492	4 158
2020	143 071	1 000
2021	203 752	21 755
2022	317 573	19 470
2023	284 098	13 749

Note. The content of this table is containing the information based on interviews conducted by the writers of this report. The information refers to then amount of black and grey water received by the port each year from 2018 until 2023.

4.1.3 Regulations

The ports are applying all relevant international regulations, including MARPOL, HELCOM and the Directive (EU) 2019/883 of the European Parliament and of the Council of 17 April 2019, as well as Swedish Transport Agency regulations and municipal regulations. To ensure these regulations are being followed, Port of Stockholm issues sampling. Port of Gothenburg are issuing waste delivery receipts, where all ships arriving at the port, must report in MSW not later than 24 hours prior arrival a forecast about their waste status. If one fails to provide a waste delivery receipt one may face a penalty of 10 000 SEK, in accordance with the Swedish law 1980:420 (6th chapter, 11a§). See appendix for a standardized waste delivery receipt.

4.1.4 Environmental aspect of blackwater management

From an environmental perspective regarding blackwater management, Port of Gothenburg does not do anything specific, more than just connecting and receiving it. Port of Stockholm on the other hand, take several actions to minimize the blackwater managements environmental affect. For instance, they have collaboration projects to increase the sorting of food waste from ships as well as charging surcharges if the blackwater consists of too high levels of hydrogen sulphides. There are also environmental incentives for ships that have high level of environmental performance, see chapter 2.2.

4.2 Expenses for shipowners during the blackwater management process in ports

In large ports, transparency and uniformed pricing models can be found in specified at the port's webpage. Both Port of Gothenburg and Port of Stockholm use a standardized fee structure to aim and offer their services to their freight operators and customers, and work align with the regulation stated from the Swedish Transport Agency (Transportstyrelsen, n.d.).

In the case of these two ports, neither of the port uses the no special fee system, rather the ports follow the standard guidelines stated from the Swedish Transport Agency. Apart from the conventional no special fee system, these ports impose additional fees for certain services such as handling, storage, and trash management.

4.2.1 Pricing

The ports also facilitate the handling of the blackwater and charge for it based on different rates, as stated below. Every port functions autonomously, determining its own pricing strategies based on variables like operating expenses, capital expenditures for infrastructure, and market dynamics, while also considering the recommendations. Port of Gothenburg distributes the service based on GT-based (gross tonnage) pricing for waste management services (*Övriga Fartyg - Hamntaxa 2024*, n.d.) as shown in table 2 below. These fees are specified and are applied on specific ships and their own uniqueness. Port of Stockholm uses another system, and the pricing is based on a m³ base rate (*Priser Och Villkor 2024 Stockholms Hamn*, n.d.).

Table 2

Ship waste charges for various types of vessels in Port of Gothenburg and Port of Stockholm

Ship waste charges – Port of Gothenburg			**Ship waste charges – Port of Stockholm**	
All below are the discount applies if the vessel is certified according to Commission Implementing Regulation (EU) 2022/91.			Waste fees are charged according to the Swedish Transport Agency's regulations and general advice (TSFS 2023:15). IN CASE OF NON-REGISTRATION OR DEFICIENCIES, MARK STADIUMS MAY OCCUR	
All types of ships excl (yachts) Charges for ship generated waste			Fixed waste fee *1	26 600 kr
Ships arriving from ports in Europe	0,12 SEK/GT		Discount fixed waste fee (under 20,000 GT or short sea shipping *2)	-13300
Ships arriving from ports outside Europe	0,24 SEK/GT		Variable waste fee *1	0,10 kr/GT
Discount on certificates	- 0,05 SEK/GT		Discount variable waste fee *3	-0,05 kr/GT
Yachter - Price per started m3			Sewage *1	18,96 kr/m³
Connection fee to ship weekdays 08:00 - 19:00 Connection fee to ship at other times	43 SEK/m3 875 SEK 2 675 SEK		Sludge	1 427 kr/m³
			Scrubber residue	1 598 kr/ton
			*1 For ships lying at the quay, 12 m³ of sludge is included. Where there is a fixed quay connection to the municipal sewage network, 100 m³ of sewage is included. For vessels that are at a buoy or at anchor, the price is stated on request. *2 The Ports of Stockholm determine the definition of short sea shipping. *3 Ships that meet the criteria according to "Waste instructions for Ports of Stockholm" receive a 50 percent discount on the variable waste fee.	

Note. This table includes information based on the different ports strategy in terms of waste charge. It is based on ship waste charges for various types of vessels in Port of Gothenburg (Övriga Fartyg - Hamntaxa 2024, n.d.) Ship waste charges for vessels in Port of Stockholm (Priser Och Villkor 2024 Stockholms Hamn, n.d.)

As mentioned above, the ports are forced to follow Swedish law and regulations regarding handling of blackwater sewage. The aim is to create a stable predictable environment for all stakeholders in the maritime transportation sector. The overall aim for both ports is to work towards and promoting smooth and cost-effective handling of logistic and operational management, by offering environmental discounts.

Addition to the pricing we asked Port of Gothenburg and Port of Stockholm if they are familiar with the "no special fee" as mentioned in the theory. In the operation of Port of Gothenburg and Port of Stockholm neither of them is using the no special fee system. They both refer to their own system as mentioned in chapter 4.2. For specific expenses and pricing strategies see table 2.

4.2.2 Environmental granted discount

For a shipowner to be eligible to apply for the environmental discounts on the disposal of the fee for leaving blackwater. Section 9 e discount is granted if registration has been carried out in accordance with the regulations of ESI (Environmental Ship Index) (*ESI Portal*, n.d.) and CSI (Clean Shipping Index) (*Clean Shipping Index* , n.d.). ESI (Environmental Ship Index) and CSI (Clean Shipping Index) gives a total of the certified points for CO2, NOx, and SOx/PM is considered for CSI see table 2 above for the general waste charge in the ports.

In addition to vessel notice, a request for CSI/ESI discount must be made for boats not engaged in regular liner business, and for CSI discount, a copy of the current certificate must be sent. For further information regarding the CSI, ESI and environmental discount certification of ship waste charges, see table 3.

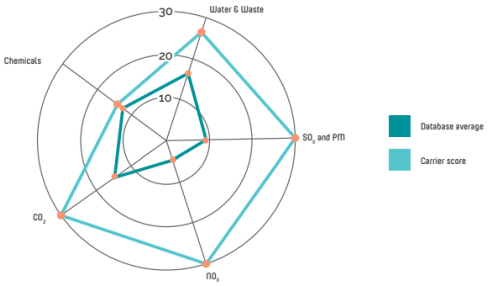
4.2.2.1 CSI points and score

The parameters that are being taking into an account for CSI are:

- Carbone dioxide (Co2) emissions
- Nitro oxides (nox) emissions
- Sulphur oxides (socx) emissions
- Particulate matter emission
- Use of chemicals
- Water and wastewater management

Figure 1

Representation of environmental scores on each of the different environmental parameters



Note. This figure describes the different environmental parameters that is consider when developing and measure the CSI score. This is used in every assessment of CSI score (Clean Shipping Index , n.d.).

The database referring to IMO data that is used primarily. CO2 scoring compares a vessel's efficiency to that of a reference vessel of the same size and type. Points are awarded for surpassing legal environmental compliance for additional parameters. IMO Tier levels are referenced in NOx scoring. The SOx and PM scores are determined by the emission levels linked to the sulfur content of the fuel. Shipping businesses disclose the chemicals they use, awarding points for ecologically friendly solutions. Solid waste management, wastewater treatment, and other aspects are also considered. Each vessel's data is input, and carriers' fleet scores are averaged. The vessel scores are contrasted with carrier and database averages.

Final scores for vessels are based on the outcome of the questionnaire. A total of 150 points can be obtained, 30 points for each of the 5 different parameters. The final score results in CSI Class 1-5 according to the below scheme:

CSI Class 5: 125-150 points
CSI Class 4: 100-124 points
CSI Class 3: 75-99 points
CSI Class 2: 38-74 points
CSI Class 1: 0-37 points

4.2.2.2 ESI points and score

For ESI is also a voluntary system to design and illustrate the environmental performance of sea going vessels and they score shown below.

ESI AIR SCORE = ESI NOx + ESI SOx + ESI CO2 + OPS (max. 100)

ESI NOx = x 2 x NOx sub points - ranging between 0 and 100 - divided by 3;

ESI Sox = y SOx sub points - ranging between 0 and 100 - divided by 3;

ESI CO2 = 5 for reporting (every half year) of fuel and distance; + z efficiency increase in % is added in points; total capped at 15;

OPS = 10 if On-shore Power Supply (OPS) installation is fitted;

NOx sub point is defined as the limit of NOx emissions accordance to IMO regulations and MARPOL Annex VI, regulation 13. The Engines must meet Tier I specifications or a value of zero must be entered for ships without EIAPP certificates in order for them to receive ESI NOx points. Every engine, both primary and secondary, needs to be identified.

ESI NOx is defined an calculated as stated:

$$\text{ESI } NO_x = \frac{100}{\text{Rated Power } \Sigma \text{ of all Engines}} \times \frac{(NO_x \text{ limit value} - NO_x \text{ rating}) \times \text{Rated Power}}{NO_x \text{ limit value}} \Sigma \text{ of all Engines}$$

The SOx sub-points show fuels with sulfur contents that are lower than IMO regulations. For Marine Diesel Oil/Gasoil and Heavy Fuel Oil, the fuel classifications are MID (0.10%-0.50% S), LOW (≤0.10% S), and HIGH (>0.50%-3.50% S). For every bunker operation, Bunker Delivery Notes (BDNs) that document the kind, mass, and percentage of sulfur in the fuel are necessary. BDNs from the two quarters prior are considered. Based on ship-owner submission, BDNs for scrubbing fuel are transformed into virtual BDNs of MID or LOW grade when scrubbers are employed.

Sox sub points = = x * 50 + y * 50/70/100 where

x = the relative reduction of the average sulphur content of MID

y = the relative reduction of the average sulphur content of LOW

For CO2 sub points the ship energy efficient operational indicator (EEOI) principle selected from ESI aim to ensure the fully capacity to operate the most efficient fuel consumption Initially, ships record their fuel consumption and distance traveled in accordance with MEPC.1/Circ. 684 rules. By comparing three years' worth of baseline data with subsequent yearly performance, ESI CO2 calculates vessel efficiency. The ESI score is improved by increased efficiency over the baseline period. The efficiency estimate corresponds to the reporting periods of BDN.

CO2 points:
CO2 = 5 for reporting + 10 *relative reduction of the energy efficiency compared to the baseline

For the last parameter is the OPS sub point after berthing, ships with shore power installations should establish a connection within three hours. Onboard generators can supply extra power for up to five percent of the berthing period if necessary. OPS continues to exist. Smaller vessels have a capacity of 0.5 to 1 MVA, whereas bigger vessels have a capacity of 10 to 15 MVA. When berthed in a port with shore power, this technology works in conjunction with regular shore power breakers to enable shipboard generators to be turned off.

OPS points:
OPS = 10 if fitted

The port of Gothenburg and Stockholm uses these two as measurements to see and calculate the discounts that can be offered in their port.

But shown in the port taxation website the port of Gothenburg also states that in:

> Section 10 For vessels in short-sea shipping*, a discount on waste disposal fees is provided in the form of a lower rate, SEK/GT, for vessel-generated solid waste. Vessels actively working to reduce their waste volume and able to provide a certificate demonstrating compliance with the requirements specified in Commission Implementing Regulation (EU) 2022/91 will receive an additional discount of 0.05 SEK/GT from the standard waste disposal fee.

Port of Stockholm illustrates their scoring board on their website uses a table to demonstrate the discount based on points for the vessels see table 3. Port of Gothenburg, information about points is not specified in a scoring board but on vessel type as shown in table 2. Further down see table 4, shows how many vessels that has received the environmental discounted during a period of time in Port of Gothenburg and Port of Stockholm.

Table 3

Scoring board of Port of Stockholm environmental discounts based on CSI and ESI score

CSI (Sox, Nox och CO2) or ESI		
CSI	**ESI**	
Poäng	Poäng	**Discount/unit**
45 – 47,9	50 – 52,9	-0,01 kr/GT
48 – 50,9	53 – 55,9	-0,02 kr/GT
51 – 53,9	56 – 59,9	-0,03 kr/GT
54 – 56,9	60 – 62,9	-0,04 kr/GT
57 – 59,9	63 – 66,9	-0,05 kr/GT
60 – 62,9	67 – 69,9	-0,06 kr/GT
63 – 65,9	70 – 72,9	-0,07 kr/GT
66 – 68,9	73 – 76,9	-0,08 kr/GT
69 – 71,9	77 – 79,9	-0,09 kr/GT
72 – 74,9	80 – 82,9	-0,10 kr/GT
75 – 77,9	83 – 86,9	-0,14 kr/GT
78 – 80,9	87 – 89,9	-0,15 kr/GT
81 – 83,9	90 – 92,9	-0,16 kr/GT
84 – 86,9	93 – 96,9	-0,17 kr/GT
87 – 90,0	97 – 100,0	-0,19 kr/GT

Note. Scoring board of Port of Stockholm regarding environmental discounts in relation with CSI and ESI scores (Priser Och Villkor 2024 Stockholms Hamn, n.d.). This is used when assessing the discount of vessels arriving in the port of Stockholm.

Port of Gothenburg representative says that there are no demands from officials to disclose how much black and grey water the port receives separately, therefore both ports disclose this as a lumpsum of both. Representative from Port of Gothenburg said:

” We cannot answer that as there is no requirement for them to report the amount of black or greywater. The amount we receive varies greatly as it is related to the number of cruises calls, we have. However, it should be noted that on several occasions it was only grey water, so this figure should not be used to calculate the amount of black water”. Port of Stockholm follows this, but they seem to work towards more transparency and disclose the work to limit dangerous gases when handling the sewage.

As shown in table 4 below, the number of ships in the port varies. Both ports states in their reports that the global situation with covid for a few years ago and the situation of war in Europe makes the number of ships arrive differ from year to year.

Table 4
Number of vessels receiving environmental discount

Number of vessels receiving environmental discounts						
Port	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Gothenburg - all vessels	6 554	6 335	5 331	5 294	5 816	5 672
Vessels reciving discount	2031	2724	2558	2541	2849	Data is missing
Stockholm - all vessels	Data is missing	7 495	6 110	6 097	6 450	5 456
Vessels reciving discount	Data is missing	3747	3055	2728	3225	2728

Note. Number of vessels receiving environmental discounts, calculations have been made and therefore they are assumptions and not completely accurate. Port of Gothenburg has exact number in their reports and port of Stockholm makes a yearly assumption that average of 50% of vessels received the discount, this information is based on the interview answers from representatives.

As shown in table 1, each port receives different amounts of black and grey water per year. This shows an indication about the different port's strategies and target market. As mentioned before from the representative form Port of Gothenburg, the amount of black and grey water differs depending on how many cruise ships arriving in the port. As shown in table 4 above, the number of vessels arriving in the port differ. To see if the discount has an effect of vessels investing and using their own treatment plants, we asked the question how many vessels are eligible to get the environmental discount. See table 4 for how many vessels are giving the discount in the two ports. Both Port of Gothenburg and Port of Stockholm promoting in their environmental reports that they are working closely with officials to give shipowners the possibility to safe money in their operational using the discount, which is a initiative and incitement for a better climate in their saying.

4.3 Operational challenges today

After conducting interviews with the port representatives, they evaluate the challenges regarding blackwater differently. The representative from Port of Gothenburg states that the content of sewage can cause operational failures, for instance the drains can be clogged if the sewage consists of more than just toilet paper, for example sanitary napkins and fabrics.

Port of Stockholm, states that a high level of hydrogen sulphide in the sewage is a challenge. Hydrogen sulphide, H2S, is a colorless gas, known for its odor of rotten eggs (*Giftinformationscentralen*, n.d.). If one is getting exposed to H2S, for example through inhalation, it can result in unconsciousness, respiratory arrest which increases the risk of death if not treated correctly. H2S is also corrosive, which may affect the concrete and metal. This may result in weaker pipes on board, hence the reluctance towards H2S in the sewage. (Nielsen et al., 2008).

Port of Stockholm was also asked if the ship type matters in terms of blackwater deliveries, and they both had the same answers. As the passenger vessels are transporting humans, it is resulting in more blackwater being created, and therefore passenger vessels are the biggest contributors.

In terms of extreme situations and disasters regarding blackwater, the ports are both conducting tests and samples to be sure that the equipment is reliable. Port of Stockholm states that they are prepared for eventual leaks in the hoses. Port of Gothenburg are proactive in another way, if a hose would start to drip or leak, the pumping would stop immediately to limit eventual disasters.

But as said in an article from 2023 Stefan Scheja expresses his concerns about the development of the war in Ukraine and the past few years of pandemic that had a critical impact of the port and business (*Kriget Leder till Ny Ekonomisk Smäll För Kryssningsturismen - Svenska Dagbladet*, n.d.).

> "This deplorable war was yet another roller blind as was pulled down. It has been a tough blow economically".

This view is shared from the perspective of port of Gothenburg as well but not in a significant impact of the development of the war (*Göteborgs Hamn Och Kriget i Ukraina*, n.d.). They say that the impact of the war is minimal, due to the change of customer behaviors of purchasing oil products from Russia. But as well the security level is on the same level as before and they do not see any threat, but they follow the development as the authorities have.

For both ports the security work is important, and the express of security is on the ports webpage and the continues work of safety for people and ecosystem.

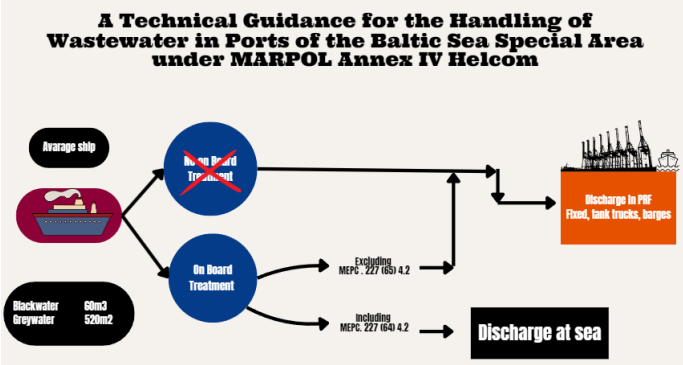
4.4 Innovation trends and future developments

During the interviews we asked questions regarding future trends and developments to improve the operational in the port when handling the sewage.

Port of Gothenburg says from a port side they do not have any further innovations of improvements, but they say that the vessel processes the sewage and wastewater before it is connected and pumped on shore. The process of vessels has their own processing (treatment plants) onboard is shown below in figure 2 This figure has a general overview of the discharge from vessel and is not permitted in a special area. But Port of Stockholm pushes the innovation of the treatment plants onboard the vessels and the importance of them. They also separate the dry matter from the vessel, to have a correct separation of the disposal.

Figure 2

Flowchart of a vessel that does have a treatment plant onboard or not



Note. Shown in figure the flowchart of a vessel that does have a treatment plant onboard the vessel or not, and the steps for treating the blackwater and greywater based on a average size vessel (*A Technical Guidance for the Handling of Wastewater in Ports of the Baltic Sea Special Area under MARPOL Annex IV Helcom.Fi*, 2019).

Also, in the future work and development port of Gothenburg states that there is not much to do. They do see that blackwater is disposal from human waste and is generated based on humans' presence on vessels. Bigger ships, generate more waste and vice versa. Port of Stockholm has another take on this matter, and states that they have a big focus on develop a method to separate food waste, and other human waste to give the blackwater, and grey water a better quality. This is essential due to the ecological recycling focus.

The improvement of the operation when receiving blackwater and waste is normal and port of Gothenburg states that the department that handling this do not see any risks or requirements for improvement, the operation is working and is in no need of change. Port of Stockholm do have a goal of separate the waste to give the waste a more quality and ecofriendly material to be recycled in a correct way as mentioned earlier.

5. DISCUSSION

In this chapter we will discuss the different findings from our research. The discussion will focus on the content of our report, beginning with our aim of the study to the result chapter. The aim of the study was to gain further knowledge about the ports different handling methods regarding blackwater, as well as their pricing strategies and offerings. By conducting semi structured interviews with representatives from the port and scientific literature, the result was formed. Therefore, the purpose is to give the readers a deeper understanding of the results.

5.1 Study objectives and purpose

The target of this study was to get an understanding of how two of the biggest ports in Sweden is handling blackwater. The study has shown big differences in how much blackwater the different ports receive. The amount of blackwater received can be closely connected to how the world is developing, for instance during the covid-19 pandemic, the blackwater levels decreased. This also applies for the war in Ukraine which leads to fewer vessels arriving in the ports, meaning less blackwater deliveries in the ports.

Port of Gothenburg and Port of Stockholm are two big hubs in northern Europe, and they are important to the import and export of goods, but also for people traveling for work or holiday in the cruise ship industry.

The study has focused on the handling of blackwater in the two ports, how well equipped the ports are and if there are any differences in terms of how they work depending on the different cycles in the shipping industry. As shown in table 1, the amount of blackwater differs can be a result of cycles such as pandemic and wars because as we see it is the world connected by industries and political challenges.

If there is a regulation that is clear and firm, the industries and ports will follow the rules. But as shown in this report there are challenges and lack of regulation in the handling of blackwater which gives us the believe that more can be done, therefore we have been following our aim and purpose to get a larger understanding of the ports role.

During the study we got a better understanding of the importance of a port and the significance of the steady flow of goods in and out of the ports. However, in 2024 one might think and have an appreciation that large hubs in Sweden are fully developed and have clear goals and targets that is visible for the public.

Through the semi structured interviews, we got firsthand data that have been used throughout the report. To get more information, we had to do more research on the ports websites and environmental reports, example the environmental discounts as mentioned in chapter of the results. To improve and motivate shipowners to move towards a more sustainable approach in the industry, the ports have come up with incitements as an attempt for the future's best. This is closely connected with the ports sustainability goals and the overall view of the ports.

However, as stated in the report there are no strict regulations that tells the port to disclose how much blackwater the port receives. There are no regulations that says that it should be separated in the vessels, in the port or before it is transported away from the ports facility areas. This is something that we miss in their reports and interview answers. The method of receiving the sewage is clear, but we do not have more information of the responsibility from the ports perspectives.

To read a report of environmental work or an annual report to search answers are not as sufficient as you think. When gathering information, we were forced to reach back to the representatives from the ports multiple times due to the limited amount of information available online. Therefore, we hope to see more transparent reports to give the public a better understanding of the operational work.

During the work of this study there are sometimes we miss out on information. For example, the exact of percentage of vessels that received the environmental discount in Port of Stockholm. In this case we were given an assumption and an average over the years that was affected. For Port of Gothenburg, we faced similar challenges about missed data since the ports are working with their annual reports, and environmental reports. That is why their representatives could not provide us the information that we were asking for, as explained in table 4.

The aim of the work was to give the reader an overview of the handling of blackwater in the different ports, and the questions was to answer and give the reader more information about the blackwater handling. However, as the results show in previous chapter it is not that clear and easy to say.

In the result chapter we can see that there is not regulation that says that it is mandatory to give such information. This gives us and the reader more complexity to give a deeper understanding. However, to connect the introduction and aim to the results there is a connection that can be made. Both ports sees that there are synergies between vessel activity and the number of vessels arriving in the port. As a result of globalization more people traveling around the world, hence why more blackwater is generated. But also, the results and the research questions were also to answer how much blackwater and what the handling methods were, this is something no one can answer, not even the ports themselves. This is due to the challenges that we see now, there are not regulation and policies to disclose this.

Something that we discovered was that the environmental discounts and classification of the certificate to get discounts in the port to promote a more environmentally friendly handling method. This is due to the problematic with dumping waste in open water. This gives the port an important role of education and promotion to ensure that all shipowners understand the consequences of releasing their blackwater out in the free water.

It appears that the ports are undergoing an eco-friendly transformation, however there is a sense that they are only doing what is necessary and not going above and beyond. From our perspective, this approach is counterproductive. Why would not they want to be the frontrunners in this area? There seems to be a lack of initiative from Port of Gothenburg, whereas Port of Stockholm is taking a different approach by actively collaborating to address the issues blackwater brings and its potential consequences if not handled correctly.

5.2 Key findings and insights

After reviewing the report, several key findings and insights have been conducted thought out the discussion below.

5.2.1 Blackwater received

The representatives from the ports were asked to present the amounts of blackwater that they received during the period 2018 to 2023, year-to-year. Port of Stockholm handed over statistics showing how it differs quite drastically between the years, with the amount of blackwater received peaking in 2018. Port of Gothenburg on the other side, could only provide statistics for 2023. The amount provided was neither totally comparable, since they stated that it was some cases where it just was greywater they received and therefore it should not be seen as perfectly accurate.

Another aspect of the amount of blackwater received that surprised us, was the low amount of blackwater that Port of Gothenburg received in 2023. In the interview with Port of Gothenburg, they stated that they had a record year in terms of number of port calls, despite this, they only received 13 500 m3 that year. Taking that into consideration as well as the fact that it was not only blackwater included in that amount, astonished us. Because Port of Stockholm's amount during the period stretched between 143 000m3 and 593 000 m3, which is significantly higher than 13 500m3. One possible reason behind this is the amount of cruise ships arriving at the port. Even though Port of Gothenburg is Scandinavia's biggest port, they do not have as many cruise calls. Port of Gothenburg is more diverse than Port of Stockholm in a way because they have both container and RoRo, but also Ropax and other passenger vessels, however this sector is the smallest. Cruise vessels are producing much more blackwater than container vessels, due to the simple fact that there are more humans on board on a passenger vessel. Therefore, they also deliver much more in the ports and that is one of the main reasons behind Port of Stockholm's high amount of blackwater received.

In addition, the huge difference between the ports was unexpected. Despite Port of Stockholm being more cruise-oriented, the amount of blackwater Port of Gothenburg received during this period is much lower than expected. It is also worth mentioning that the number of cruise calls seems to be the biggest factor behind the amount of blackwater received. However, Port of Gothenburg states that they had a record-breaking year in 2023 in terms of port calls and despite this, they received higher volumes the two previous years which does not add up. Finally, Port of Gothenburg could not provide us with data from 2018 which from our point of view is a direct consequence of the lacking regulations and the non-necessary duty to report the amount of blackwater received.

5.2.2 Lacking regulation

The main reason behind the limited amount of data provided by Port of Gothenburg can be the non-necessary measures that is not required in the regulations. In the interview with Port of Gothenburg, they stated that they do not have to report the amount of blackwater they received. In other words, they do not have separate black- and greywater. Hence, the ports do not get encouraged to focus on this.

Environmental work is crucial and necessary for all companies. In annual reports there are in general much focus on environmental work. In addition, many companies also have annual sustainable reports. Therefore, it is interesting that blackwater does not feature that often and clear in their reports. So, we had a thought that if the regulation was stricter and if there were more initiatives from the port side to separate the material the work to increase, the recycling treatment would be bigger.

But if we zoom out to a broader perspective that the port has the services and facilities to provide and receive black and grey water is great, but out in the open outside the special areas, the vessel can release blackwater directly into the ocean. This is something that is odd when the consequences of releasing the blackwater into the ocean is well known. So, if the regulation got stricter the shipowners will be forced to install treatment plants onboard the vessels. This will increase the wellbeing of people living in areas where the water is clearly affected, and the ecosystem will increase in the wellbeing of the life under sea, which also is an SDG-Goal based from United Nations SDG goals.

5.2.3 Pricing and vessel discount

As presented in the results there are several initiatives regarding pricing and environmental discounts. CSI takes carbon dioxide, nitro oxides and sulphur emissions into account when calculating the CSI score. The more points one has, the more discount one will obtain. The same applies for the ESI score.

This promotes shipowners to develop or invest in vessels, to be able to reach these discounts. If the discounts were to be even bigger, the interest in shipowners would most likely increase drastically, since there is money to be saved. However, that would require economic support from public authorities, since the ports also are seeking to be profitable and if not, they are in any case not targeting a negative result. Therefore, from an environmental perspective, it would be positive if the authorities could finance the ports environmental and clean shipping discounts.

On the other side, the problematic with developing or investing in new vessels is the life cycle of a ship. Vessels that were built ten years ago still has ten years minimum to be used and therefore it can differ hugely in terms of environmental and clean shipping scores between new and old vessels. Shipowners that have invested capital in new ships, have locked their money and will not be able to receive future environmental discounts until they invest in newer ships. At the same time this will be a problem until laws and regulations states the opposite.

Another aspect of developing and investing in new vessels is the type of vessel. A hot topic is the electrical driven vessels that are slowly beginning to arise on the market. They would probably obtain better scores than already existing non-electrical driven vessels. It is still not clear how the batteries will affect the environment when they are not usable anymore, which makes this a grey zone. Because the vessels would be seen as environmentally friendly and obtain maximum discounts, but in the end after the batteries are consumed, they would not be seen as environmentally friendly anymore. This does not mean electrical driven vessels should not be implemented, but it is an interesting aspect of how the ports can offer environmental and clean shipping discounts regarding vessel type.

As mentioned in the theory chapter about the no special fee system, we had in our imagination before our research that the no special fee system was used on a day-to-day basis in operations in the port. But as mentioned in the results both port of Gothenburg and Port of Stockholm does not use this system, but their own management systems instead.

For us it seems to be up to the port to choose if they want to use the no special fee or not, but as we have presented in the results, the basis of what charges that is included or not when a vessel enters to the port is specified in table 2 in terms of waste charge. We had a thought that it is important to highlight the pricing needs to be fair and consistent. The fairness should be mentioned so vessels and ship owners are treated the same, and if the ship owner do not correct information, it should be easy to find.

The no special fee is a lumpsum of various charges for vessels entering a port, one sub charge is the sewage and waste charges, as the results presents the specific ship waste charges for various types of vessels in Port of Gothenburg and Port of Stockholm is each companies charge types. As mentioned earlier about the no special fee it is not only for blackwater handling it is also the costs of entering a port.

5.2.4 Port safety and regulation

When it comes to port safety and regulation, there is a slight difference between the two ports. Port of Gothenburg seems to have a clear vision of what they can do and are doing. The work of proactive activities seems to be a part of the day-to-day work but not something they highlight as important when conducting the interview and reviewing the result. This is something that we thought was little concerning. In the environmental responsibility report, Port of Gothenburg has a goal of long-term work to prevent the environment to be effective in some ways.

We think they develop the port in general but in our research area we think they can do more. In comparison with port of Stockholm the representative highlights the importance of safety of checking the material, hose, sprinklers, and equipment. Also, they highlight the importance of take samplings of the material to see the levels of hydrogen sulphides, which has a large impact on humans and nature. In Port of Stockholms environmental report, they highlight the work to prevent any uncertainty of accident to happen. The work is to prevent anything to happen to their own property, humans, or ecosystems. Port of Gothenburg says that they want to minimize and sort waste in all parts of the business and always do resource-smart choices. Port of Stockholm also has that vision as well to be a front figure for other businesses.

But as we read and doing the analysis of the results and reading different reports that is industry base, we think that they can do more to prevent the mix of black and grey water. If it would be possible to separate black and grey water, it might increase the handling time of the material, but also minimize the risk of corrosiveness.

Based on the goals of the two ports we do think they can do more and put pressure on their suppliers of the handling of the black and grey water, if they separate the material, they can showcase that it is possible and do measurements of what the separation is contributing to. We think it might increase the safety of leaking black or grey water into the water, and the risk of treatment is not as efficient as it can be when the material is separated already. Then the risk might get smaller of material that is corrosive is spread in the treatment plant and affecting others.

Although it seems that neither of the two ports have separate tanks or separated treatment in house, the importance of taking samplings is something we think is a good step to see what the material is made of, and the amount of the corrosive material is in the sewage. All steps to prevent miss handling or a disaster is a good activity in our opinion, just as Port of Gothenburg states in their environment report “Prevent environmental accidents and maintain a good preparedness to limit the effect in the event of an accident”.

5.2.5 Cycle and circular economy

In terms of cycles and circular economy, they seem to be in the background and not a central topic in the report. But as both ports disclose in the results on previous chapters. Both ports have seen change in behavior and trends when it comes to world instabilities such as war and pandemics.

The pandemic was and still is something that the industry still has an effect off. But as the pandemic the blackwater number rapidly decreased. This was due to the number of people traveling was limited and the world was on a holt. But we think that during this time an internal work could have been a focus improve the work of the separation of blackwater from grey water and try to recycle the material.

As the Swedish Environmental Protection Agency is referring to new rules that was implemented in 2028, to reduce the waste volumes, and the goal was to increase the product waste and the recycling to improve the waste management (*Nya Regler För Avfallsförebyggande*, n.d.). The revised legislation from EU waste plan is important in our opinion. This is due to a growing population, and the waste will increase. And the richer counties are getting richer, and we would say that due to the pandemic, people want to get out and travel more. This will boost the waste when more people traveling by vessels. In a circular economy, resources are kept within society's loop instead of becoming waste. That we see is that if the waste management and the work to reduce and take care of all waste all work will contribute and have positive benefits for all humans and climate.

An important goal is true and correct statistics. The Swedish Environmental Protection Agency also states this. The true statistics is important to make assumptions, make plans for improvements and to see the true effect of the business (*Nya Regler För Avfallsförebyggande*, n.d.). To disclose the true statistics is an important tool, this to build trust in the society that is affected of disinformation campaigns on platforms.

5.3 Ethics and environment

From an environmental and ethical perspective, we think that they are working proactively in the certain areas where they need. They also work on a corporate social responsibility level well. This is something that is new in terms of taking care of people and the environment around in this case the port and close by city. The goal is to care about all stakeholders and be more socially accountable.

Both Port of Gothenburg and Port of Stockholm have clear environmental goals and visions and they are working to be more sustainable and eco-friendlier but as we mention above in the discussion about what they can do more in the terms of the content of this report there is more to be done.

This is an ethical perspective the ocean belongs to all humans, if they can put pressure on regulators, to regulate more strict directives to have treatment plants onboard or be forced to have separate tanks in the vessels so the receiving operations is smooth and fast. This at the same time for the ports operation to work close with their suppliers that supplies the expertise in the area “Gryaab and Stockholm Water and Waste”. This will highlight the initiatives to have cleaner oceans and have less acidification.

5.4 Methodology discussion

The paper has been formed using several types of methods. To begin with, we conducted a literature review to find scientific articles within the area. To be able to access the best articles possible we have used keywords, such as shipping AND blackwater, “ship discharge blackwater”. We have also used the AI tool in Scopus where the AI search for the words for you. In this case we searched for “blackwater from shipping industry”.

5.4.1 Selection method

Moreover, in collaboration with Chalmers Library we decided to use Denscombe’s “Forskningshandboken” and “Enkätboken” written by Trost. (Denscombe, 2018) recommended conducting interviews, and more specifically semi-structured interviews for this type of paper. The questions in the interview were formed together with Chalmers Library. They were shaped as open survey questions to let the representatives from the ports express themselves as freely as possible.

However, we should have maybe used a different method, in any case additional methods. Because after the interviews, we were forced to ask additional questions to get all necessary information to develop the result chapter. This seemed to be a clear disadvantage with this method.

Another potential disadvantage regarding the data gathering was that we did not choose to investigate more ports instead of two. However, after discussing the paper’s scope together with our supervisor we decided to continue with just Port of Gothenburg and Port of Stockholm, due to the geographical location and different conditions. After the interviews it also became clearer since there are some deviations between the ports handling methods and strategies, but not to the point where other ports would have generated a much more differentiated answer in terms of blackwater management. Including and investigating more ports, for instance ports outside of Sweden, would have generated a less delimited paper, with a broader aim and research questions, which is not wanted. It would most likely also bring other topics, such as regulations and legislation in other countries which would have made the comparisons between the ports incomparable.

But overall, we think that an interview face to face would have been better, because it could have saved us some time instead of waiting for emails to be returned to us. At the same time, then we could have missed out of using one of the ports as an alternative as they wanted to be anonymous if we were determined to only do face to face interview. Therefore, we think that we did the right thing to be flexible to meet the “requirements” of the interviewees to be able to conduct them.

5.4.2 Ethics

To be as ethical as possible, the representatives were asked in the interview if they wanted to participate anonymously or not. Since one of them wanted to be anonymous, we therefore protected them both by just calling them" Representative from Port of Gothenburg and Representative from Port of Stockholm". Denscombe states that the interviewed shall be protected and not harmed for participating in the research (Denscombe, 2018). In addition, we thought that for the readers perspective it is easier to navigate with Port of Gothenburg and Port of Stockholm throughout the whole paper instead of "making up names" for the representatives.

5.4.3 Validity and reliability

In this paper we choose to interview two representatives as mentioned in the method discussion. This was a well thought out decision and we wanted to get a clear picture of the situation. And how to validate our decision of using two representatives was thought out meetings with our advisor. We also got recommendations from our professor Martin Larsson, and when contacting companies in the industry we got recommendation about the two representatives. Therefore, we think that there was a good selection of representatives in terms of the scope of the paper and their validity and reliability.

We have chosen two professionals within the selected research area, and these individuals are giving us firsthand from the industry perspective information. The questions in the interview were formed to be as valid as possible, by asking the same questions to both representatives in the most specific manner as possible. The questions were also formulated in a precise way to avoid misunderstandings and misperception, which makes them reliable.

To make the paper as credible as possible, secondary data have been used to form the background and the theory chapter. These chapters are essential for the readers perception about the paper. Therefore, data and information from authorities have been used to give the reader a better understanding about what regulations control the blackwater management.

During the writing process we have used trustworthy statistics directly from the sources because that is the most important aspect to do a correct interpretation and conclusions.

6. CONCLUSION

To conclude, Port of Gothenburg and Port of Stockholm are working differently regarding their blackwater management. As they are in separate regions and have different characteristics, in terms of attracting different types of customers and vessels, they have some differences and some similarities.

In general, blackwater seems to be a grey area. Because there are no requirements to separate black- and greywater from each other, hence why it is sometimes known as sewage instead. There is neither a requirement to report black- and greywater separately, which is the reason behind the lacking data provided by Port of Gothenburg. While completing the results, several e-mails and phone calls were required in order to get hold off the statistics regarding the amount of black- and greywater received as a consequence of lacking regulations. When receiving the statistics, it became also clear that it could be used in the results but carefully and not completely since it was a mix of both black- and greywater. However, Port of Stockholm is reporting it consistently as well as presenting it on their platforms. Even though they are not forced to do it, they do it anyways. It could however be a consequence of the types of vessels that are entering Port of Stockholm. Since they have huge amounts of cruise vessels arriving and departing at the port, they receive more blackwater than Port of Gothenburg and that could possibly be a reason behind the different approaches regarding blackwater between the ports.

Therefore, it became clear after this report that the regulations regarding blackwater needs to be stricter to overcome the problems blackwater may result in if not handled correctly. If there were regulations, stating that every port needs to have reception facilities as well as reporting the amounts, the life below water would not get damaged in the same way.

Another aspect which after conducting this report emerged, is how much the amount of cruise calls contributes to the amount of blackwater received. Comparing the blackwater received between the ports illustrates this. A port with much more cruise calls versus a port with not as many cruise calls is clearly affecting the received amounts. This was even clearer in 2019, before the covid-19 pandemic where Port of Stockholm received approximately 580 000 metric tons whereas Port of Gothenburg received just over 4 000 metric tons. The huge difference between the ports can be described by the number of cruise calls, or as mentioned before, lacking regulations which may be a factor behind the extremely low number for Port of Gothenburg.

When analyzing the results and during the discussion chapter it became clear that there is more to be done. We think that it will be a key factor in the future to precent the actual amount of blackwater, hence it is a big contributor to the environmental impact under water. This is an assumption that we make and conclude on our research after the paper, the demands of environmental actions will affect shipowners. One thing that could be done is to estimate the amount of generated blackwater on specific vessels and force shipowners to discharge the blackwater in the next or end destination port. This to prevent of harming the life under water. But this needs an international change in regulating blackwater handling in the whole shipping industry.

We have not reached a result of how the assessment of the discharge charges would look like. But it should be like the system Port of Gothenburg and Port of Stockholm are using, to develop the existing CSI and ESI systems. If a shipowner would invest in environmentally friendly vessels and solution not just the environment would take advantage of that, but all life on the planet, reducing the emissions and environmental impact. But we think that government and regulators can do more such as state aid and packages for business in their countries of flag state to create the possibility for change.

7. RECOMMENDATIONS FOR FURTHER RESEARCH

As a result of the research made from this paper, we would suggest that more research should be done. For a further and deeper understanding of the ports roles and responsibilities in a larger scope more ports abroad should be included. It would also be interesting to see the different handling methods and how the biggest ports compared to Swedish ports proactively and environmental differs.

Furthermore, we think that it would be interesting to investigate how the European union, or another organization might develop a regulatory framework to prevent or limit the ability to discharge blackwater into the oceans. This could include and explore the potential policies, technologies and international cooperations strategies to aim a mitigated environment prevent of the impact of the maritime environment.

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APPENDIX 1

The image depicts a standardized waste receipt for black and greywater from Gothenburg Port, crucial evidence of environmentally friendly waste management. We received this receipt from representatives of Gothenburg Port upon request during the interview

PORT OF GOTHENBURG

WASTE DELIVERY RECEIPT

Receipt number: _____

1. PORT RECEPTION FACILITY AND PORT PARTICULARS

1.1. Location/terminal name:
1.2. Port reception facility provider(s):
1.3. Treatment facility provider(s) – if different from above:
1.4. Waste delivery date and time from: to:

2. SHIP PARTICULARS

2.1. Name of the ship:			2.5. Owner or operator:	
2.2. IMO number:			2.6. Distinctive number or letters: MMSI (Maritime Mobile Service Identity) number:	
2.3. Gross tonnage:			2.7. Flag State:	
2.4. Type of ship:	☐ Oil tanker	☐ Chemical tanker	☐ Bulk carrier	☐ Container
	☐ Other cargo ship	☐ Passenger ship	☐ Ro-ro	☐ Other (specify)

PORT OF GOTHENBURG

3. TYPE AND AMOUNT OF WASTE RECEIVED

MARPOL Annex I – Oil	Quantity (m^3)
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 (NLS)	Quantity (m^3)/ Name (1)
Category X substance	

MARPOL Annex V – Garbage	Quantity (m^3)
A. Plastics	
B. Food waste	
C. Domestic waste (e.g. paper products, rags, glass, metal, bottles, crockery, etc.)	
D. Cooking oil	
E. Incinerator ashes	
F. Operational waste	
G. Animal carcass(es)	
H. Fishing gear	

Category Y substance	
Category Z substance	
OS – other substance	
MARPOL Annex IV – Sewage	Quantity (m^3)

I. E-waste	
J. Cargo residues (2) (Harmful to the Marine Environment – HME)	
K. Cargo residues (2) (non-HME)	
MARPOL Annex VI – Air Pollution related	Quantity (m^3)
Ozone-depleting substances and equipment containing such substances	
Exhaust gas-cleaning residues	
Other waste, not covered by MARPOL	Quantity (m^3)
Passively fished waste	

(1) Indicate the proper shipping name of the NLS involved.
(2) Indicate the proper shipping name of the dry cargo.

_____ _____

Signature, Port of Gothenburg Date

DEPARTMENT OF MECHANICS AND MARITIME SCIENCES
CHALMERS UNIVERSITY OF TECHNOLOGY
Göteborg, Sweden
www.chalmers.se

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