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Anchoring and CO_2 – the possibilities and barriers in reducing emissions

A case study on the Port of Gothenburg

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Abstract

The purpose of this study is to examine the topic of anchoring and emissions of CO_2 concerned with it in the case of the Port of Gothenburg. More specifically, the research focuses on tankers and identifying the reasons to why they are spending time waiting at anchor, investigating what possible initiatives there are to make use of to reduce the emissions concerned to this time. Moreover, it aims to consider the contractual aspects, such as the difference of operating on time charter and voyage charter, as well as commercial aspects, such as how the possible initiatives are affected by matters as demurrage and laycans. To achieve this, a qualitative study was made, analysing the results from seven semi-structured interviews with persons representing companies operating in the Port of Gothenburg, the results from a survey on the reasons for anchoring, and a literature review on the topic.

Our analysis shows that the two main reasons for tankers waiting at anchor in the Port of Gothenburg is due to awaiting a free berth or awaiting laycan, and that these two can be explained due to lack of port infrastructure, inefficient port operations or poor planning of the ships, as well as the commercial reasons implied by laycans, where the different actors does not want to risk a financial loss. The possible initiatives to make use of presented was enabling Just in Time arrival through the use of a Virtual arrival system, investing in port infrastructure to make port operations more efficient, and making use of alternative fuels or more energy efficient technologies in the ships. Regarding contractual aspects our results showed a high potential for, especially Just in Time arrival, initiatives for time charter contracts, while voyage charter contracts is much more complicated. For voyage charter contracts there are several commercial aspects, such as how to divide cost and face financial risks that must be covered in the contracts. The conclusion is that there are several initiatives to make use of for reducing emissions of CO_2 concerned to anchoring, however, they all have some barriers. The most crucial barrier identified in this research is the issue of trust between all different actors.

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Glossary

- *AIS-data* (automatic identification system) is a tracking system for ships which makes it possible to identify and follow the movements of a ship.
- *Bunker fuel* refers to any type of fuel used by the ships.
- *Bunker/Bunkering* is the process of refuelling the ship.
- *Demurrage* is the fee that is paid to the shipowner by the charterer if discharging and/or loading is not finished within the agreed time (the laytime)
- *Despatch* is what the charterer can claim from the shipowner if discharging and/or loading takes less time than scheduled and refers to the time the shipowner saves.
- *First come, first serve* is a queuing system where the first to arrive get serviced first.
- *IMO,* International maritime organisation, is an international organisation under the UN.
- *Laycan* is the specified time period when the shipowner must send its NOR (see below). It is expressed with a layday and cancelling day.
- *Laytime* is the time specified time allowed for discharging and/or loading.
- *Mooring* is the process of attaching the ship to a fixed structure to hinder free movement of the ships.
- *Note of readiness (NOR)* is a document issued by the ship at the designated port to inform that the ship is ready to unload or load.
- *Port call* is the process of the ship approaching and arriving into the specific port.

1 Introduction

1.1 Background

All over the world people have started to feel the effects of climate change. More extreme weather in the form of heat waves, floods, and more intense hurricanes are just some examples of what we are facing right now, and it is a change that is expected to continue (WMO, 2021). The climate change can be considered a global emergency, and to stop this development several nations signed the Paris agreement, an agreement to have nations try to lower their emissions of greenhouses gasses (GHG)[1] and work together to reduce the total amount of emissions (UN, 2021).

Climate change is an issue affecting the whole world and is a topic highly concerned with different emissions derived from human activities. One such activity is the global demand of goods, and in turn the demand of transportation of it. According to the International Transport Forum (ITF, 2019) the demand for global freight will have tripled by 2050 compared to 2015, if growth continues at same rate as today. Further on, this is expected to particularly increase the demand of maritime transport (ITF, 2019). In the EU GHG emissions has progressively decreased over the last years, however not in the transportation sector (EEA, 2020). More specifically, in 2018 shipping accounted for 3.7% of GHG emissions in the EU (European Comission, 2020).

The maritime industry has a crucial role in global trade, accounting for more than 80% of the international trade over the world (UNCTAD, 2021). The amount of goods shipped by sea vessels can be linked to the increasing trade between countries around the world and has therefore turned sea trade into a complex trade network (Stopford, 2009). Due to the large amount of goods transported by ships compared to other transport modes, maritime transport is for most goods considered the most cost-efficient mode of transport (IMO, 2021). Taking the distance travelled and the tonnage carried into consideration, shipping can be considered an energy efficient mode (Bergqvist, Turesson & Weddmark, 2015; Merk, 2014; Abadie, Goicoechea & Galarraga, 2017), however, as previously mentioned, it still emits emissions generated from operating the ship (Fuglestvedt et al., 2009; Corbett, Wang & Winebrake, 2009).

[1] Greenhouse gases are gases that has a negative effect on the climate as they contribute to the global warming by trapping heat in the atmosphere, CO_2 being the main one (WMO, 2021)

To face the issue of emissions created from the shipping industry the International Maritime Organization (IMO) initiated a focus and strategy on reducing the GHG emissions concerned to it (IMO, n.d.). The IMO is an organization established to regulate ships involved in international trade, with a focus on safety, efficiency, and pollution (IMO, 2021). Moreover, the IMO has the authority to enforce and pursue legal and administrative actions on these topics (IMO, 2021). In 2018 the IMO set two goals regarding the issue of shipping and reducing CO_2. Compared to the emissions of shipping in 2008, the first goal aims to reduce the average emissions of the transports by 40% before 2030, and by 70% in 2050. The second goal aims to reduce the total annual emissions of GHG by 50% in 2050, and work towards phasing them out. (IMO, n.d.)

Beyond CO_2 (carbon dioxide), the most crucial emissions from shipping are SO_x (sulphur oxide) and NO_x (nitrogen oxide) (Lindstad & Eskeland, 2016; Corbett, Wang & Winebrake, 2009). Several initiatives have been made to reduce the emissions of SO_x, one of these initiatives is the emission control area (ECA). The ECA initiative is focused on reducing the amount of sulphur in the ECA areas, for example one located in the northern Europe. This has led to shipowners using scrubbers and switching to a fuel containing less sulphur. (Bergqvist & Monios, 2019) However, these initiatives do not focus on the reduction of CO_2, which is the focus of this study. The strategy of IMO to reduce CO_2 includes mandatory energy efficiency management plans which could encompass better planning of voyage and the use of new technologies. Moreover, one important aspect mentioned is the collaboration between the port and the shipping sector to enable a reduction of CO_2. Ensuring a good collaboration could be used for better planning and enabling a Just-In-Time arrival of the ships to reduce emissions. The port was therefore identified as an important stakeholder in reducing CO_2 in the shipping industry. (IMO, 2020)

The port act as a hub linking sea vessels with land vessels by enabling the transfer of gods between them. The governing actor in the port area is the port authorities which oversee the port area (Stopford, 2009, pp. 81-83). The port has several functions which are important for both handling cargo and moving passengers to and from the ships. Efficient cargo handling reduces the overall cost for sea transportation and to achieve an efficient handling special port infrastructure can be invested in. To cover its cost for the port operations, the port charge for their services and the type of service required change depending on the cargo (Stopford, 2009, pp. 81-83). As the shipping industry is becoming more environmentally focused, the time ships spend in port has become a focus, and one way to reduce the time is by more efficient port

operations (Eide et al, 2011). Reducing the time in port can lead to the ship having the time to slow steam, which is reducing the speed to consume less fuel. However, if the port operations exceed the designated time must the ship speed up to remain on schedule and thus consuming more fuel in the process (Seong-Hyeok Moon & Kyun Woo, 2014).

The climate issues have caused ports around the world to act against it through several programmes and initiatives such as Clean Air Action Plan and the Green Ship Programme. The Clean Air Action Plan initiative by Port of Los Angeles is aiming to reduce the air emissions from all operations in the port. This action plan requires close collaboration between the different stakeholders as well as the regulators. (Port of Los Angeles, 2018) The Port of Singapore has initiated the Green Ship Programme to reduce greenhouse gases. The ships who adapt their operations according to the environmental goals of the IMO will be economically rewarded by lower fees (Maritime and Port Authority of Singapore, 2021). Additionally, another example of an initiative is the Port of Rotterdam who is a part of a project to improve the port call process, making it more efficient and enabling sharing information between the different stakeholders digitally, in turn to enable an optimized speed of the ships to lastly reduce the amount of CO_2 emitted (Port of Rotterdam, 2019).

If the arrival process of ships is not optimized ships need to wait, either mooring with the engines running or by anchoring (IMO, 2020). Moreover, the reasons for ships anchoring could be waiting for a berth or for operational reasons, such as maintenance of the ship or waiting for the right cargo price depending on the cargo of the ship (IMO, 2020). However, the topic of anchorage has not been covered to a high degree in earlier research, and also not considered in the examples from Los Angeles, Singapore and Rotterdam mentioned above. When at anchor, even though the main engine is not operating, the vessels are still emitting due to the use of auxiliary engines (IMO, 2020). The amount of CO_2 emissions from a ship anchored has been reported to vary between different ports around the world and could be affected by the operations and the location of the port.

In the case of the Port of Gothenburg and the ships calling the port, the time spent waiting occurs for different reasons, and is spent either within the terminal or outside. According to a study by Parsmo and Winnes (2020) on the Port of Gothenburg, ships that are spending time waiting outside the terminal at anchor was a crucial cause for the high amount of the CO_2 emitted in the port. However, the study showed that in Gothenburg the amount of CO_2 emissions from different types of ships waiting at anchor substantially differed. While different

types of tankers had a high amount of CO_2 emissions when at anchor, container ships and RoRo (Roll on, Roll off) [2] vessels basically had nothing, with the reason being that there were mostly tankers waiting at anchor. Tankers are vessels often used to transport liquid bulk such as crude oil or other energy liquids, and for the case of the Port of Gothenburg, the tankers stood for about a third of the total amount of ships calling the port in 2019 (Parsmo & Winnes, 2020). The liquid or gas products often transported as raw material to the producer which transforms the raw material to a consumer product, e.g., crude oil to petrol (Stopford, 2009, pp. 430-435). The operations of discharging and loading a tanker is often dependent on transport by pipelines, moving the products and connecting the terminal with the refinery (MirHassani, 2008).

According to the study by Parsmo and Winnes (2020), the ships spending time at berth, within the terminal, discharging and/or loading cargo or because of other operational reasons, was the cause of a high amount of the CO_2 emitted. As further mentioned, this could possibly be reduced by onshore supply of electricity to the ships, enabling them to turn off the engines. Onshore power supply allows ships to connect to the power grid at berth and thereby reduce the CO_2 emissions produced by the ship (Bergqvist & Monios, 2019). This is something that is already adapted by some parts of the Port of Gothenburg (Port of Gothenburg, 2021a). However, for the time the tanker ships are spent anchored outside the terminal, this solution is not possible today, meaning that the emissions from the ships waiting at anchor must be reduced in some other way.

1.2 Problem description

Pressured by organisations such as the IMO, with their focus on reducing CO_2 mentioned earlier, the transport business and logistics companies are nowadays pressured to reduce their emissions to ensure a sustainable global trade of goods. Since earlier, the maritime industry has been focused on using alternative fuels or the use of different solutions such as scrubbers, to reduce emissions (Abadie, Goicoechea & Galarraga, 2017). Beyond this, an issue regarding ships and emissions could be the time they are spending waiting in port, either moored or anchored, with engines running and thereby emitting greenhouse gases. Several studies have covered the issue of emissions related to operations and movements in ports (see Merk, 2014; Saxe & Larsen, 2004; Hulskotte & Denier van der Gon, 2009; Fuglestvedt et al., 2009), however, to the best of our knowledge, not analysing the topic of the time a ship is spent

[2] Container ships are specialised to handle containers, RoRo ships are ships which allows road vehicles to roll on and roll off the ship (Lumsden, 2009).

anchored. As previously mentioned, in the study by Parsmo and Winnes (2020), examining the emissions from ships in the Port of Gothenburg, the CO_2 emissions from ships at anchor (see figure 1 for the outer anchorage locations in the Port of Gothenburg) showed to be of a considerable amount, however differing between various types of ships, where tankers were the main polluters due to spending time in anchored mode. The importance of the tankers in the case of Port of Gothenburg is further emphasized by ITF (2017), as more than half of the goods handled consist of liquid bulk. Therefore, it is of interest to fill this research gap and investigate the reasons why the tankers approaching the Port of Gothenburg are anchored to further investigate if this time can be reduced, hence reducing the CO_2 emissions concerned to this issue.

As for the case of Gothenburg, where the port is in near proximity to the city centre, the air emissions SO_x and NO_x concerned with shipping can be considered harmful to the inhabitants (Saxe & Larsen, 2004), exposing them to a higher risk of diseases concerned with the emissions, as for example respiratory diseases or cancer (Cullinane & Cullinane, 2013; Merk, 2014). Though this study has a focus on the emissions of CO_2, a result from reducing time spent at anchor could also reduce other types of pollutants, as the time is reduced. Further mentioned by Parsmo and Winnes (2020), the number of emissions of CO_2 is an indication of how much fuel is being used by the ship, which moreover other emissions are following proportionally. This gives further importance to studying possible reduction of CO_2. As mentioned by Mat et.al (2016), port cities, such as Gothenburg, are also faced with high emissions of CO_2. Being the largest port in Scandinavia and considered the most important port in Sweden (ITF, 2017), the Port of Gothenburg plays a crucial role in the Swedish economy, as almost 30% of the Swedish exports moves through the port (Port of Gothenburg, 2021b) why the Port of Gothenburg is a port of interest to look further into.

To reduce the emissions, a study in what can be changed must be done. As stated by Johnson and Styhre (2014) a reduced fuel consumption can be achieved by improving the operations and logistics systems and by using new technologies in the ships. One such operation is port calls, a process which can be more optimised compared to today as ships repeatedly must wait at port (IMO 2020). Moreover, Merk (2014) suggest some changes to reduce emissions in port which implicate that some operations should be modified, for example regarding routing and some structural changes regarding efficiency in the port and possibility of reducing vessel speed.

However, changes can be complicated, and for the case of the shipping industry must different aspects be considered. Such as the type of freight market the ships are operating in or what kind of contracts there are between the different actors. Further, as stated by Johnson and Styhre (2014) the high number of different stakeholders that are a part of the shipping freight operations can aggravate changes in the operations, as they all may have different incentives. What could further complicate the possibility of enabling changes considering the commercial aspect, as all stakeholders wants financial gains. Lastly, as stated by the IMO (2020) an incentive to become more efficient in the port operations is not only to reduce the emissions, but it can also be a way for the port to create a competitive advantage. If the port can supply the right information to ease the operations of the ships, enabling them a more efficient use of fuel, the ships could lower their costs and their environmental impact, enhancing the competitiveness of the port (IMO, 2020).

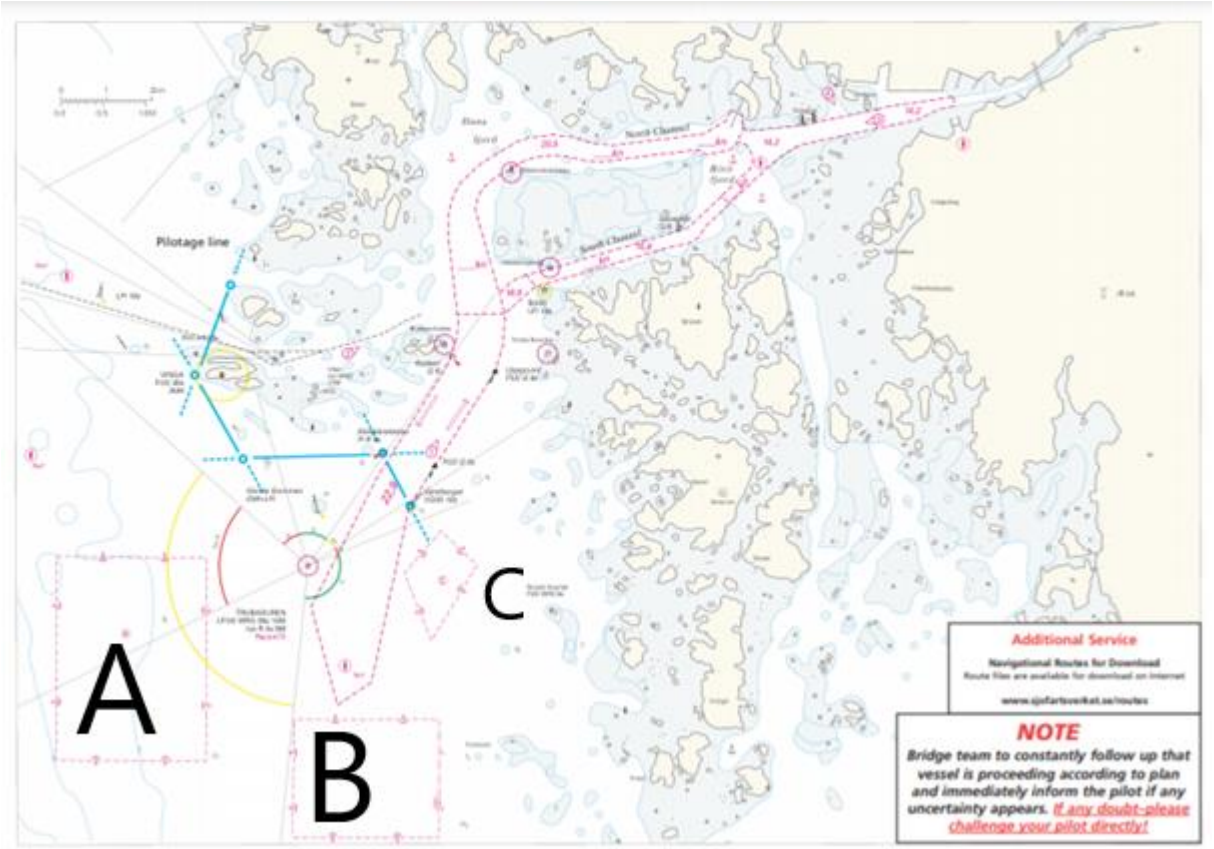


Figure 1 Showing the places available for anchoring in the Port of Gothenburg (A, B, C) (Sjöfartsverket, 2021)

1.3 Purpose and research question

The purpose of this research is to conduct a case study of the Port of Gothenburg, aiming to fill the current research gap of anchoring and CO_2 emissions for tankers. Thereby, firstly the intent

is to identify the reasons why tankers in the Port of Gothenburg are anchoring, to later examine what is affecting these reasons for anchorage and explain them. After identifying these, the purpose of our study is to investigate and to determine possible initiatives on how the emissions concerned to anchorage can be reduced, taking the commercial and contractual aspects into consideration. By identifying the reasons, the aim thereby is to investigate the specific case of Port of Gothenburg to find solutions that are applicable for this case. This purpose sums up into our research questions:

❖ What are the reasons for ships anchoring in the Port of Gothenburg and what are the underlying explanations of these?

❖ What initiatives are there to make use of to reduce CO_2 emissions concerned with anchorage in the Port of Gothenburg?

❖ What contractual and commercial aspects must be considered to enable this change?

1.3.1 The project BRAVE ECO

This study is a part of the project BRAVE ECO - "Benchmark for Reduction of Anchoring Vessels' Emissions - Enabling Change of Operations". The project was initiated by the Port of Gothenburg with a purpose to investigate what opportunities there are to reduce emissions from ships when anchored. The project is a collaboration involving Furetank, Preem, Terntank, IVL (Swedish environmental research institute), the School of Business, Economics and Law at Gothenburg university and Chalmers university of technology. Further, the project wants to determine the primary causes of anchoring, define a model for calculating the emissions of CO_2 for different types of ships and developing initiatives to reduce emissions concerned to anchoring. Our contribution to the project will focus on examining the reasons of anchoring and new initiatives, viewed upon with a commercial and contractual perspective. Additionally, two other groups of students from Chalmers are participating, one of which we have collaborated more closely with in regards of making use of a survey conducted by them. The group conducted a survey to collect data for reasons for anchorage which results are used in this research. The survey is further explained in chapter 3 and its results are shown in chapter 4.

1.3.2 Port of Gothenburg

The Port of Gothenburg is the largest port in Scandinavia, serving almost 30 percent of the Swedish international trade. The port is operating with container traffic, RoRo, passenger traffic, cars, oil, and other energy products. There are several different owners of the various operating segments, the container terminal by APM terminals, RoRo-terminals owned by Logent and DFDS, and the terminal with energy products are operated by the communal owned Port of Gothenburg. Moreover, there are several different companies operating in the port, handling various types of operations. As this report will be focused on the tanker segment, it will further focus on the communal energy port. (Port of Gothenburg, 2021b). At the energy port over 20 million tons of crude oil and other energy products are handled and roughly 2500 ships call the energy port every year. The energy port can be divided into three smaller different ports specialising on a particular energy product. Torshamen is focused on crude oil, Skarvikmanen and Ryhamen is focused on the refined products (Port of Gothenburg, 2021c).

2 Literature review

This section aims to give the reader the information needed to understand and follow the following report. The literature review will be applied to the empirical data in the discussion, and later as a ground for the conclusions. The literature review is divided into subheadings covering the freight market, energy consumption, information, Just in Time, and Virtual arrival.

2.1 The Freight Market

In the freight market of shipping, you are selling and buying transport by sea. The market is often divided into four sectors, two of them being voyage charter market and time charter market (Alderton & Rowlinson, 2015). As mentioned by Stopford (2009, pp. 181) there are three major actors in the freight market, a shipowner, a charterer, and a broker. The shipowner is the one providing ships to hire, and the charterer is the one who possesses an amount of goods that needs to be transported, dependent on orders from third parties such as buyers and sellers of goods. The contact between these two actors is often managed by a broker, where the charterer uses this actor to find a vessel for transport. The broker manages negotiations between the actors, to set the terms of agreement between them to finalize the contract, referred to as the charterparty. How the agreements and contracts between the actors are formed are also dependent on what sector of the freight market they are operating in. (Stopford, 2009, p. 181-182) It is of importance that the charterparties are well formulated and negotiated, including different clauses for unexpected problems. For example, if the ship breaks down or it does not arrive at the port on the agreed time. (Stopford, 2009, p. 185)

2.1.1 Voyage charter

The voyage charter market implies that the ship is hired by the charterer to accomplish a specified trip, where the price is agreed and fixed per ton carried (Stopford, 2009, p. 183). The charterparty usually includes that the owner of the ship will ensure that it has the right equipment and that it is available at the right place at the agreed time, while the charterer needs to ensure that the unloading and loading of the ship is done in the agreed time (Law, 2016). To save time and effort the charterparties used are often standard contracts, as for example the BIMCO charterparty (see example in appendix 8.3), ensuring all parties participating that most possible outcomes are covered (Stopford, 2009, p. 187) The shipowner is responsible for the cost of the voyage and running the ship, such as fuel and employment cost, as well as port

related costs, such as port charges (Stopford, 2009, p. 182). The high amount of costs that the shipowner pay for, means that the charterer need to cover this. Voyage charter contracts therefore usually implies a high cost, but charterers find them beneficial when they do not want to want to restrict themselves to a longer contract. Moreover, if there is a sudden rise in the demand of the cargo, the charterer might need to quickly adapt and make use of a voyage charter for a certain trip. (Menon, 2021).

The voyage cashflow analysis (VCF) is a tool used to aid in day-to-day chartering decisions and aims to calculate the possible cashflow of different alternatives of voyages. A VCF is divided in to four different parts, ship information, voyage information, voyage cashflow and voyage earnings. These four categories need to be analyzed and evaluated before the shipowner decide to accept a transportation. It is common for a broker to provide a list showing possible cargo, rate, and pick-up location. However, this does not mean that the shipowner must accept an offer from a broker, the shipowner can wait and see of the shipping rate increases.

The four main categories in the VCF:

- Shipping information. Details about the ship which affects the daily operation costs such as fuel consumption.
- Voyage information. Information focused on the voyage, distance between ports and cargo related details.
- Voyage cashflow. Net voyage cashflow, after the brokers fees, fuel cost and the cost for the daily operations has been deducted.
- Voyage earnings.

(Stopford, 2009, p. 267)

2.1.2 Laytime and demurrage clauses

As mentioned by Furness Wilson (2010, p. 49-52), one of the most crucial clauses between the shipowner and the charterer is the agreed time of how long the process of loading and discharging the ship can take, what is referred to as laytime. If the charterer fails to complete discharging and loading within the specified laytime they are obliged to compensate the owner to cover for the extra cost, what is referred to as demurrage. The demurrage rate is often fixed in the charterparty, as a safety for the shipowner. Further, this usually implies that the charterer wishes for a longer laytime, if there will be any unforeseen events, while the shipowner wishes to reduce this time, as it enables them to make use of the ship elsewhere, and thereby earn more

money. However, often the charterer also has the possibility to earn despatch, a payment they get if completing the operations faster than the specified laytime. This is also usually a fixed rate, stated in the charterparty and can be considered an incitement for faster handling in port, which also benefits the shipowner. (Furness Wilson, 2010, p. 49-52)

What is considered difficult is agreeing on when the laytime starts to run. When arriving at the port, the shipowner gives a notice of readiness (NOR), indicating that the ship is at place and ready to load or discharge, however, if there is no berth available at arrival this risk could fall on the shipowner, if not agreed upon differently in the charterparty. Therefore, it is of importance that the charterparty covers the aspect of when the ship can be considered arrived at port, for example it being in the port area or at a berth. Moreover, in the charterparty it is agreed on the estimated date of arrival of the ship, and a period for when the ship should arrive. In contrast to laytime, the shipowner usually wishes to have as long time as possible for this, due to unforeseen events such as bad weather. To ensure the safety for the charterer, this period is often set with an expected date of arrival of the ship and a cancelling date, meaning that if the ship has not arrived within the time period the charterer has the right to cancel it and instead chose to charter another ship, often referred to as Laycan (Laydays and Cancelling). (Furness Wilson, 2010, p. 49-52)

2.1.3 Time charter

In contrast to the voyage charter, a time charter means that the charterer are hiring the ship over a specified time period, rather than for a single voyage, spanning over a few days up to a few years. The shipowner are managing the vessel and bear the operational costs, while the charterer bears the voyage costs, such as bunkers, and the cost of handling cargo. (Stopford, 2009, p. 184) The charterer usually pay a monthly hire to the shipowner, and their income are dependent on how well the ship can perform, why it is of importance that the charterer receives all necessary information about the ship (Furness Wilson, 2010, p. 88). This information for example includes how much fuel the ship consumes, the cargo capacity and the speed of the ship (Stopford, 2009, p. 184). Moreover, for the charterer to earn as much of the ship during the time charter, it is of interest for them to schedule as many trips as possible (Furness Wilson, 2010, p. 88-90). Stopford (2009, p. 184) mentions three different reasons to why time charter could be beneficial. Firstly, that the charter wants to control a ship, but does not want to own it. The second reason could be that it could save costs and that capital is not tied up in a ship, and lastly that the shipper could be expecting changes in the market (Stopford, 2009, p.184). When

using time charter, the charterer can use the ship more freely, compared to the voyage market where the destinations must specify the ports and routes in question. Often shipowners prefer time charter over voyage charter, due to ensuring a fixed income rate, and can also function as a protection against fluctuations in the chartering rates. On the contrary, in the perspective of the charterer, these possible fluctuations can imply a risk in being tied downed to the specified rate. (Menon, 2021)

2.1.4 Tanker freight rates

The tanker segment has since long experienced short run fluctuations in the freight rates, affecting the contracts between the shipowner and the charterer, and the costs structure between them. These fluctuations are to a high degree explained by the global marker of oil and oil products, which in turn is affected by the global economy. (Alizadeh & Talley, 2011) This was further made clear in the Covid-19 crisis, with lockdowns over the world. The demand for crude oil and oil products fell and at first, the lower oil prices boosted the tanker freight rates, however shortly after falling quickly after several years of growing. The fallen freight rates for tankers in 2020 was seen regarding both voyage charter and time charter. (Sand, 2020)

2.2 Energy consumption and CO_2

Emissions of CO_2 can highly correspond to the amount of fuel consumed by the ship (Cullinane & Cullinane, 2013). One action in reducing the GHG emissions from the ships is by switching from fossil fuels to other alternatives. One such fuel is Liquefied natural gas (LNG) (Bergqvist and Monios 2019). Switching to LNG could reduce local air pollutants drastically, as NO_x and SO_x, however, not having the same great impact on emissions of CO_2, as it only reduces this by 25%. As mentioned by Parsmo and Winnes (2020), a small number of ships calling the Port of Gothenburg is operating on LNG. Some barriers to introduce more LNG is mentioned to be a lack of places for refuelling. There are additional fuels, such as hydrogen or biofuels that are being investigated, however not implemented to a high degree. The same goes for battery solutions, which would be a good environmental solution, yet these three alternatives would require large investments in port and ship infrastructure. (Bergqvist & Monios, 2019; Cullinane & Cullinane, 2013)

As further mentioned by Bergqvist and Monios (2019), an alternative for switching fuels could be to lower the speed of the ship, referred to as slow steaming. Reducing the speed have a significant impact on lowering the fuel consumption and thereby the emissions of CO_2 (Corbett,

Wang & Winebrake, 2009). The consumption of fuel increases progressively as the speed is increased, why even a smaller reduction in the speed of the ship can result in considerable savings in fuel and emissions (Andersson & Ivehammar, 2017; Styhre et.al., 2014). Not only is this environmentally motivated, but it can also reduce the cost of fuel. (Bergqvist & Monios, 2019) The fuel cost is one of the most substantial cost of the voyage of the ship (Stopford, 2009, p. 233-234; Pocuca, 2006), why there can be an interest in lowering this, yet still ensuring operating the ship in an optimal speed, as fuel consumption might increase if going to slow (Cariou, 2011). The potential of slow steaming is to one point also dependent on the price of the bunker fuel. If the price is high, there is a higher incitement to slow steam, to use less fuel, why a lower price could lead to operating with a higher speed (Cariou, 2011; Eide et.al, 2011).

2.3 Information

The value of information in the supply chain has increased as information can be used to increase the efficiency of the supply chain (Rushton, Croucher, & Baker, 2017, p. 748). As the supply chain has become more digitalised it has become easier for companies to collaborate and share information. In logistics 4.0 five different key elements can be described (Strandhagen, et al., 2017).

1. Real time data analytics of vehicles
2. Raid manufacturing
3. Autonomous warehouses
4. Real time information exchange between the different actors
5. Cloud-supported network to keep the information flow intact (Strandhagen, et al., 2017).

The increased amount of information and accesses to internet can add a flexibility to the routing of cargo shipments as well as transferring important physical documents into digital documents. The digitalized documents have a high level of consistence and accuracy as the information can be directly validated and the different actors can easier share the information (Kia, Shayan, & Ghotb, 2000).

Studies conducted in 2018 at the Port of Rotterdam showed the importance of sharing information in advance. If the ships would have communicated their time for berth 12 hours before arriving, immense fuel savings could have been possible, because of the opportunity to adjust their speed (IMO, 2020). A close collaboration between all stakeholders in the port and

ensuring a continued communication of relevant and correct information to the right party at the right time are crucial in enabling a more efficient port operation. By ensuring the information being shared, it can lead to positive effects for all stakeholders, mostly as it enables better and more accurate planning. (IMO, 2020)

In several ports around the world initiatives using blockchain technology to share information have been initiated. The Port of Antwerp initiated a project to introduce blockchain technology for handling documents. With the project, the different stakeholders could receive real-time data, while still ensuring the authenticity of it. (Port of Antwerp, 2018)

Blockchain can enable sharing of information without it being manipulated by anyone else. The technology can speed up the handling of the documents required in the shipping industry. By using a blockchain solution, the documents could be digitalized, while still ensuring transparency and safety, and moreover enable real-time data to be shared with the stakeholders (Ao, et al., 2017).

2.4 Just in Time

Optimizing the speed is also a crucial part when talking about becoming more Just in time (JIT) (IMO, 2020). JIT is a set of principles focused on delivering at the time needed, not before or after but at the right time for the customer. For JIT to work the previous processes must do what the next prosses wishes (Liker, 2009, pp. 44-45). If the delivery is not delivered at the right time one of the processes must wait for a delivery or wait before being able to deliver, the waiting is one of the “wastes” in the lean thinking (Harrison, Van Hoek, & Skipworth, 2014, p. 225).

2.4.1 JIT in shipping

JIT arrival foremost implies reducing the waiting time for ships outside the terminal (Styhre et.al, 2014). On the topic of Just in Time, the IMO published a report (2020) stating that the operations today can be described as “Hurry up and wait”, meaning that the ships are going on full speed to the port, to realize that there is no free berth, forcing them to anchor while waiting (see figure 2). To prevent this, the operation would need better communication of information about the availability in the port. If the ship is informed about availability in beforehand and continues to get frequent updates, it can enable it to travel on a lower speed, and thereby using less fuel (IMO, 2020; Johnson & Styhre, 2014). Instead of spending time waiting at the port, the ship could have slowed down during the voyage, and thereby used less fuel and emitted less

(Styhre et.al., 2014). However, as further mentioned by Styhre et al. (2014), the policy of first-come-first serve can be a counteracting aspect of slow steaming, meaning that ships might race in order to reach the port first, and thereby be the first in line for a free berth.

The goal of IMO (2020) is not to shorten the total time needed for the whole operation, but enabling a more optimized speed, to reduce waiting time and the time spent at anchor. Becoming more JIT could on the other hand lead to some ships needing to increase the speed to meet the time schedule and additionally, some ships would need to be at anchor for example for maintenance. (IMO, 2020) Another important aspect mentioned by IMO (2020) for the voyage charter market is that, depending on when the charterparty has decided laytime starts, the shipowner might lose the income of demurrage, as the ship instead will reach the berth without waiting time, and demurrage can be considered an important income for some shipowners (Poulsen & Sampson, 2019). If the possible demurrage exceeds the potential cost savings of fuel, the shipowner can be motivated to arrive early at the port (Andersson & Ivehammar, 2017).

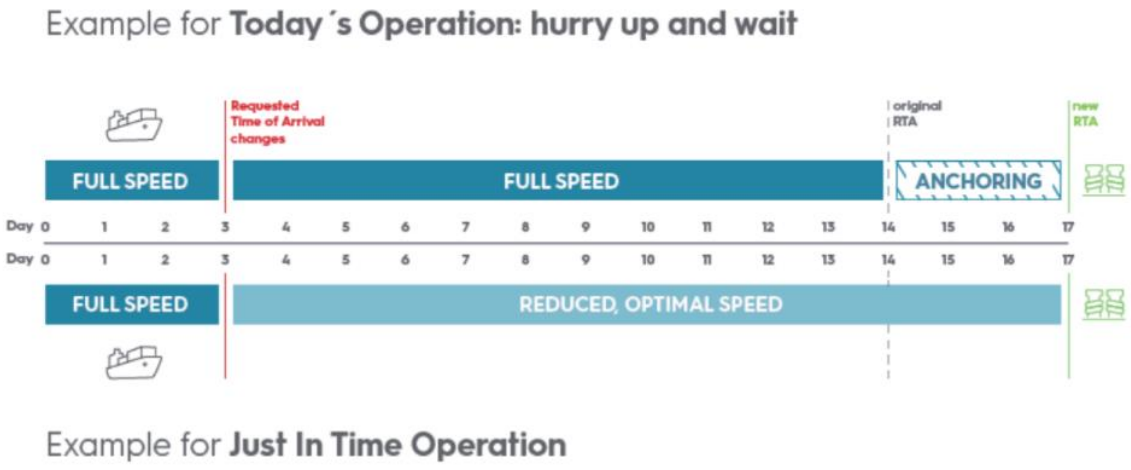


Figure 2 An example of just in time transport (IMO,2020)

By introducing JIT arrival, the GHG emissions is not only reduced during the voyage, as speed is optimized and the ship becomes more energy efficient, it also reduces the emissions in the port. If the ship arrives at a time when there is an available berth, it does not have to wait at anchor and thereby reduces emissions concerned to it. (IMO, 2020) As mentioned in the introduction, in the case of Port of Gothenburg, the ships that spent time waiting at anchor, and thereby emitting CO_2 was tankers (Parsmo & Winnes, 2020). Reducing the time that a ship is

spent waiting at anchor can also be seen upon as something that benefits the environment as well as the businesses, with the lower costs and emissions (Poulsen & Sampson, 2019).

To enable implementation of JIT arrival, IMO (2020) mentions port call optimization as a crucial aspect, where information must be shared and communicated to the parties in need of it. The information must be handled efficiently and be updated to the actors in need of it. As further mentioned, it would be in the ports interest to become more efficient in this, as it can increase the competitiveness if ships are able to arrive JIT, which would include cost savings for the one in charge of the ship. Moreover, for the port and the terminal operators it would enable better planning and scheduling of berths, however, if not implemented yet, it would demand them to change the way of operating to enable the sharing of information. (IMO, 2020).

A reason to the waiting time for ships could be that there is no free berth or that the cargo to be loaded is not available yet (Anderson & Ivehammar, 2017). The process of planning the port operations is complex and can be made further complicated if needing to replan (Pratap, Daultani, Tiwari, & Mahanty, 2018). Making the port operations, such as loading and discharging of goods, more efficient can be considered a cost-effective way in reducing waiting time (Eide et al., 2011). The importance of improving these operations is further emphasized by Styhre et.al (2014), stating that this is one of the most crucial aspects in reducing waiting time at port.

2.5 Virtual arrival

To enable JIT arrival actors can introduce a virtual arrival system. As exemplified by Poulsen and Sampson (2019) with the case of the energy company BP and Maersk tankers, a virtual arrival clause was included in their voyage charter contract. This implied that when given the information about that the oil terminal is not able to take in the ship at the original expected time (the layday), the ship was able to slow down and arrive later. However, the ship could arrive virtually, due to that the ship would have been able to arrive at this time if continuing in the same speed. Without this clause the ship would have needed to be physically in place to be considered arrived at the port and send its notice of readiness. For the extra time the charterer made use of the ship, the difference of the originally arrival and the actual arrival, the shipowner received demurrage. The savings in bunker fuel cost from slowing down was then shared between the two actors, resulting in a positive result for both parts. (Poulsen & Sampson, 2019) There are prepared clauses for virtual arrival, for example created by BIMCO (see appendix

8.3). For voyage charter they have created a virtual arrival clause and for time charter a slow steaming clause (BIMCO, 2013); BIMCO, 2011).

2.5.1 Barriers of JIT and virtual arrival

In the report from IMO (2020), some barriers to implementation of JIT arrival are mentioned. Taking the different types of contracts into consideration, implementing JIT arrival for voyage charter is seen upon as more complicated than for time charter. For time charter the charterer oversees the ship, and can easily control the speed, are paying for the bunker fuel and benefits from the possible cost savings when consuming less fuel due to speed reduction. For a voyage charter, it could be more complicated to calculate, and split possible savings or costs concerned with JIT arrival, as the shipowner are responsible for any delays during the voyage and the charterer for delays in port. (IMO, 2020) Additionally, there is a possible issue of lack of trust between the different actors, regarding if the information about possible savings is accurate (Poulsen & Sampson, 2019). As previously mentioned, demurrage can for some be considered an important income, why they will be reluctant to make use of solutions such as virtual arrival clauses (Poulsen & Sampson, 2019). For a ship in a voyage charter, they might not be willing to risk missing the laycan, since they could thereby risk losing the opportunity to ship the goods, in favour for another ship, and therefore they are reluctant to slow steam, with regards to considering unforeseen events such as bad weather (Styhre et al., 2014)

Further mentioned by Poulsen and Sampson (2019), a reason to why virtual arrival clauses is not adapted is because of the first-come-first-serve policy adapted by many ports, putting pressure on the ship to be at the port to receive their place in the queue. With this policy the different actors must trust each other, for example that the terminal does not trust the information given about the virtual arrival time from the charterer. Moreover, the value of the cargo could be a barrier. The value of the cargo can be considered higher than saving fuel cost, which in turn making the charterer or the owner of the cargo not wanting to risk that the ship will arrive late. The highly volatile oil market contributes to this, as the charterer could find it more beneficial to bear the cost of demurrage against the shipowner, rather than discharging the cargo because waiting for the right price on the market. (Poulsen & Sampson, 2019) Another barrier to enable change is that shipping is a vastly conservative industry. Many actors are reluctant to change their way of operating and to make changes in their contracts between different parts. The actors can be unwilling to share data and the high amount of actors that are part of the port call process, such as port authorities, terminals, agents, and shipowners, can also

make the process of sharing data complicated, pressuring the system to be well functioning. (IMO, 2020) As mentioned by Flodén (2018), there are several risks concerned to introducing a new information system, for example it being too complex, or it not being accepted by the users. Lastly, there is a possible uncertainty of how a court would handle a case where two parties have adopted a new clause, and a conflict arises (IMO, 2020).

3 Methodology

This section aims to explain the methodology used in this research, covering aspects such as research process and research logic. Moreover, it explains the use of primary data (interviews) and secondary data (survey and literature review) made used of. Lastly the methodology is reflected on with terms as validity, reliability, and limitations.

3.1 Research purpose

The purpose of this research focuses on conducting an exploratory and descriptive study, aiming to determine the reasons why ships are anchoring in the Port of Gothenburg and possible changes there are in reducing the emissions concerned to it. An exploratory study aims to observe and attain knowledge as a ground to later research, which is applied to this study in trying to fill the research gap of anchoring of tankers and its emissions. A descriptive research is further examining and describing the exploratory research and the current issue (Collis & Hussey, 2014).

3.2 Research process

This study has been conducted with a qualitative approach, with some elements of quantitative data. The survey used, which is explained further down, resulted in quantitative data, however analyzed with a qualitative approach. The interviews were conducted with a qualitative approach. A qualitative approach is suitable when analyzing “soft” data based on words, compared to a quantitative approach which is rather is based on numerical data (Patel & Davidsson, 2011). The qualitative approach was found beneficial as the aim was to interpret the results from interviews as well as the survey used in the project and finding reasons behind it, something a qualitative approach is set to do (Collis and Hussey, 2014). Further, for analyzing the data, a data triangulation method was used. This aims to make use of data from multiple sources in different times (Collis & Hussey, 2014), as for the case of this study is from several interviews, the survey and earlier literature. The results from these different sources were discussed and analyzed to find similarities and differences, which is discussed in chapter 5.

3.3 Research logic

Further, the research logic of the study has been abductive. An abductive design implies a mix between the deductive and the inductive (Bryman & Bell, 2015). The deductive takes stand in a theoretical framework to formulate hypothesizes from, which then is tested with the empirical data. On the contrary, the inductive logic takes stand in the empirical data and its results are framing the theoretical framework. The abductive procedure works as a combination of the two, with an aim to make use of existing theory, but being open for unexpected empirical results, and combining these two to find the most accurate conclusions. (Bryman & Bell, 2015) The choice of logic was made as we wanted to have an open mind and not limit our thoughts to only theory or empirical data, as we for example wanted to make use of initiatives tested in other ports around the world at the same time as having an open mind to new ideas from the respondents participating in this study.

3.4 Case study

This report is a case study of the Port of Gothenburg, as it aims to look at the specified topic in this certain place. As stated by Collis and Hussey (2014), a case study aims to access specific knowledge about a specified phenomenon. Being a part of the project BRAVE ECO, the scope of Port of Gothenburg was already set, and the aim is to find solutions or conclusions that are applicable on this certain case. Due to being a part of the project, this study can be considered what Collis and Hussey (2014) refers to as an opportunist case study, as participating in the project gave us the opportunity to gain knowledge about the specific phenomenon from contacts within the business. Moreover, it can be described as an experimental case study, where we aim to define the benefits of introducing new ways of operating, at the same time as examining the difficulties of this (Collis & Hussey, 2014). There is a high probability that the results are applicable in other ports, but it is important to notice that they are based on the specific case of Port of Gothenburg. The respondents to the study are operating in Gothenburg, why we want to make use of initiatives or solutions that has been conducted in other ports and study if they are applicable in this case.

3.5 Data collection

The collection of data for this study is made using a mix of primary data, in form of interviews, and secondary data in form of a study of existing literature and results from a survey conducted in the project BRAVE ECO.

3.5.1 Primary data

The primary data in this study is collected through interviews. Using interviews was found beneficial, as we wanted to gain deeper understanding to why the reasons of anchoring are as they are, as well as gaining knowledge about their current way of operating and lastly to attain knowledge to come up with new possible solutions for them.

Due to being a case study of the Port of Gothenburg, the respondents approached and chosen was actors active in this specific place. One respondent and the company represented are not placed in Gothenburg, however, has a crucial role in one other company participating, why we believed the respondent could contribute to our case study. In total, seven interviews were conducted, with eight respondents representing five different companies. The companies are further described in empirical data.

The interviews were semi-structured, which is defined as the interviewer preparing several questions, but with the aim to let the respondent to talk freely about the topic and as respondents, coming up with more questions during the interview (Collis & Hussey, 2014). Moreover, these types of questions are found suitable when wanting to understand the concepts, ideas, and logic of the respondent. The prepared questions were a mix of open, to receive broad information, probes, which are questions to ask as a response to the respondent for greater understanding by using examples, hypothetical questions, to enable the respondent to think broader, and lastly summary questions, as a way for us to verify that we have understood the respondent in the right way. Due to Covid-19 related restrictions were all interviews conducted online, using video conferencing, which also enabled us to record all interviews, with permission from the interviewees. As stated by Collis and Hussey (2014), recording the interview can enable a more extensive understanding, which we found beneficial. Additionally, the negative aspect with online interviews mentioned by Collis and Hussey (2014) is that we must ensure that the interviewees has the right equipment and software for participating. Again, due to Covid-19, we did not consider this a problem, as the pandemic has pressured this type of usage to a new degree. Lastly, the interviews were conducted by both authors, as we wanted to minimize the risk of one person misunderstanding the respondent as well as covering all aspects of interest. Potential problems with the interviews are discussed further in the section methodology reflection and the interview guide is included in the appendix.

3.5.2 Use of survey

As this report is part of the bigger project BRAVE ECO, we make use of use of results from a survey conducted by a pair of students from Chalmers University of Technology, who are also a part of the project. We chose to make use of this survey for two main reasons. First, as being part of the same project, with the same scope as we found it beneficial for our study. Second, since we shared the same scope, we considered it to be a risk of conducting a survey of our own, as it could be difficult in getting responses from two similar surveys.

The survey aimed to determine the reason to why the vessels where anchoring in the Port of Gothenburg. The survey was sent to 40 ships approaching the Port of Gothenburg and 16 ships answered giving a response ratio of 40%. The question and the results that we make use of in this study regards the main reason of anchoring was. The result from the survey is presented in chapter 4.

3.5.3 Secondary data

The literature used is collected from academic articles, through Google Scholar and GU Super search. Moreover, the study makes use of other sources as books about the maritime industry as well as news articles covering the area of interest. Our research of literature mostly aimed to cover the contractual and commercial aspects of the ships operating in the Port of Gothenburg, and to find initiatives for possible changes, using terms such as ‘Time charter’, ‘Voyage Charter’, ‘Virtual Arrival’, ‘Port operations’ and ‘Emissions in shipping’.

3.6 Methodology reflection

To ensure the credibility of the study we must consider the reliability and validity of the report, which implies how reliable the results of the study are and makes sure that it measures what it is supposed to (Bryman & Bell, 2015).

3.6.1 Reliability

According to Bryman and Bell (2015), reliability can be measured as internal and external. The internal reliability refers to that the authors of the study share the view of how the data is interpreted. To ensure this we have had continued discussion about all aspects being analyzed in this study. Moreover, before conducting the interviews, the questions and topics have been discussed thoroughly to make sure that we share the viewpoint. The external reliability refers

to that someone else should be able to repeat the study again (Bryman & Bell, 2015). When conducting a study with a qualitative approach this can however be difficult, as the collected data easily change from one moment to another, depending on the current circumstances. As this is a case study of the Port of Gothenburg, there could be difficulties in conducting the same research elsewhere. Moreover, when executing interviews, the results might also change depending on the respondent. (Bryman & Bell, 2015). When conducting interviews, it is important to have the issue of personal bias in mind, both in the perspective of the respondent as well as the interviewer, as we might have personal values affecting our answers and questions (Collis & Hussey, 2014). We consider it to be a modest risk in not getting the true answers from the interviews. Mostly we base this on the transport and oil industry that all respondents were operating within. Because of this, we believe that the respondents could feel pressured to exaggerate their focus on environmental issues, as our report focuses on emissions. However, we further believe that this was reduced to some degree with regards to the respondents and companies being anonymous.

3.6.2 Validity

According to Bryman and Bell (2015) the topic of validity is also measured with an internal and external perspective. Internal validity refers to if there is a connection between cause and effect. By conducting more thorough interviews, the aim was to reduce this issue and to gain deeper understanding on these connections, to ensure validity. Further, external validity refers to if the results of the study can be generalized or not (Bryman & Bell, 2015). This is a potential issue for this specific study, as it is a case study for the Port of Gothenburg.

3.6.3 Limitations

As mentioned above, a limitation with this study is that it is a case study of the Port of Gothenburg, which imply that the results might not be applicable elsewhere. Another important issue identified before conducting the interviews was the large number of different actors active in the Port of Gothenburg, the aim was to gain perspective from different actors, which we believe we mostly succeeded with. The perspective that we consider missing, and what we believe could be interesting for further research is the perspective of an agent. As mentioned later, communication and sharing of information is crucial, where we believe the agents, perspective could have developed the research. Lastly, there were 16 respondents answering the survey and we believe a higher number could have given it a higher validity. This is to some

degree handled by asking the respondents of the interviews the same question, to thereby gain more data on this and enable us to make a conclusion of it.

4 Empirical data

In the empirical data segment, the collected data from the interviews will be presented, as well as the results from the survey, and the data will later be analysed combined with the literature review into a discussion.

4.1 List of respondents and companies

Here follows the introduction of the five different companies represented by the eight different respondents.

4.1.1 Company 1

Company 1 is a company active in the energy business in Gothenburg, having a refinery in the Port of Gothenburg, which makes this port one of their main ports. The company buys crude oil to refine it into other oil-based products, such as diesel or petrol. When possible, substitutes to crude oil are used to produce a greener product, to become more sustainable. The company mostly acts in Scandinavia, where most of the refined products are further transported within Sweden. The company is represented by Person 1,2,3 and 4, with different roles within the company.

4.1.2 Company 2

Company 2 is also an energy company with a refinery in the Port of Gothenburg, refining crude oil and creating other energy products. The company is mostly shipping to Norway, Finland or within Sweden. The company is closely connected to company 4 in is planning and chartering of ships. The company is represented by Person 5.

4.1.3 Company 3

A family-owned shipowner company located in Gothenburg. The company owns and operates ten tanker vessels, and works closely with company 1, 2 and 4. Currently the company has seven ships on time charter and three ships on voyage charter. The company is represented by Person 6.

4.1.4 Company 4

Company 4 is a Finnish supply company, working as a logistics company within the oil industry. One of the main tasks is managing the logistics and shipping for company 2. The company is represented by Person 7.

4.1.5 Company 5

The fifth company is represented by the Port of Gothenburg, and more specifically the Energy Port. The company is represented by Person 8.

4.2 Company 1

The company uses a mix of time charter and voyage charter contracts, where the time-chartered ships are often renewed on a yearly basis (Person 1). For two of the ships on time charter, the contracts have been renewed repeatedly for a long time, making company 1 in full use of these. For the voyage-chartered ships, a new contract is agreed on for each voyage and they want to find the best ship for the best price (Person 2). However, even if there is a new contract, the company often hire voyage charter ships from the same companies, because of having a good relationship with them (Person 1,2,3,4). Of the ships hired, several are from Company 3. The ships that are time chartered they want to make full use of (Person 3). For the ships on time charter, they are in full control over.

The ships that are well known by the company, in other words the ships they have a well-developed relationship with, are often willing to slow steam in order to better match the available time at berth, but other ships do not want to risk being late (Person 1). As mentioned by Person 2, even if on voyage charter, they are able to sometimes slow steam, with the aim of becoming more JIT. This is however dependent on that the shipowner is a party they have a good relationship with and also that the ship arrives to a berth that company 1 has the control over. The clause used in this case is similar to the BIMCO voyage clause (appendix 8.3), resulting in that the party for example divides the earnings from saved fuel. Further mentioned by Person 1 is that from their perspective they are willing to become more JIT, as there is no point in them having ships anchoring, and it can reduce the risk of them paying demurrage. As stated by Person 3 and 4, the reasons for other shipowners not wanting to agree upon optimizing speed could be of not believing they will profit from it or that they find it uncertain. Another issue today is the first come first serve rule, which hinders them from speed optimization for

ships that are not going to the berth in their control (Person 1,2,3,4). However, as mentioned by Person 3 and 4, in today's situation, without a virtual arrival system, they do not have any good alternative, as it is the fairest system to use.

Regarding sharing of information and communications between different actors, Person 3 and 4 believes that can be a complicated question. They mention the issue of not trusting the information given by others, especially if it regards an actor that they do not work closely with. Further exemplified by person 4 is something they believe could become an issue with virtual arrival. If two ships have given the same estimated time of arrival, one might change theirs to before the other ship, resulting in that ship number two slows down and the first ship becomes first in line by "cheating", as this ship finds the commercial winnings to be important from this. If the port would implement a new information system, Person 3 also mentions that this could imply a risk that ships chose to go to another port if they find the new system too complicated.

One of the main differences between voyage-chartered ships and ships running on time charter is the topic of demurrage, the voyage charter ships have a possibility, or risk, of demurrage while the time charted does not. This is mostly due to that the company is already financing the ships daily cost and thereby already has an incentive to keep the ship moving (Person 2). The same goes for laycans to consider. For voyage-chartered ships with shipowners, Person 2 says that this date is not written in stone and can be consider flexible in favour of both parties. If their berth is available, there is not always a need to await the certain laycan date.

As Company 1 has a long collaboration with a Swedish shipowner whom a deeper trust has been established, they are willing to slow steam. As person 2 states, JIT transports function well between Swedish companies and emphasizes that trust between the stakeholders is of great importance (Person 2,3,4). Person 1 states that JIT transportation is an efficient way to reduce anchorage time. The trust between companies is important to establish for virtual arrivals to work (Person 2). However, as continued by Person 2, the company still must act according to their obligations to the buyer or seller of goods, something that could hinder operations as slow steaming. If they would slow steam, and something would happen on the way, making them not arriving at the estimated arrival time, the financial loss against the buyer would be a too high risk, as the buyer might already have sold the cargo to someone else.

Moreover, as mentioned by Person 1 and 2, the operations in the port are causing anchorage time in two main ways. Firstly, the specifications of mixing the right product are often very tight, making this a difficult process, and if not met, they could have an immense impact on the

loading time, which further creates queuing for other ships. They state that this could be eased by better port infrastructure, for example by having more pipelines for the products or infrastructure to speed up the loading. Another, more direct solution is mentioned by Person 3 and 4, if the product is not meeting the specifications, they could be able to sell it anyway, but to a lower price. Lastly, they also mention the lack of berths for reducing waiting time.

4.3 Company 2

Company 2 mostly makes use of time charter contracts, hired from company 3. As similar to company 1, company 2 have a complex loading process, with tight specifications of the products to be met, something that can be derived to the complexity of handling oil and energy products. For the case of company 2, the specifications for example differ a lot depending on shipping to Norway or Finland. To reduce the time of the loading and unloading process of the ships, ships with an advanced unloading system can be used, which most of the ships owned by Company 3 has (Person 5).

Company 2 and company 4 are working together in a synergy. Company 4 act as carrier for company and are thereby in charge of contracts and handles the communications with the ships to and from the port area while company 2 decides when a ship will port call. Company 2 do not mind if ships arrive to early if the ship owner agrees to skip laycans and if possible, load earlier and thereby increase the efficiency. However, this is sometimes refused by the shipowner who motivates and refers to the contract and “that it has always been that way” (Person 5).

Company 2 differentiate itself from company 1 by using an economical speed for the ships instead of slow steaming. The ships company 2 uses ask whether to focus on speed or reducing fuel consumption on a scale from 1 to 5, as most of these ships are time charted by company 4, there is deeper collaboration between the actors. Depending on the situation at the port, Company 2 can have a ship slow down or speed up as an option to reduce the anchorage time for the vessel, as it can lead to demurrage. The cost of demurrage can be expensive and main reason for the increasing demurrage cost is the lack infrastructure at the Port of Gothenburg (Person 5). The company oversee one berth in the port, enabling them to be more flexible in managing the ships arriving, as in terms of being flexible on agreed dates and times. However, for those ships that must make use of another berth in the port, in the control of Port of Gothenburg, the ships often must hurry to the port, in order for them to ensure their place in the

queue. Another barrier for JIT mentioned by Person 5, as was the case for company 1 as well, is that the buyer of the goods is not willing to change their contracts according to this.

Regarding sharing information in order to enable introducing virtual arrival, Person 5 is quite sceptical. In theory they find it to be a good idea, however company 3 does not see the benefit outweigh the potential loss of sharing important information. One point Company 2 mentioned would be needed is a sort of validation system to ensure that the information shared is correct, to come round the risk of actors not sharing the correct information. (Person 5)

4.4 Company 3

As mentioned earlier, Company 3 mostly operates their ships on the time charter market. As stated by Person 6, it is usual that shipowners prefer to operate on the voyage charter market, due to receiving a higher freight rate and revenue. Some of the higher revenue can be derived from the demurrage and according to Person 6 some shipowners expect to earn demurrage and calculate for it in their budget. However, as said by Person 6, Company 3 mostly prefers operating on time charter, as it brings with it a secure and stable income. Moreover, the company is interested in making the process, including the voyages and in the port, more efficient, to end up with the best results, both financially and environmentally. The time charter contracts are often over a year but are often renewed with the same companies. As stated by Person 6, the company wants their charterers to be as satisfied with them as possible, to that degree that it is only a question of cost when choosing to hire their ships.

Company 3 tries to reduce the amount of anchorage time by slow steaming and states that virtual arrival can have a further positive impact on the positive effects of slow steaming. To some degree the company has succeeded in making use of virtual arrival clauses in the voyage charter parties already. In these it is stated on how the different actors should split for example the savings of making use of less fuel. However, Person 6 mentions the ports queue system “first come, first serve” as a hinderance to further development of virtual arrivals, as a ship which slow steams will fall behind a ship that did not slow steam. Increasing the information flow between the port and the ship would increase the efficiency of slow steaming as it would allow the ship to faster adapt its speed to the circumstances at the port. As mentioned by Person 6, receiving any information, independent on how much is left of the route, could enable them to adapt the speed, and thereby reduce emission when at route, and also to some degree reduce waiting time.

One of these circumstances mentioned by company 1 and company 3 is time spent adjusting quality errors caused when mixing the products, and thereby affecting the time needed in port for that ship. As mentioned by Company 3, the faster they could get the information the faster could they adjust their speed to arrive at a more beneficial time. For companies to rely on information shared between the different actors it would require a sort of verification system as it affect the company's bottom line. Lastly, the respondent mentions a concern regarding too much focus being on reducing the speed of ships, as the person believes this could neglect the need of continuously make use of better and alternative fuel and more energy efficient technologies in the ships. (Person 6)

4.5 Company 4

As mentioned earlier, Company 4 are managing the chartering for Company 2. The company uses a mixture of time charter and voyage charter, where the voyage charters are mainly to handle the capacity gap of the time charters. Due to the volatility in the oil market, it is not considered commercially beneficial to only make use of time charter, as there might be a scenario where they do not need to make use of it, and thereby still are obliged to pay for it. Generally, the length of the time charter contracts is short, about a year, but as they have had a successful collaboration with Company 3 over a longer time it has led to the contracts being renewed over a longer period. The deeper collaboration has led to the Company 3 creating knowledge how to company 4 acts and run their operations and thereby they can achieve more efficient daily operations (Person 7).

Ships charted from the spot market are chosen and determined by more criteria than the price, choosing a ship with a previous successful operation is preferable as more trust has been established. As the ship is charted from the voyage charter market, laycans still apply and these ships will not slow steam and for the ship owner it could be considered a higher risk financially. According to Company 4 the entire industry is built on laycans, but when they control the transport chain and owns the cargo the laycans are much more flexible. Company 4 have tried to reduce the anchorage time by adapting the speed of the ships but see the capacity gap at the Port of Gothenburg as one of the main contributors to increased anchorage time (Person 7).

The communication with other actors is made by phone and mail by Person 7, and further mentions that communication is key in enabling any changes in speed. For the ships on time charter, the communication is often made directly to the captain of the ship, but for voyage charter there is usually an agent in between in charge of this. As previous respondents, Person

7 also mentions that a possible issue in introducing virtual arrival or any other information sharing system is the lack of trust.

4.6 Port

The Port of Gothenburg has a good geographical position as its anchor spots are protected from harmful weather conditions and a good access point to the Baltic Sea. The port also offers good infrastructure for crew change and bunkering. The person from the port estimates that roughly 60 percent of all ships anchoring near Gothenburg port calls at the port. One of the main reasons for ships anchoring is wating for an empty berth. If needed to build new berths, this would be extremely costly, and also difficult due to the lack of space in the Port of Gothenburg (Person 8).

Person 8 further states the impact that the oil market has on type of charter contract. If favourable times for the oil market, the shipowners often want to make use of voyage charters, to make a higher revenue, but if the market is more uncertain, the owner prefers time charters, as it enables a secure income. However, on the contrary, for the charterer this could be the opposite, as the voyage charter contract often implies a higher cost for them.

Port of Gothenburg uses a first come first serve as queuing system, which Person 8 means is the most fair and relevant system but would be willing to use an alternative or adapt it if a virtual arrival system were in place. A virtual arrival system, and also some sort of validation system to ensure the right information is given, is something that the port has been looking into and would be willing to operate and manage. Further, for the issue of trust in a potential information sharing system Person 8 mentions the need for a validation system to hinder the stakeholder from purposely share disinformation and thereby get an unfair advantage in the queuing process. For ensuring true data in a virtual arrival system, they could make use of AIS-data to ensure the position of the vessel, and some AI-validation in ensuring this is true. (Person 8)

4.7 Reasons for anchoring

Below, in figure 3, is the result from the survey presented. The ships that called the Port of Gothenburg and anchored before entering the inner port answered the question of what the main reason for anchoring was. The only two alternatives that the 16 respondents answered was either awaiting laycan (43,8 %) or awaiting free berth (56,7%). (Wass & Therman, 2021)

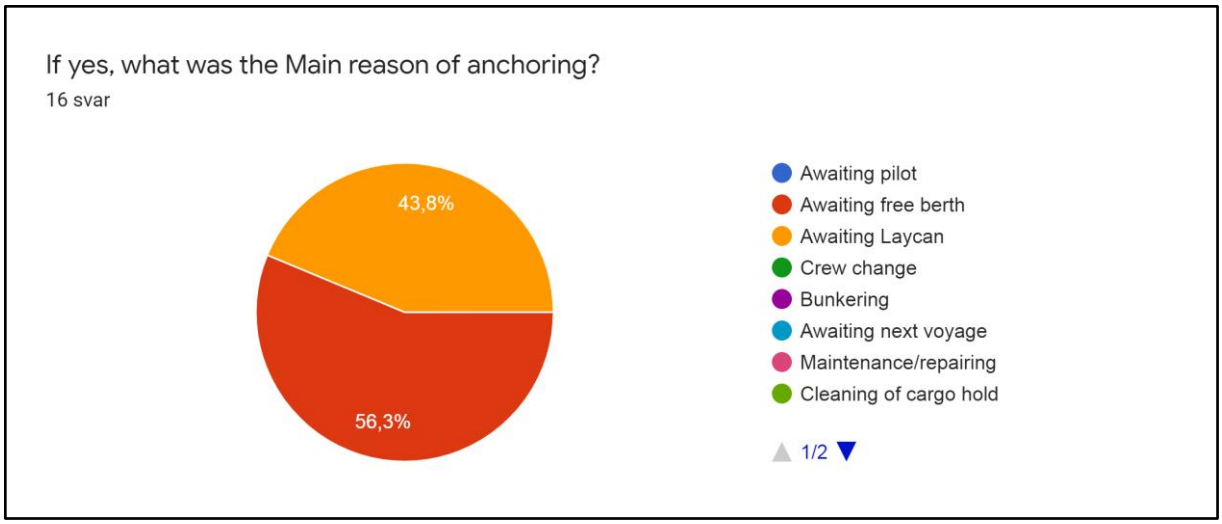


Figure 3 Displaying data the main reasons for anchoring from the survey. (Wass & Therman, 2021)

Table 1 summarizes the results from the empirical data collection.

Table 1 displaying data from the empirical data collection.

Topic	**Company 1**	**Company 2**	**Company 3**	**Company 4**
Is it possible to reduce anchorage time?	Yes	Yes	Yes	Yes
Have the company tried to reduce it?	Yes	Yes	Yes	Yes
Successfully?	To some degree	To some degree	To some degree	To some degree
Optmizing speed	Yes	Optimal speed	To some degree	
Is speed optimization possible?	Yes	Yes	Yes	Yes
Any hinderances?	Yes	Yes	Yes	Yes
Contracutal (laycans/demurrage)	Yes	Yes	Yes	Yes
Port operations as a hinderance	Yes	Yes	Yes	Yes
Is the industry conservative	Yes	Yes	Yes	Yes
Positive to Virtual arrivals?	Yes	Depends	Yes	Yes
Information sharing as a tool to reduce anchorage time (virtual arrival)?	Yes	No	-	Yes
Could laycans be a hindrance for reducing anchorage time?	Yes	Yes	Yes	Yes

5 Discussion

This segment aims to analyse and discuss the results together with the literature review. The discussion is later fundament for answering the research questions and the conclusions following this chapter.

5.1 Reasons for anchoring

As mentioned by Andersson and Ivehammar (2017) some reasons to why ships are anchoring could be because of unavailability of a free berth or that the cargo to be loaded is not available yet. As shown in the survey, the reasons for the 16 ships to anchoring where either awaiting laycan or awaiting a free berth. No ships had reasons such as bunkering or maintenance as their main reason to anchoring, however, some ships conducted such activities while awaiting berth or laycan. This goes in hand with the view of Person 8, who especially pointed out awaiting free berth as a reason behind anchorage. Moreover, the lack of available berth was mentioned by Person 1, 2, 5 and 7 as a hindrance for them to reduce waiting time for the ships they were handling. They pointed on the lack of infrastructure in the Port of Gothenburg, both regarding lack of berths for ships to arrive to and lack of infrastructure for handling discharging and loading of the ships, something that is not mentioned as an issue in previous literature. By having more berths available, they mean that waiting time can be reduced, as they will not have to compete with other companies in the Port of Gothenburg to reach the berth to the same degree as it often is today. Both Company 1 and 2 have either one or two berths they oversee, something they mention as crucial in easing planning and control of the ships they are charge in of. They state that this makes them more flexible in handling unforeseen events, such as not meeting the specification of the product, and thereby might needing to remake it. Regarding infrastructure for discharge and loading of cargo, this is mentioned as a possible bottle neck in within the port, stating that more pipelines would be needed to speed up the process while at berth, to later reduce possible waiting time for other ships. (Person 1, 2 and 5)

Improving port infrastructure can be seen as a quite easy answer to improve port operations and later reduce waiting time, however this would be an extremely costly process (Person 8). Person 8 further mentions that in the case of the Port of Gothenburg, expanding the port, for example in terms of more berths is difficult as the port already is “maximised”.

As mentioned by Furness Wilson (2010, p. 49-52) reducing the time spent at berth could be in interest for the charterer. Depending on the agreements in the charterparty, in terms of specified

laytime, the charterer could earn despatch if completing the operations at berth faster than the laytime. If a time charter, the charterer would benefit from being able to make as much use of the ship as possible during the time period hired and if a voyage charter the charterer can benefit from reducing the risk of paying demurrage to the shipowner. The shipowner is not considered to benefit from this in the same way. If a voyage charter, they can benefit from being able to conduct more travels, however, miss out on possible demurrage (Furness Wilson, 2010, p.49-52). For Company 3, the aspect of demurrage however differs from what Furness Wilson (2010, p.49-52) states. According to Person 6, they are more interested in making the whole process more efficient rather than ensuring a possible income of demurrage. However, as confirmed by Person 2, this is possibly not the case for other companies.

5.2 Just in Time, virtual arrival, and speed optimization

Additional to focusing on improving the port operations in order to reduce waiting time at anchor, and thereby emissions of CO_2, the waiting time could also be reduced by preventative measures such as enabling the ships to arrive just in time (IMO, 2020). As stated by IMO (2020), the JIT arrival implies that a ship is optimizing its speed according to the situation in the port, aiming to reduce the time the ship must anchor if there is no berth available. Most respondents see JIT arrival and speed optimization as one of the more feasible initiatives to become more sustainable, something that is confirmed by IMO (2020), as it enables reduced emission of CO_2 as well as saving fuel costs.

Company 3 is working closely with both Company 1 and 2, in hiring their ships to them, with time charter parties as well as voyage charter. As mentioned by Person 1,2,5 and 7, JIT arrival with the ships time chartered from Company 3, as well as their other time charter contracts, is possible and to a high degree already implemented. This is doable due to that they, as charterers, have a lot of control over the ship and its planning, as well as a long and a valuable relationship with Company 3 (Person 1 and 2). The same is confirmed by Person 5 and 7, pointing to the that a good relationship is crucial in finding a beneficial solution for all actors. Moreover, Person 6 also confirms this from the perspective as the shipowner, as it eases collaboration and is an incentive to set the contracts in benefitting both shipowner and charterer. As previously mentioned, JIT arrival is somewhat already integrated for some operations of Company 1, 2 and 3. As Company 1 and 2 has two respectively one berth in their control, this enables a better planning, and enabling a control of the ships time chartered. For ships hired through voyage charter JIT arrival is considered much more complicated. Taking the importance of good

relationship into perspective, it is mentioned to be more difficult to achieve beneficial collaboration with an actor that you do not have the same experience from working with before (Person 1-7). IMO (2020) also emphasizes the need of good collaboration between different actors, why this could be considered an important aspect.

To enable JIT arrival, there is a need for adopting virtual arrival clauses and that the different actors facilitates for this. As mentioned by Poulsen and Sampson (2019) virtual arrival means that the ship arrives virtually in the port, at the time where it was estimated to arrive if going full speed. Company 3 has to some degree succeeded in using virtual arrival clauses in their voyage party contracts, where the fuel savings from slow steaming is divided on both actors. Having a clearly stated charterparty, covering the potential financial aspects, such as dividing cost savings, is considered crucial also by Stopford (2009, p. 185-187). However, something that is mentioned as a hinder from respondent 1-5 to becoming more JIT is the first come first serve policy adopted in the Port of Gothenburg. For the Port of Gothenburg, this is a necessary policy, as it is most fare that the ship that arrived first is the one who will reach a berth first (Person 3 and 4), which Person 8 agrees to. Styhre et al. (2014) and Poulsen and Sampson (2019) further emphasises that first come first serve can act as a hinder. However, what is important is that a virtual arrival procedure is accepted by the different actors in the port, so that the virtual arrival can count as taking your place in the queue (Person 2,4,7). This is further emphasized by Flodén (2018), who mentions the importance of user acceptance when introducing a new information system. Person 8 sees positively on the introduction of virtual arrival in the Port of Gothenburg, showing that the from the port's point of view, this is something in their interest.

5.2.1 The barrier of trust in introducing virtual arrival

What is mentioned by all respondents as a main barrier for becoming more JIT and introducing virtual arrival clauses is the issue of trusting other actors (Person 1-8). As for example mentioned by Person 5, virtual arrival is a great idea in theory, but also see several issues in making use of it in practice. Firstly, if making use of virtual arrival, a well-developed information sharing system must be developed, including several different actors in the port. This is confirmed by Poulsen and Sampson (2019), who states that there is a risk that the terminal does not trust the information given by about the virtual arrival of the ship. The ship might exaggerate the point in time of its estimated virtual arrival. As exemplified by Person 4, if two ships have given the estimated virtual arrival, one ship might change its to earlier, to

make the other ship slow down as they otherwise will have to wait for a free berth, when in fact the first ship then can arrive before even if this was not the case from the start. As mentioned by IMO (2020), this issue is the same independent of what type of charter party there is. The issue of trust also applies between the different charter parts. As mentioned by Poulsen and Sampson (2019), there can be an issue in trusting the information shared for example regarding the savings in fuel costs, which are supposed to be shared between the actors. This is confirmed by the respondents in the cases of when chartering from a company that you do not have earlier experience from or a good relationship (Person 1-7). One of the major reasons to why JIT arrival is seen more positive on by the respondents could be that the logistical chain is controlled by one company and thereby adjust to changes much faster as they would be controlling both the physical and information flow. This would remove the potential problems originating from the lack of trust between the actors as it involves just one company. To overcome the issue of trust IMO (2020) highlights the importance of validation of data to be shared, which is further emphasized by person 8. One way of ensuring the security of the data and to make sure it is not manipulated is by making use of solutions such as blockchain technology, as in the case of Port of Antwerp (Port of (Port of Antwerp, 2018), 2018). However, there is one aspect mentioned by IMO (2020) and that can act as a further barrier into introducing virtual arrival. That is the insecurity of how the court would handle a possible conflict between different actors, in an issue with the contracts, since it has not been tested to a high degree today, which in turn, could make users hesitant into introducing it.

5.2.2 Information sharing

To implement JIT and virtual arrival sharing information is a crucial part. As stated by Rushton, Croucher and Baker (2017, p. 748), information is crucial in making the whole logistics chain more efficient. However, as previously mentioned, there is a risk regarding trust with information sharing, but also that the shipping industry often is highly conservative in its operations, usually reluctant in making changes (Poulsen & Sampson, 2019). This is also confirmed by Person 7. The process of sharing information between the different actors are to a high degree made through e-mail and telephone, as stated by Person 7, an immense number of phone calls is made every day and the person also handles a huge number of e-mails every day, to and from actors in the port and on the ship, but the respondent does not feel the need of changing this. Moreover, Person 7 believes not to be not the only one who are not eager to change the way of working. The concept of virtual arrival is highly dependent on establishing

an information sharing system, and the reluctancy to sharing data and to changing the way of working can therefore be seen as a major barrier. To encourage the actors to share information IMO (2020) firstly highlights the importance of ensuring that the actors understand the importance of it, and how they can benefit from it. Further, they suggest solutions such as port regulations, as an enforcement for the actors to implement an information system. One risk with this could be as mentioned by Person 3, that the Port of Gothenburg could lose out on competitiveness if actors find it too complicated to ship there, rather choosing to ship elsewhere. On the contrary, IMO (2020) states that being a port with focus on sustainability, and succeed with a well-functioning information system, it can improve the competitiveness of the port.

5.3 Financial aspects

As previously mentioned, one main reason behind ships waiting at anchor in the Port of Gothenburg was due to awaiting laycan. The ships with the reason of awaiting laycan can put weight on the importance of the economic aspects, such as demurrage, despatch and ensuring to not miss the laycan period, and thereby risk losing the shipping of the goods. As mentioned by Person 2 and by Poulsen and Sampson (2019), laycans and demurrage have a large impact on the shipping industry, as could be said that the laycans set some of the rules and act as a hindrance towards slow steaming. If the shipowner slows down to save fuel and thereby not are able to send the NOR before the date the laycans start, the shipowner could lose more financially from losing demurrage compared to the cost for the fuel saved. From a shipowner perspective the removal of possibility of demurrage would have a negative impact on their business, hence some shipowners might use demurrage to reduce their offering to minimum and then create the revenue from demurrage. In this example is speeding up and arriving as soon as possible of outmost importance and fuel saving comes second. As the example shows, if ships could send a virtual arrival as soon as possible they would do it as it can have a positive financial impact on their business. The financial gains from abusing a virtual arrival system by the ship owner could motivate the owners to send misinformation to maximise the possibility of a high demurrage, depending on when decided to be considered an arrived ship. As mentioned by Company 1 and 2 the cost for demurrage can become high, therefore is in the interest of the transport buyer to reduce the possibility of demurrage. The conflict of interest between these actors can act as a barrier for increasing the efficiency of shipping industry. In the conflict they will both protect their own interests and act accordingly to what benefit them the most and thereby potentially lose in the long run. The virtual arrival is an example of this. Both parties

could reduce the overall cost but only viewing things from their point of view might hinder further development.

Apart from this, another important aspect to consider is the value of the cargo, and the volatile market for oil products. As mentioned by Poulsen and Sampson (2019), the value of the product, and ensuring that there is no risk of not delivering it on the time expected, might outweigh the potential savings from optimizing the operational speed. This is further explained by Person 2, who means that there are several economical aspects who control the operations. For example, as charterers they have obligations to the buyers and sellers of the goods, which might lead to them not wanting to take any risk in arriving late.

5.4 Other initiatives

Except from improving port operations or preventing waiting time at anchor by speed optimization, CO_2 emissions can possibly be reduced by using better fuels or ships with more energy efficient engines and construction. What could be considered a hindrance to this is mentioned by Bergqvist & Monios (2019) and Cullinane & Cullinane (2013), as the use of an alternative fuel, such as LNG, or possible new ones with more effect on CO_2 reduction, would require large investments, for example in the port infrastructure. Again, as mentioned by Person 8, investing in port infrastructure is considered very expensive, which could be considered a possible barrier. Another interesting aspect regarding this question is mentioned by Person 6. The person fears that too much focus on slowing down the ships might lead to less focus on using more environmentally friendly fuels or investing in better ships, as he believes that these are important aspects in reducing emissions, why this can still be considered a highly important question.

6 Conclusion

This research aimed to fill the current research gap of anchoring and CO_2 emissions for tankers, looking specifically at the case of the Port of Gothenburg. As stated in the introduction, tankers at anchor brings with it a high number of emissions of CO_2 in Gothenburg, why we found it necessary to identify the reasons for anchoring, to later examine what could be changed. With knowledge about the different contractual aspects the actors must take into account, while also ensuring their operations to be financially doable, the research further aimed to gain understanding in what contractual and commercial aspects must be considered when considering the possible initiatives.

6.1.1 Contribution

The two main reasons for anchoring outside Port of Gothenburg is awaiting laycans and awaiting a free berth. These two reasons are the main reasons, but they can be derived from many other underlaying reasons. The issue with no free berth could be due to infrastructural issues at the port level, adding waiting time to the queue as the discharging of the ship takes longer than predicted. From the interviews, what was considered a main problem for creating queue from the port operations is the process of mixing the right product. We therefore consider making these processes more accurate a crucial part in reducing anchorage time, and thereafter CO_2. The explanation behind the reasons of awaiting laycan considers that ships speed up to arrive at the port to ensure their place in the queue. Due to the current policy of first come first serve system in the Port of Gothenburg, the ship must be near the port to get this. When the laycans starts and the ship has arrived, the demurrage will start, if decided in the charterparty, which is in the best interest for the shipowner. As the ship arrived and the NOR was sent on time, the cargo owner cannot cancel the transport and therefore the shipowner has secured the cargo as well as of possible revenue from demurrage.

The possibility of mitigating this we find difficult. Firstly, there are several commercial interests that must be considered. The charterers have obligations against sellers and buyers, that might put them in a position where a risk of delaying the cargo can imply a high financial loss, and the shipowner have an interest in earning demurrage and not risking getting cancelled. However, we believe it is important to emphasise that it is possible to introduce JIT arrival in the port, this is something that to some degree already is done by the interviewees. For JIT arrival to function for them, a good relationship, were the actors trust each other, are key. Also,

for them to do this today it requires that they are in control of the berth, enabling them to be more flexible as they do not have to consider other ships. Moreover, our research show that for time charter, introducing JIT arrival, and thereby speed optimization is also much easier, as the charterer has control.

To reduce the time ships spent at anchorage near Gothenburg different initiatives can be initiated with focus on anchorage. Initiatives focused on increasing the infrastructure capacity at the energy port could be done to reduce the ships wating at anchorage. The increased loading and unloading capacity would speed up the ports operations but not remove the wating time for a faulty mixture. An initiative that is highlighted in much literature is the introduction of a virtual arrival system, as a way for reducing speed of the ships on the route to reduce waiting time and enabling JIT arrival, and thereby also reducing emissions of CO_2 during the voyage as well as in the port.

We find virtual arrival to be the most important possible initiative to make use of, however, we also find it the most difficult one. One of the most crucial aspects that we found in our research was the lack of trust between the different actors, and the reluctance of sharing information. We believe that a new information system must ensure validation of the data and also be user friendly, as it can be a hindrance in making a conservative industry change.

To summarize our contribution, as of now, the contractual aspects can be seen as hindrance for initiatives in reducing anchorage time and the CO_2 emissions concerned to it in the Port of Gothenburg, especially regarding voyage charter contracts. However, adapting and renewing the contracts is something we see as crucial for enabling change. The issue of commercial aspects, as for example the financial obligations against other actors, should be considered in the contracts. Therefore, it is of importance to highlight the need of covering the commercial aspects in the contract, as these could be seen as something that makes actors not wanting to risk being late, and therefore rushing to the Port of Gothenburg to wait at anchor, and thereby emitting CO_2. For the case of Gothenburg, where free berths and laycan are the reasons for anchoring, we see the potential in initiatives as Virtual Arrival and making the port operations more efficient, to reduce CO_2 emissions, while still putting effort into making use of alternative fuels and energy efficient technologies.

6.1.2 Future recommendations

As previously mentioned, one of the most crucial aspects identified in our study was the lack of trust between the different actors. Therefore, future research is suggested to focus on this issue. Firstly, what is concluded is that a possible Virtual arrival system is in need of validation of the data and information that is shared, why it could be of interest to look more specifically into this question on how to ensure this. Additionally, it would be of interest to further look into how information is shared and communicated today between the actors, to enable an information system that is adapted according to this, and the wishes from the potential users of it. As mentioned in chapter 3, this study could have benefitted from the perspective of an agent, which often is in contact with a high number of different actors. Therefore, a further suggestion is gaining more insight into the agent's perspective, as it could give deeper understanding into the issue of communication and trust.

As the port infrastructure also was identified as a crucial issue in our study, we suggest further research in possibilities to face this, to identify potential solutions for a port that is already considered maximised in its capacity of space. For the specific case of handling energy products in the Port of Gothenburg, where the tight specifications were identified as an issue, it is also of interest to look further into how this process could be improved. Lastly, as this study was a case study of the Port of Gothenburg, a further recommendation is to investigate other ports around the world, to (Bergqvist, Turesson, & Weddmark, Sulphur emission control areas and transport strategies -the case, 2015) identify other possible solutions and gain insight into their operations.

7 References

Abadie, L., Goicoechea, N., & Galarraga , I. (2017). Adapting the shipping sector to stricter emissions regulations: Fuel switching or installing a scrubber? *Transportation Research Part D: Transport and Environment, 57*, 237-250. doi:https://doi.org/10.1016/j.trd.2017.09.017

Alderton , P., & Rowlinson, M. (2015, 10 05). *Law Explorer*. Retrieved from The Economic of Shipping Freight Markets: https://lawexplores.com/the-economic-of-shipping-freight-markets/

Alizadeh, A., & Talley, W. (2011). Vessel and voyage determinants of tanker freight rates and contract times. *Transport Policy, 18*, 665-675. doi:https://doi.org/10.1016/j.tranpol.2011.01.001

Andersson , P., & Ivehammar, P. (2017). Green approaches at sea – The benefits of adjusting speed instead of anchoring. *Transportation research, 51*, 240-249. doi:10.1016/j.trd.2017.01.010

Ao, L., Haitham, C., Yue, C., Philip, A., Chibueze, A. P., & Zhili, S. (2017). Blockchain-Based Dynamic Key Management for Heterogeneous Intelligent Transportation Systems. *IEEE Internet of Things Journal, 4*(6), 1832-1843. doi:doi: 10.1109/JIOT.2017.2740569

Bergqvist, R., & Monios, J. (2019). Green Ports in Theory and Practice. In *Green ports in theory and practice* (pp. 1-17). Cambridge: Elsevier. doi:10.1016/B978-0-12-814054-3.00001-3

Bergqvist, R., Turesson, M., & Weddmark, A. (2015). Sulphur emission control areas and transport strategies -the case. *European Transport Research Review, 7*(2), 1-15.

BIMCO. (2011). *BIMCO Slow Steaming Clause for Time Charter Parties 2011*. Retrieved 03 20, 2021, from BIMCO - Contracts and clauses : https://bi-cd02.bimco.org/contracts-and-clauses/bimco-clauses/current/slow_steaming_clause_for_time_charter_2011

BIMCO. (2013). *Virtual Arrival Clauses for Voyage Charter Parties 2013*. Retrieved 03 20, 2021, from BIMCO - Contracts and clauses: https://www.bimco.org/contracts-and-clauses/bimco-clauses/current/virtual_arrival_clause_for_voyage_charter_parties_2013

Bouzekri, H., Alpan, G., & Giard, V. (2021, 01 04). Integrated Laycan and Berth Allocation and time-invariant Quay Crane Assignment Problem in tidal ports with multiple quays. *European Journal of Operational Research*. doi:https://doi.org/10.1016/j.ejor.2020.12.056.

Bryman, A., & Bell, E. (2015). *Business Research Method.* Oxford: Oxford University Press.

Cairou, P. (2011). Is slow steaming a sustainable means of reducing CO 2 emissions from container shipping? *Transportation research, 16*(3), 260-264. doi:10.1016/j.trd.2010.12.005

Collis, J., & Hussey, D. (2014). *Business reseach - a pracitcal guide for undergraduates and postgraduate students.* London: Red Globe Press.

Corbett, J., Wang, H., & Winebrake, J. (2009). The effectiveness and costs of speed reductions on emissions from international shipping. *Transportation research, 14*(8), 593-598. doi:DOI: 10.1016/j.trd.2009.08.005

Cullinane, K., & Cullinane, S. (2013). Atmospheric Emissions from Shipping: The Need for Regulation and Approaches to Compliance. *Transport Reviews , 33*(4), 377-401. doi:https://doi.org/10.1080/01441647.2013.806604

EEA. (2020, 12 18). *Greenhouse gas emissions from transport in Europe*. Retrieved 04 10, 2021, from European Environment Agency - Indicators : https://www.eea.europa.eu/data-and-maps/indicators/transport-emissions-of-greenhouse-gases-7/assessment

Eide, M., Longva, T., Hoffmann, P., Endresen, Ø., & Dalsøren, S. (2011, 01 10). Future cost scenarios for reduction of ship CO2 emissions. *Maritime Policy & Management , 38*(1), 11-37. doi:https://doi.org/10.1080/03088839.2010.533711

European Comission. (2020). *2019 Annual Report on CO2 Emissions from Maritime Transport.* Brussels : European Comission. Retrieved from https://ec.europa.eu/clima/sites/default/files/transport/shipping/docs/swd_2020_82_en.pdf

Fernie, J., & Sparks, L. (2014). *Logistics and Retail Management: Emerging Issues and New Challenges in the Retail Supply Chain* (4 ed.). London, UK.: Kogan Page.

Flodén, J. (2018). *Essentials of Infomration Systems* (2 ed.). Lund: Studentlitteratur.

Fuglestvedt, J., Berntsen, T., Eyring, V., Isaksen, I., Lee, D., & Sausen, R. (2009). Shipping Emissions: From Cooling to Warming of Climate—and Reducing Impacts on Health. *Environmental Science & Technology, 43*, 9057-9062. doi:https://doi.org/10.1021/es901944r

Furness Wilson, J. (2010). *Carriage of Goods by Sea* (7 ed.). New York: Longman.

Harrison, A., Van Hoek, R., & Skipworth, H. (2014). *Logistics managment and stratagy* (5 ed.). Edingburgh Gate: Pearson.

Hulskotte, J., & Denier van der Gon, H. (2009). Fuel consumption and associated emissions from seagoing shipsat berth derived from an on-board survey. *Atmospheric Environment, 44*, 1229-1236. doi:doi:10.1016/j.atmosenv.2009.10.018

IMO. (2020). *Just In Time Arrival Guide - Barriers and Potential Solutions.* London: IMO.

IMO. (2021). *Introduction to IMO*. Retrieved 03 07, 2021, from IMO: https://www.imo.org/en/About/Pages/Default.aspx

IMO. (n.d). *IMO action to reduce greenhouse gas emissions from international shipping.* London: International Maritime Organization. Retrieved 04 10, 2021, from https://wwwcdn.imo.org/localresources/en/MediaCentre/HotTopics/Documents/IMO

%20ACTION%20TO%20REDUCE%20GHG%20EMISSIONS%20FROM%20INTERNATIONAL%20SHIPPING.pdf

ITF. (2017). *The Impact of Mega Ships: The Case of Gothenburg.* Paris: OECD/ITF. Retrieved from https://www.itf-oecd.org/sites/default/files/impact-mega-ships-gothenburg.pdf

ITF. (2019). *ITF Transport Outlook 2019.* Paris: OECD Publishing. doi:https://doi.org/10.1787/transp_outlook-en-2019-en

Johnson, H., & Styhre, L. (2014). Increased energy efficiency in short sea shipping throughdecreased time in port. *Transportation Research Part A, 71*, 167-178. doi:http://dx.doi.org/10.1016/j.tra.2014.11.008

Kia, M., Shayan, E., & Ghotb, F. (2000). The importance of information technology in port terminal operations. *International Journal of Physical Distribution & Logistics Management, 30*(3/4), 331-344. doi: https://doi.org/10.1108/09600030010326118

Kotachi, M., Rabadi, G., & Obeid, M. F. (2013). Simulation Modeling and Analysis of Complex Port Operations. *Procedia Computer Science, 20*, 229-234.

Law, J. (2016). *A Dictionary of Business and Management* (6 ed.). Oxford: Oxford University Press.

Liker, J. K. (2009). *The Toyota way, Lean för världsklass* (1 ed.). Malmö: Liber.

Lindstad, H. E., & Eskeland, S. G. (2016). Environmental regulations in shipping: Policies leaning towards globalization of scrubbers deserve scrutiny. *Transportation Research Part D, 47*, 67-76.

Lumsden, K. (2009). *Logistikens Grunder* (2 ed.). Lund: Studentliteratur.

Maritime and Port Authority of Singapore. (2021). *Maritime Singapore Green Initiative*. Retrieved 03 20, 2021, from Maritime and Port Authority of Singapore: https://www.mpa.gov.sg/web/portal/home/maritime-singapore/green-efforts/maritime-singapore-green-initiative

Mat, N., Cerceau, J., Shi, L., Park, H.-S., Junqua, G., & Lopez-Ferber, M. (2016). Socio-ecological transitions toward low-carbon port cities: trends, changes and adaptation processes in Asia and Europe. *Journal of cleaner production, 114*, 362-375. doi:10.1016/j.jclepro.2015.04.058

Menon, A. (2021, 02 9). *Voyage Charter vs Time Charter*. Retrieved 03 05, 2021, from Marine Insight : https://www.marineinsight.com/maritime-law/voyage-charter-vs-time-charter/

Merk , O. (2014). *Shipping emissions in ports.* Paris: International Transport Forum, Organisation for Economic Co-operation and Development (OECD).

MirHassani, S. (2008). An operational planning model for petroleum products logistics under uncertainty. *Applied Mathematics and Computation, 196*(1), 744-751. doi:https://doi.org/10.1016/j.amc.2007.07.006

Parsmo, R., & Winnes, H. (2020). *Emissioner från fartygen i Göteborgs Hamn 2019.* Göteborg: IVL Svenska miljöinstitutet.

Patel, R., & Davidsson, B. (2011). *Forskningsmetodikens grunder: att planera, genomföra och.* Lund: Studentlitteratur.

Pocuca, M. (2006). Methodology of day-to-day ship costs assessment . *Transportation Economics, 18*, 337-345.

Port of Antwerp. (2018). *Antwerp blockchain pilot pioneers with secure and efficient document workflow*. Retrieved 03 20, 2021, from Antwerp blockchain pilot: https://static1.squarespace.com/static/5a4c923580bd5e51e5536643/t/5b2782a0aa4a99e2ba580730/1529316001759/FinalPressRelease-T-Mining-150618.pdf

Port of Gothenburg. (2021a). *Onshore power supply for vessels*. Retrieved 03 05, 2021, from Port of Gothenburg - Greener transport: https://www.portofgothenburg.com/about-the-port/greener-transport/onshore-power-supply-for-vessels/

Port of Gothenburg. (2021b). *The Port of Gothenburg*. Retrieved 02 20, 2021, from https://www.portofgothenburg.com/about-the-port/the-port-of-gothenburg/

Port of Gothenburg. (2021c). *Bulk Liquid*. Retrieved 05 26, 2021, from Port of Gothenburg: https://www.portofgothenburg.com/terminals-and-services/bulk-liquid/

Port of Los Angeles. (2018). *Inventory of air emissions for calender year 2017*. Port of Los Angeles.

Port of Rotterdam. (2019, 09 27). *ONE aims to reduce waiting time with Pronto*. Retrieved 03 10, 2021, from Port of Rotterdam - Digitisation: https://www.portofrotterdam.com/en/news-and-press-releases/one-aims-to-reduce-waiting-time-with-pronto

Poulsen, R. T., & Sampson, H. (2019). 'Swinging on the anchor': The difficulties in achieving greenhouse gas abatement in shipping via virtual arrival. *Transportation Research Part D: Transport and Environment, 73*, 230-244.

Pratap, S., Daultani, Y., Tiwari, M., & Mahanty, B. (2018). Rule based optimization for a bulk handling port operations. *Intell Manuf, 29*(2), 287-311. doi:10.1007/s10845-015-1108-7

Rushton, A., Croucher, P., & Baker, P. (2017). *The handbook of logistics and distribution managment* (6 ed.). London: Kogan Page Limited. Retrieved 11 21, 2019

Sand, P. (2020, 09 09). *Tanker Shipping: Freight rates back at loss-making levels after 12 very profitable months*. Retrieved 04 05, 2021, from Hellenic Shipping News: https://www.hellenicshippingnews.com/tanker-shipping-freight-rates-back-at-loss-making-levels-after-12-very-profitable-months/

Saxe, H., & Larsen, T. (2004). Air pollution from ships in three Danish ports. *Atmospheric Environment, 38*, 4057-4067.

Seong-Hyeok Moon , D., & Kyun Woo , J. (2014). The impact of port operations on efficient ship operation from both economic and environmental perspectives. *Maritime Policy & Management, 41*(5), 444-461. doi:10.1080/03088839.2014.931607

Sjöfartsverket. (2021). *Ankarplatser*. Retrieved 04 15, 2021, from Sjöfartsverket : https://www.sjofartsverket.se/sv/tjanster/lotsning/lotsomrade-goteborg/nautisk-information/ankarplatser/#yttre-ankarplatser

Stopford, M. (2009). *Maritime Economics* (3 ed.). London: Routledge/ Taylor and Francis.

Strandhagen, J. O., Vallandingham, L. R., Fragapane, G., Strandhagen, J. W., Hætta Stangeland, A. B., & Sharma, N. (2017). Logistics 4.0 and emerging sustainable business models. *Adv. Manuf, 5*, 356-369. doi:https://doi.org/10.1007/s40436-017-0198-1

Styhre , L., Winnes, H., Bännstrand, M., Karlsson, R., Lützhöft, M., Falk, M., & Åström, D. (2014). *Energieffektiv svensk sjöfart.* Göteborg: IVL Svenska Miljöinstitutet.

UN. (2021). *The Paris Agreement*. Retrieved 03 05, 2021, from United Nations - UN and Climate Change: https://www.un.org/en/climatechange/paris-agreement

UNCTAD. (2021). *Review of maritime transport*. Retrieved 04 15, 2021, from UNCTAD - Transport, logistics and trade facilitation: https://unctad.org/topic/transport-and-trade-logistics/review-of-maritime-transport

Wass, F., & Therman, A. (2021). The reasons for anchoring. *Project BRAVE ECO*.

Watson, R., Holm, H., & Lind, M. (2015). *Green Steaming: A Methodology for Estimating Carbon Emissions Avoided.* Fort Worth: Thirty Sixth International Conference on Information Systems.

WMO. (2021). *State of the Global Climate 2020.* Geneva : World Meterological Organization.

8 Appendix

8.1 Appendix 1 – Interview guide in English

Interview guide English

1st part with a more general focus: About the respondent and the company and its legal aspects

Who are you and What is your role in the company?

In what market is the company operating?

- E.g. Oil, gas etc.

In what freight market?

- Voyage charter, time charter etc.?

Overall view: How does the company operate according to this market?

What is your business model?

Can you give an example of a "daily operation"?

How are the ships managed?

If operating with voyage charter:

- How is this affecting you?
- How is it conducted?

What contracts are there to consider?

- Between the different parts
- How are these affecting you?

Are you making use of Lay-cans?

- How is this affecting your business?

Are there any other legal aspects to consider?

- E.g., How much can you decide yourselves vs. what is decided from "above"?

2nd part: More specific about the operations, anchorage, and possibilities to reduce time.

Arrival:

How is the process of arrival of the ships to the port?

Is there any specified order/system or first come/first serve?

What activities are conducted during the port call?

- Which are you as a company in control of?

Do you see any potential in time savings in any of these?

Has there been any initiatives to reduce the time spent in port?

Have there been any initiatives to reduce waiting time at anchor?

Is this considered a problem?

What would be required to reduce this?

Is the waiting time affected by the type of freight market (voyage/time)?

Do you see any potential financial benefits or loss by reducing the waiting time?

- E.g., demurrage

Do you have digital sharing of information between the different parts?

- Information sharing systems, Virtual arrival, Blockchain technology to share documents and data etc.

3rd part: Summarizing and overview.

Would you consider the different contracts/legal aspects to be an enabler or a barrier for change?

- Why?

Do you consider it to be beneficial for your company to become more just-in-time? (In other words, reducing time spent at anchor)

- Why?

What do you consider to be the main barriers for change?

8.2 Appendix 2 - Interview guide Swedish

Fråga om sekretess

Vilken juridisk enhet du jobbar i? (Legal entity – vet ej riktigt hur man ska säga)

Vilken är din position/roll i företaget?

Vilken avdelning jobbar du inom?

Vilken är din erfarenhet inom den här industrin?

Inom vilken marknad verkar företaget?

- T.ex. Olja, gas etc.?

Inom vilken typ av freight market? Alltså typ av marknad för hur man hanterar shipping. Äger egna båtar, hyr för en viss tid eller hyr för en resa?

- Voyage charter, time charter etc.?

Överblick: Hur opererar företaget med grund av denna fraktmarknad? Alltså t.ex. om man använder sig av voyage charter, hur går detta till i praktiken?

- Dagliga operationer på befraktning, hur de letar efter fartyg att ta deras laster? Hur hanterar ni er befraktning?

Om ni använder er av voyage charter market?

- Hur görs detta?
- Hur påverkar de er?

Vilka kontrakt finns det som ni måste ta hänsyn till?

- Mellan olika parter
- Hur påverkar dessa er?

Använder ni er av Lay-Cans?

- Hur påverkar detta er business?

Finns det några andra legala aspekter att ta hänsyn till?

- T.ex. Hur mycket kan ni bestämma/styra själva och hur mycket bestäms ”ovanifrån”?
- Kanske från port authority etc?

Del 2: Mer specifikt om operationer, ankring och hur man kan minska tid

Anlöp:

Hur ser ankomstprocessen ut för er i Göteborgs hamn?

- Finns det en specificerad ordning/system eller gäller first come/first serve?
- Hur ser ni på eventuell problematik med detta?

Fokusera på Göteborg

Vilka delar I anlöpsprocessen är ni som företag en del av?

Ser du potential i tidsbesparing I någon av dessa?

Har det genomförts några tidigare initiativ för att minska tiden i hamn?

Har det genomförts några initiativ för att minska tiden fartygen ligger ankrade utanför terminalen?

- Ur befraktningssynpunkt → Är det svårt att göra det ur avtalssynpunkt?

Ses detta som ett problem?

Vad skulle krävas för att minska denna tid?

Påverkas denna tid beroende på vilken freight market det är? (voyage/time)?

Ser ni potentiell finansiella positiva eller negative effekter med att minska denna väntetid?

- T.ex. Demurrage

Använder ni er av någon typ av digital informationsdelning?

Har ni haft några sådana initiativ?

Olika typer av informationssystem?

- Virtual arrival, JIT arrival, Port Community system, Port exchange i rotterdam, uniqy i finland mona lisa projekt, Port of LA, Early depatrure procedure, Blockchain eller andra säkerhetsprocedurer

Del 3 Summarizing and overview.

Anser du att de kontrakt som finns/legala aspekter är möjligörare eller hinder för förändring?

- Varför?

Hur ser ni på BIMCO-avtalen?

Ser ni nya standardkontrakt som något som behövs eller är befintliga bra?

- Skulle man kunna använda dom om tekniken fanns?
- Är de en flaskhals?

Anser du att det hade varit fördelaktigt för ert företag att bli mer JIT? (In other words, reducing time spent at anchor)

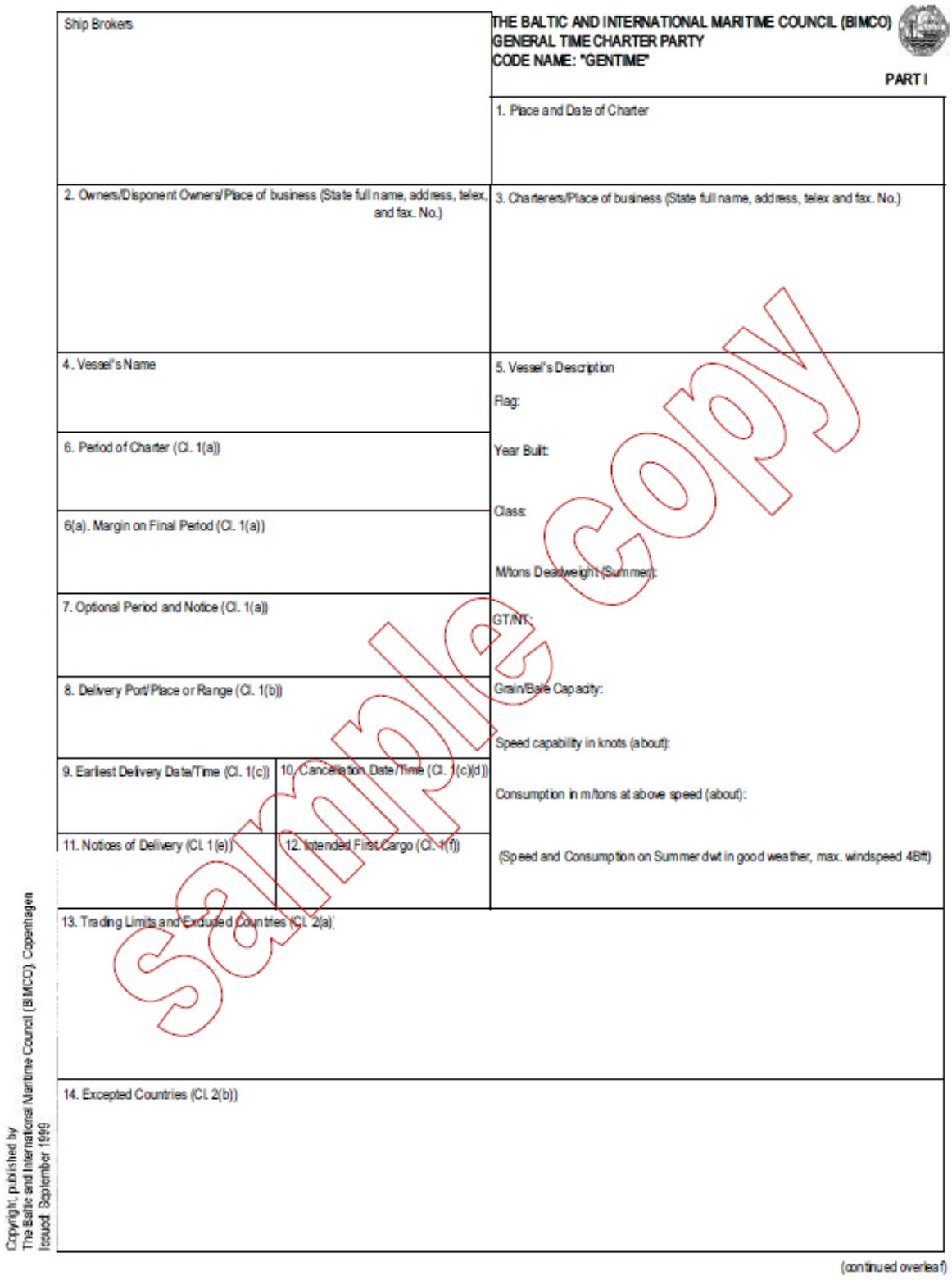
- Varför?

Vilka tror du är de största hindren för förändring?

Del 4: Closing remarks

Är det några aspekter av era operationer som du anser att vi har missat?

8.3 Appendix 3 – Example of BIMCO charter parties



Ship Brokers

THE BALTIC AND INTERNATIONAL MARITIME COUNCIL (BIMCO)
GENERAL TIME CHARTER PARTY
CODE NAME: "GENTIME"

PART I

1. Place and Date of Charter

2. Owners/Disponent Owners/Place of business (State full name, address, telex, and fax. No.)

3. Charterers/Place of business (State full name, address, telex and fax. No.)

4. Vessel's Name

5. Vessel's Description
Flag:
Year Built:
Class:
M'tons Deadweight (Summer):
GT/NT:
Grain/Bale Capacity:
Speed capability in knots (about):
Consumption in m/tons at above speed (about):
(Speed and Consumption on Summer dwt in good weather, max. windspeed 4Bft)

6. Period of Charter (Cl. 1(a))

6(a). Margin on Final Period (Cl. 1(a))

7. Optional Period and Notice (Cl. 1(a))

8. Delivery Port/Place or Range (Cl. 1(b))

9. Earliest Delivery Date/Time (Cl. 1(c))

10. Cancelling Date/Time (Cl. 1(c)(d))

11. Notices of Delivery (Cl. 1(e))

12. Intended First Cargo (Cl. 4(1))

13. Trading Limits and Excluded Countries (Cl. 2(a))

14. Excepted Countries (Cl. 2(b))

(continued overleaf)

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Figure 4 First page of a BIMCO contract

15. Excluded Cargoes (Cl. 3(b))			
16. Hazardous Cargo Limit (Cl. 3(c))	17. Redelivery Port/Place or Range (Cl. 4(a))		18. Notices of Redelivery (Cl. 4(c))
19. Fuel Quantity on Delivery (Cl. 6(a))	20. Fuel Quantity on Redelivery (Cl. 6(a))	21. Fuel Price on Delivery (Cl. 6(c))	22. Fuel Price on Redelivery (Cl. 6(c))
23. Fuel Specifications (Cl. 6(d))			
24. Hire (Cl. 8(a))	25. Owner's Bank Account (Cl. 8(b))		
26. Grace Period (Cl. 8(c))	27. Max. Period for Requisition (Cl. 9(c))	28. General Average Adjustment (Cl. 14(b))	
29. Supercargo (Cl. 15(f))	30. Victualling (Cl. 15(g))	31. Representation (Cl. 15(h))	32. Hold Cleaning by Crew (Cl. 15(m))
33. Lumpsum for Hold Cleaning on Redelivery (Cl. 15(m))		34. Vessel's Insured Value (Cl. 20(a))	
35. Law and Arbitration (state Cl. 22(a), 22(b) or 22(c) of Cl. 22 as agreed; if 22(c) agreed, place of arbitration must be stated (Cl. 22))		36. Commission and to whom payable (Cl. 23)	
37. Additional Clauses			

It is agreed that this Contract shall be performed subject to the conditions contained in this Charter Party consisting of PART I including any additional clauses agreed and stated in Box 37 and PART II as well as Appendix A attached thereto. In the event of any conflict of conditions, the provisions of PART I and Appendix A shall prevail over those of PART II to the extent of such conflict but no further.

Signature (Owners)	Signature (Charterers)

Figure 5 Second page of a BIMCO contract