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Faculty of Technology, Natural Sciences and Maritime Sciences

Master's Thesis

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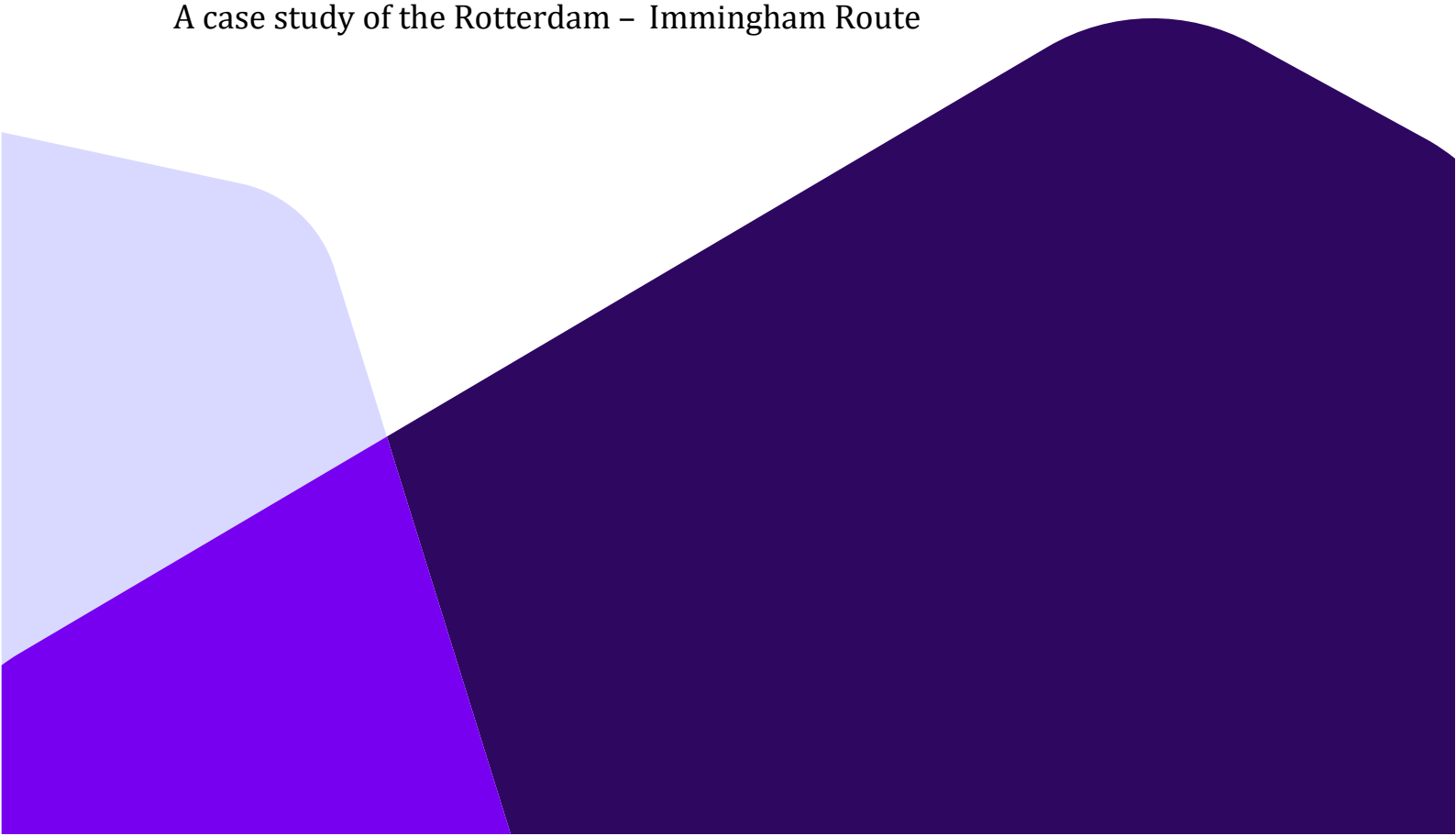
The relative competitiveness of Short Sea Shipping

A case study of the Rotterdam – Immingham Route



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This thesis is worth 30 study points

Summary

The green shift have implications for the global supply chains in terms of increased awareness on emissions and the environmental footprint left by humans. As a result of this, we see an increased willingness in demands towards the companies operating in these supply chains. Areas not earlier as affected by environmental requirements, have suddenly seen a change in this approach. As the most used method of transporting goods across the world, the shipping sector are going to be under the limelight as we seek to address its sustainability. With newly imposed regulations, and further expected requirements, the shipping sector could experience the need to change. With that change, the prerequisites for operations could be changed as well, which could have effects towards rates and service-level. Throughout this thesis, the aim is to analyse the relative competitiveness of Short Sea Shipping. The research question is deducted from an hypothesis that, if enough requirements are imposed, ship transport could be seen as a less viable option when compared to Road transport.

Through a comprehensive and detailed literature review, some of the different factors that could affect Short Sea Shipping and road transport is presented to give an overview of the complexity of the problem.

To contextualize the thesis, a case study have been used, focusing on the Rotterdam – Immingham route. The use of a case study makes it possible to discuss different factors on the background of realistic examples. The assignment is structured to give a general introduction and explanation of the state of the competitiveness now, before discussing it under the case study.

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Foreword

I would like to start with a sincere thank you to my supervisor Per Haavardtun. His guidance through the process of writing this thesis have been crucial for my ideas to materialize into a finished product. Furthermore, I would like to thank the University of Southeastern Norway, and the lecturers for being flexible and adaptable throughout the study. Without this flexibility, it would be impossible for me to combine this study with a full-time job at sea.

Lastly, I want to thank my fiancée and my kids for having the patience to endure this with me. Your support and encouragement have helped me keep my motivation going forward. And you have been an immaculate support through the entirety of my study.

Thank you.
Bergen / 20.11.2023

Ole-Martin Instefjord Hansen

1 Introduction

The problem/challenge

Throughout the entire logistical chains around the world, a major change is occurring. We are experiencing a change in thinking, driven by an increased focus on the environmental footprint left by human activities for the past decades. The shift in focus is embodied by targeted efforts to mitigate the effects we already are experiencing of global warming through reduction of greenhouse gas emissions and other forms of pollution. The changes are multifaceted, complex, and have an extensive reach across all sectors of the supply chain. The global initiative towards environmental regulations has been unfolding for a while, for all modes of transport. We expect these regulations to have a positive impact on the environment. However, it could spark a debate regarding the relative competitiveness of these sectors under a new regulatory regime. This research seeks to address this relative competitiveness of Short Sea Shipping by examining a specific case: the Rotterdam-Immingham route. Rotterdam is a major hub in the global logistical network, as the port is a critical junction for shipping and freight transport. Immingham is a central cog in the short sea shipping network, and especially the shipping towards Great Britain. At Immingham, 46 million tons of cargo are handled annually, and in terms of activity, container shipping mounts to approximately 10 % of all port calls (Marine Traffic, 2023). This underlines the ports significance as a logistical point for the UK. This route is believed to be relevant for such a case study, as it is using short sea shipping as its main mode of transportation. However, there is an option to use road transport for delivery of goods at this route, and the characteristics of each mode will be further elaborated throughout the thesis.

The question of the relative competitiveness of short sea shipping versus road transport on this route is the central focus in this thesis. The thesis is built upon the assumption that increased regulations, particularly those concerning environmental demands and emission requirements, will inevitably elevate the cost of short sea shipping. The further assumption is that this will decrease the level of convenience for the customer, and this research probes the potential consequences of such a dynamic. Specifically, it examines the likelihood that road transport could emerge as a viable alternative, provided that the infrastructure and road networks support such a transition.

As Container feeders on this route have the capacity to carry between 350 and 1000 containers or TEUs, a significant alteration in the cost structure could precipitate a shift in customer preference. The underlying hypothesis is that a subset of those customers may opt for road transportation if the conditions are favorable in terms of delivery and cost, as well as being considered relatively sustainable. This is, of course, reliant on a rational approach, operating under a generalization that customers demand is predominantly driven by delivery time and costs, and secondarily driven by a concept of environmental responsibility.

In highlighting these dynamics, this thesis will offer a nuanced insight into the complexity of the modern transport industry. By examining the case of the Rotterdam-Immingham Route, it aims to shed a light on broader trends and challenges. These are believed to come as a result of environmental focus, regulations, and the ongoing process of increased focus on sustainability and competitiveness in the future of global logistics.

Throughout the thesis, the relative competitiveness of container shipping versus road transport will be discussed. The thesis is built upon an assumption that when facing enough regulations in terms of environmental demands and emission requirements, the cost of short sea shipping will increase. If this happens, the further assumption is that on a route where the infrastructure and roads allow it, road transport could become a viable option. The assumption builds on the fact that shipping have been able to operate without much scrutiny over their operations in regard of climate impact until now. Road transport, however, have seen a gradual shift towards a sustainable approach along with the same happening for personal-used cars. The impact of the problem is that if the assumption that road transportation becomes more competitive relative to short sea shipping, it could redefine the way we plan our supply chains, disrupting the established practice. Furthermore, the problem is applicable to other routes, as the trends examined in this assignment is assumed to be applicable and relevant for similar routes in different places.

The goal of the thesis is to identify and discuss potential challenges regarding the sustainability and competitiveness of short sea shipping. The research has been narrowed, focusing on existing literature and scientific studies to gain the adequate prerequisites for an analysis through discussion some of the challenges for relevant actors. The literature review will also be used to explain some of the market fundamentals, and how different measures have had an impact in the modes of transportation so far. Through examination of the

reactions from the marked on existing environmental measures taken towards a more sustainable way of shipping, lines toward the future will be drawn to discuss the potential future outlook for this route, and the competitiveness. As it is not possible to predict the future, the aim will be to identify the different drivers of change and price and try to identify how these could come into play, an discuss the relative competitiveness after an assumption has been made on how the market reaction is likely to be. The case study is used in order to contextualize the problem of the thesis and create a basis for the comparison.

To give the assignment a structure easy to follow, it is modelled around a main research question;

How will the increase in environmental measures and regulations affect the relative competitiveness between Short Sea Shipping and Road Transport?

The main aspects of price, time usage and emissions will be the focus of the thesis, but other factors which can affect the competitiveness will also be highlighted.

2 Methods

Through this chapter, the methods used to write this assignment will be presented. Method can be described as a systematical approach to research. It connects the different aspects of the research, providing a base to transform the claims of the author into knowledge. (Frankfort-Nachmias et al., 2015). The aim is to create a research process, which will help systemize the data and the further analysis of it. It is important in order to systematize the information, and gain clarity and transparency towards how the data or scientific background of a study and assignment is acquired, thus give a basis for better understanding.

The research method for this assignment is the use of a structured literature review, along with a case study. The aim of the literature review was to find sources that could help understand the complexity and different factors relevant to the two modes of transportation. To provide factual and relevant information, scientific research engines such as ScienceDirect, Oria, Research Gate, and Google Scholar were utilized to identify initial sources. The search started with relevant keywords toward the thesis to provide initial knowledge before more specific searches helped build the validity of the thesis. Furthermore, to assure the quality of the thesis, the sources were evaluated before being considered for further use. It is made a point to try to go through several diverse sources to not get a biased approach. This have prolonged the literature review process, but in the end, it is believed to provide more nuance to the thesis. The review is structured with an intention to be chronological in terms of starting at a general perspective on the modes of transport, before presenting some of the specific differences and the complexity of the different modes of transport discussed in this thesis.

Case studies provide a valuable method for gaining in-depth and detailed analysis of a given situation or phenomenon. The word “case” comes from the latin word casus, underlying the importance of the single instance (Jaobsen , 2005). It can help gain a comprehensive understanding of a situation, as it allows the research to be discussed in relation to reality (Andersen, 2013). A case study is conducted in order to contextualize the problem and give a basis for discussion regarding consequences of the altering of different factors. In opposite to traditional research, where it is an empirical case that is being studied, the case study is based on a constructed case based on reality, with situations and events that one cannot control

(Andersen, 2013). As this is a thesis discussing a potential outcome, the possibility of field research or quantitative data collection is largely eliminated. Therefore, the use of a case study is considered appropriate, as it gives the possibility to take an observer-role to the problem being discussed. Case studies are particularly useful if the events are rare or unique, as it can provide a basis for a comprehensive analysis of the matter (Jaobsen , 2005). Case studies can also be a good platform for building theory in existing cases, as the approach is practical, which makes it instructive in its nature. Case studies are often based on N-studies, which is an explanation of how many units or factors that is observed (Jaobsen , 2005). In this thesis, the different factors are those presented in the case study, and the limitation of the case study, is the specific route, with the restrictions and opportunities that follows this route.

With the case studies, there are both strengths and limitations. On one hand, case studies can help understand complex problems using real-life context. They allow the researcher to explore specific issues and use the real-life grounding of these issues to gain knowledge and insights. Furthermore, the comprehensive and detailed knowledge the researcher gains towards a certain case could help the research gain a high degree of validity (Andersen, 2013). On the other hand, case studies can have limitations. A case study risks being too specific, and therefore not generalizable, as the sample size often is restricted to only the specific case (Andersen, 2013). Furthermore, the study is dependent on the data-collection process, which could be biased if not done properly and comprehensively enough. As there are no formal procedures on how one should create an explanation in studies, much is reliant on the researcher (Andersen, 2013).

Therefore, the researcher must be careful, and consider both the reliability and validity of the study when a case study is applied. These limitations are important to acknowledge, and they should be kept in mind when interpreting and applying the case study. To mitigate the threat of bias, several sources have been used in order to gain a comprehensive approach. Furthermore, the literature reviewed is either peer reviewed and widely cited or have their origins from relevant credible actors such as the European Union.

Starting this thesis, A hypothetic-deductive approach was used, supported by a qualitative approach of data collection. A hypothetic-deductive research method is based on an expectation of the reality, thus an expectation of a possible conclusion for a problem (Jaobsen , 2005). In this case, the expectation of reality is that the environmental focus and

requirements looming over the global supply chains will lead to an increase in rates. The following hypothetic conclusion from the start was that this can make Short Sea Shipping less competitive compared to other transport modes, such as Road transport. The hypothetic-deductive approach uses the collected data and knowledge to confirm if the expectations are correct (Jaobsen , 2005).

The research is written as a qualitative study. Qualitative data uses fewer sources, but rather a more in-depth approach to gain comprehensive knowledge of a topic. As few units are chosen, a larger account of detail is taken (Jaobsen , 2005). Furthermore, in this case, a quantitative approach is deemed to be inappropriate, as the thesis focuses on several factors that are difficult to quantificate, such as environmental measures. The assignment is written in a hypothetical manner in order to shed a light on potential outcomes of increased environmental awareness within different sectors, which in turn makes it difficult to get quantitative data.

Risks with using a qualitative approach is that with few sources, one risk to have faulty data biased on the opinions of the source. To mitigate this, the information is read with a healthy bit of skepticism, and several sources regarding the same topics is read in advance in order to confirm some of thew information given by the sources.

Ethical considerations

In terms of ethical considerations, one should make some reflections. As this study have been conducted without the handling of personal data, it should not be an issue regarding identification of people. As it is written based on a hypothetical approach, it is important to clarify that the writer have a connection to either of the presented alternatives and should not be biased based on personal connections. When talking to companies regarding contributions to this assignment for price-references, they wished to remain anonymous due to competitive reasons, and these wishes have been met, as the prices are considered easy enough to obtain through open sources that it should not be a concern in terms of the validity of the discussions.

3 Literature Review

Goal(s) for the review

Throughout this literature review, the goal is to provide a sense of context and framework, as well as identifying some of the decision-points in terms of competitiveness between both road transport and short sea shipping. Firstly, we will have a look at some prerequisites to understand the hypothesis and gain a sense of the terminology used further in the assignment. Secondly, environmental regulations and measures for both shipping and road transport will be presented. The literature review will provide a baseline for understanding the thesis and the central points in the discussion. Although not everything in the literature review will be discussed clearly in the case study, it contributes to contextualize and give a basis for the considerations done later on.

Literature Review

Choice of transport

As the focus of the thesis is the choice of transportation method for transporting goods, it is appropriate to start with some words regarding choice of transport method. There are several factors that will decide which mode of transport is used. Instances of these can be price, nature of the cargo, convenience, and so on. In this thesis, the focus will be on Short Sea Shipping and Road transport.

To make the two modes comparable, the thesis will build on an assumption that a customer wants to ship one TEU, and that the customer will be completely rational in the approach. With a rational approach, it is meant that the customer wants the best solution based on his preferences, which are price, delivery time, and sustainability.

Methods of freight

Shipping transport

Shipping transport is defined as transport of persons or goods on water. Maritime supply chains are critical for the global supply of goods, and as much as 90% of the goods transported around the world is transported by sea (Rushton et al., 2017).

Shipping is divided into several subcategories, based on what type of ship it is, and what is in their cargo, and the size of the ship. Although there are differences in ship types, the global shipping market is often described as a near perfect market in terms of supply and demand (Stopford , 2009). As the nationality of the ship does not matter, a shipping company is free to relocate their ships as they please based on the best conditions. As this mechanism is felt around the whole market, it creates a "perfect market" where supply meets demand in a way that the other modes of transport struggles to match. One of the biggest advantages of seaborne transportation is that it is considered relatively cheap in terms of price per ton.

Throughout the thesis, the short sea container shipping segment will be in focus. When talking about short sea shipping, one is talking about regional shipping routes that does not cross the large oceans (Stopford , 2009)

International road freight

Road transport is the use of trailers to transport either containers or other types of cargo. It is considered the most important way of transporting goods within an individual country (Rushton et al., 2017). It is also an important international method, and it is a flexible and fast way of transporting goods. As road transporters utilize the same infrastructure as the general population using their cars for personal transport, the road transport network (roads) has been continuously maintained and looked after, as it is in the publics best interest. Furthermore, this work has been largely funded by governments, and it makes the argument that road transport the most governmentally subsidized type of transport. This claim could be backed by the large public funding of road infrastructure which can be seen almost every day

in most countries around the world. Road transport is considered especially effective for short distances, where it is seen as a cost effective mode of transport.

Rates

Shipping rates

Shipping rates are affected by supply and demand within the shipping market. Often, the rates are listed in TEUs, or Twenty-Foot Equivalent Units, which means the price of shipping a twenty-foot container, or the usage of the equivalent amount of space at a ship. Shipping rates are available at the Clarksons database, which gives insight into the historical rates at a given route and segment. This creates a fairly transparent system where the statistics are publicly available for analysis, which further validates the claim of a "perfect market" within shipping.

The shipping rates are dynamic and is affected by both macro- and microevents in the world (Stopford , 2009). According to Stopford (2009), there are mainly ten factors affecting supply and demands. For supply, the five are world fleet, fleet productivity, shipbuilding production, scrapping and losses and revenue. For the demand side, the five most prominent are the world economy, seaborne commodity trades, average haul, random shocks, and transport costs (Stopford , 2009). Looking at these factors, the equation can be quite easily summarized, as if it is a change within one factor, it can lead to a disproportion between the supply and demand, which in turn can affect the rates. To take an example, if the shipbuilding is higher, it affects the supply of ships, making the supply larger, which raises competitiveness in the market, possibly driving price down. Another example is if transport costs increase with for instance higher taxes or fuel prices, it can affect the demand because customers look at other possibilities for transporting their goods, as the price is higher, lowering the demand for ships. The different factors have however a different time-horizon in terms of affecting the market. If there are economic turnaround or shocks, it could lead to a quicker change in this function than if there is a longer-term operation like renewing the fleet to operate more cost-efficient.

As mentioned, the shipping rates are affected by events within the world (Stopford , 2009). The outbreak of COVID-19 saw an increase in online retail due to lockdowns, which again drove the demand upwards, thus pushing the rates up. This is illustrated in figure 2 below, where a notable surge in shipping rates from May 2020 is shown. Although it decreased sharply through 2022, the level is still higher than the years before the pandemic, but the trend is pointing downwards.

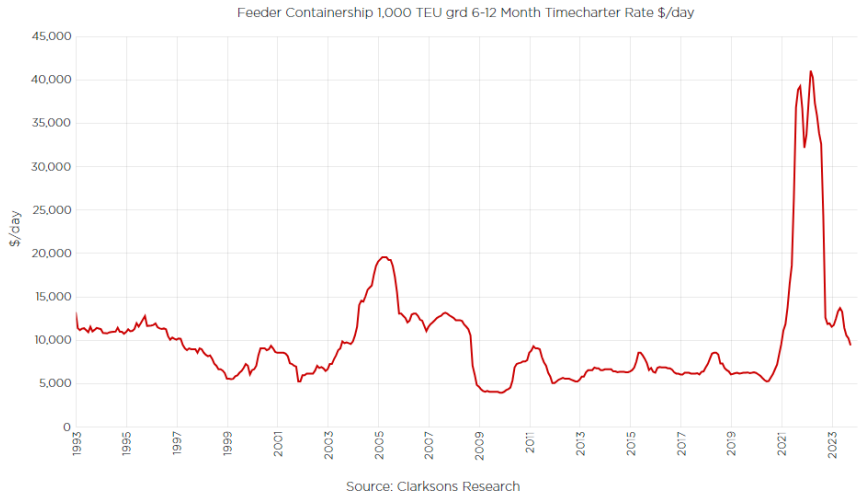

Figure 1: Container feeder rates 1993-2023 Source: Clarksons

Road freight transport rates

In contradiction to Shipping transport, the rates for Road transport are not as openly attainable. For shipping, the Clarksons network give a relatively good estimate, while road transport largely is calculated for each instance. On can, however, break the road transport cost into subparts distance and time. The distance- equation consists of fuel in EUR per kilometer, multiplied by the fuel consumption per kilometer for the trucks (Persyn et al., 2019). Furthermore, the toll costs are also in this equation, which is specific per route. The time-equation have the labor cost per hour for the driver as the main component. Summarized, we can therefore say that the main drivers of road transport are the fuel consumption along with the labor cost of the driver (Persyn et al., 2019). Of course, there are also a margin on top there for the company operating the trucks, which also needs to be taken into the equation.

Environmental impact

Environmental impact of shipping

For the shipping sector, there are several environmental factors being discussed, which in turn leads to different suggestions regarding future regulations. As there have been an increased focus on the environmental footprint left by humans, there have been several environmental regulations and measures implemented or in the pipeline of being implemented. To understand which measures are being taken, one should have a perspective on which types of environmental impact shipping can have. Throughout the lifecycle of a ship, from shipbuilding to shipbreaking, there are several types of emissions and environmental impacts occurring (Walker, et al., 2018).

The release of pollutants from ships, such as Sox (Sulfur oxides) and NOx (Nitrogen Oxides) have been linked to pollution which potentially can have an adverse effect on both the environment and humans (Walker, et al., 2018). According to the European Environment Agency, Sulphur dioxide emissions from ships in European ports totaled to about 1,63 million tons, which in turn is about 16% of SO2 emissions from all shipping in the world (European Environment Agency , 2023). The emissions of greenhouse gas (GHG) are a major concern as it contributes to global warming. Maritime transportation is a significant contributor to the overall global GHG emissions, and experts are expecting a further rise in GHG emissions towards 2030 (Walker, et al., 2018). Containerships are the largest contributors to CO_2 emissions from maritime transport. Ships are responsible for 13,5% of all GHG emissions from transport in the European Union (European Environment Agency , 2023).

Rotating propellers cause noise underwater, which can have effects on marine life. As the demand for shipping increases, the noise also increases, and underwater noise doubled in Europe in the time period from 2014 to 2019 (European Environment Agency , 2023). The largest contributors to the noise are passenger ships, tankers, cruise ships and container ships. The total impact of shipping is yet to be shown. Another not that reviewed aspect of maritime emissions is the introduction of non-indigenous species to their waters. As this is a field not entirely reviewed, it is still difficult to address and assess the consequences of this introduction. As animals in the ocean could have the opportunity to travel relatively freely, it

is difficult to deem whether they come from ships or is taken by streams. There are, however, some species that are believed to be a result of shipping, one instance is the pacific oyster, which have started to populate the shores of Norway. This species normally populates the pacific, and as there are no streams or currents capable of transporting such a organism at such a distance.

Lastly, Oil spills should be mentioned as a potential environmental threat from shipping. When talking about oil pollution, one is talking about large spills caused by accidents or other happenings. As ships sails across waters, filled with fuel, the statistical risk of new oil spills increases, and the amount of oil transported at sea is increasing (European Environment Agency , 2023)

Environmental impact of road transport

Similar to shipping, the usage of roads for transportation also creates an environmental consequence. There are three main consequences from the usage of trailers:

Air pollution. As for shipping, the emissions different pollutants are a major environmental backside to its usage. Road transport contributes to poor air quality in urban areas, and transport related pollutants contribute to local and regional air pollution, creating increased health risk in certain areas (Greener Ideal , 2023).

Greenhouse gas emissions. Road transport is a major contributor to greenhouse gas emissions. This is primarily in the form of CO_2, from the exhaust of the trailers, which contributes to increased global warming (Vestreng, et al., 2009).

Disturbance of wildlife and population. Road transport can lead to a disturbance of both the wildlife located around the roads, and the people living along the roads. The disturbance can be in the form of noise pollution, or in the form of disruptions of habitats where roads are expanded, as well as contributing to degradation of water quality (Greener Ideal , 2023).

A point worth mentioning when talking about emissions due to road transport, is that many analyses focus on the emissions from road transport as a whole. This would mean that personal cars are in equation as well, creating a faulty picture when we, as in this instance, are talking about a given segment.

Environmental standards and regulations

Environmental standards in the shipping market

In order to make shipping more environmentally friendly and sustainable, various measures have been implemented. One of the most important aspects is the use of cleaner fuels for ships. The use of cleaner fuels not only leads to climate tradeoffs, but also have an impact on public health. This can indicate that a reduction in emissions can lead to an improvement in air quality, which can have a dual purpose, as it helps both public health and the climate (Sofiev, et al., 2018). When talking about environmental measures taken, that are setting the standard within the market, the Sulfur Directive from 2015 should be highlighted as a major step. The directive was implemented by IMO and aimed to reduce the maximum amount of sulfur in marine fuels. In designated Sulfur Emission Control Area (SECA) such as the English Channel, ships who operate within this zone are required to comply with a sulfur content limit of 0,1% in their fuels (Kattner , et al., 2015). One can, however, use “dirtier” fuel outside the designated zones, but the overall aim is to incentivize the shipping companies to opt for cleaner fuels, with the hope of a widespread usage of a cleaner fuel type. This regulation has led to a substantial decrease of sulfur dioxide (SO2) levels in European harbors. Compliance with the sulfur content requirement is something that has been, and is still being monitored, and measurements taken has shown a high degree of compliance with the regulations (Kattner , et al., 2015).

The sulfur directive is believed to have had implications for the practice in shipping in terms of both the operational practice and the choice of fuel type. Operators have opted to switch to other cleaner fuel types in order to comply with this limit. These fuels include low-sulfur marine gas oil and liquified natural gas (Spoof-Tuomi & Niemi , 2020). Although the price for fuel increase when opting for a cleaner type, it has contributed to a reduction in sulfur emissions and improved air quality.

In addition to the choice of fuel types, sustainable practice within shipping can be affected by the stakeholders. As Tran, et al. (2020) discusses, stakeholders play a key role, as they can drive the focus towards environmental practices by placing a greater emphasis on this. Furthermore, there are some success factors within sustainable shipping management; They are believed to be stakeholders focus, intra-firm management, the acceptance of new technology, collaboration within the firm, and how the strategy of the company is laid out (Tran et al., 2020). This underlines the need for a holistic approach to the problem to streamline and optimize the shipping operations toward a sustainable practice.

Slow steaming is another mean that is used in the shipping world in order to reduce emissions. It is simply to reduce the speed of the vessel, and several studies have shown that slow steaming can lead to a reduction in carbon dioxide (CO_2) emissions, with reports showing reduction in carbon emissions as far down as 43% (Maloni et al 2013). As emissions for ships have been heavily discussed, it has also been studied comprehensively, and mostly agree with slow steaming as a immediate measure for bringing the emissions down. Studies have also shown that slow steaming can lead to a reduction in the emissions of nitrogen oxide (NOx) along with the CO_2 emissions cuts already mentioned (Boersma et al. 2015). Additionally, slow steaming has been shown to lead to fuel savings, which again leads to cost reduction for the shipping companies (Mallidis et al. 2018). As NOx is harmful for both the environment and human health, one could say that slow steaming gives a dual purpose in terms of removing both environmental hazards, as well as human hazards. Combined with the cost reduction, the benefit of slow steaming seems to be obvious. The decreasing speed is shown in figure 2, and the declining trend seems to correlate with the EEXI-implementation of 2023. Furthermore, it is reasonable to assume that slow steaming can help incentivize the shipping sector to order and deploy more environmentally friendly ships as one could be assumed to be at the end of the line in terms of quick environmental efforts when slow steaming, the incentive is clear in terms of staying competitive by introducing more efficient vessels.

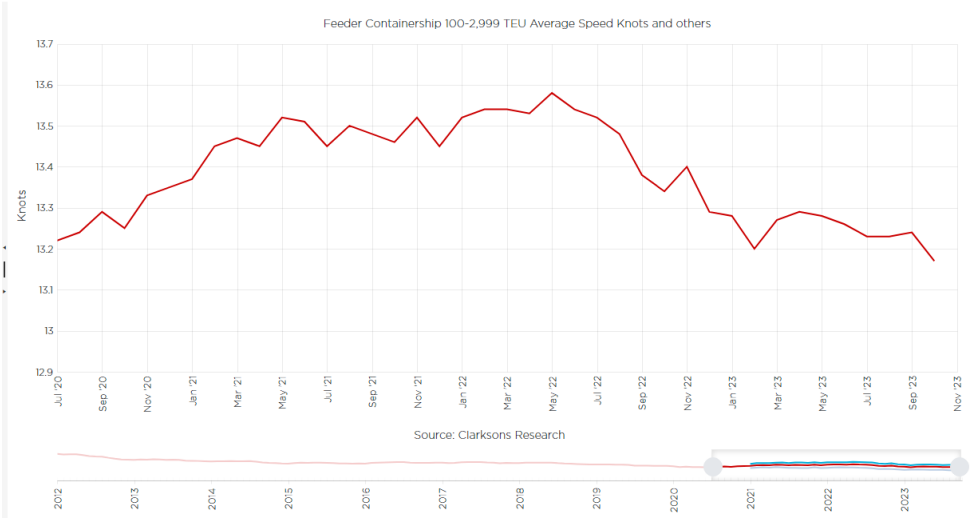

Figure 2: Average speed of Container feeders. Source: Clarksons

Environmental standards within the road transport market

For Road transport within Europe, a standard called EURO 6 was introduced in 2015. Although not mandatory, in terms of usage, most new trucks are compliant to EURO 6. The Euro 6 engines are characterized by their built-in cleaning technology which not only cleans the air going out of the engine, but it could ultimately contribute to cleaner air by cleaning the air taken into the engine. This is, of course a major simplification, as there are other environmental challenges connected to truck transport, such as noise pollution and air pollution from the road. The conversion towards EURO 6 was started after several studies linked NOx to respiration problems. The permitted emissions of NOx were reduced from 180 mg/km to 80 mg/km. Among the incentives for converting the fleet of trucks to EURO 6 are greater fuel efficiency, more power in the truck and less taxing on the new trucks running cleaner.

Furthermore, the impact of road transport is being addressed worldwide. The emergence of environmental-friendly policies shows a demand from the population to think green, and several places have laid out plans for pedestrian-friendly cities where the infrastructure and collective transport systems aims to make large trucks obsolete.

Regulations affecting the shipping market

In terms of regulations that experts expect will affect the shipping market in the coming years, it is safe to assume that the process of further cutting down emissions will be a high priority. The new Energy Efficiency Existing Ship Index (EEXI) standard was implemented by IMO at the start of 2023 and seeks to impact the emissions of the entire shipping sector. The aim of the EEXI standard is to improve energy efficiency on ships by defining a requirement for the carbon intensity of ships (DNV, 2023). As it is a new standard, its effect is yet to be seen clearly, but it is expected to drive forward the adoption of more energy-efficient technologies and further improve operational practices. This could also influence the cost of shipping, but as mentioned, the results and implications are yet to be seen clearly. Clarksons considers the EEXI a short-term measure and expect a significant fleet-renewal in the coming years due to such measures. An immediate measure to comply, is a more widespread usage of slow steaming as a practice. In the container-market, the average speed was at an all-time low at 13,7 knots in February 2023, and the trend is pointing further downwards, which could indicate that it is a measure used by the companies to comply with the EEXI standard (Holden, 2023).

The type of fuel and propulsion is another aspect of shipping that is anticipated to be a subject of innovation and change in the years to come. As Shipowners and customers grow aware of the impact the choice of fuel can have on the environment, the industry is starting to explore various alternatives. Electricity, Ammonia, and LNG are among the contenders to spearhead the next shift in shipping, and the technology and solutions are evolving rapidly. A change in fuel type could also raise the need for infrastructural changes at the port to accommodate for the new fuel (International Transport Forum , 2020). An example of this is the ferry-chargers in Norway used to charge the electric ferries between the voyages.

Spoof-Tuomi and Niemi (2020) discussed the impact of different fuel types in Short Sea Shipping, and their study looked at the different emission profiles of Marine Diesel Oil with sulfur content of 0,1% (MDO), Liquid Natural Gas (LNG), and Liquified biogas (LBG). They highlighted the use of LNG as fuel and stated that it could lead to a 25% decrease in emissions directly from shipping. However, due to upstream emissions in the LNG process,

the actual decrease in emissions is believed to be around 10%. LBG is believed to be a more climate-friendly alternative, with significant reductions in emissions compared to MDO 0,1S. (Spoof-Tuomi & Niemi , 2020). LBG is however, not as available as LNG, and it is also significantly more expensive, with prices approximately 169% higher than MDO 0,1S. Therefore, the potential implementation and usage of LBG as a fuel system will need a significant backing in terms of making it available if it should be considered as a credible alternative. It could become a potential fuel in the future, but it is reliant on a significant effort from the governing bodies within shipping, as well as the willingness to take risks by shipping companies. At the time it is too much uncertainty regarding LBG, especially based on availability and price at the time being, and therefore, LNG seems like a more viable option to the fossil fuel most in use today. LNG could also serve as a steppingstone towards the more environmentally friendly LBG, as LNG infrastructure could be used for LBG (Spoof-Tuomi & Niemi , 2020).

Furthermore, the emphasis of sustainability is expected to proceed. Although it might not be seen as an immediate measure, a focus towards design and propulsion with the aim of noise reduction is something that could get increased focus when talking about newbuilding (Smith & Rigby, 2022). A look at the infrastructure surrounding the operations of the ships is also expected to get sustainable solutions. This includes efforts to make the environmental footprint as low as possible, and the usage of green construction practices (International Transport Forum , 2020). This holistic approach to the operations could lead to changes in operational practices such as waste management. As the ocean is troubled by large amounts of waste, a focus towards better waste management practices in the ports are another aspect where its speculated that will get more attention in the years to come.

Regulations affecting the road transport market

As for ship transport, the main environmental effort in the Road Transport market is expected to be focused on emissions. Stricter measures or controlling the NOx emissions have already been implemented, and the clear results makes it fair to assume that these measurements will be stepped up (Vestreng, et al., 2009). A focus on sustainability in the sector as a whole is also expected, with an increased awareness on policies to get a holistic

approach towards the entire industry. The reduction of CO_2 emissions is another focus area, making it one of the most discussed aspects in studies addressing road transport and its environmental impact. (Vestreng, et al., 2009). Electricity as a fuel is expected to be further assessed, and as the market for personal-use cars have had electricity as a fuel for some years, it is expected to move over to the commercial aspect of road transport. Tesla, who have pioneered the EV-market for personal use, have also started their venture towards the commercial aspect of road transport. Tesla states a range of 804 kilometers on their new Tesla Semis (Tesla , 2023). Such an effort towards electrifying the transport sector can have repercussions for the sector, propelling it towards alternative fuels, as one could speculate that the companies pioneering this shift can gain a large amount of goodwill from the possible customer base.

Furthermore, Low Emission Zones (LEZ) and Ultra Low Emission Zones (ULEZ) are concepts introduced in several countries. To be able to freely operate the trucks in those zones in the given countries, the trucks need to meet the Euro 6 standard or be better in order to be compliant. The LEZ- and ULEZ-zones requires non-compliant vehicles to either pay a fee, or sometimes restricts them from enter at all. These zones could be presumed to be targeting older vehicles, and aims to incentivize the use of newer, cleaner vehicles. Some countries in Europe are taking it a step further, banning truck transport at certain times of the day. The average road network in Europe is in a dire need for upgrades, and the population are in many countries growing tired of congestion and unsafe roads due to transport of goods by road. The aim of these restrictions is to mitigate different negative repercussions of high traffic volume, such as reducing traffic congestion, improving the quality of the air, and to force a larger degree of planning and sustainability into transportation options. Some countries across Europe have imposed general bans on transport heavier than 3,5 tons. This ban is imposed at given times, such as Sundays and in holidays (DHL , 2023) This means that container carriers are not allowed to drive on these roads. As the countries stretch from France in the west, to Hungary and Romania in the east, they form a “belt” across Europe. This belt can have severe implications for container transport, as it means that the container carriers to an even larger extend needs to plan their voyages, or risk using an unnecessary amount of time either driving around these countries or waiting for the ban to be lifted. Further reasoning behind a total ban at given times is that the roads are already at max capacity at some places.

Lastly, a set of new requirements for new trucks is expected in some years. As we for now have Euro 6, the next step will be Euro 7. As the standards are still being developed, there are only expectations toward this, rather than facts at this time. It is anticipated that Euro 7 will focus on NOx and PM emissions, and a further reduction of these (Touratier-Muller & Jaussaud, 2021). As we see technological steps forward every day, one could without much doubt assume that Euro 7 will focus largely on innovation and technology. The standard will push for increasingly stricter regulations than Euro 6, and the solution could be cleaner practices and technologies, with adaption of low- or zero-emission vehicles.

Other factors

Bottlenecks

Bottleneck is a term for describing which places in a process where there is either a higher risk of congestion, or already a congestion (Goldratt, 1990, s. 4). This theory can be applied in production processes and in real life processes where it follows a given pattern of dependable processes. In Shipping transport, the part of the process most prone to delays and congestions are the ports. This is regarded a bottleneck, as if it is a delay in a port, the process cannot proceed until it is sorted out, and there are no way to continue the process without the ports for shipping transport. For road transport, the bottlenecks can be more difficult to identify. Depending on the characteristics of the route, there can be several potential bottlenecks. Examples of this can be customs clearing, roadwork, or time-specific traffic congestions (afternoon rush).

Corporate social responsibility

Corporate social responsibility is a term created to describe the increasing focus on sustainability within different sectors and industries. It refers to voluntary initiatives and actions taken to address both environmental and social concerns into the business of the company (McWilliams & Siegel , 2001). The emergence of this concept is a way to recognize the responsibility and power of corporations in terms of having a holistic view of the results of their business, not only looking at the bottom line (McWilliams & Siegel , 2001). CSR

have become increasingly important to stakeholders, and it is incremental to build public trust for companies (McWilliams & Siegel , 2001). This responsibility could also play a factor within choice of transport method, as it affects the customers of the supply chain, where they could be believed to want to show through their actions that they are thinking about which way they get their shipments delivered.

Summary of literature review

Ship transport and road transport are both two modes of transportation that causes their fair share of environmental consequences. Although instrumental for the world trade to go around, the repercussions they cause needs to be taken seriously, and in recent years, they have. As the focus from both society and different organizations narrows in on the different sectors, the need to meet a demand of environmentalism arises. The regulations have, in both modes, become increasingly restrictive, and as new restrictions and measures emerge, steps are taken in the right direction. For ship transport, measures such as the Sulfur cap, and the EEXI-standard should be considered successful, and we are still seeing the results of these. For road transport Low-emission-zones incentivize the owners to think environmentally, and the EURO-standards are setting a baseline for the entire fleet of trucks in Europe.

For the coming years, an even larger emphasis on sustainability and environmentalism is anticipated for both road and sea. As customers become more wary of their responsibility, they demand a larger responsibility from the different links in the supply chain around the world. As technology makes the information even more accessible, fast and effective measures are expected on behalf of the different transport companies. In many ways, the power has shifted towards the customers, making them more aware of their power over the transport companies, and what they can expect and should demand. Examples of this is shown in a greater number of restrictions and demands that companies need to follow. For instance, several countries are banning road long haul transport trucks entirely in given time-slots. In the shipping market, IMO are getting more aggressive in their approach of implementing standards and regulations. The EEXI-Standard is one instance of this. How these demands are going to affect the rates and the market are yet to be shown, but one should be able to draw some conclusions based on assumptions. The potential increase in price would also rely on the willingness at different companies to accept risk, thus focus their newbuilding efforts to

comply with fuel types more focused on the future. In shipping, this effort needs to be especially backed by the governing bodies within shipping, as well as the owners of ports and terminals, as there is a need for large investments within infrastructure to make it realistic to use other types of fuel than fossil. The most notable conclusion to be drawn by this, is that all upgrades needed to be compliant with the demands of today are costly and will require heavy investments. Furthermore, it could lead to a hike in the rates, as it would be irrational to believe that the companies would solely bear the economic consequence of retrofitting, newbuilding, and change of operational practice to comply with new standards.

4 Discussion

Before attempting to draw a general conclusion prior to the case study, one should start to look at the characteristics of each mode, and the different factors that could possibly affect their competitiveness. Ship transport is the largest mode of transport in the world, and to change that all together, a revolution would need to happen within the transport sector. That is highly unlikely, and there would probably not be an alternative to outsource all of the transport now going on keel, to other modes. This thesis focuses on a smaller part of the short sea shipping segment; the customers who ships smaller quantities. For those, a change towards another mode of transport could be more viable. The choice of transport could be based on dogmatism, or the fact that ship transport is better for those customers, and based on the assumption this assignment is built on, we need to at least assume that for now, ship transport is the best approach. Being the most used and preferred mode of transport for haulage of large amounts of goods, shipping could be said to already have an edge towards it competitor road, but how it reacts to changes within the cost of prerequisites such as fuel and taxes aimed at limiting the overall environmental impact of shipping could pave the way for competing modes of transportation. As the customers is believed to be completely rational in their approach, wanting the best type of transport based on time consumption and price, any changes in either can open new markets, or at least have an effect.

Time spent

Shipping transportation is a time- consuming process. It includes loading and unloading of the vessel, along with the voyage from port A to port B. At the ports, one can encounter problems such as port congestion, which could make the time spent waiting even longer.

Road transport have a different time-consumption. The loading process itself is usually not that time-consuming, as the amount of cargo is lesser. Simply put, you only wait for your own cargo to be loaded and unloaded, and not for everyone else's cargo, as is the case with ship transport. On the other hand, the uncertainty along the route could be argued to be higher than at sea. On the road, traffic-congestion can occur along the route, and one is vulnerable for factors like construction work and other things blocking the preferred route. However, the customer could save a lot of lead time, as the customer can, with road transport get their shipment delivered straight to the destination, not having to wait for it to be unloaded, and then transported to the intended destination.

Road transport cold be believed to be more cost-efficient on shorter distances, especially when the aspect of door-to-door deliveries are considered. However, as discussed by Maloni et al. (2013) one of the key strengths of shipping is the haulage of larger shipments, which gives cost advantages due to economies of scale. When discussing the price, efficiency is another consideration that should also be discussed. Short sea shipping provides a higher capacity and lower fuel consumption compared to road transport, which in turn could make it more efficient at certain routes and cargo types (Maloni et al., 2013). Road transport, however, offers a greater flexibility, and could provide the possibility of delivery without the need for transshipment or additional handling, which could make it more beneficial, especially for smaller shipments or time-sensitive deliveries.

The shipping rate of seaborne transport is often listed per TEU, or twenty-foot equivalent unit. For short sea shipping at the Rotterdam-Immingham route, the estimated cost is at 3200 Euros. In this cost, the cost of operating the ship, as well as the entire administration around it, including handling fees at both sides are included in the rate. As the operations and administration is assumed to be optimized, the part that could be affected, is the fuel price, along with other prices connected to environmental demands. The fuel price is

assumed to drive approximately 50% of the shipping rates. In the market we see now, with fairly low rates, one could assume that the margin on top is low, and therefore fuel could be presumed to have a larger impact.

For road transport at the same route, the shipping price is estimated at 500 Euros. This price includes handling fees, fuel, and other expenses (ferry, etc). Compared to shipping, the administration and handling could be presumed to be lesser per shipment, but on the other hand, one could say that it is less "per TEU" for shipping than road. In terms of fuel costs, it is the same with road transport as with ship transport, with an estimated 50% of the rate being fuel costs.

Environmental impact is another increasingly important factor when deciding which mode of transport that should be selected. Road transport is a significant contributor to GHG emissions and air pollution (Greener Ideal , 2023). In contrary, Short Sea Shipping, especially when calculating in the slow steaming practice, can have a smaller environmental footprint due to lower carbon dioxide emissions. The environmental advantage of Short Sea Shipping should therefore not be underestimated, and with usage of practices such as slow steaming, its competitiveness could be enhanced, and it could also be able to comply towards new regulatory requirements.

What could be called environmental reaction time is something that needs to be assessed when talking about both sea- and road transport. With reaction time, we mean how fast the industry is to adapt to different environmental demands. For a ship, the standard time of usage could be estimated to 25 years (Stopford , 2009). In road transport, one is talking about 10-15 years before the trailer is replaced with a newer one (European Union - Directorate-General for Climate Action, 2018). In a practical sense, it could mean that when the new EURO 7-standard is launched, the road delivery companies will need less time to make their fleet compliant to the new emission standards than a shipping company. One should also take into consideration that the financial impact of investing in new trucks would be significantly smaller than the impact of investing in a new ship, even though a truck will need to be replaced earlier. This could lead to the road transport companies gaining an edge compared to short sea shipping in the coming years, as the reaction towards new requirements and standards possibly could happen faster than their competitors at sea.

Rates

While supply and demand are the driving force behind shipping rates, fuel costs can often exceed half of the running cost of operating a ship, hence also affecting the shipping rates (Stopford , 2009). It seems obvious that if the fuel prices are stable, supply and demand will dictate the rates, but if we see a hike in fuel costs, it would leave lesser of a margin for the shipping companies. This could, in turn, could drive the rates higher, as there needs to be a margin there, making the shipping route attractive to run for the shipping companies. In this case, if one is to ship a large amount of goods, shipping would most likely still be the preferred, but of one is to send smaller batches (few containers), a rational customer would look at the total package before deciding for a transport mode. For road transport, the case is different. There, the customer will have a clear expectation of what goes into the price, and it could be considered transparent for the customer. For customers shipping smaller batches, they do not get the economy of scale, which should be considered one of the main advantages of transport by se rather than other modes, and therefore, customers with smaller batches could be open to changing mode of transportation.

Implementation of environmentally-reasoned demands

As mentioned earlier, the time of implementing environmental demands is different between sea and road. This also makes the sense of urgency being perceived differently in those sectors, as a road transporter will both have a shorter time before normally changing its fleet of trucks and the overall delivery-time is also shorter. Ships, on the other hand, have a larger logistical footprint even if one would like to retrofit it to run more sustainable. An example of this is the installation of scrubbers that makes it possible to use heavier fuel and still be within environmental demands. As the scrubbers are made to order, the lead time is estimated at six months, before one also need to wait for an available slot at a shipyard for installation (Kinch, 2020). All the time waiting for installation is potential time without income for the shipping company, making it a critical component to install. Another factor is that if several ships are taken out of service to either be retrofitted or changed with newbuilds in order to comply with environmental demands, a decrease in supply of ships could lead to a disproportion between supply and demand, pushing the price upwards. The newbuilding

process is also time-consuming, and as most commercial ships are built to order, the process is both costly and time-consuming, and the building process can take between 12 months and 3 years depending on the Shipyard and characteristics of the vessel (Stopford , 2009). If one should expect shipping companies to build future-proof vessels, the incentives needs to be in place as well, as newbuilding of ships is a large and costly project.

Incentives

Incentives for the companies could be easier to apply than for the customer. The customer is assumed to be rational in their approach in terms of wanting the best solution, at the best price, and the incentives for the customers could therefore be assumed to be based on either price or delivery time. If the companies should only focus on pleasing these two incentive groups, they could burn heavier fuel, and drive faster, but that would, in turn, lead to higher emissions. Therefore, the incentives for going towards a more environmentally friendly approach should be focused on the companies. In terms of incentives, they could be split into two main categories, immaterial incentives and material incentives. Immaterial incentives could be for instance reputations and awards, which have been a practice within both shipping transport and road transport. As mentioned earlier, there are many different was to incentivize environmentalism in both shipping and road transport, and the most notable for each sector could be said to be the incentives that trinkle down from larger regulations within each sector. For shipping, it is the geolocated areas where there are demands for fuel cleanliness. For road transport, on the other hand, the largest incentive within Europe could be argued to be the LEZ and ULEZ zones where taxes will be applied if the regulations are not followed properly.

As important as the gains from the incentives, is the expectations created. If a company is not trying to change their environmental approach even though there are incentives in place, it could send a message towards their potential customers, possibly costing them sales. It is here corporate social responsibility, or CSR, comes into play. The increased focus on CSR around the world makes it credible to argue that CSR itself creates an immaterial incentive for further advancements within the environmental practice.

Sub – Conclusion

The environmental focus has made repercussions throughout the world, and all sectors of transport can expect to be under close observation in order to identify how it could be streamlined and optimized, as transport accounts for a large number of emissions. As different types of measures are taken, the sectors have adapted. After the initial review of the two modes, we can see that there are several differences, as well as similarities within each sector. To start off with the similarities, both sectors are driven by supply and demand, with an increased focus on sustainability and environmental measures looming over them. Although different in terms of capacity and nature of operations, their prerequisites become somewhat similar as it is the same forces and demands that is setting the pace for the sector as a whole. As both sectors aims for the same goal, to deliver goods to a specific location, the differencing factor is decided by the needs of the customer. As short sea shipping is cheaper per average ton, it has the edge on road transport when it comes to large orders due to economy of scale. However, if a customer is to ship smaller batches, the road transport market becomes a more viable solution. As we see the rates rise along with an increase in time spent on the voyage by ship, and the on- and offloading, road transport emerges as the option most suited if one assumes that the customer choosing based on service and time spent. It becomes clear that road transport is less volatile compared to shipping when there are changes within their prerequisites.

5 Case Study

As mentioned earlier, the Rotterdam – Immingham Route is used for the case study in this thesis. It could as well be another Short Sea route, but to shine a light on the different aspects implicating the choice of transport module, this route is seen as fitting. Rotterdam is a shipping-hub centrally placed for logistics in the north of Europe, and Immingham is in this case more of a destination port. However, this is a bit of a simplification, as Immingham is a key port seen with British eyes. To make it generalizable for this thesis, the starting point is Rotterdam, and the stopping point is Immingham. This is however a simplification of reality, as the road transport solution would have a more logical route directly to the destination, rather than delivering at the port of Immingham, if not specified. The most preferred mode of transport on this route today is short sea shipping, but there are also many semi-trailers arriving at Immingham each day. To discuss the competitiveness of the modes, different factors are highlighted and discussed. As stated, the most relevant for the thesis problem will be time sage and price, but also environmental impact can be touted as a driver behind choice of mode, as environmentalism is becoming an increasingly important factor. Lastly, the segment labeled “other factors” will be discussed, where factors that not necessarily are directly affecting the price, but still can be relevant for the transport solution will be addressed.

Figure 3 Routes to Immingham from Rotterdam

The daily situation in terms of transportation and flow of cargo, is the use of either ship, trailers, or train as transport mode. As the focus of the thesis is to discuss the impact environmental regulations can have on shipping and its relative competitiveness, Road transport have been chosen as the other mode of comparison. Both modes of transport imply the use of ship at a point, with the Road transport needing to use a ferry to cross the English Channel. In the case study, no new transport solution is presented, and it relies on the existing routes.

Alternative modes of transport

In the case study, two different routes are identified:

1. Ship transport from Rotterdam to Immingham, port to port.

2. Semi-truck from Rotterdam to Calais, before crossing the Channel by ferry to Dover. From Dover, road is used to Immingham.

It should be noted that there is a third option, with the use of ferry from Rotterdam to Colchester UK, but this option is considered too similar to regular container ship transport,

both in terms of time usage and availability, and therefore it is not included. The reasoning between the choice of the two routes discussed in the thesis is that there are major differences between them, both in terms of perceived time usage, and in terms of flexibility and method of transportation.

Assumptions

For simplification, the distance between Rotterdam and Immingham is used consequently through the case study. Using Immingham as the final distance is however only relevant for the seaborne transport solution, as road transport is not bound by ports, and would rather transport the shipment all the way to the intended destination. The distance in a straight line between the two ports is 365,37 kilometers. For the shipping route, the estimated route is 198.9 Nautical miles, or 368,4 Kilometers. For the road transport on this road, the estimated route is 743,9 kilometers long. Through this route, the truck needs to drive through the Netherlands, Belgium and France, before taking the ferry from Calais. After arrival in the United Kingdom, the drive is approximately 415 kilometers to reach Immingham. An assumption on the ships speed in this route is built on data from Clarksons, citing the average speed in this segment this year. This assumption have been further validated by sources within a Norwegian company, along with the estimated cost of shipping a TEU, and the estimated on- and offloading times. The company who provided reference-prices will be kept anonymous, of competitional purposes. The road transport route estimate is based on the estimated driving time, which have been rounded up to take potential waiting for the ferries into account. Furthermore, an estimate of 1 hour for on- and offloading, and potential customs clearance have been added. In terms of price-estimate, the same process have been conducted towards a large transporting company, who could provide a estimate, on the premise of given anonymity for competitional purposes. For both modes of transport, better prices could be available through agreements with the transport company. The price estimates in this thesis are gained from companies which the author do not have any previous connections to.

Calculation of emissions

As the technology have given enough empirical values to get good tools for reporting and the subsequent analysis of further emissions, several calculating-sites are available to give an estimate of emissions. To calculate GHG emissions along with NOx emissions, the

emission calculator from EcoTransIT has been applied in this case (EcoTransIT , 2023). This this is an emission calculator verified by Clean Cargo, which is an independent industry body (Kuehne + Nagel , 2023). For shipping, a load factor of 70% is assumed. For road transport, a load factor of 90% is applied. Furthermore, it is assumed that the truck used is a EURO 6 compliant truck, using a diesel engine. The load factors will have a influence on the emissions, as the higher the load factor, the heavier the vessel, meaning that one would need more engine-power to move the vessel.

Route	Distance	CO_2 emissions per TEU	NOx	Estimated time	Estimated cost
Rotterdam – Immingham (ship)	368,4 km	0,05t CO_2e Per TEU	0,467 kg/TEU	14,5 hrs transit, 8 hrs loading, 24 hrs offloading	€500
Rotterdam – Calais – Immingham (Road + ferry)	743,9 km	0,6t CO_2e Per TEU	0,512 kg/TEU	9 hr Transit 1 hr customs and loading	€3200

Figure 4 - Key figures for the case study

The estimated time spent to deliver the shipment is shown above. An important note is that the delivery time by ship is estimated from port to port, not including further transport with a semi to the intended destination. We can see that seaborne is slower than road, and in terms of price, seaborne transportation is believed to be lower than road transport. As seen from the emission-calculations, there is a fairly large difference between shipping and road transport in terms of emissions for this route. Further discussions regarding these factors will be addressed below.

Price

As seen, the price of shipping a TEU is lower than it will be to transport a TEU on road. However, when we take account for an increase in regulations, experts have speculated that the shipping rates will go up. As for now, we see an easing of the rates, which experts from Clarksons estimate to last through 2024 (Holden, 2023). Through COVID there was a large increase in online retail, and subsequent need for container vessels to ship these orders. This resulted in filled orderbooks for newbuilding, along with a lower degree of scrapping. Now, we could potentially see a shift towards what could be perceived as a "buyers market", where the supply is disproportionate to the demand, and the rates becomes lower as the companies are competing on margins. The X-factor in the equation could therefore be further focus on environmental demands and requirements, which can have the potential to affect the price. The freight rates will need to get a hike of 640% in order to be The same as shipping a TEU using road transport, but at the same time, it is a more likely scenario with a hike in shipping costs than road transport costs based on some factors. Firstly, the time spent to build a new ship is about 2 years after ordering to delivery. After these two years, the ship have an expected lifespan at about 25 years (Stopford , 2009). Off course, the shipping companies could offload the ship through the secondhand market, but they would then rely on another company's willingness to buy the ship. In road transport, the build time is much lower, and one can expect a waiting time at around 2 months. The operating time for a semi is estimated to be around 10-15 years, making the average truck fleet newer compared to the shipping fleet. A large shift in focus and demands can cause such a change in the market parameters that shipping companies will be needing to replace their ships earlier in order to comply with new demands. The replacement of a ship before its planned lifetime can cause shipping companies to lose planned revenue, as the plan in terms of income from the ship is planned for the whole lifetime. A change in this means a "double cost" where the company not only stops their ship from gaining income for several years, but also requires them to spend additional money to renew their fleet. Off course, there are other options as well, such as installation of scrubbers, but that as well takes the ship out of operations, and causes an extra cost, which most likely will be reflected in the rates. It would also be a blow for road transport companies if new regulations were applied, but the total investment-cost, combined with the fact that most semis are not made to order, as with ships, makes the prospect of a urgent need of renewal of the fleet more viable in the Road Transport market than the Short Sea Shipping

market. Therefore, we can expect the shipping rates to be more volatile towards a change in requirements than road transport, as the road transport fleet is on average newer, and the build time is lower. As the cost different is as high as it is, and even with a hike based on the demands, it is difficult to imagine a 640% increase in the rates.

Time usage.

As seen in figure XX, the time spent on the route for ship transport is around 14 hours, while the time spent on road transport is estimated to be between 8 and 9 hrs. This is already a substantial difference, and road transport thereby have an edge over ship transport. One should also take into account that for road transport, the environmental regulations will not affect the truck speed, but it quite possibly will for shipping. Slow steaming is one of the immediate responses to changes within environmental demands, and while it cuts the emissions from the ship, it also increases the time spent to deliver the shipment. How far down the shipping companies are willing to go slow steaming is based on their own analysis of elasticity within their range of speed. Therefore, it could be difficult to predict. Analysts from Clarksons reported that in February 2023, slow steaming speed hit an all-time low within the container market, at 13,7 knots, and numbers are showing a downward trend in ship speeds. From empirical data provided by Clarkson's Shipping Intelligence Network, we can see that the average speed of container feeder vessels in the period October – November 2023 is at 13,44 knots. If we take this speed as a basis when looking at further emission requirements being applied to shipping, we get a transit time of 14,5 hours. If we also calculate an estimated additional 4 hours to on- and offloading of cargo, the total transport time for ship becomes 18,5 hours, approximately 10 hours more than road transport. Off course, if one has a large shipment of containers, 10 hours may not be that much, but if one customer is to ship smaller shipments, such a time difference can be crucial when deciding mode of transportation.

Emissions

The main advantage for ship transport is along with the price, the emissions. As we can see by the emission numbers in table XX, the amount of NOx is similar, but there is a bigger difference in GHG emissions measured in CO_2e per TEU. When looking at these emissions numbers, we see the economies of scale in action, as the emission from a ship is

divided between several containers, while at Road transport, the number of containers is low, hence giving a higher emission per TEU. When we start to look at the estimates and assumptions generated by the discussion earlier in this thesis, we can see a decrease in attractivity of shipborne transport, as emission and environmental demands affects the operations of shipping companies larger than road transporters. This is, as mentioned earlier, possibly a result of shipping not being under national laws, and therefore not having had the environmental limelight towards it for a long time, but the effect of increased awareness surely becomes clear here. If the ship, for instance should slow steam in order to cut the emissions, the total transit time will depend on how slow the shipping company is willing to go. As one can say that the slower the speed, the bigger the inconvenience for the customer it becomes, the balance between both delivering within a reasonable time, while also keeping the costs and emissions at a reasonable level, is a matter of prioritizing and risk-taking on behalf of the shipping company. Road transport companies, however, does not have the same option, as they are bound to follow the same speed as the rest of the traffic. When talking about emissions on road transport, the emission per TEU is significantly larger than for shipping. This is as expected, and one can speculate that the introduction of electric semi trailers can have a positive impact on these numbers. However, the economies of scale will be against road transport in this case, as the capacity of the trailer is severely lower than on the ship. As a sub-conclusion on the points of emissions and speed, one can therefore say that shipping has the edge in terms of emissions, and road has the edge in speed.

Marginal external costs.

Through use of different modes of transportation, there are societal costs which are not always addressed through the standard reporting scheme. This includes for instance wear and tear on infrastructure and accidents, and it is costs that are generated without the transporter taking notice or consideration of them, hence them being marginal. The Institute of Transport Economics(TØI) in Norway did a study in 2017, highlighting among other things, the marginal external costs of road transport versus Short Sea Shipping. Although the analysis focused on a route for shipping and road transport within Norway, the key points regarding societal costs could be relevant as it is about road transport and Short Sea Shipping in northern Europe, and it is regulatory-wise and in terms of attributes not that different from the case study between Rotterdam and Immingham. The key finding of the analysis of marginal

external costs was that in terms of taxes and fees, Short Sea Shipping scored lower than Road transport (Pinchasik & Hovi, 2017). On external costs, Road transport was significantly higher due to accident rate and wear of infrastructure, making the overall equation concluding with Short Sea Shipping as the best alternative when considering marginal external costs (Pinchasik & Hovi, 2017).

Accidents can also indirectly affect the shipment, if for instance, the traffic is congested as a result of an accident. In the given case, the accident rates for European vessels are relatively low, with an average of 25 deaths per year due to accidents (European Union , 2022). However, this report does only account for accidents with a fatal outcome, and only focused on EU-registered vessels. There are shadow numbers in terms of migrant ships capsizing in the channel, and they could have implications towards commercial freight, as ships are obliged to help in case of an emergency at sea (United Nations, 1982). All in all, however, the accident rate is believed to have little effect on the ship transport in the English Channel. For road transport at the suggested route, the numbers look a bit different. There are significantly more accidents at the road in the countries the Semi needs to cross in order to deliver to Immingham. These accidents can potentially lead to congestion in traffic, or the trailer with the container could be the casualty. The numbers usually focus on traffic deaths, and it is a downward pointing trend in Europe, and the European roads are considered among the safest in Europe (European Comission , 2022). As studies shows a higher increase in accident-risk when the driver is foreign, this risk could be increased as the driving route from Rotterdam to Immingham goes through a total of 4 countries. Wen compared, road transport should be defined as more accident-prone than short sea shipping.

Other factors

	Median waiting time starting port	Median waiting time destination port
Route 1 (Ship)	0,5 Days (Rotterdam)	0,15 Days (Immingham)
Route 2 (Road)	0,41 Days (Calais)	0,03 Days (Dover)

figure 5: Median waiting time at ports

Another factor affecting the efficiency of the transport modes in this route is bottlenecks, along with local restrictions on transport. Port congestion is a known problem within the world of shipping and is something that easily can happen. In this route, both ports can be affected by congestion, which in turn can delay the shipment. The ports are natural bottlenecks within the logistical chains in the world, and in this case, the ports are obvious bottlenecks. It is defined as a bottleneck because they are prone to delays, and because there is no way around these places in the given routes. To ship the cargo, the customers need a port to load and unload the vessel, hence the dependency.

From MarineTraffic, one can see the congestion numbers for the ports; In Immingham, the congestion numbers for containerships are not considered substantial, but they should be mentioned as it contributes to uncertainty within the supply chain. In Rotterdam, which is a significantly busier port, the numbers are a tad higher at 0,5 days estimated waiting. It is, however not specified if a day is measured at 24 hours, or if it is a workday, and this clarification would have a large impact in terms of what to expect. The numbers differ from week to week at the ports as well, and in Rotterdam, there are several days with 0 days estimated waiting, which shows that at the time being, it is not guaranteed that one would have to wait extra at the port. Congestion can also be a problem for Road transport. If there are congestions on the road, one can surpass it by re-routing if there is a need for urgent delivery, but if the obvious bottleneck, the crossing of the Channel, is congested in some way, it will have serious implications on the delivery time of the shipment. It should however be noted that ship transport in this regard could be considered more predictable, as it only has 2 bottlenecks (the ports). The road alternative has many potential bottlenecks although the ferry is the most notable. Other bottlenecks include customs when crossing borders, and potential congestion in traffic.

Figure 6: LEZ zones in Europe

LEZ and ULEZ zones have been presented briefly earlier in this thesis, and such zones are applied through the route the semitrailer is supposed to follow in the transport alternative presented here. Starting already at the dock in Rotterdam, this area is defined as a LEZ. This means that vehicles in this area needs to comply with the EURO 6 -standard. As seen in the map, As studies shows a higher increase in accident-risk when the driver is foreign, this risk could be increased as the driving route from Rotterdam to Immingham goes through a total of 4 countries.. Even if one does not plan on driving through such a zone, accidents or road congestion could lead to an alternative route, suddenly creating the need to drive through a LEZ. In some European countries, the population and government have taken it a step further. This have resulted in some countries banning road haulage entirely. In our case, France is the only country on the route having such a ban, banning trucks over 7.5t from driving Sundays and public holidays from 0AM to 10PM, along with additional bans in the holidays. This can create a need to either plan more in advance or re-routing the transport. However, one should not assume that this ban stops with the countries enforcing it, or that it will be restricted to only holidays. For various reasons such as congestions and the risks of accidents, public discontent are growing towards massive usage of roads to transport goods, and a demand towards an even more comprehensive approach banning road haulage could be a reality in

more countries. This could raise questions whether it is viable or not to move haulage from ships to road at all.

Future Outlook

When discussing how the potential future could look like, it is important to take two paths into consideration. On one hand, we have the immediate future where we potentially do not see as many changes from the standard operations now. On the other hand, there is the medium-long-term perspective, where freedom of action becomes larger because of more time disposable. In the short-term perspective, the measures taken are somewhat stretched. for instance, the potential of slow steaming in this route could soon be assumed utilized to its maximal capacity, and there will be little to gain from going further down. In the same way, the road transport market is following the regulations, and are quick to adapt. If we look a step further, towards the future, the potential for shifts at this route becomes bigger. As mentioned, the future of propulsion and fuels are still being investigated and discussed, and the result of these discussions and this research could potentially become instrumental towards deciding the future of transport at this route. For a short-medium-term, the installation of scrubbers can be viable, but what should come after that? If the need for slow steaming becomes lesser, it could potentially make Short Sea Shipping more competitive towards road transport in terms of delivery time, as the transit time could be perceived to be lesser. One should however, note that fixing one aspect will not cure the problem entirely. As seen by the congestion numbers, there are bottlenecks in both sides of the route, and if the ships speed is turned up, one risks to just have ships waiting outside the port, as the handling time at shore is the same. Therefore, an emphasis towards a holistic view of infrastructure and operations at the different ports is also needed to cut down on the time and make Short Sea Shipping more competitive. The complexity of the situation lies in the fact that each link of the supply chain is equally dependent, and in one operates at a lower pace, it could potentially become a bottleneck.

For Road transport, there are exciting times ahead, as electricity and other fuels are being explored, but at the same time, the road transport business have been under a closer watch, with closer updates of standards throughout. This makes it more difficult to make a sound prediction about how the rates can react to new environmental standards, but at the same time, the EURO-standards are often anticipated, meaning that the market can adjust and

react ahead. The use of electric vehicles could make road transport more competitive towards ship transport, as the GHG emissions directly emitted from the transport would be zero. The shipping market is another story, as it has not been as affected by large regulatory changes and demands. As shipping is a global market where one easily can move a vessel from one continent to another, new demands and rules needs to apply for the entire market, or else the shipping companies can just move the vessels to a location fitting for their vessel. This, we can see now, as IMO is demanding action and driving innovation forward through the implementation of widespread demands towards emissions. The SECA-zones was a good start, and with the EEXI, the companies needs to be creative towards emissions to operate their ships. As the study by Spoof-Tuomi and Niemi (2020) showed, there are future fuels that can help lower the emissions of shipping transportation, but the time-horizon of when these are viable options vary. A likely shift towards the usage of LNG as fuel is the most realistic at this point, but a further shift towards LBG could be the step further. This, however, relies on a holistic approach, as there is a need to invest to upgrade infrastructure on shore as well as investing in new ships compatible to LBG use. The market reaction of such investments could be assumed to affect the price, especially if LBG is used. As we know the price of fuel dictates approximately 50% of the rate, it is easy to do a simple calculation on the effects of a shift in terms of direct cost from more expensive fuel. The indirect costs, including the costs of infrastructure and new practices, could also be assumed to be reflected within the rates. To keep the progress towards a sustainable future in both sectors, incentives are needed. To gain more immediate results, one could assume that financial incentives are the most likely ones to be implemented, especially through different types of taxations based on the emissions. When looking at the estimated price difference, it becomes clear that for such changes, road transport could be more vulnerable than Short Sea Shipping. As there is such a difference in price, one of the last things needed from a road transporters perspective would be to give the customers more incentives to opt for shipping rather than road.

Furthermore, the rent and operating costs at the ports are also poised to rise if there is a need of large investments towards port infrastructure. On the other hand, one could argue that such a hike in rates and operating costs could be edible for the customers when looking at the alternative. If we look at the estimated priced, there is a difference at approximately 2700 Euro. For shipping, it would mean a price-hike at 640 % to meet the daily level of road transport, and then possible changes in road rates are not accounted for. Such an elevation in

price have never happened before, and it feels unlikely to happen now as well. Furthermore, the public attitude towards road transportation could have implications for the rates and service of road transport. As countries are opening for the closing of roads at given times, we see a trend where the public are more vocal regarding usage of their roads and demands towards the industry. As these measures are taken, it is believed to be more probable that the measures are escalated rather than de-escalated, and this practice could as well spread to other countries. A growing public discontent could also make companies and customers opt away from road transport, as the CSR-aspect comes into play. The environmental shift have become a topic of discussion in both worldwide politics and the public, and as the world acknowledges the challenges related to a sustainable future, the focus on, and need of action is only poised to grow further.

6 Conclusion

After reviewing the different aspects of the thesis, and looking at potential mechanisms for the future, it is considered possible to draw a conclusion of the thesis. Due to especially the economy of scale, along with the price, Short Sea Shipping gets the nod in these discussions. Therefore, the conclusion is that Short Sea Shipping have a competitive advantage towards road transport based on the discussions in this thesis.

The economy of scale is the main competitive advantage of Short Sea Shipping, and it gives short sea shipping an advantage compared to road transport. This is reflected in most aspects discussed. The price difference seems to be large enough to have room for emission-reducing measures, and still deliver transportation at a lower rate than road transport. In terms of emissions, short sea shipping have less emissions per TEU than road transport, and if the expected measures are implemented, a subsequent increase in environmentally-based competitiveness is expected. The main discussion and competition between the two modes of transport would be in terms of delivery time, where road transport is touted as the best alternative. To address the delivery-time on this route, an increase in ship speed is considered to be inadequate, as it could potentially end up with the saved time "lost" to congestion. To address the issue of speed within the short sea network, a holistic approach is needed, as the infrastructure is in need for upgrades if it is supposed to be compliant to new fuel types as well as increased ship speed. One should, however, not omit road transport entirely. There are daily deliveries using road transport at this route, underlining a need for road transport to still be an option. It is also considered a good option if there is a need for a speedier delivery. However, potential transport-bans in Europe looming over the road transport sector could underline the argument of transporting more goods by sea rather than by road. Either way, as the requirements regarding emission standards and measures are escalated, the responsibility of the customers to be proactive and forward-thinking in their approach are growing.

With the need for large investments in both sectors, the future looks bright. It is difficult to state what is going to happen, as the market fundamentals are moving based on new technological progress and new trends.

Limitations of the research

The research is only as good as its data. The sources have been based on scientific research along with a supplement in the form of rates given by actors in the different industries. In terms of reliability, the result could be affected by the sources, and the fact that the literature review was conducted based on scientific papers and reports, making the data secondary data as it was already somewhat processed. Due to this being a fairly new problem, in terms of the rapid evolving technology and trend in society, the use of a qualitative approach was considered to be the approach which would give the most reliable result. As the literature review was fairly comprehensive, the result presented could be considered valid, as the sources used showed much of the same results regarding the aspects discussed.

Further research

As the EEXI standard is relatively new, further research should focus on assessing the outcome of this standard. Furthermore, a large study of central ports, focusing on the gap between the situation today and a situation where several types of fuel can be accommodated should be considered. This could help bridge the gap between now and the future and prove to be a relevant topic of consideration.

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List of tables and charts