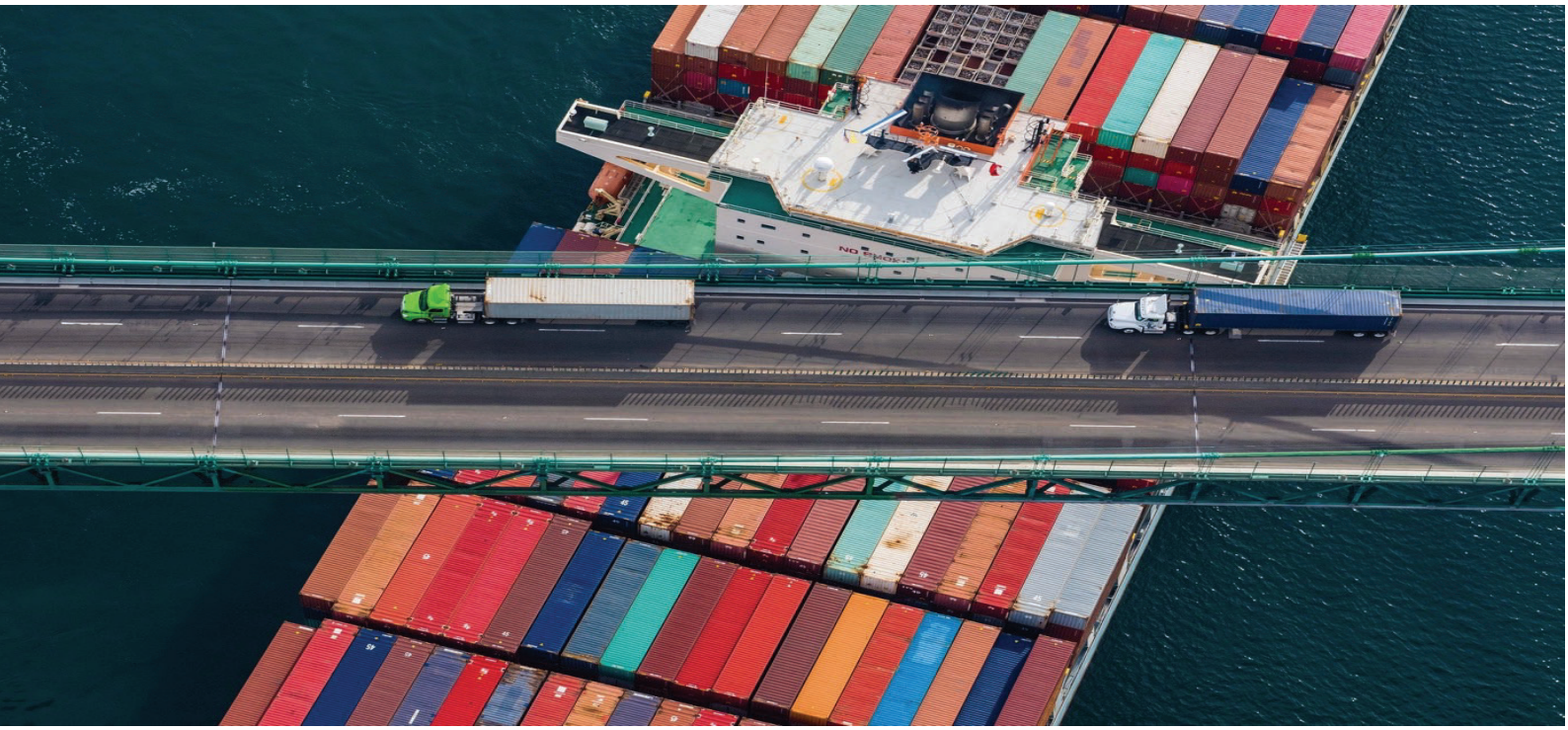
The future of modal shift

The case of the freight corridor between Rotterdam and Moerdijk



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Colophon

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SMART PORT connecting knowledge

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Summary

As freight flows have been increasing for decades, road transport is no longer able to meet the demand. Road capacity is being exceeded and the need for sustainable transport is high. Transport by water is a possible alternative modality for this. Inland waterway transport still has enough capacity to take over the pressure of the flows of goods. Even though this modal shift offers a suitable solution and initiatives have already been made, it has however not been carried out on a large scale yet. Lots of factors and stakeholders are involved, which make it hard to achieve this shift in modality. The central question to this study therefore is:

Why are the stakeholders' modal shift ambitions not achieved in the freight corridor between the port of Rotterdam and the strategic hub of Moerdijk, and what can these ambitions mean for Moerdijk as an extended hub?

A qualitative method in combination with the case study of the corridor between Rotterdam and Moerdijk is chosen to gather information for this research. The research is done in conjunction with an internship at SmartPort Rotterdam. Data is obtained through desk-research, discussions with six experts, thirteen interviews and a focus group discussion.

The literature review in this study revealed that several factors are important for a modal shift to be successful. The modal shift ambitions that exist within the stakeholders must be guided. Various means can be used to steer in this modal shift, policies are required but private parties are involved as well. The Netherlands, with Rotterdam as its port, appears to play an important role in the global supply chain. The importance of inland hubs is mentioned in the scientific literature, showing that fulfilling the function as an extended hub can reduce congestion in a deep seaport like Rotterdam. The results of the interviews are largely in line with the literature review but add that there are other factors that are also important in making the modal shift successful. Furthermore, various means of steering the modal shift are indicated. Means such as digital tools, to improve planning, and carbon foot printing, to map emissions, both contribute to making inland navigation more attractive. It also appears that Moerdijk is already seen as a very strong hub in the Netherlands and is working on developing itself into an extended hub of Rotterdam.

A conclusion is drawn to answer the main question in which it becomes clear that in order to make a modal shift successful, a number of actions need to be taken. Small and medium-sized enterprises (SMEs) must go on board with inland waterway transport, congestion in seaports needs to be tackled and both public and private parties must play an active role in steering the modal shift from road to water. In doing so, we must look at how Moerdijk, as an extended hub of Rotterdam, can be further exploited, with the help of inland navigation.

Preface

In this study, the ambitions for the modal shift from road to water on the route between Rotterdam and Moerdijk are examined. By following the Master in Spatial Planning with the specialization Urban and Regional Mobility, I discovered this subject. Because I wanted to gain experience in the field, I chose to write my thesis in combination with an internship at SmartPort Rotterdam. Their expertise in logistics, infrastructure and energy in seaport areas and their scientific experience helped me a lot in the process. While writing my thesis, I found out that my interests are within the right field of logistics in seaport areas. I continued to find the whole process interesting and educational, and I see myself continuing in this field.

During the process of writing my thesis from March 2021 to September 2021, I was guided by my thesis supervisor, Sander Lenferink, from the Radboud University. I would like to thank him for all the advice, support and time during the process. I would like to thank my internship supervisors Dirk Koppenol and Anique Kuijpers of SmartPort and of course all the other team members of SmartPort Rotterdam as well. Their expertise, knowledge and informal manners have helped me a lot and I have completed my thesis research here with great pleasure. I would also like to thank the respondents who participated in the interviews and the focus group. With their contribution, I was able to complete my research. Finally, of course, I would also like to thank my family and friends for their support.

This study is suitable for anyone interested in the modal shift and all that it entails.

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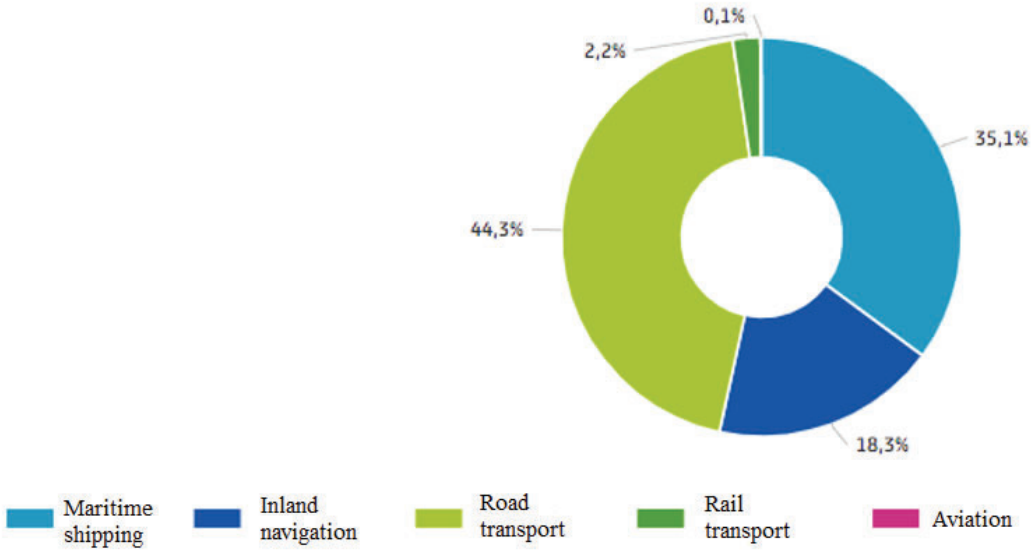
Chapter 1: Introduction

1.1 Problem Statement

In 2019, 1.73 billion tonnes of goods were transported from, to ,and within the Netherlands. This growth was mainly due to the increase in domestic freight transport. 689million tonnes of these goods were transported by lorries (CBS, 2020; CBS, 2021). The transport of goods by road accounts for the largest share in the Netherlands (Baaz, 2019). CBS (2021) shows the division of the total weight of transported goods by different modes in 2019. This also clearly shows that road transport accounts for the largest percentage (44.3%) (see Figure 1.1). Inland waterway transport in the Netherlands accounts, on the other hand, for 17% of the domestic flow of goods (Rogerson et al., 2020; CBS, 2021).

Figure 1.1: total weight of goods transported in 2019



Source: CBS, 2021

Looking at container transport, it seems that this type of transport has increased over the past decades (KiesZon, 2020). These container goods are transported from seaport to inland terminals. It is expected that if the inland terminal network for containers will be expanded, even more, regional and national container transport will take place (Rickandie, 2016). Inland distribution is becoming an important dimension of maritime transportation, globalization, and the freight transportation paradigm. Previous structural changes in logistics have namely led to new approaches to the hierarchy of ports and new patterns of cargo distribution (Notteboom & Rodrigue, 2004).

The ease with which a modal shift can be realized depends on the possible favorable conditions. For longer distances, for example, transport by water is the most desirable transport mode, because of the economies of scale, size of ships, and transshipment costs. But these conditions make waterway transport less attractive for short distances (Rogerson et al., 2020). The modal shift from road to water is thus an achievable goal at least for long-distance transport of containers. For the medium term, it seems that inland shipping can achieve a small positive way forward due to the increasing congestion on Dutch roads (Nieuwsblad Transport, 2020, 25th March). Transport by water has several advantages in comparison to transport by road. It does not cause traffic jams, it has still a growth capacity,

larger quantities of goods can be transported per vehicle and it produces less CO2 emissions than transport by road does (Rickandie, 2018). Rogerson et al. (2020) say that lots of goods are transported by waterways in sectors with large volumes of goods, adequate policy support, and desirable transport geographies.

According to Logistiek (2020), there is a list of projects that are promising for a great start for the modal shift from road to water. One of the projects was the co-creation between Heineken and CCT with the triangle Moerdijk, Alphen aan de Rijn and Rotterdam. Specifically for the case of Moerdijk, it seems that all modalities – shortsea, inland waterways, and rail – are growing. The Port of Moerdijk wants to achieve the modal shift ambitions for both the Dutch hinterland as for European destinations (Nieuwsblad Transport, 2020, 23rd November).

The Southern part of the Netherlands is considered a gateway for Europe. It has a network of highways, canals, and railroads which ensures that it is well connected to the Port of Rotterdam and other important waterways (PROLOGIS, 2021). West-Brabant serves as a hub for wide-ranging (inter)national flows of goods to the entire European hinterland, because of its industrious and dynamic character. Moerdijk, which is located in West-Brabant, has its deep seaport which is an import connection for transporting goods from and to Rotterdam (REWIN, n.d.). Moerdijk also disposes of multiple transport modes – water (sea, inland water, and various quay facilities), road, rail, and pipelines (REWIN, 2019). This makes it therefore interesting to look at the freight transport between Rotterdam and Moerdijk.

Already for years, policymakers have wanted to stimulate more transport of goods by barges and rail, but there still has been no large-scale shift (Logistiek, 2020). Although governments have spent millions to encourage shippers in this modal shift, it turns out that many companies seem to be fond of road transport and have little or no intention of using other modes of transport (Nieuwsblad Transport, 2020, 25th March). Policymakers at the European and national levels see the necessity to take urgent measures in this. The increase in road transport can barely be sustained. A serious loss of economic competitiveness exists due to congestion of road transport. Drastic action is therefore needed to stop the growth of freight transport by road and to shift the balance between different modes of freight transport (Blauwens et al., 2006; Tsamboulas, Vrenken, Lekka, 2007). So, although the need for a modal shift is clear and modal shift initiatives and incentives have been put in place before, a large-scale shift has not yet taken place.

1.2 Research aim

Nowadays, the demand for goods cannot only be fulfilled by the transport of goods by road. There are opportunities for transporting goods through inland waterways. This shift in modality provides more capacity and is also a more sustainable choice. This research will therefore examine why the modal shift from road to water has not yet been applied on a large scale, what the modal shift ambitions of the stakeholders are and how private and public actors can steer in this. The focus of this research is on the freight transport corridor between the logistic hub of Moerdijk and the port of Rotterdam. Moerdijk is a place with multimodal transport and it is a strong strategic node in the Netherlands. The port of Rotterdam is the largest seaport in Europe and has excellent accessibility by both sea and intermodal connections. This study will examine whether Moerdijk can become an extended node of Rotterdam by making use of inland waterway transport. The resulting research -and sub-question therefore are:

1.3 Research questions

Why are the stakeholders' modal shift ambitions not achieved in the freight corridor between the port of Rotterdam and the strategic hub of Moerdijk, and what can these ambitions mean for Moerdijk as an extended hub?

- What are the characteristics of the freight transport corridor between Rotterdam and Moerdijk?
- What modal shift ambitions do stakeholders have?
- Which future challenges should be taken into account?
- What means can be used to steer in these modal shift ambitions?

1.4 Societal relevance

Today, climate change can be considered one of the greatest threats to our planet. The consequences of climate change also pose a threat to future developments (Zhang & Witlox, 2020). To combat climate change the United Nations adopted the Paris Agreement in 2015. The overall goal of the Paris Agreement is to limit the global average temperature to 1.5 °C instead of 2.0 °C. To achieve this, the current greenhouse gas emissions such as global CO_2 emissions urgently need to decline (Rogeli et al., 2016; Davis, Caldeira & Matthews, 2010). The largest producer of the global share of CO2 emissions is the transport sector (26% contribution to global CO2 emissions) and it is expected that the emissions in this sector will continue to grow (Davis et al., 2010; Zhang & Witlox, 2020). Almost two-thirds of the total transport-related emissions come from road transport (Davis et al., 2010). For this reason, the transport sector needs to find a way to limit its emissions. Lots of transport agencies all over the world are focusing on reducing greenhouse gas emissions. Climate change needs to be tackled and sustainable transport needs to be approached by changing behavior and by promoting more sustainable practices (Zhang & Witlox, 2020).

A shift in modality, from road to rail, water or air, can be seen as a means for solving the disadvantages of road transport, such as air pollution, traffic congestion, and social costs (Hesse & Rodrigue, 2004.; Rogerson et al., 2020). A modal shift must be initiated, as existing strategies are no longer sufficient to achieve the desired emission reduction targets (de Miranda Pinto, 2018). Kurtulus and Cetin (2020) and Hesse and Rodrigue (2004) say that the other forms of transport – rail and waterway - are more sustainable alternatives of transport than transport by road because they produce fewer negative effects on the environment and consume less energy and land. Rickandie (2018) complements by saying that transporting goods by water can be environmentally friendly, safe, smooth, and economically advantageous. The research of Brooks et al. (2012) and Rogerson et al. (2020) even say that short sea shipping is the most environmentally friendly mode of transport.

Apart from emissions, there is another reason why a modal shift should be realized. The modal shift from road to water is necessary because freight transport by road is under pressure by rising costs and environmental taxes and it is, therefore, unable to always deliver goods on time (Infomil, n.d.). Rickandie (2016) says that freight transport capacity by road is almost at its maximum and when, according to Schijndel and Dinwoodie (2000), the demand for road space crosses the available road capacity, congestion occurs. A possible solution for this capacity problem is transporting goods by water. Transport by inland waterways does have enough capacity to fulfill this demand for goods. This type of transport can keep up with the growing flows of freight transport. It has greater capacity than the road transport sector has at present (Rickandie, 2016).

Making a modal shift from road to water could help reduce greenhouse gas emissions and come closer to the goal of limiting the global average temperature to 1.5 °C. It also solves both road congestion and the lack of road transport capacity. Thus, because of the available capacity, environmental limits, and sustainability, the importance of waterborne transport is increasing (Nederlandse Vereniging van Binnenhavens, 2021). Given these problems, it is of great importance to improve knowledge about the composition, dynamics, and volume of physical distribution at different geographical levels. Empirical evidence on the interactions of geographical firms and consumption systems is thus required to make a modal shift (Hesse & Rodrigue, 2004).

1.5 Scientific relevance

It seems that, up to recently, not much attention has been paid to freight transport and logistics in economic and transport geography. This working field focuses mainly on individual mobility issues, passenger difficulties, or freight transport in an urban context instead. Concerning the transport of goods by water most of the academic geography has focused on trade and ports, while other spatial implications of logistics and distribution have not been explored by many authors (Hesse & Rodrigue, 2004). This makes the modal shift from road to water, which is connected with logistics and distribution, an interesting topic to research. Feo, Espino, and Garcia (2011) state that a desired modal shift from road to water has not yet been put into practice on a significant level after years of trying. Freight transport is still dominated by transport by road. The research of Zhang, Janic, and Tavasszy (2015) complements by saying that already for decades efforts are being made to promote this modal shift, but the shift has stayed limited.

In addition, the opportunities for medium-to-long-haul transport are still mainly being explored. Kurtulus and Cetin (2020) mention that in research of the behavior of choosing a particular mode of transport not much research is done in short-distance transport in corridors with specific origins and destinations. Meers et al. (2017) agree with this. They argue that while there is a clear market for short-haul intermodal container transport, much research is still focused on medium- to long-haul transport.

When speaking of policy regarding modals shift it seems that nowadays policy approaches are largely underused in this sector (Kaack et al., 2018). The role of the government and its policies is often lacking in scientific research for freight transport (Zhang et al., 2015). The research by Meers et al. (2017) points out, in addition to the modal shift itself, the importance of the mental shift. Decision-makers do not always have access to the appropriate information about intermodal transport. Many of these decision-makers have not even considered using intermodal alternatives. It is, according to the researcher, therefore necessary to also focus on a mental shift to achieve an actual modal shift to alternative modes.

Lastly, Notteboom (2007) states that inland container transport is still focused on point-to-point services to and from large centers such as Rotterdam and Antwerp. The researcher points out that further access of inland container transport to other seaports is important to look at in the future. This research will therefore look at the future opportunities for the strategic hub of Moerdijk. Whether Moerdijk can perform its role as an extended hub of the Port of Rotterdam further by making more use of inland waterways for freight transport.

Chapter 2: Literature review

This chapter will give an overview of the different main themes of this study. First, freight transport in terms of sustainability will be discussed, followed by a discussion of some of the main theories surrounding the transport of goods and the concept of multimodality. Then, the focus will be on the modal shift ambitions and the means needed to steer in these ambitions. Subsequently, the factors that are important in making the modal shift and logistics corridors along with extended hub functions will be discussed. Finally, a conceptual model will be illustrated to structure the literature review in a visualized manner.

2.1 Sustainability

Transport of goods in Europe continues to grow. Because of this growth, the total CO_2 emissions have increased to 25.3% in 2012, while it contained 18.8% of emissions in 1990. The EU's current climate and energy target is to reduce greenhouse gas emissions by 40% by 2030 compared to 1990. The transport of goods must play an essential part in achieving this emission reduction target (Jonkeren, Francke & Visser, 2019). Green logistics play more and more an important role in new logistic approaches, both on micro (companies) and macro (national) levels. Consciousness and ecological aspects have increased in the last few decades, especially in developed economies (Beškovnik & Twrdy, 2012). Government policies and client requirements are more and more focused on sustainability and inland port and waterways are also preparing themselves for this trend (KiesZon, 2020). According to Veenstra et al. (2012) shippers demand, more and more, sustainable and efficient multimodal transport. An increasing number of businesses are demanding more environmentally friendly solutions, such as multimodal transport, for transporting their products. One example of the increased demand in multimodality is the desire of the company Proctor and Gamble. They want to transport their environmentally friendly washing gel from the seaport to their warehouse locations, in the United Kingdom and other parts of the European continent, in a more sustainable manner. Intermodal initiatives, such as the one in Brabant (see figure 3), are exactly what these kinds of companies are looking for.

Transporting goods by rail or inland waterways is more sustainable than transporting them by road. This modal shift has, among other things, a positive effect on CO2 and Nitrogen emissions (Zhang et al., 2015; Rogerson et al., 2020). The modal shift from road to water generates less CO2 emissions, less noise pollution, and less congestion and is therefore thus a more sustainable transport mode (Rogereson et al., 2020). With the use of modal shift as a strategy, international organizations expect to increase the degree of reduction in urban noise, health impacts, urban air pollution, diesel dependency, land-use competition, and traffic accidents (De Miranda et al., 2018). The European Commission says that the flows of freight shift towards a more sustainable transport mode is an important policy strategy. This namely can help to determine a sustainable transport system that is in line with society's social, environmental, and economic needs (Zhang et al., 2015). Inland ports rely on and contribute to the integration of different modes of transport and therefore have a positive impact on the environment. The positive influence of the inland ports on the environment, therefore, must be included (Wei & Sheng, 2017).

2.2 Modal shift

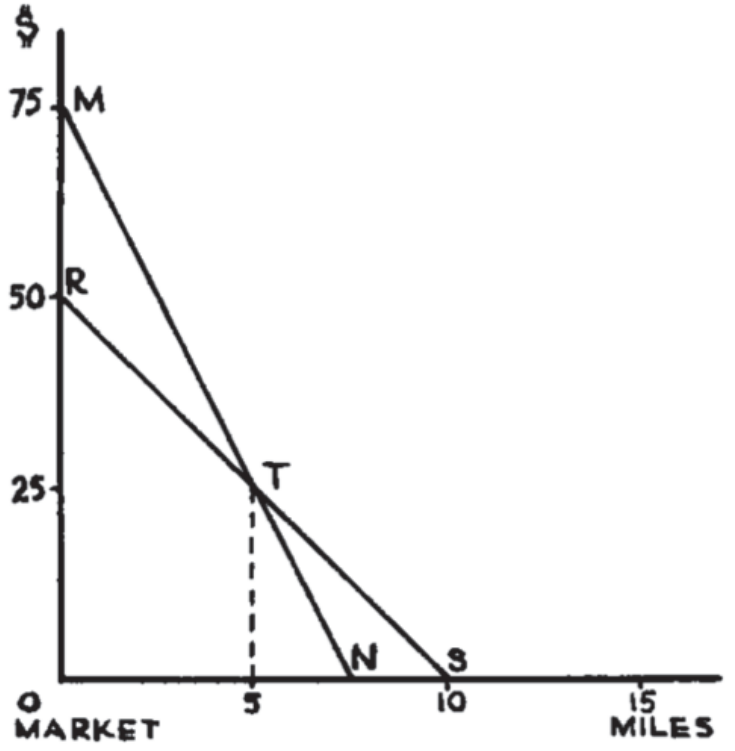
The transport of goods mentioned above is linked to some important major theories and it is therefore important to consider these in this research. The theories briefly discussed in this research are the theories of Johann Heinrich von Thünen, William Alonso, and Walter Christaller.

2.2.1 Transport theories

Von Thünen

One of the early and well-known theories in a spatial context is Von Thünen's theory, which formed the basis for land price and land use theories and is still used in current research (Koomen & Buurman, 2002). Von Thünen's original model of agricultural land use is considered a cornerstone of land use theory (El-Barmelgy et al., 2014), and was even named as 'one of the patron saints of econometrics' (Fischer, 2011). The model of Von Thünen refers to transport and location costs, which are characteristics of a land parcel. Although Von Thünen only analyzed land-use patterns, the explanation of land prices was an important result of his model (Koomen & Buurman, 2002). In the agricultural model, see figure 2.1, the relationship between land price and land use is illustrated by two products. It can be seen that the potato growers (line MN) can offer higher rents in the zone between 0 and 5 miles from the market and that outside this range, carrot growers (line RS) can offer higher rents. For this reason, potato cultivation will occur in the ring of 0 to 5 miles and carrot cultivation between 5 and 10 miles from the market. The sections MT of the curve and TS will be the effective rental prices (Alonso, 1960).

Figure 2.1: The agricultural model of von Thünen



Source: Alonso, 1960

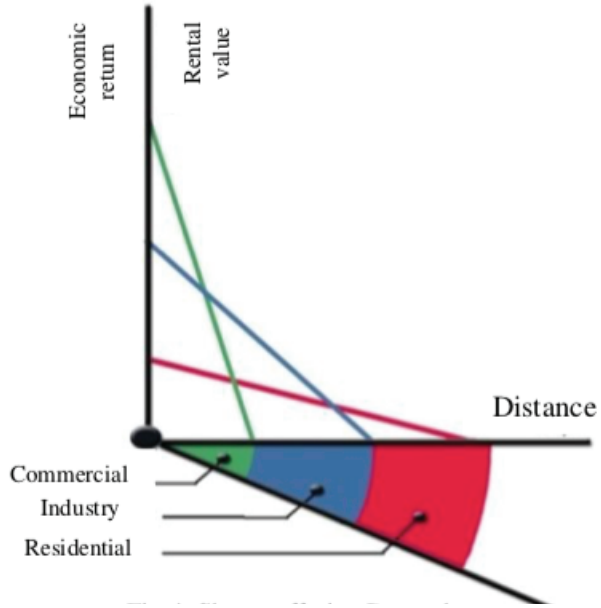
According to Crosier (2001), von Thünen says that in an 'isolated state' the central marketplace would be surrounded by different rings of agricultural land use. The area within

the nearest ring around the market will generate products that are economically profitable on the market but are difficult to transport, and the same applies the other way round.

Alonso

Alonso was able to generalize Von Thunen's understanding of bid rent curves to an urban framework. Since this period, the theory of urban economics has undergone rapid development, leading to a large body of theoretical and empirical work (El-Barmelgy, 2014). According to Alonso (1960), it seems that since the early twentieth century, there has been great interest in America for the urban land market. Nevertheless, there are interesting problems that urban land theories must take into account. For example, there is a paradox in American cities: the poor live close to the center, on high-priced land, and the wealthy live in the periphery, on low-priced land. The study by El-Barmelgy et al. (2014) also mentions other values that exist besides the market price, such as social land values due to zoning restrictions. The research of Narvaez, Penn, and Griffiths (2014) further explains by stating that centralization is where socio-economic activities are centered, depending on connectivity and location. Competition for location is about organizing distances within the city, and consequently, forming land-use patterns. This self-organization process is seen as localized agglomerations in which the economic space becomes the result of considerations between the cost of living and location. The relationship between economy and space is examined by bringing together an economic model, often known as the "bid rent theory", with the configuration theory of spatial planning as the core background, as can be seen in figure 2.2 below (Narvaez et al., 2014).

Figure 2.2: The bid-rent model of Alonso



Source: El- Barmelgy et al., 2014

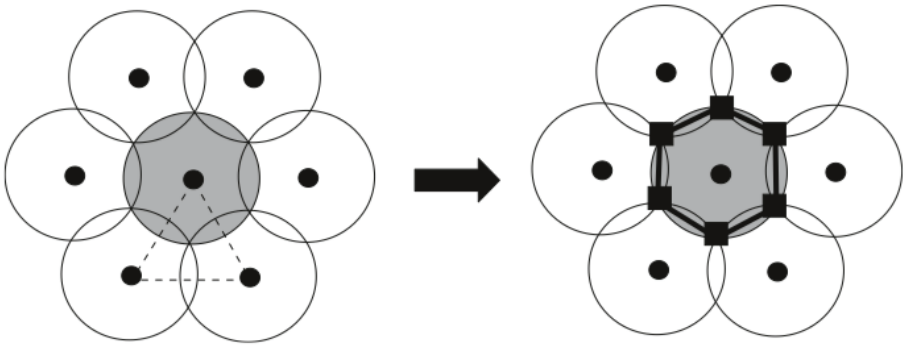
In a very simplistic view, firms and households make a trade-off between transport costs, the amount of land they use, and the land price (El-Barmelgy et al., 2014). According to Narvaez et al. (2014, p.213), the term 'bid rent' refers to *"the amount of rent a user is willing to pay for a more central location but is willing to accept a location further from the central built-up area at a lower rent cost in compensation"*. This trade-off process of the bid rent model of Alonso results in a land price curve that has the highest land prices located close to the city center.

(El-Barmelgy et al., 2014). The model indicates that as the distance from the CBD increases, there is less land available at a lower price. Alonso's model is far removed from reality when it comes to explaining the actual distribution of land uses, but it does however give insight into how to think about distance as a form of urban architecture instead of just a measure (Narvaez et al., 2014).

Christaller

How economies are organized is partly the result of the emergence of various centers within a city (Narvaez et al., 2014). The central place theory attempts to explain the locational and functional features of market centers (Mulligan, 1984). It was based on multiple centers that Walter Christaller formulated the theory of central places. Unlike von Thünen, who assumes a single city as the center of consumption and a spread-out production of (agricultural) goods that must be transported to the city by the producers (farmers), Christaller's approach assumes that consumers must travel to the central place to buy the central goods. (Fischer, 2011).

Figure 2.3: Central places model of Christaller



Source: Fischer, 2011

Under Christaller's theory, 'economic distance' is the most important factor in deciding whether a place is centrally located, and this understanding is related to the time a consumer has to invest in transport, the cost of transport, and the inconvenience associated with it (Fischer, 2011). Christaller said that the main characteristic of a city is to be the central point of a region and that the range of a good is the distance that the scattered population is willing to cover to buy a good that is offered at a central location (Getis & Getis, 1966). In figure 2.3 these central places and the hexagon structure are illustrated. The black dots are the central places where all customers can be served within the range of the circle the dot is located in. People who find themselves out of that area cannot be served from that central place. They need to be served from other central places that are in their range. This pattern results in the hexagonal circle packing as can be seen in figure 2.3 (Fischer, 2011).

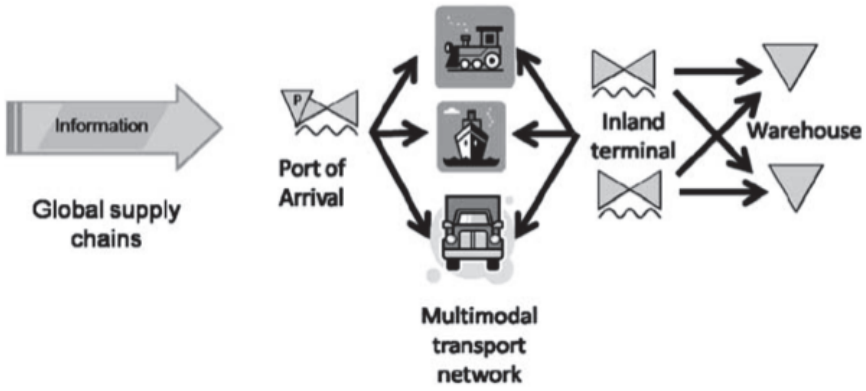
2.2.2 Multimodality

Intermodal (or multimodal) transport has been stimulated by regional, national, and international policies throughout Europe. This way of transport accounts for many cases as a more environmentally friendly alternative than transport by road (Meers et al., 2017). In the past few years, intermodal transport networks have gained renewed attention. This is because of the focus on shifting containers from truck transport to other modes of transport (barge or

rail) and because of the increased competition on hinterland transport between maritime transport players (Van Riessen, 2018). The potential for intermodality can influence decision-makers at the supply chain level. It can increase the attraction of new business activities from a national perspective (Veenstra et al., 2012). Multimodality is also able to compete with road transport in a short-distance corridor for domestic container transport (Kurtulus & Cetin, 2020).

An example of multimodality can be seen in the multimodal transport framework (figure 2.4) in the Brabant region in the Netherlands. In this region, there has been set up a joint subsidiary between four independent terminals, which is called Brabant Intermodal. This network coordinates cargoes from a deep-sea terminal to hinterland terminals and it also creates larger cargoes with higher frequencies (Veenstra, et al., 2012).

Figure 2.4: Multimodal hinterland network



Source: Veenstra et al. (2012)

Despite the success in the Brabant region, the modal split of inland freight transport has hardly modified between 2005 and 2016 (Table 2.1). In the Netherlands, the share of road transport has stayed on the same level (52%) in both 1990 in 2015 (Jonkeren et al., 2019). Road transport has thus been dominant for many years in the Netherlands but in the EU as well. Alternatives like inland waterways and rail carry less weight than transport by road does (Van Wee et al., 2013). Veenstra et al. (2012) mention the division of the use of transport modes in the Port of Rotterdam. The current modal split in the Port of Rotterdam needs to change as well. A move needs to happen from the current truck/rail/barge of 55/10/35 percent to 35/20/45 percent. Road transport has to decrease and both rail and barge need to take a larger part in the transportation of goods.

Table 2.1: Split in the modality in EU28 (% based on ton-kilometres)

Mode	2005	2016
Road	75.7%	76.4%
Rail	17.9%	17.4%
Inland waterways	6.4%	6.2%

Source: Jonkeren et al., 2019

To overcome the imbalance between the different modes of transport, there is a need for alternative modes. These alternative modes of transport ensure more sustainable economic development and strengthen competitiveness (Larranaga et al., 2017). Alternative intermodal transport is needed to shift goods from road to intermodal transport for short distances (Meers et al., 2017). To achieve such a shift in modality, goods need to be transported on intermodal corridors (Van Riessen, 2018). Freight transport by water is in line with this multimodality. This type of transport modality wants to facilitate the growth in the logistic sector, and it wants at the same time to counteract the negative effects of this growth. The Trias Mobilica is maintained to achieve this:

1. Reduce demand, by diminishing inefficient freight transport
2. Preserve the kilometers, by a modal shift to water
3. Technique and behavior, by logistic improvements and education

(Rekenkamer Oost-Nederland, 2016).

With the rapid growth of container flows and multimodal transport developments, seaports are facing infrastructural challenges related to increasing congestion and storage space (Fatimazahra et al., 2016). One of the policy approaches (see also section 2.4 means to steer) that can be used in this are infrastructure investments. The investments are focused on the development of efficient intermodal terminals, rails, and properly facilitated ICT (Kaack et al., 2018). The goal for the Netherlands is to optimally connect the different infrastructure networks to strengthen economic competitiveness. This goal can be achieved through developing multimodal transit nodes and through proper coordination between spatial planning and infrastructure (Van Geet, Lenferink & Leendertse, 2019).

Besides these infrastructural challenges, several operational challenges also need to be entailed to design and implementation a multimodal network. These challenges are related to the necessity of increasing the reliability of transport operations, the challenging task of joint optimization of terminal operations across the network, or the coordination of decision-making processes to create an optimal trimodal transport service (Veenstra et al., 2012).

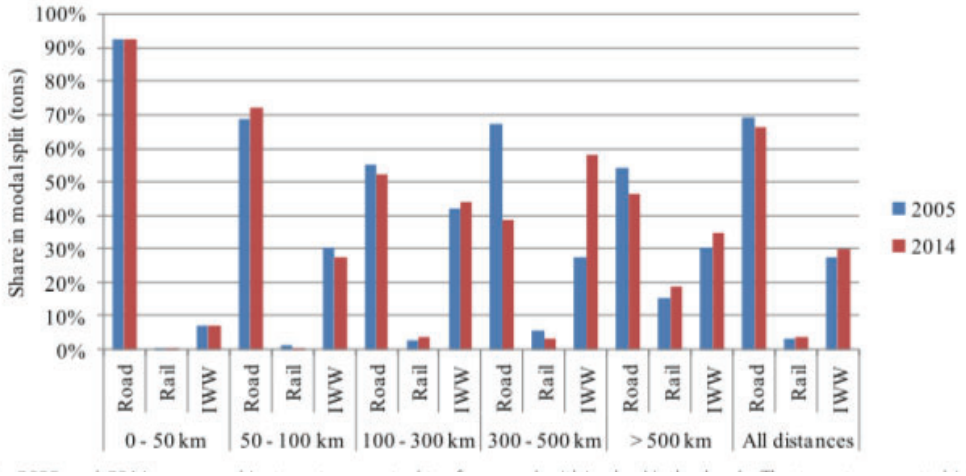
2.2.3. Modal shift ambitions

The reason why shippers increasingly want to transport their goods from seaports by multimodal transportation to the hinterland differentiates. One reason, as mentioned earlier (see section 2.1), is that shippers who produce environmentally friendly products prefer a more sustainable way of transport as well. They want to reach a fully sustainable system. Another reason why shippers increasingly rely on multimodal transport connections in the Netherlands is because of the unreliability of transit times of road traffic to the Port of Rotterdam or the forthcoming renovations of the port highway, the A15 (Veenstra et al., 2012). Western Europe faces a substantial growth in road freight transport, which has resulted in lots of congestion problems on European highways and increased environmental problems, which in turn leads to higher costs for society. If no measures will be taken to reduce road transport it will continue to grow in the future, and the negative effects will cause more and more problems for the whole society (Blauwens et al., 2006). The need to move away from road transport is thus great.

In the figure below (figure 2.5) it becomes clear that the transport of goods by inland waterways makes the largest growth when it has to cover a distance of between 300-500km.

According to Jonkers et al. (2019), this is due to the increase in the energy industry, in which coal transport continues to grow, and because of the various power plants in Germany that are located within a radius of 300-500 km from the port of Rotterdam. For shorter distances and longer distances, it can be observed that less use is made of inland waterway transport.

Figure 2.5 Choice of transport mode per distance travelled (in 2005 and 2014)



Source: Jonkers et al., 2019

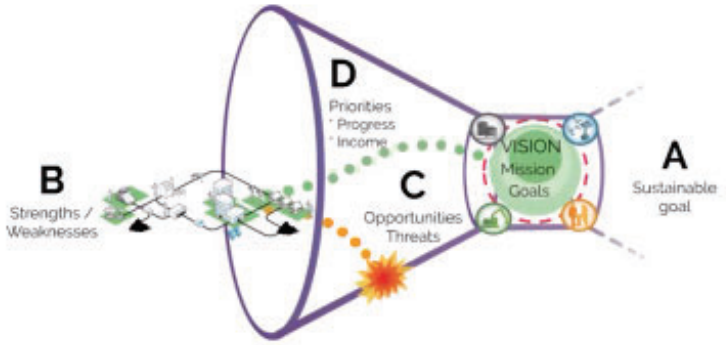
In the article of Rogerson et al. (2020) there are some steps in the process to explain the shift to inland waterways. The first step is to inform port terminals and staff about the characteristics of inland waterways and what is needed to realize this. Another step that needs to be taken to realize the modal shift is to invest in adaptations, facilities, and equipment for this new way of transport. This will prepare inland ports for this new type of transporting goods. To convince parties to invest, a good explanation about the business opportunities of inland waterway transport needs to be given. It namely contributes to an attraction of flows of goods and it also creates possibilities for filling, a depot for empty containers, or storage (Rogerson et al., 2020). But even though the steps to make a modal shift are clear, achieving a modal shift stays a difficult task. The alternative freight transport modes can only compete with road transport when it fits in the supply chain of shippers and if it can fulfill the logistical requirements of the shippers (Blauwens et al., 2006).

2.2.4 Future visions

To fulfill these modal shift ambitions, we need to look to the future. How can these ambitions be achieved? Creating a vision is therefore important, but at the same time complicated. After all, the future cannot be predicted. Nevertheless, access to the conditions for achieving a desirable goal will help in inventing a successful future. But at the same time, these conditions are linked to changes from different dimensions, which makes creating a vision remains difficult (Robèrt, Borén & Broman, 2017). The ABCD process is a tool that can shape strategic thinking in an intuitive way (Robèrt, 2020). Within this process, a backcasting approach is used. Backcasting is a better approach than forecasting when considering long-term planning and achieving new goals in complex systems (Broman & Robèrt, 2017). This backcasting approach can be applied to transport as well. According to Tsamboulas et al. (2007), the transport routes and modes of transport are determined in advance, due to the

uncertainty of stimulating future situations. In Tsamboulas' research, co-modality is preferred. In this type of modality, the combination of modes of transport is pre-determined on when, where, and what kind of goods are most efficient.

Figure 2.6: ABCD-process



Source: Robèrt, 2020

The funnel process of the ABCD procedure in figure 2.6 describes the process in which a certain vision can be made by using the ABCD system. The ABCD- procedure is explained as follows. The figure shows four letters: A B C and D that each represents a different part of the process. The first step (A) is about the learning process of sustainability challenges and opportunities. The second step (B) analyzes the current situation and compares this with the vision to be achieved. It also sums up both the assets and challenges that the current situation has to deal with to achieve the vision. In the following step (C) possible solutions to the challenges are thought of, for example by brainstorming and in the last step (D), strategic guidelines are applied to make prioritizes of the possible solutions made in step C (Broman & Robèrt, 2017).

2.3. Modal shift factors

Choosing a certain modality depends, according to KiesZon (2020) on several factors such as *accessibility of the destination, flexibility, velocity and costs per kilometer*. The research of Van Riessen (2018) mentions, among other things, *cooperation, transport planning and mental shift* as factors for multimodality. Meers and Macharis (2015) mention factors such as *accessibility*, *shipment size and transport speed*, while Kurtulus and Cetin (2020) mention the importance of *transportation costs, transit time and reliability*.

Overall, it is thus clear that many factors are involved in making a modal shift. In this research the choice is based on a combination of factors that have emerged from both the literature and discussions with various experts (*see Chapter 3 section 3.3*) as being the most important factors for making a modal shift a success. The chosen conditions are *transport costs, reliability, cooperation, transport planning and mental shift*.

Transport costs

The growth of the freight flows causes contemporary changes in the economy at all scales. Both the local and regional as well as the global level experience these changes (Hesse & Rodrigue, 2004). Changes in freight transportation costs can be one of the consequences of this increase in the flows of goods. Transportation costs are mentioned by Kurtulus and Cetin

(2020) as one of the most important factors that influence mode choice. When the costs for freight transport increase (e.g., tolls or oil prices) it might influence shippers to switch to other transport modes (Van Wee et al., 2013). The research of Rogerson et al. (2020) mentions the demurrage costs, which can be reduced to make inland waterway transport more attractive. Next to the fact that Inland container shipping not only draws additional flows of goods, it can also create possibilities for value-added services such as the provision of a depot for empty containers. These benefits shippers who are situated close to the location where containers have to be returned and reduce the corresponding container demurrage costs.

Monetary costs and travel time are not the only important costs, the notions of "transport services" and social costs (e.g., noise pollution and congestion), which are often much higher in road freight transport than in rail or inland waterway transport, are also important factors to consider (Hesse & Rodrigue, 2004; Van Wee et al., 2013). Transport services can influence on for example reliability and discomfort. It thus influences the decision to make a trip or the way to transport goods. A generalized term of 'transport costs' is used by economists to include all resistance factors (Van Wee et al., 2013). The research of Zhang et al. (2015) complements with structuring several costs related to each type of connection in freight transport:

- Commodity-related costs, CO2 emission charges, and transport modality-related costs. These costs are included within all types of modalities (e.g., road, rail, or barge).
- Commodity-related time costs, which are independent of the transport modality.
- Terminal operators' costs, which include handling costs.
- Access and transit costs for the route of trucks between the highway and their destination.
- Pre- and post-transport costs for the route of trucks between the terminal and the destination.
- The costs of hub-based inland waterway connections.

As can be seen, there are many costs involved in transporting goods. The financial capacity required to start up multimodal transport services is, according to Van Schijndel and Dinwoodie (2000) high. Therefore, frequent transport services must be offered from the start to persuade the shippers of their usefulness, which entails start-up costs that must be buffered over a fairly long time.

Reliability

According to Kurtulus and Cetin (2020), there are contradictions as to what are the most decisive factors for a modal shift. A study in Portugal on short-distance inland transport corridors lists the price as the most influential factor in choosing a mode, while other research states that measures to increase the reliability of alternative modes are more effective than cost. Brooks et al. (2012) in addition mentions saying that reliability is specifically important for goods that are time-dependent on arriving at their destination. Goods with a high value and high cost of inventory and perishables need to be transported efficiently to reduce risks and lower total costs.

According to Meers et al. (2017), an intermodal alternative that can compete on price and time is needed, to shift goods from road to other modes of transport over short distances. An efficient organization together with a reliable and frequency timetable is

essential to be able to compete. The flexibility of planning, mentioned by Van Riessen (2018), can contribute to dealing with uncertainties and thus with the increase of reliability of transportation. The research of Kurtulus and Cetin (2020) even shows that reliability is the most important characteristic of inland container shipments. Reliability consists of two components. The first is that reliability needs to be provided to deliver freight within a fixed window that is acceptable for retail self-stocking or the input in production processes. Another component is reliability that is required to minimize costs and reduce stock (Larranaga et al., 2017).

The European Gateway Services (EGS) is concerned with for example hinterland transportation networks. Their goal in this is to increase the reliability of the arrival time of container transport and to increase the utilization of inland vessels and trains (Van Riessen, 2018). According to the research of Brooks et al. (2012), short sea shipping is namely seen as a less reliable way of transport than a truck. The research of Meers et al. (2017) agrees with this, by stating that it is hard for inland waterway transport to compete with road transport because both inland navigation and rail transport are considered 'slow modes'. A difference can be made in the modal shift from road to intermodal transport by emphasizing reliability and increasing the frequency of services up to a daily departure for fixed transport services.

Cooperation

It seems that ports often make strong connections with inland terminals, because they hope it will bind freight to seaports. However, freight transport flows follow the most suitable route. Freight flows cannot be forced to follow a certain route and port authorities are aware of this. Free riders do exist and are definitely a problem. Port authorities therefore prefer indirect collaboration instead of direct formal strategic partnerships with a defined number of inland terminals. The indirect collaborations involve, for example promotion and joint marketing, which require fewer financial means and are less binding (Notteboom & Rodrigue, 2004). Cooperation is, according to the research of Van Riessen (2018) an important factor related to multimodality, and it is therefore included as a factor for the potential of modal shift in this research.

In many logistics operations, economies of scale are crucial to achieve reduced unit costs. Economies of scale can be achieved, for example, by bundling single products into larger batches (Van Wee, 2013). Attracting sufficient freight volume is a major barrier to modal shift, as shipping operates on a larger scale than road and rail (Van Riessen, 2018; Rogerson et al., 2020). For transport to the hinterland, large volumes are carried by using rail-road or water-road transport. The capacity of carriers to transport goods from the hinterland at the minimum cost and with reliable and regular services is an absolute prerequisite for competing with other modes (Frémont & Franc, 2010). Attracting and combining freight volumes can help in the process of modal shift from road to water (Rogerson et al., 2020).

Transport Planning

In recent decades, much has been devoted to solving congestion. Traditional transport planning has therefore primarily been conceived as an approach to reducing (road) congestion (Martens, 2016). The main challenging task for an operator of a container transport network is to constantly draw up an effective transport plan. Assigning containers to available inland facilities like barge, train or truck falls within the idea of creating an

efficient transportation plan. In such an efficient plan, all orders need to be accessible to services in the whole transport network (Van Riessen, 2018). When looking at the realization of a modal shift, this also requires adjustments. In order to realize the shift in modality the flows of goods in inland waterways need, for example, different processes, loading and unloading of goods, storage and different investments and labor than the regular flows of goods (Rogerson et al., 2020). Changes in logistics have led to new approaches to port hierarchy and to new freight distribution patterns. The current improvements in efficiency of logistics, mainly container transportation, consists largely of inland distribution (Notteboom & Rodrigue, 2004).

The research of Hesse and Rodrigue (2004) points out that common studies of freight transport and logistics refer to the fragmentation of the business activity in different sections of the value chain and the respective transfers of goods. When logistics and transport are looked at as a derived demand, they turn out to be flexible and strongly adapted to the specialized demand of receivers and shippers. Zhang and Witlox (2020) also mention that accountability and efficiency can be encouraged by giving stakeholders the opportunity to participate in the formulation of plans to explain the direction of the sector and thus support good planning. Increased planning flexibility should, according to Van Riessen (2018), contribute to a higher degree of utilization of inland waterway transport and rail capacity and thus to lower emissions and costs. Planning flexibility can thereby also be used to cope with disruptions and uncertainties and thus improve the punctuality and reliability of transport.

Mental shift

To achieve a modal shift, a mental shift should also be considered. KiesZon (2020) says that besides the physical conditions of the modal shift the mental shift of shippers is also very important to take into account. What are their incentives to make the modal shift to rail or water and what do they get from it? The research of Meers et al. (2017) mentions that lots of decision-makers do not always have sufficient access to the appropriate information about intermodal transport. A mental shift is necessary to provide this information and to make a modal shift. Van Riessen's (2018) research contributes to making this mental shift necessary by citing it as one of the most important factors in choosing a particular mode of transport.

However, achieving modal shift remains a complex process. An integrated network approach and a change in mentality are needed to achieve a more integrated inland transport. Efficient transport planning methods are essential to achieve this and to meet customer requirements (Van Riessen, 2018). The truck is the most commonly used transport modality because it has lots of advantages, e.g., low costs, flexibility, and reliability. However, at the same time, it certainly has several disadvantages (De Miranda Pinto et al., 2018). Modern societies are characterized by increasingly individualized lifestyles, which accords with the desire for a flexible, largely self-determined form of mobility that can be adapted to the daily needs of each individual. The car can be integrated into this lifestyle like no other mode of transportation. The consequence is the emergence of highly car-dependent mobility behavior (Nobis, 2007). For this reason, it is important to pay attention to the mental shift needed to look beyond road transport. Van Riessen (2018) strongly urges intermodal transport to continue to make an effort in achieving the required mind shift and overcome practical obstacles. Only through continued effort, intermodal transport will be able to offer a truly embedded transport solution and become synchromodal transport.

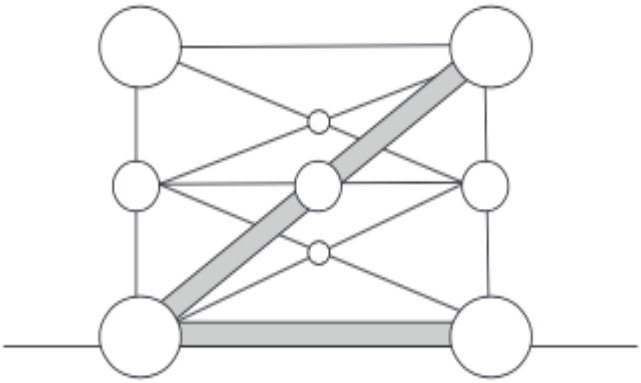
2.4 Logistic corridors

When looking at the trade of goods it is fundamental to look at how the freight transport is moving instead of only looking at the origin and destinations of the transported goods (Hesse & Rodrigue, 2004). Logistics namely refers to the management of the movement of people, information and goods from the origin to the point of consumption (Beškovnik, & Twrdy, 2012). These goods are transported in corridors. A corridor refers to a series of available transport possibilities between two locations. For such corridors a variety of inland services are available which are characterized by the cost per container, departure and arrival time, the mode of transport (truck, rail or barge), and by the capacity of a vehicle (Van Riessen, 2018).

If we look at the transport of goods in the Netherlands, it appears that it plays an important role in the global supply chain. They achieved this important position through their strong infrastructure and logistics industry, centuries of trade activities, and the port of Rotterdam as the largest port in the world (Veenstra et al., 2012). Seaports, such as the port of Rotterdam, are an essential part of the supply networks. They provide a wide range of services and are important for the economic area. One of their main tasks is to facilitate both international and domestic trade in goods. Third and fourth generation seaports act as logistics centers in developed urban, logistics and distribution functions (Montwill, 2014). However, the Port of Rotterdam has also faced challenges in moving shipments through their port. These challenges exist due to unstable hinterland connections, pollution, delays, congestion and competition between terminals and carriers (Veenstra et al., 2012).

In the near future it is very probably that barge transport operations will continue to change. The hierarchy of terminals is under scrutiny by different stakeholders. Some strategically located terminals will maintain its hub function with important exchange functions (e.g., between barges), while other terminals will become secondary to these hub terminals which will be focused on serving regional and local markets (Notteboom, 2007). In order to illustrate this hierarchy between terminals the 'main street' model (figure 2.7) is used. The large circles represent the ports and inland terminals (dry ports), the smaller circles represent the smaller nodes, and the grey lines the priority corridors between the ports and the nodes (Wilmsmeier, Monios & Lambert, 2011). This model thereby shows an explanation of an idealistic sequence of transport development and the improvement of accessibility through internal expanding transport networks within the maritime industry (Fatimazahra et al., 2016).

Figure 2.7: the 'main street' concept



Source: Wilmsmeier et al., 2011

It is interesting to notice that the relations between nodes, which create the priority corridors, are changing. In the past these corridors were hold back by the barriers of port location, they were static. Nowadays this static view has changed. Inland terminals are now transformed into active nodes, which are based on vertical cooperation strategies instead of solely the location of physical infrastructure (Wilmsmeier et al., 2011).

Intermodal corridors make use of rail or barge services between inland and deep-sea terminals. In this intermodal network intermediate container transfers at network terminals are used in order to transport containers by one or more barge and rail services. Even though intermodal corridors are in practice already for decades, they undergo many practical problems: the demand for container transport is unstable, imbalanced and seasonal which results in low utilization of barge and rail services. Because of this new method that is required in terms of reliability, cost and emissions, these networks are normally formed by the collaboration of multiple stakeholders like terminals, barge and rail service operators (Van Riessen, 2018).

2.4.1 Extended hub

As for the port hinterland, it seems that inland ports are defined as "*hinterland locations with a waterway connection to a deep-sea port by means of a corridor*". These inland ports play an increasingly important role in the evolution of port systems. As freight transport increases around the world, deep-sea ports need to expand themselves and diversify their incoming flows along cross-border corridors to inland ports, or a combination of both (Witte et al., 2016). Seaport terminals must be able to transport many containers to the hinterland, instead of waiting for containers to be picked up by barge, truck or rail. In this way, congestion can be reduced. Shifting the transport of containerized goods to hinterland locations enables transshipment of goods without involvement of the shipper, the receiver, the shipping company or custom authorities (Veenstra et al., 2012).

The function of the hinterland location in this type of transport is called 'dry port' (e.g., extended hub), and has been operationalized between the TCT terminal Venlo and the ECT terminals in the Port of Rotterdam (Veenstra et al., 2012). An 'extended hub' is in concept the same as a 'dry port', but in practice there is a difference. According to Tsao and Linh (2018), Monios (2011) and Veenstra et al. (2012) A dry port is: "*an inland intermodal terminal directly connected to seaport(s) with high-capacity transport mean(s), where customers can leave/pick up their standardized units as if directly to a seaport*". The difference with an extended gate is explained by Van Riessen (2018) who explains an extended hub as follows: "*a dry port for which the deep-sea terminal can choose to control the flow of containers to and from that inland terminal*". The idea behind an extended hub is to extend the point of delivery from a seaport terminal alongside a corridor to a multimodal inland terminal from a shipper/receivers' perspective, and potentially to a final destination like a distribution center (Veenstra et al., 2012).

Dry ports can contribute to reducing emissions and relieving road traffic when a modal shift is encouraged (Tsao & Linh, 2018). The concept of a dry port is based on the idea that not all economic and industrial activities need to take place in the vicinity of seaports. Indeed, good inland nodes and infrastructure can also help to accommodate trade growth and steer regional development inland. An extended gate can even fulfill the function of a

multimodal platform. This will help inland terminals to develop their services and also to evolve into real multimodal service providers (Veenstra et al., 2012).

2.5. Means to Steer

Europe must take action in changing the common transport policy. New targets need to be set to bring about this change in freight transport. A balance between the modes of transport must be achieved, intermodality developed and congestion tackled (Blauwens et al., 2006). To adjust the EU intermodal transport policy, a policy action plan is introduced. The aim of this plan is to increase opportunities and remove obstacles in order to increase the share of intermodal transport (Tsamboulas et al., 2007).

The shift of transport from road to transport by water has been pleaded by both international and national governments (Rogerson et al., 2020). Since the last decades the European Union has taken some initiatives in stimulating this modal shift, such as the Marco Polo, Trans European Network (Ten-T) and Motorways of the Sea programs (Douet & Cappuccilli. 2011; Rogerson et al., 2020). The Ten-T program improves the port-hinterland connections by constructing or upgrading them and the program of Motorways of the Sea is aimed to substitute the highways of land in order to avoid congested land corridors and to improve a better connection between waterborne -and surface transport (Douet & Cappuccilli, 2011).

With the construction of these motorways of the sea, the European Union hopes to offer maritime services that can compete with road transport (Van Wee et al. 2013). Feo et al. (2011) however, mention that even though measures have been taken to stimulate the modal shift from road to water - road pricing schemes and aid from the European Commission and national governments - the modal shift still hasn't been implemented on a significant level. The research of Zhang et al. (2015) and Jonkeren et al. (2019) complements by saying that already for decades efforts are being made to promote the modal shift from road to more sustainable modes, but the shift has stayed limited.

2.5.1. Public and Private parties' engagement

When looking at these programs, it becomes clear that such a program covers vertical scale political actors (state, region and city) as well as political actors on a horizontal scale (e.g., port authorities, shipping lines and terminal operators) (Douet & Cappuccilli, 2011). This multi-actor concept refers to "public-private partnership (PPP)". A PPP is a cooperation of public and private actors, who work together to reach a mutual goal (Panayides, Parola & Lam, 2015). Responsibility for the production of public policy lies not only by the governments, but it also involves many other stakeholders outside the government spheres, especially from the private sector. Governance strategies are established in order to not be dependent on governments (Raimbault, 2019). In strengthening port management, private actors are increasingly involved in port operations (Panayides et al., 2015). In terms of inland port governance, mechanisms and structures between private and public actors can be analyzed. Both parties are involved in the development and management of port spaces, which includes informal interactions (based on their different strategies) and on formal coordination such as laws (Raimbault, 2019).

Within the maritime sector there are two directions identified in port regionalization, these contain the "outside-in" and the "inside-out" directions. The first direction indicates inland ports development driven by actors on the seaward side (private terminal operators

and seaport authorities). The other direction indicates land-based actors (inland port authorities and local governments) implementing inland port strategies (Raimbault, 2019).

Another thing that is important to take into account is the role of the government and its policies, which is often lacking in scientific research in freight transport (Zhang et al., 2015). Regarding transport policies there are limited approaches, especially when it comes to the effectiveness of policy measures for the modal shift in freight transport. Continuously new initiatives cause that the assessment of new transport policies becomes crucial (Tsamboulas et al., 2007). Rogerson et al. (2020) therefore mentions that the transport of a considerable amount of goods by water requires, among other things, good and adequate policy support. Van Geet et al. (2019) complements by saying that realizing policy objectives effectively has always been the core of policy design. A right combination of instruments that is used in the policy process is needed in order to achieve multiple goals.

It is often more difficult than policy makers think to change the modal share of freight. This is because shippers not only take into account a large number of resistance factors, but the shippers also take different decisions from each other when deciding to use a particular mode of transport (Van Wee et al., 2013). In the shift to new transport policies for the modal shift in freight transport not only shippers are of relevance. To determine the impact of the policy measures that are focused on the modal shift, the entire transport market should be taken into account (Blauwens et al., 2006). It is necessary, for instance, to look at the relationship between the capacity of transport systems and the travel demand growth and the policies that are involved in this growth (Tsamboulas et al., 2007).

Most of the logistic zones are in contradiction with the regional policy objectives because they are developed by fragmented suburban coalitions. A possible solution is to create a regional planning of multimodal logistic zones. The already existing multimodal terminals are protected by the 'general destination map' of the SDRIF. However, the SDRIF cannot plan new multimodal logistic zones or preserve warehousing zones. In order to govern the allocation of logistic places at a regional scale better, public policies are thus desired. The regional authority needs to work together with already existing public authorities in order to implement regional policy goals (Raimbault, 2019).

The development of the hinterland ports, which will become an extended gate, also requires appropriate policies. In Europe, both local governance structures as well as an equal partnership between inland ports and seaport terminals are needed to tackle the seaport problems that will arise in the hinterland. European and national authorities will need to take a different view of the monitoring of all incoming cargo, and additional measures will be developed for this purpose. New partnerships between multimodal transport service providers and terminal operators will have to be created, partnerships that fit within current and future transport frameworks, but which also develop new flexibility for integrated services in multimodal hinterland networks (Veenstra et al., 2012).

2.6. Conclusion

The most common motivation for switching to multimodal transport or waterborne transport is sustainability. Transport by water is more sustainable and that is what many parties are striving for nowadays. More and more companies are asking for more environmentally friendly solutions, such as multimodal transport, for the transportation of their products. In

addition, there is also the ambition to switch because of the congestion on the roads and the infrastructure renovations that need to be carried out here. This harms the reliability.

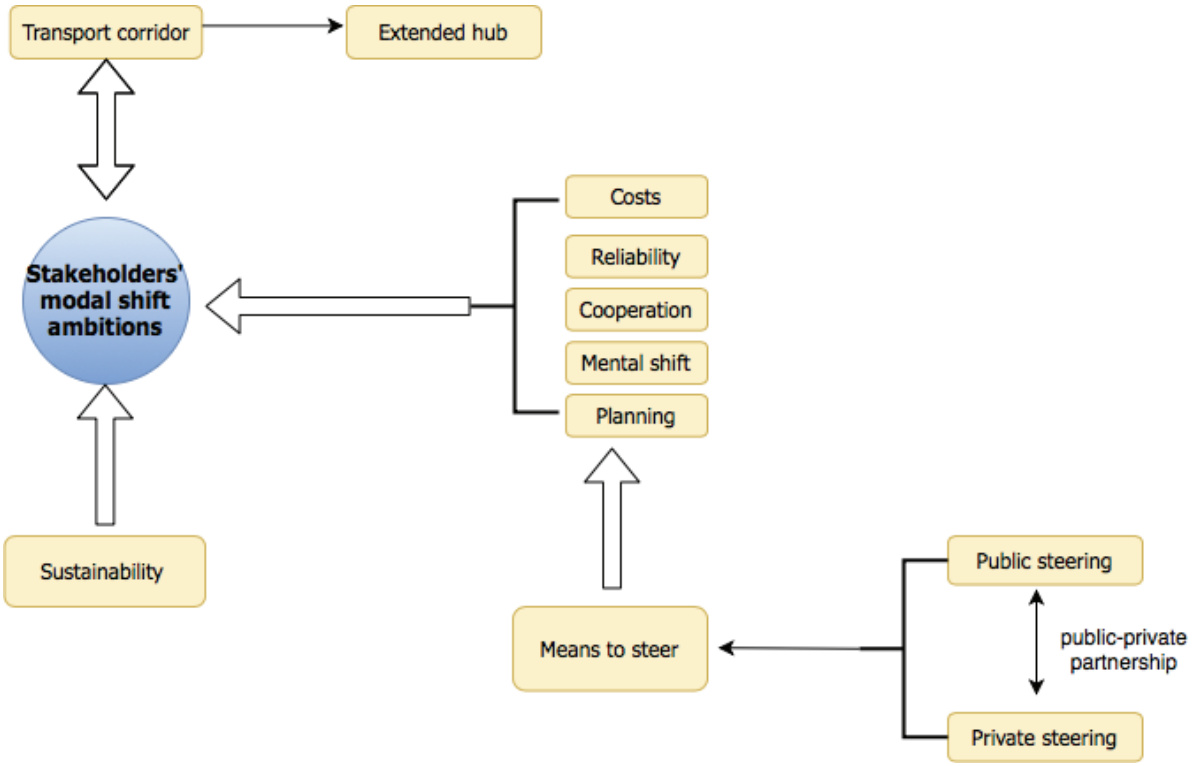
To fulfill the ambitions, vision-oriented work is needed. This is difficult since the future cannot be predicted, and many factors and stakeholders are involved in the process of modal shift. The literature reveals five factors that can contribute to making the modal shift from road to water a success. These factors are transport cost, reliability, transport planning, mental shift, and cooperation. It can be concluded from this that several aspects need to be worked on and that modal shift is, therefore, a difficult process to achieve. It is for this reason that modal shift is not yet widely applied in practice.

The port of Rotterdam offers a wide range of services and is important for the economy. Partly because of this, the Netherlands plays an important role in the global supply chain of freight transport. The corridors are very important in this respect. For such corridors a variety of inland services are available. Some locations function as hubs, in which inland hubs are becoming increasingly important. These can even serve as extended hubs, to reduce congestion and pressure in seaports such as Rotterdam. This is important for the future as freight flows are expected to continue to increase. Creating more extended hubs will help to reduce emissions and relieve pressure from road transport as well.

Lastly, various means can be used to steer in the modal shift ambitions. The literature shows that various programs and policy strategies have already been applied in Europe to make a modal shift (e.g., Marco Polo), but that the shift has stayed limited. To make the modal shift a success, appropriate policies are required. The literature shows that the responsibility for the realization of these policies and port governance lies with both the government as well as many other stakeholders from the private sector. The ultimate goal is therefore to guide cooperation between public and private parties.

2.7 Conceptual model

In order to structure the theory discussed in the literature review, a conceptual model is established. The concepts in this model can be derived from the main question and sub-questions of this study, within which the connections are indicated by arrows. To achieve the main concept, the modal shift ambitions of the stakeholder, a number of important concepts are taken into account. These concepts are transport costs, reliability, cooperation, transport planning and mental shift. The first connection that can be made is that sustainability goals influence the modal shift ambitions; sustainability is becoming more and more important and is therefore often the reason to make a modal shift. In order to achieve these ambitions, means of steering are needed and the means are in turn deployed by public or private parties or a combination of both. When looking at corridors, such as the route between Moerdijk and Rotterdam, and the possibility for Moerdijk to become an extended hub, there is a mutual connection with the future ambitions. The current corridor must satisfy the future ambitions and the future ambitions in turn determine what the corridor needs to contain.


Transport corridor
Extended hub
Stakeholders' modal shift ambitions
Costs
Reliability
Cooperation
Mental shift
Planning
Sustainability
Means to steer
Public steering
public-private partnership
Private steering

Chapter 3: Methodology

In this research, the existing literature was first reviewed to gather information on the topic of interest. Additional information was then collected by means of desk research, conducting interviews and a focus group discussion. The founded theories were subsequently combined with the collected empirical information in order to formulate an answer to the main and sub questions of the study.

3.1 Research strategy

A distinction between quantitative and qualitative methods is often made in the methodological literature (Van Thiel, 2014). In this research a qualitative research has been carried out. In qualitative research priority is given to the perspectives of the respondents. Their subjective actions, meaning and context are being illuminated (Fossey et al., 2002). Therefore, qualitative method is the best method to find out which conditions are necessary to make a modal shift between the strategic node Moerdijk and the port of Rotterdam successful. This is because all kinds of actors are involved in the process of making a modal shift successful and all these actors have their own opinions that should be taken into account.

Another reason why a qualitative approach is the best method for this study is because a case study is chosen. A case study research is a research method in which one or more cases are examined in a real-life setting. Cases can be all kinds of things, for example a group, a country, an organization or a city (Van Thiel, 2014). The cases in the research concern the strategic hub of Moerdijk and the port of Rotterdam. In case study research a holistic approach is applied. This means that a great deal of content of mainly qualitative data is collected. Taking interviews is a method that is often used in case study research (Van Thiel, 2014). Since this research includes interviews to gather data, case study research is an appropriate strategy.

Two areas are chosen as case study, this concerns the port of Rotterdam and the strategic junction of Moerdijk (*see section 4.1*). The port of Rotterdam is the largest seaport in Europe. It has an excellent accessibility by both sea and intermodal connections. The port thus takes a leading position. Hundreds of millions of tons of goods are transshipped annually at the port (Port of Rotterdam, 2021). The port of Rotterdam is therefore chosen as case study in this research. The connection of the port of Rotterdam with the strategic hub of Moerdijk is also interesting. Moerdijk is centrally located and is one of the key submarkets for warehouses and property in the south of the Netherlands (PROLOGIS, 2021). Moerdijk has its own deep seaport which is an import connection for transporting goods from and to Rotterdam and it disposes of multiple transport modes – water (sea, inland water and various quay facilities), road, rail and pipelines (REWIN, n.d.; REWIN, 2019). Because the central locations of both Rotterdam and Moerdijk, their convenient accessibility and their already existing connection between the two, they are the appropriate case study for this research.

This thesis has been carried out in conjunction with a research internship from March to September 2021. An internship was chosen because it combines research and practical experience. The research looks at a problem that requires research according to a certain organization. In this case the research is done for SmartPort Rotterdam, a partnership of key players of Rotterdam (*Deltalinqus, Port of Rotterdam, Erasmus university, TNO, Deltares,*

Marin, TU Delft and Municipality of Rotterdam). SmartPort forms the beating heart of scientific research.

3.2 Research philosophy

Different paradigms exist that are competing with each other to gain acceptance within scientific research. Within every paradigm, both quantitative as qualitative methods can be used. However, to qualitative research four paradigms – positivism, post-positivism, critical theory, and interpretivism – are relatable (Guba & Lincoln, 1994). As in this research qualitative methods are used, all four paradigms above are worth mentioning. However, according to Fossey et al. (2002), only two paradigms underpin qualitative research. These paradigms are the interpretive and critical theories. According to the research of Harrison et al. (2017) case study research is closely related to an interpretive approach. An interpretive view sees reality as subjective and is aimed to discover meaning and understanding of experiences. It is therefore that in this research with a qualitative approach of a case study research, the interpretive approach is enhanced. This paradigm is, ultimately, central to qualitative research.

3.3 Research method

Information was gathered through desk research, through taking interviews and a focus group discussion. Secondary data helped to form a perspective on already existing information about modal shift and about the ports of Rotterdam and Moerdijk. This formed the basis of the information used for this research and answers the first sub-question of this research: "*what are the characteristics of the freight transport corridor between Rotterdam and Moerdijk?*". Interviews, on the other hand, were conducted to see what the stakeholders' modal shift ambitions are, what future challenges there are and what means can be used to steer in the modal shift, which all focused on the case study of the transport corridor between the port of Rotterdam and the Moerdijk strategic hub. Based on this, the sub-questions 2, 3 and 4 were answered (*See Chapter 1*). Finally, a focus group discussion was held to validate the results of the interviews.

According to Fossey et al. (2002) and Anyan (2013) interviewing is next to focus groups and participant observations a common method for collecting qualitative data. According to Brinkmann and Kvale (2005) and Fossey et al. (2002) qualitative research is namely about understanding the purpose of human experiences and their actions. The viewpoints of those that are involved are maintained.

3.3.1 Discussion with experts

At the start of the writing of this study, a number of discussions were held with experts. It was a conscious decision to do this at the beginning of the study. The researcher knew very little about the modal shift from road to water and everything around it. By talking to various experts, a clearer picture was formed of the subject of the thesis and what the research should look like. It gave insights on what the focus of the research should be, and it made for interesting conversations. A number of expert conversations also led to a number of candidates for interviews, so it also contributed to networking.

Most of the experts were approached by using SmartPort's network. Experts were also approached through the network of the thesis supervisor from the university. In total, conversations were held with a diverse group of 6 experts (see table 3.1). These were informal

conversations in which the researcher explained the purpose and topic of the research and then engaged in conversation with the experts.

Table 3.1: Questioned experts

	ORGANIZATION
EXPERT 1:	Port of Moerdijk
EXPERT 2:	LCB
EXPERT 3:	Jak Management & Advice
EXPERT 4:	Province of Zuid-Holland
EXPERT 5:	Port of Rotterdam
EXPERT 6:	United Waalhaven Terminals

3.3.2 Interviews

Although, Meers et al. (2017) recommend doing face-to-face interviews in order to avoid misunderstandings, it was not possible to conduct face to face interviews due to the COVID-19 pandemic. The interviews were conducted digitally and took place between 18 May and 11 June, in which 15 stakeholders in 13 interviews in total were interviewed. Regarding the interviews, several organizations and governments were interviewed, but not all possible units of study were questioned. A selection had to be made. This is because it is not possible to include all potential study units in one research (Van Thiel, 2014). The respondents were stakeholders that are involved in the whole logistic chain of the modal shift from road to water. In this research the selection consisted of cargo organizations, the ports of Moerdijk and Rotterdam, governments, terminals, shippers, inland waterway organizations, branch organizations and transporters that are engaged in the modal shift (see table 3.2).

Table 3.2: Respondents interviews

RESPONDENTS	**ORGANIZATION**
RESPONDENT 1:	CCT
RESPONDENT 2:	Port of Moerdijk
RESPONDENT 3:	Province of Zuid-Holland
RESPONDENT 4:	TLN/FENEX
RESPONDENT 5:	CBRB
RESPONDENT 6:	Port of Rotterdam
RESPONDENT 7:	EICB/Bureau voorlichting binnenvaart

RESPONDENT 8:	Danser Group
RESPONDENT 9:	ECT
RESPONDENT 10:	Evofenedex
RESPONDENT 11 AND 12:	Province of Brabant MCA Brabant
RESPONDENT 13 AND 14:	BLN Schuttevaer
RESPONDENT 15:	Total Produce

The information to be obtained from the respondents covered various topics (*see appendix 1 and 2*) related to the central and sub-questions of the study. Questions were asked such as: *is there the willingness to make the modal shift? Are all actors involved well informed? What are your sustainability goals? What is needed to make this modal shift work? To what extent will future challenges influence the modal shift? What efforts are already made in this modal shift? Who do you think plays an important role in stimulating the modal shift? How do you view the relationship between Rotterdam and Moerdijk? Does there exist a future for the modal shift?*

3.3.3 Focus group discussion

After the interviews were taken, a focus group discussion was arranged (*see chapter 5*). A focus group discussion is a technique in which a researcher brings together a group of individuals to discuss a specific topic, with the intention of drawing on the beliefs, complex personal experiences, attitudes and perceptions of the participants through a mediated interaction (O. Nyumba, 2018). This helped the researcher to make a better understanding of the results gained from the respondents from the interviews. The goal of the focus group discussion in this thesis was to validate the outcomes of the interviews and to start the discussion on notable findings. Sim and Waterfield (2019) confirm this approach by saying that a common practice in qualitative research is respondent validation, which means that participants can comment and give an opinion on the researcher's interpretation of the interviews conducted.

The focus group discussion was conducted on the 30th of July 2021 from 9:30 till 10:30, a session of about one hour. This was chosen because it was during the summer period. A period in which respondents do not have much time due to planned holidays and other obligations. However, one hour was sufficient to obtain the information the researcher hoped for. The session was held online via Microsoft Teams, because lots of the respondents had to work at home due to the COVID-19 measures. In this focus group, all respondents were invited to participate in the discussion, but due to the summer period only 4 participants were able to attend the focus group (table 3.3.). According to O. Nyumba (2018), a potential disadvantage of a focus group discussions is that there is no assurance that all invited participants will participate in the discussion. A stakeholder who was actually supposed to join as well – the representative of the Inland Waterway Information Office – could for example unfortunately not attend the focus group due to personal circumstances. The

participation of an additional member would have made the group even more complete, but nevertheless, the participants were a diverse group consisting of a government agency, a terminal and two branch organizations.

Table 3.3: Participants focus group

	ORGANIZATION
PARTICIPANT 1	ECT Rotterdam
PARTICIAPNT 2	Danser Group
PARTICIPANT 3	Province of Zuid-Holland
PARTICIPANT 4	TLN

The programme of the focus group discussion (*See appendix 3*, *table 1*) started with a short presentation by the researcher of about 10 minutes on the general findings and on some remarkable findings that emerged from the results of the interviews (*See Appendix 3, figure 7 and 8*). This was done by sharing the screen in Microsoft Teams and showing a Microsoft PowerPoint presentation with several slides. After the researcher's presentation, there was room for questions from the participants, which was followed by the discussion based on the four statements. Finally, there was a general discussion with closing remarks on the propositions (*see chapter 5*).

3.4 Validity and reliability

Validity of research consists of 2 parts, internal and external validity. Internal validity looks at whether the theories used in the research have been adequately operationalized and whether the relationships between the different variables do exist (Van Thiel, 2014). This research is internal valid because the theories used are operationalized in interviews and the information gathered does make a connection with the different variables of the research (modal shift with policy). External validity looks at if the research can be generalized. Does the research count for other organisations, persons, locations or other moments in time? (Van Thiel, 2014). For this study, it is interesting to argue whether the findings can be generalized. After all, goods transport goes further than solely between Rotterdam and Moerdijk. The findings of this study could provide an example for other ports, nodes or an entire logistics corridor. However, to make this research generalizable, the chosen conditions of the research must remain the same. For example, different locations bring different types of conditions, making it difficult to generalize one case study research. Van Thiel (2014) agrees with this by stating that it is difficult to generalise findings to other situations, because one specific case study fits a specific context.

Chapter 4: Context: case and stakeholders

In order to obtain a clear understanding of the respondents and the case study, and to answer sub-question 1: "*What are the characteristics of the freight transport corridor between Rotterdam and Moerdijk?*", this chapter will provide more insight into the Moerdijk-Rotterdam corridor and the role that the interviewed stakeholders played in it.

4.1 Desk-research case study

Southern Netherlands is considered a gateway to Europe. This important logistics center is located in the heart of the inland region of the Netherlands. Because of the network of highways, canals and railroad the Southern Netherlands is well connected to the Port of Rotterdam and other important waterways (PROLOGIS, 2021).

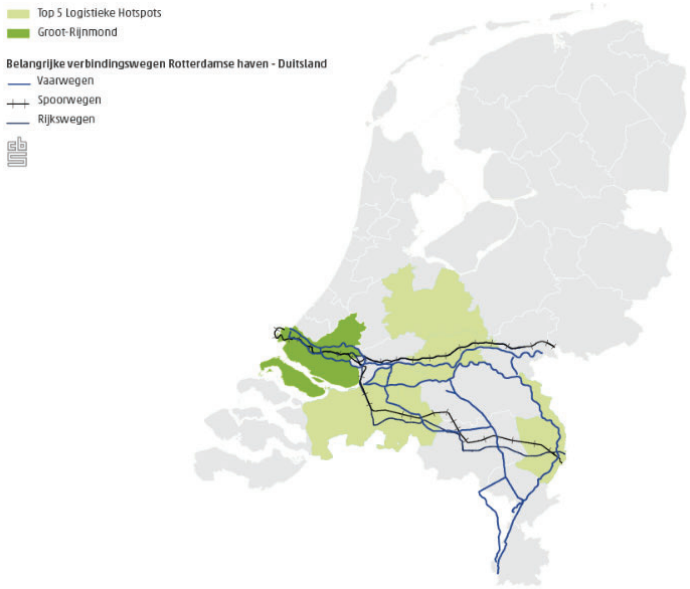
4.1.1: West-Brabant region

In the Netherlands freight transport with barges, trucks or trains is increasingly going through logistics hotspots. In these hotspots (nodes) goods are transshipped. The top 5 logistic hotspots of the Netherlands in sequence are (see figure 4.1):

1. West-Brabant
2. Tilburg-Waalwijk
3. Venlo-Venray
4. Rivierenland
5. Utrecht

The hotspots Rivierenland, Venlo-Venray and West-Brabant made the fastest growth in transshipped weight in 2017. For the most part it involves transferring goods from or to the port of Rotterdam. In 2017 namely, 2.5 million sea containers were transported from the Rotterdam port area to the Dutch hinterland. One third of these were unloaded in one of the five logistics hotspots (CBS, 2018).

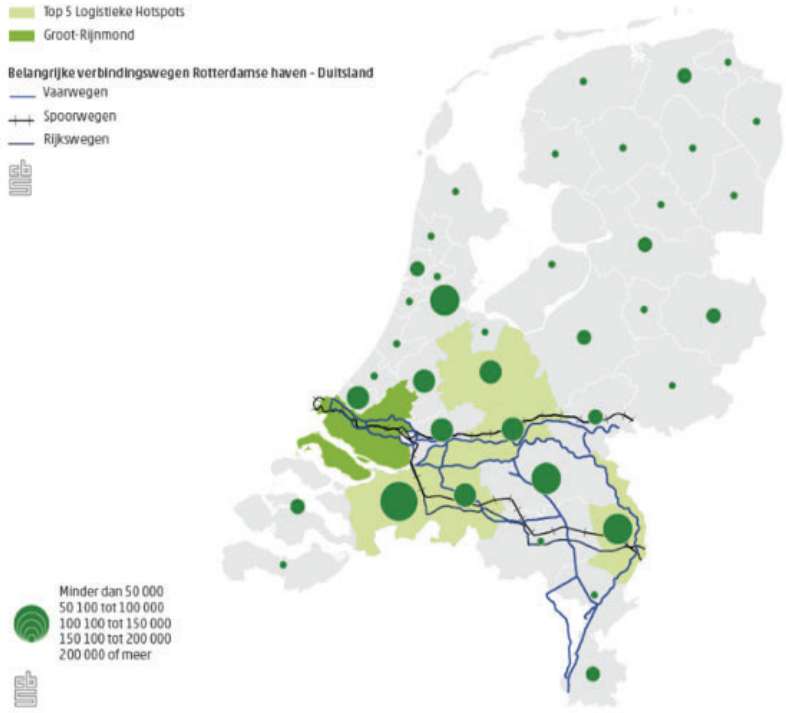
Figure 4.1: important connections in the Netherlands



Source: CBS, 2018

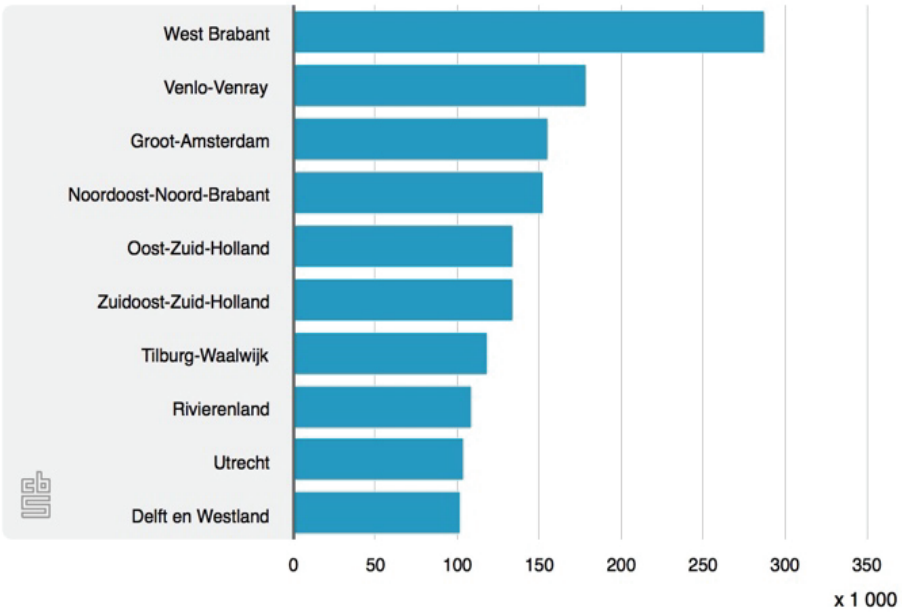
It seems that from these 5 logistic hotspots, West-Brabant, by far, handled the most containers (see figures 4.2 and 4.3 below). This is partly because smaller seagoing vessels calling at Rotterdam can sail on to Moerdijk to load and/or unload (CBS, 2018). West-Brabant is centrally located between the ports of Antwerp and Rotterdam and knowledge centers Delft and Eindhoven, which makes it occupies a special economic position (REWIN, n.d.).

Figure 4.2: containers unloaded from Rotterdam seaport area.



Source: CBS, 2018

Figure 4.3: Top destinations for shipping containers in the Netherlands



Source: CBS, 2018

West-Brabant serves as a hub for wide-ranging (inter)national flows of goods to the entire European hinterland, because of its industrious and dynamic character. Companies in this area profit from the proximity of main ports Rotterdam and Antwerp and of the deep-sea port Moerdijk with its inland and short-sea connections (REWIN, n.d.).

Businesses are seeking more and more for a combination transport through road, water, and rail. West-Brabant fulfills this question because multimodal transport is well organized. This makes West Brabant a base of operations for many enterprises. The businesses that are located in West-Brabant are well accessible by water through the connections with the Schelde-Rijnkanaal and the Hollands Diep. In addition, with Moerdijk, the area also has its deep seaport at its disposal. These connections through water ensure that the Netherlands is directly linked, from Rotterdam to other parts of Europe (REWIN, n.d.).

4.1.2: Moerdijk

The area of West-Brabant consists of 16 municipalities among which Breda, Bergen op Zoom, Moerdijk (see circle figure 4.4), Oosterhout, Roosendaal and Etten-Leur (REWIN, n.d.). In this research, the focus will be on the municipality of Moerdijk. Moerdijk is located in the central north of the region West-Brabant on the border with Zuid-Holland (REWIN, 2019). In addition, Moerdijk is one of the key submarkets for warehouses and property in the South of the Netherlands (PROLOGIS, 2021).

Figure 4.4: 16 municipalities of West-Brabant

Source: REWIN, n.d.

The municipality of Moerdijk has a working population of 20.000 people, with three main labor sectors: industry, wholesale and retail trade, and transportation and warehousing (REWIN, 2019). As mentioned earlier Moerdijk has a deep seaport which is an import connection for transporting goods from and to Rotterdam (REWIN, n.d.). Moerdijk, in addition, disposes of multiple transport modes – water (sea, inland water, and various quay facilities), road, rail, and pipelines. Moerdijk's' business park is located next to the highway and the deep seaport on the Hollands Diep is part of the business park. The nature of the business activity is logistics, chemistry, manufacturing, and port related activities (REWIN, 2019).

Port of Moerdijk

Southern Netherlands is an important logistic node that links the inland of Europe with other places. There are many European distribution centers with global brands located in this area, which serve whole Europe and its surrounding areas. The Port of Moerdijk is located on the Hollands Diep, between the main ports of Rotterdam and Antwerp. This port is an ideal for logistics operations, global goods arrive and depart from this area. Next to the global level, the Port of Moerdijk is also accessible for inland vessels by its wide inland waterway network (PROLOGIS, 2021).

Logistic Park Moerdijk

Strategically located between two highways (A16 and A17), along the railroad line from Rotterdam to Antwerp, near the port of Moerdijk and east of the large-scale business park of Moerdijk, the new Logistics Park Moerdijk is being developed (LPM) (Witteveenbos, 2021; REWIN, 2019). The area is designed for large-scale warehousing, distribution activities, and value-added logistics (Port of Moerdijk, 2021; REWIN, 2019). Developing the Logistic Park Moerdijk has been accepted in September 2020 and it is to be expected that the first companies will settle in 2021 (Port of Moerdijk, 2021).

The arrival of the LPM offers advantages for the port authority. Besides the expansion of the port and for the industrial area, the LMP also strengthens Moerdijk's' multimodal hub through road, rail, and water. There is space for large logistic businesses of storage and distribution. Not only does the Port of Moerdijk benefit from this development, but the whole area of West-Brabant also gets a boost in their economy and employment opportunities (Port of Moerdijk, 2021).

4.2: Role organizations

When looking at the characteristics of the Moerdijk-Rotterdam corridor, it is important to consider the role of the stakeholders interviewed in this respect. Table 4.1 below gives an overview of this. The current actions taken by each stakeholder to steer the modal shift are discussed later in chapter 5.

Table 4.1: Role of each organization

RESPONDENTS	ROLE ORGANIZATION
CCT	- Are very dependent on the barge transport between Moerdijk and Rotterdam. They have set up the West-Brabant corridor, which has given them permanent windows in Rotterdam. - Have short sea services to England at their terminal.
PORT OF MOERDIJK	- Really looking at how to look at corridors and what facilitating role they can play there. - Are interwoven in the programs of LCB and MCA, in the joint corridors, where they really want to give support to the whole chain.

PROVINCE OF ZUID-HOLLAND	- Accessibility of South-Holland and sustainability as reasons to advocate modal shift. - In the coalition agreement, they as a province have named modal shift as an ambition.
TLN	- It was originally more of a road transport operator, but many of its members now also want to do something with intermodal transport. - Focuses on intermodal transport rather than specific modal shift. - Have lobbied for the rapid publication of zero-emission zones. - As a branch association, they are always there to help their members. - Work a lot with shippers in the area of sustainability.
CBRB	- On the one hand, they are occupied with everything to do with containers, but on the other hand with logistics in a broader sense. So, for example, also the digitalisation ambitions, modal shift policy from the government and junction policy.
PORT OF ROTTERDAM	- Are the managers of the port and can encourage companies to do something, but they have less influence on the parties in the corridor. Nevertheless, they do try to provide incentives to stimulate cooperation in order to get sustainability off the ground. - Mainly lobby for the transport connections from Rotterdam to the hinterland and initiate or help to initiate this together with other parties.
INLAND WATERWAY TRANSPORT INFORMATION CENTER	- Constantly evangelize everywhere
DANSER GROUP	- Is one of the larger inland navigation companies sailing on various corridors (e.g. West-Brabant corridor and North Sea Port corridor).

ECT	- Is a terminal at the Maasvlakte where they have two large terminals. - Established the European Gateway Service, a subsidiary of ECT in which they offer barge and rail transport to various locations in the hinterland
EVOFENEDEX	- Is an association of entrepreneurs, with 15,000 members and 20% of those members are very large companies, the multinationals that also have a logistics process in NL and 80% are SMEs.
MCA BRABANT *AND* *PROVINCE OF NOORD-BRABANT*	- MCA is involved in sustainability and emission-free shipping and the climate agreement, clean energy hubs and the growth of inland shipping. - Two years ago, the province signed the Green Deal on seagoing and inland navigation and ports and MCA Brabant is following in that direction - The Province has drawn up a broad picture of the future in 2030 together with 7 parties among which the Port of Rotterdam, ministry of Infrastructure and 3 other provinces. - Both are looking at corridor context and in clean-energy hubs, which applies to both modal shift to inland shipping and railtrack, sustainability (Clean Energy Hubs) and digitalization.
BLN	- Have stated in the Inland Shipping Green Deal that the shift from road to water must be an aim to achieve the greening of transport. - Consults with members of the Dutch Parliament to give substance to the modal shift objectives. - Lobbies nationally and internationally for adjustment and scaling of waterways, bridges and flood locks - Have stated in the Inland Shipping Green Deal that the shift from road

	to water must be an objective to realise the greening of transport
TOTAL PRODUCE	- It is part of the Total Produce Group worldwide, by far the largest player in the fruit and vegetable sector. They are a company that has always had strong ties with the port of Rotterdam. - Are the world's largest fruit and vegetable company, but they act locally as an SME.

4.3: Conclusion

In conclusion, sub-question 1: "*what are the characteristics of the freight transport corridor between Rotterdam and Moerdijk?*" can be answered. The characteristics of the Moerdijk-Rotterdam corridor become clear based on the desk research. As one of the logistics hotspots in the Netherlands, West Brabant transports many goods to and from Rotterdam. West-Brabant serves as a hub for wide-ranging (inter)national flows of goods to the entire European hinterland. Moerdijk is located in this area and is one of the key submarkets for warehouses and property in the South of the Netherlands. With a deep-sea port with multimodal accessibility and the emergence of a new logistics park, Moerdijk is a strong hub connected to Rotterdam as the largest port in Europe. From the overview of the roles of various stakeholders, it becomes clear that many parties are involved in the Moerdijk-Rotterdam corridor. Many initiatives are aimed at, for example, sustainability, corridors, and modal shift specifically.

Chapter 5: Results interviews and validation

This chapter discusses the results of the interviews and their validation, and elaborates on the sub-questions 2, 3 and 4 of this study (*see Chapter 1*), which will be specifically answered in Chapter 6. There are some key themes that are discussed. First, the modal shift ambitions of the stakeholders are discussed, followed by the modal shift factors in the context of the Moerdijk-Rotterdam corridor and the role of the extended hub. Then the means to steer and who provides steering in the modal shift are discussed. Finally, the results are validated by means of a focus group discussion.

5.1: Modal shift ambitions

According to the organization TLN, most of their members are still focused on road transport. But differences between the members gradually emerge. Lots of the members of TLN, especially the large companies, are considering doing something with intermodal transport. The ambition for the organization itself is also to look at all modalities and to use the most optimal, sustainable, and often also the fastest one. The province of Zuid-Holland agrees with this by saying that every level of government does feel the need to use, among other things, inland waterway transport but also, and above all, multimodal transport.

"*Modalities should not be competing but cooperating*" – TLN and Port of Rotterdam

When speaking of the modal shift ambitions, these also exist within the organization of Inland Waterway Transport Information Center (in Dutch: Bureau Voorlichting Binnenvaart). The ultimate goal is to bring the modal shift to a larger scale. They are just like LCB and MCA Brabant involved in various programs such as Joint Corridors Off-Road, which aims to reduce the number of road kilometers, bring about a modal shift from road to water or rail and consider how this can be organized.

When looking at the future, a representative of the terminal CCT Moerdijk foresees a positive future for inland waterway transport. They started with fewer ships than they have now, and they see more opportunities for expansion in the future. But the modal shift from road to water is not their only ambition, they go even further. CCT already has fully electric-powered ships between Alphen aan de Rijn and Moerdijk, and their ambition is to have fully electric-powered ships between Rotterdam and Moerdijk as well. The province of Zuid-Holland has more or less the same ambitions as CCT has. In the coalition agreement, the modal shift has been put forward by the province as an ambition, and in addition to this, smart shipping and digitalization are also ambitions for inland navigation that the province pursues. Just like CCT the province of Zuid-Holland and the Port of Rotterdam also want more goods to be transported by water and next to this ambition they also strive to make inland waterway transport more sustainable.

The terminal ECT Rotterdam mentions a division in motivation in the ambitions across different stakeholders. In the view of ECT, the Dutch ministry wants a modal shift from road to water for a different reason than they claim. The ministry markets the ambition of the modal shift under the notion of sustainability, while it is actually about the fact that the roads are congested and that they want to decongest them more. According to ECT, it has nothing to do with a green ambition. The province of Zuid-Holland, as a government authority, confirms this by saying that their motivation to transport more goods by water is mainly to

get transport off the road. Although the congestion motive is also confirmed by the Dutch Royal Association of Shippers (BLN), they, like ECT, see a divide between the stakeholders. In general, they see that congestion on the road leads to the idea that we have to shift to water transport and that this is also the underlying reason why it has become a government objective. The authorities have a social interest in transporting more by water. But BLN sees another motivation as well and that is sustainability. According to BLN the European Commission and the Dutch inland shipping also strive for a modal shift from road to water but then in the framework of greening, they have the ambition to lower the emissions. The Port of Rotterdam claims that modal shift is not a solution for congestion, as congestion is mainly caused by commuters (passenger cars), however, modal shift should provide an opportunity for shippers to avoid congestion and the associated costs of truck time losses.

"*Whose ambitions are these?*" – ECT

When speaking of sustainability ambitions, the port of Moerdijk for example has stated in their vision that they want to be the most sustainable logistics hub in the Dutch-Flemish Delta. The Port Vision 2030 describes what they do in the field of sustainability and that includes sustainability for inland and seagoing shipping. Total Produce mentions the horticultural agenda developed by GreenPort Netherlands. The agenda identifies seven themes that must be tackled at the national level, where there are long-term ambitions. One of these is fresh logistics. The most important part of that theme of fresh logistics is sustainability and that includes modal shift. The horticultural sector has stated that in the future, say by 2030, it will make a strong case for this modal shift as a more sustainable form of logistics. The organization CBRB and the Province of Noord-Brabant also indicate sustainability as an important goal and that it is increasingly becoming an item for companies. TLN has signed the climate agreement in which the most important points for their sector are included: from 2025 there will be zero-emission zones in the 30 to 40 major cities, and the goal is to create a 30% CO2 reduction for the hinterland. The Port of Rotterdam and the port of Moerdijk also agree with the climate agreement and have the goal as a port to become CO2 neutral in 2050. The Inland Waterway Transport Information Center adds to it that they want to achieve a reduction of CO2 between 35% and 50% and mention another agreement, the Green Deal. The Green Deal was agreed with the sector at the national and European levels. It expresses the wish to reduce CO2 emissions from the fleet by 40/50% compared to 2015, by 2030. It is interesting to notice that according to Danser Group, the government determines the direction of sustainability. If the legislation changes, then the sector changes too.

5.1.1 Future challenges

It can be stated that many factors and stakeholders play a role in making a modal shift a success and that inland navigation faces several challenges in the future. Future challenges such as climate change, as well as the increase in online shopping, capacity, and lack of space, are challenges that are acknowledged by the majority of the respondents, which can affect the modal shift ambitions. CCT and TLN emphasize the high and low water problems. CCT mentions, for instance, that in their green corridor from Alphen aan de Rijn to Moerdijk, they have to pass under certain low bridges, which means that with high waters at certain times of the day fewer containers can be loaded onto inland vessels, which in turn results in a loss of capacity on the ships. So, if climate change leads to an increase in the low and high

tides, then that is something that needs to be taken into account. CBRB also agrees with this climate problem, but then also points out the challenge of overdue infrastructure in the hinterland (see 5.2.). Danser Group however mentions to say that when it comes to Moerdijk, Venlo, Brussels, or Ghent, there is not a climate problem, but when it comes to the Rhine, low water is a problem.

A solution given by Danser Group for low water is to work with hubs. They work for the Rhine with the hub at Nijmegen. So, if instead of sailing from the Rhine to Rotterdam and Antwerp, the ships can only sail to Nijmegen, which is a solution for low water. In that case, however, it must be ensured that transporting from that hub to the seaports can also be done reliably. (see 5.2).

Another important challenge at the moment is the COVID-19 pandemic. Evofenedex indicates that the pandemic shows that trade and production chains are very vulnerable, and MCA Brabant indicates that COVID-19 has worked to the advantage of road transport. At the beginning of the pandemic, the trucks could make more trips because there were far fewer traffic jams at that time, as many Dutch people worked from home. As a result, the cost price for freight transport immediately goes down and inland waterway transport cannot keep up. The Port of Moerdijk and Total Produce complement by saying that there are many developments in road transport, such as shipping regulations for driving and resting times, and Total Produce mentions, in addition, the congested A15 as a bottleneck. ECT mentions another important challenge, space usage. There is a lack of space in the Netherlands, but the rest of the large areas of the Netherlands are subsequently filled with all kinds of warehouses for the rest of Europe to store and transport goods. This, of course, creates extra pressure on the Dutch roads and society. The province of Noord-Brabant looks outside Europe and sees that the costs of transport from China to Europe and political sensitivities both increase, and that nearshoring (= bringing back a part of the production to Europe) may be a possible solution.

The province of Zuid-Holland and BLN see another challenge. They see that the traditional flows of inland waterway shipping are declining. Inland navigation has mainly grown up with the massive bulk flows (coal/ ore) and these are industries that are decreasing at the moment or will decrease in the future. To tackle this, inland waterway transport should move on to the new streams. A new stream that still has a lot of opportunities according to the Inland Waterway Transport Information Center, is the city distribution and particularly for e-commerce. It all has to go to the city anyway, so they still see a lot of opportunities for urban distribution by water, especially in the Randstad.

Finally, Evofenedex mentions the important challenge of digitization. If one wants to be competitive in a digitalizing world market, a transition will also have to be made in one's logistics process (see 5.3).

5.2. Modal shift factors

The transporter organization Danser Group concurs with the modal shift ambitions but points out by saying that if inland waterway transport wants to become successful, a lot has to be done to achieve this success. They believe in a future for inland waterway transport if everything is tighter arranged. The province of Zuid-Holland agrees by saying that there are a lot of factors that play a role that contributes to a successful modal shift. It is an internal logistic process, it is infrastructure, it is the relationship between shippers and shipping

companies that also play a role. Following the Province of Zuid-Holland, they say that there needs to be a start with what does a goods flow need? What does such a flow of goods lack to make such a modal shift?

"*This could be a lack of knowledge, of course, but it could also be that some preconditions simply have to be in order. This could be a transshipment location, but it could also be insufficient cargo flows, or that they cannot fit it into their logistics system*" – Province of Zuid-Holland

TLN agrees with the factors named in the quotation above by stating that communication and information are very important factors when speaking of a modal shift. But they complement by mentioning the importance of the type of goods, reliability, velocity, costs, and capacity (= congestion and infrastructure). MCA Brabant also mentions that multiple factors are of importance. There must be transparency about the connections, they must be reliable, but on the other hand, success experiences are necessary, and they must also be affordable.

Costs

According to the province of Zuid-Holland, most of the companies are driven by price. Generally speaking, sustainability performance is not the primary choice for a company. The organization of ECT complements by saying that the SMEs (small and medium-sized enterprises) are also mostly cost-driven, and that inland waterway needs to become cheaper to become more attractive. The terminal ECT additionally mentions that the real change will come when road transport becomes more expensive by, for example, taxing traffic jams. The fact that road transport is still very competitive is sometimes overlooked. If something is cheaper or more competitive, the tendency is to choose it, and that often happens with road transport. If this step is going to be taken, it must be ensured that inland shipping is cheaper than road transport. BLN and Evofenedex complement by stating that when road transport is going to be priced on CO2, inland waterway transport will become more attractive as a result. That is the kind of thing the government should be getting into.

Evofenedex on the other hand thinks that it depends per shipper. Some parties are more aware of other costs like sustainability and waiting times, while others only focus on the financial costs. CBRB complements by stating that it is interesting to start the discussion whether trucks are indeed, especially on large distances, as affordable as we assume. The Port of Rotterdam agrees with this by mentioning to say that waiting times and environmental costs are not always included in road transport. The port is thinking about whether shippers and the industry are prepared to pay a little more for sustainability. Some of them are, they want to be more sustainable and are prepared to pay a little more for that, but some are not. That is also one of the considerations in the European context, shouldn't we pay for CO2?

MCA Brabant also states that it is not that inland waterway transport is much cheaper or much more expensive, it depends a bit on each case. According to Danser Group and the Inland Waterway Information Center, the pre-and post-transport often makes multimodal transport more expensive on shorter distances. Evofenedex and Total Produce also mention the pre -and post-transport. When a shipper is close to the port, then the pre -and post-transport is minimal and then inland waterway navigation can indeed be competitive.

"*So, I think the stakeholders who say the barge is more expensive are right on several routes, unless you can arrange the after-transport simply, or there is no after-transport, or you can make very large volumes*" – Total Produce

But Danser Group also says that recent developments such as larger ships and better capacity utilization reduce the cost of multimodal transport on water. In addition, the price per kilometer is also expected to go up for trucks in the coming years according to MCA Brabant. In this way, inland waterway navigation becomes more efficient and can compete with road transport in the future. Total produce also suspects that if really big flows are made in inland waterway transport, that is well organized and there is the right infrastructure, then it could also be interesting from a cost perspective.

Mental shift

In addition to the preconditions, the province of Zuid-Holland says that companies often lack knowledge of inland waterway transport or do not know how to obtain sufficient quantities to fill an inland barge. Both the province as well as Evofenedex, the Port of Moerdijk, Total Produce, and the CBRB endorse this unfamiliarity with waterborne transport that exists among some companies. TLN and The Inland Waterway Transport Information Centermention in addition that some parties are just used to take road transport. Not every party goes with road transport because it is easy, but some parties are just used to doing it that way and do not think about other modalities. ECT also agrees with this. They indicate that they recognize the mental shift, just like Evofenedex and the province of Noord-Brabant.

"*This is quite simple: people are not used to change, and they prefer to keep what they have and use the convenience*" - ECT

CCT and The Inland Waterway Transport Information Center explain this unawareness and habituation by saying that family businesses have been transporting their goods by road for years and that this is working out just fine. These companies do not look at other modes of transport, because why should they? The organization TLN also sees the necessity of a mental shift. Nowadays, it is expected to receive a package as soon as possible, preferably the next day. This occurs among both the consumers as well as among companies. Everyone is geared up for a package to arrive as quickly as possible. However, if agreements are made about the delivery of goods that the packages will arrive a day or two later and people are aware of this. Then the product will become more sustainable and cheaper. All it takes is a mental shift by different parties

An important remark, nevertheless, is mentioned by the terminal ECT. The terminal says that the mental shift is indeed important, but at a certain point, there could almost be said that enough has been tried to achieve that mental shift, and of course we can stay on for a longer time, but it has been happening for already 30 years. ECT is questioning whether stimulating a mental shift is still efficient. Evofenedex makes another remark, but then on water transport in its entirety. The branch organization mentions saying that transport by water does not have to be an ultimate option for every flow of goods either. All extra actions (e.g. more handling actions) that come with inland waterway shipping often cost money too, so there are always considerations to be made when it becomes really interesting for a certain party.

These considerations are also endorsed by Danser Group. They say, however, that these considerations will be accepted in the coming years and that it is simply a matter of a certain maturity of a modality. CCT even indicates that they think that inland navigation is spreading like an oil slick. The terminal has more and more companies that are joining in with inland navigation and this is probably because a younger generation is taking the lead at these companies. It does show that the demand is great and both the large parties and certainly the SMEs are contributing to this.

Reliability

Reliability seems to be an important condition for a modal shift according to most of the respondents. CBRB for example mentions saying that when a product is being sold to a shipper, reliability is key. The more reliable the product is, the quicker companies will be inclined to make the switch to inland waterway transport. What matters to CBRB is that the logistics system can meet the shipper's requirements, and that is different for each party. However, both TLN and the Inland Waterway Transport Information Center question which modality is the most reliable. According to the Inland Waterway, Transport Information Center reliability is relative. If you ask one person, it is reliable and if you ask another it is not. TLN, in addition, mentions saying that reliability goes both ways. It is, of course, possible to get stuck in a traffic jam on the road, but if, for example, the barge's departure is missed because there is a traffic jam, or if there is congestion in the port, then there is also unreliability in this modality. Total Produce also sees reliability in the sense of the alternative but also mentions reliability in the sense that it works and that the goods arrive on time.

The congestion in the seaport as an important bottleneck for the reliability of inland navigation has been mentioned by multiple respondents. Danser Group says there is indeed a problem in the handling of containers at seaports, The Port of Moerdijk mentions to say that congestion in the port of Rotterdam makes for an unreliable system. If there is the need to deliver a reliable product, it has to be certain that containers can arrive at the Maasvlakte terminals at the times agreed, and that is still just not the case. When this cannot be enforced at the Maasvlakte terminals or there cannot be paid for, the connection can be stopped right away. This has been established by the West Brabant Corridor and has been recognized as a proven product in the market. CBRB complements by stating that congestion is indeed a major factor affecting their ability to adequately deal with their reliability.

Multiple respondents mention the fixed windows that have to be made with the terminals to get the reliability wanted. CCT explains this by mentioning that the terminals in the Port of Rotterdam only make appointments for handling a ship when there is enough volume. The port of Rotterdam also acknowledges the handling of large volumes in the terminals. If a minimum number of containers is supplied, a guaranteed time slot (fixed window) can be arranged at the terminal. Danser Group mentions saying that if these fixed windows can be agreed, then suddenly there is a reference to reliable multimodality.

"*If we want to make inland navigation workable, we have to have a reliable connection from our terminals to the Maasvlakte. Then we want to have fixed windows and we want to have the capacity to do that*" – BLN

The province of Noord-Brabant and MCA Brabant also sees reliability as a very important condition for a modal shift. They give the example of the West-Brabant corridor where it is

clear that when new parties join the West Brabant corridor, that reliability is guaranteed and that they will have a positive experience. CCT mentions that the West-Brabant Corridor decided to bundle their volumes to create fixed windows with the terminals, and that is working quite well. It has become a scheduled service, which means that a very high level of reliability can be offered, and this is increasingly being used. The port of Rotterdam also said that as more and more shippers joined this corridor Brabant, the scheduled service became reliable. Companies saw that it worked and joined in. The large volumes mean that the costs can be reduced somewhat, and the frequency can be increased. So instead of a few times a week, there can be sailed every day. As a result, the West-Brabant corridor can always sail at reliable times and deliver containers.

According to the Inland Waterway Transport Information Center, the modal shift from road to water has not taken off, partly because both the ports of Rotterdam and Antwerp are congested and therefore unreliable, and partly because many companies are simply attached to the easy and predictable nature of the truck. To solve this and make the shift from road to water happen, MCA Brabant says that insights need to be given in what connections there are, and that reliability needs to be in order.

Cooperation

MCA Brabant explains that over time a shift has taken place in the organization of transport by water. A few years ago, the system, where terminals in Brabant sent its barges with containers from and to Rotterdam, which called at various terminals where they picked up and returned containers, worked well. But when economies of scale occurred, this was no longer a success anymore. Different terminals in Brabant approached each other to see how they could organize it differently. They came up with the idea of bundling their volumes and then shipping them to Rotterdam in full-loaded ships. In this way, they achieved sufficient capacity and reliable connections, which helped them to make joint agreements with the port of Rotterdam and this is how inland vessels handle their container volumes today.

Most of the respondents agreed that cooperation is an important factor for making modal shift successful. According to the province of Zuid-Holland and MCA Brabant, the West-Brabant corridor has become successful because, among other things, different parties bundle their volumes together. It is because of these bundling operations that there is a potential for shorter distance terminals. Both the Port of Rotterdam and the Inland Waterway Transport Information Center agree with the province that more can be handled with inland waterways if they are bundled. It is most important to encourage different parties to come on 'speaking terms', get them to cooperate, and make them feel that it is not only them who want to make the shift. The province of Noord-Brabant agrees and says that bundling and cooperation are necessary to stimulate a modal shift.

Danser Group gives an example of how to organize the transport by water even better in the future. It concerns the ambition to make space for barge handling in the port of Rotterdam and other seaports. However, this ambition already exists on a small scale; a terminal in Rotterdam has made a part of their terminal available for inland shipping only, large deep-sea ships are not admitted. If this ambition is developed further, Danser Group believes it could be the future for inland water transport.

However, it seems to be sometimes difficult for companies to cooperate with the competition. According to Evofenedex, it is just a psychological thing. Companies are

reluctant in working together with the competition because they are afraid of losing their customers. It is a very sensitive issue, and it takes time and effort to make companies realize that cooperation is necessary to continue logistics business in a future-proof manner (see mental shift). Evofenedex finds it very important, but according to them, shippers are not yet ready to work together on a large scale. It requires cooperation between shippers to make the modal shift, but also cooperation between the chain partners, about what does this mean and why are we doing this?

One stakeholder, however, believes that there is no longer so much work to be done in cooperation. The terminal ECT, states that in their view cooperation is not such a big concern. They say that there are barge operators that already take up the task of approaching customers and ensure that bulk cargo or containers from different customers can be loaded on a ship. That network is already there.

Transport Planning

The province of Zuid-Holland mentions both the external and internal logistic processes that are important when making the switch from road to water. They mention a large company which had to adapt their internal logistic process as well to ensure that water transport functions optimally. CBRB also says that it is important that people do something with their logistical setup. Some parties are already very progressive in this respect. In fact, once the logistics process has been properly adapted to inland navigation, inland waterway transport offers many advantages for the logistics process.

The organization CBRB and BLN also mention something else that needs to be addressed in the planning process for inland waterway transport. For both the deep-sea vessels and the inland vessels, the same cranes are used for loading and unloading the containers. As a result, the inland vessels have to wait longer to use the cranes, which causes congestion and increased waiting times in the port. This problem is also confirmed by Danser Group. For trucks or trains, it is easier to handle cargo in the port than it is for inland navigation. Inland waterway transport does not have its cranes or waterside to handle their cargo. If places can be created all over the port where only inland vessels can be serviced and only sea-going vessels on the major routes, then there is certainly a prosperous future in it. This is, however, already happening in 2 terminals in the 2nd Maasvlakte. These terminals have already been set up in a modern way with one side where the smaller cranes are for inland shipping and another side with larger cranes for the larger ships. Nevertheless, CBRB indicates that these smaller cranes also have to be shared with other parties.

According to Danser Group, on the one hand, shippers must be willing to switch to inland waterway transport, but on the other hand, there must be sufficient waterway connections to make such a switch possible. This can be achieved for example by making schemes for hubs and bundling corridors. Evofenedex agrees by saying that next to sufficient infrastructure there must also be obtained improved information about the product's track and trace through digitalization. MCA Brabant says that together with LCB they have suggested that much more information should be provided on what inland waterway services are available. Just like a sports guide, it can be looked up: I want to take my container from West Brabant to Rotterdam, where can I drop it off? What are the connections to get to Rotterdam? And how reliable are they?

Total Produce also indicates that a key factor in attracting businesses is that the process becomes easier to plan and it seems that with the help of digital tools, the planning of inland waterway transport might improve. Some respondents mention the concept of the digital tool "Next Logic". Danser Group says that this tool, one of the most ambitious plans of the port of Rotterdam, will be able to take over the planning in the future. Within this tool, shippers can specify how much volume they have and the terminals on the other hand can specify how many cranes are available on the terminals. In this way, the integral planning will of the supply chain will be organized better and more efficiently. Next Logic is what they call an optimize, a kind of brain, who will put all the pieces of the puzzle together (digitalization as a means to steer is discussed in section 5.3). However, Total Produce does not see the need for a digital program. According to them, keeping an overview is quite difficult, but if there is only one departure every morning and a shipper knows that the container will be at their warehouse at a certain time, a complicated program is not needed.

Infrastructure

In the coming 10 years, there will be many maintenance projects on the road network, which will cause a lot of road congestion according to the Port of Rotterdam and the Inland Waterway Transport Information Center Many companies will then be helped by inland shipping. But at the same time, inland waterways also have major maintenance needs.

The need to renovate the infrastructure on inland waterways has also been mentioned by the province of Zuid-Holland and CBRB. On the one hand, there is of course an advantage of inland waterways because there is always enough space on the water, but on the other hand, there are various challenges to be met. The province has its waterways, but the larger streams of goods are transported through national waterways, and it is on these waterways that there are issues with infrastructure and low water. The province of Noord-Brabant also mentions saying that for Brabant, there could be said that the Schelde Rijn Canal, Hollands Diep, Maas, and 'feeder waterways', i.e., the Wilhelmina canal, Maxima canal, and Zuid-Willems Vaart, are the most important waterways that need to be maintained in terms of infrastructure quality to ensure that the modal shift can take place.

To maintain these waterways, CBRB believes that the government must increase its efforts in the coming years to improve and renovate the outdated infrastructure on these waterways. In addition, CBRB argues that if water is to be considered a serious modality, infrastructure spending must be maintained in the forthcoming policy. The Port of Rotterdam agrees with this by stating that another public infrastructure like pipelines or electricity networks has to be financed together as a society, and therefore the Port of Rotterdam does finance a part of the required investment, but they also appeal the national government to invest and expect the companies themselves to participate as well.

According to the Port of Rotterdam and the Inland Waterway Transport Information Center it is important to look at what is needed for inland waterway transport. Is there enough dock capacity nearby? Is there a transshipment point that is available to multiple parties? Is there enough cargo for loading ships? Are the bridges high enough and, if moveable, at what times do they open? Evofenedex says that it is very important that the modalities are positioned as stable and robust for the future and that the government also ensures that the infrastructure is in order. The province of Noord-Brabant agrees with this by stating that a robust and reliable waterway network is essential for a modal shift. Even though the maintenance of the

old waterway infrastructure in the Netherlands causes unreliability because all kinds of malfunctions occur, like bridges that do not open or floodgates that block, Evofenedex says that it is a good thing that the infrastructure of waterways is being renovated. The waterways are necessary and must be maintained in terms of quality to ensure that the modal shift can take place. After all, if it breaks down because of old age, it is simply not a serious alternative to road transport.

Communication

Just like TLN, CBRB also thinks that communication and information are very important factors to take into account. People have to inform each other well about the state of affairs they are in. According to CBRB, some parties do not always have to interact at the same time, but they can still rely on each other's information flows. The Inland Waterway Transport Information Center, therefore, tries to organize OffRoad sessions to connect and ensure that local shippers and entrepreneurs talk to each other. In this way, more can be done than if there will be approached to just one company about this. They even think that it is much more important that they show more as a communication/promotion program what is possible, who is participating, and what the possibilities are than that they focus too much on the logistical details.

The province of Zuid-Holland states that getting parties together to motivate people does show results. The moment company is visited by a program manager or a logistics agent, the shift will be made, but the shift stays limited. One way is to approach shipper after shipper, calculate a business case and thus take the shipper by the hand, which is also Evofenedex's preferred approach. But this is not the most efficient manner. The other way, of course, is to look at it more broadly and to address business clusters at the national or regional level. It still, however, stays a difficult process. CBRB complements by saying that it takes time to reach a larger target group, but there are already some successes.

Another tool to make to stimulate the modal shift is to let parties share their success stories. The Province of Zuid-Holland says that if large parties share their success, it will serve as a certain promotion of inland navigation. CBRB agrees with this. It does indeed work in the end if allies communicate about inland navigation instead of outsiders saying it. They are certainly looking for the combination with Evofenedex, the forwarders, and the shippers' organizations to see how we can organize this.

It is often also the case that not everyone dares to speak about their wishes of making the shift to waterborne transport. According to the Inland Waterway Transport Information Center it is essential to start the discussion: do you dare to talk about this with your logistics service provider, your forwarding agent, your hauler? It takes courage, bravery, and will. The port of Moerdijk gives an example of such a brave shipper that communicated on television and digital webinars about the fact that he wanted to make a modal shift. Even though that there was a lot of reaction to it, he still didn't manage to set up a waterway connection. So, it is not always the case that there is subsequently experienced success. CBRB complements by stating that they are also struggling for reaching the target group. The terminal ECT explains this by stating that barge operators are just not commercially clever at selling things.

5.2.1: Sustainability

Similarly, to the above-mentioned factors, sustainability also appears to play a very important role in the modal shift. Although sustainability is indeed seen as a motive for making the modal shift (see section 5.1), respondents also clearly indicated that inland navigation needs to become sustainable to compete with road transport and that sustainability is therefore also an important factor in making the modal shift a success.

Transport by road is working very hard to become more sustainable and road transport is simple more affordable than transport by water is at the moment. This has been mentioned both by the Port of Moerdijk and ECT. The Inland Waterway Transport Information Center and Total Produce also agree with this but mention that it does depend on the distance. Post-transportation does not make it more sustainable but if there is a water-water connection then a lot of CO2 emissions and costs can be saved. The organization Evofenedex also says that inland shipping is a sustainable solution for the future. Road transport will also reach its limits at some point. Congestion is increasing and so are sustainability targets. So inland shipping is a serious alternative. The province of Zuid-Holland also mentions saying that in essence, a barge is more efficient than a truck in environmental terms. In air emissions, they are somewhat behind, but if incentives or permission policies are put into place, they can perform better in that area too. TLN agrees by stating that at the moment inland waterway transport is indeed more sustainable than transport by road. However, most of the respondents also mention saying that an inland waterway vessel lasts much longer than a truck and that sustainability will be achieved much faster in road freight transport. The Port of Rotterdam and ECT complement this by saying that when trucks go electric and thus become more sustainable, sustainability is no longer a good argument for making a modal shift from road to water. Inland navigation vessels must also become sustainable and run-on batteries or other clean energy sources (e.g., H2, methanol, biofuels, or even not yet known options). The province, in addition, also mentions the two sides of sustainability in inland waterway vessels. On the one hand, companies may feel more and more pressure to become more sustainable and, on the other hand, there is the risk that sustainability will be achieved too quickly and that the barge will become more expensive as a result.

"*I am not saying that inland shipping is less sustainable. It is just that it is sometimes difficult to insist that there must be a modal shift for sustainability because it is not so black and white*" - TLN

According to some of the respondents, there are already sustainable ways of transporting goods by water, like electrically powered ships. The Inland Waterway Transport Information Center mentions that it achieves a great deal in terms of CO2 reduction. The problem in this however is that electric ships cannot yet sail great distances. In the middle of the sea, there is no possibility of charging a ship. Consideration is therefore given to whether, for example, a hybrid system would be a solution, since this would also be more sustainable and of course, there must then also be sufficient charging points and infrastructure for the electrically powered vessels. Danser Group mentions to say that if at some point, there could be arranged to sail with batteries and only batteries, then it might be the greenest form, but one drawback that might occur is that they might not be able to handle as many containers. Besides, electric shipping (e.g., ZES-concept) is still very expensive at the moment, which makes it is thus not yet profitable. The Port of Rotterdam agrees with the possible

opportunities for electric shipping but mentions that it is necessary that space is available, that there are laws and regulations for this, and that the European Union is also using its standards for electric shipping so that it all becomes easier. The Province of North Brabant agrees with this last point. They are looking into how European co-financing (CEF2 (2021-2023)) and other subsidy possibilities can be used to help in this sustainability challenge smartly because provincial subsidies and other financial support are limited. BLN also agrees with the idea that the government should provide a hand in this and complements by mentioning another tool, the Green Deal. In the Green Deal, all kinds of parties sit around the table together, goals are formulated, and those goals are jointly estimated. It is a cooperation of sector organizations and government agencies to fill in the business community. So, according to the Port of Moerdijk, the opportunity is there but people have to make the effort to look into it. The first steps are always difficult, but they are all the more important to take them together. Although, understandably, people see obstacles, it is still possible.

5.2.2: Extended hub

The factors mentioned above (*costs, reliability, cooperation, planning, infrastructure, mental shift and communication*) together with sustainability are all interwoven in the transport corridor of this research (*See chapter 4*). This, in turn, has consequences for a node that can fulfil the role of an extended hub. Moerdijk, in particular, already seems to be fulfilling this role according to most stakeholders. This will therefore be further elaborated upon below.

Moerdijk

As an inland terminal, CCT Moerdijk initially indicated that they intended to relieve the pressure from the Port of Rotterdam, but that it was ultimately a result. Because of the pressure on the Port of Rotterdam, it just became more and more difficult to get appointments with their ships with 30 or 40 containers. Deep-sea terminals in Rotterdam simply require a minimum number of TEUs to be able to make an appointment. So, by bundling cargoes, CCT can guarantee that they will arrive with 300/400 containers on any given day and will be given priority (see section 5.2). The province of Zuid-Holland and the Inland Waterway Transport Information Center agrees by stating that the congestion in the port of Rotterdam has ensured that terminals like Moerdijk, Alblasserdam, or Gorinchem are attractive terminals to bundle cargo and to use them as extended hubs towards seaports. Danser Group, for example, has a hub and spoke model in Nijmegen, where they take the pressure off the port of Rotterdam and transport it themselves to Nijmegen, where they sail on larger ships to, for example, Switzerland.

When looking at the hub of Moerdijk, MCA Brabant says that it is the pivotal point in the story of the West-Brabant corridor. In addition, Moerdijk has further developed into a seaport and it has made developments in the area of railways as well. The Inland Waterway Transport Information Center also mentions that instead of sailing to Antwerp and Rotterdam, a ship simply stops in Moerdijk, where there is enough volume to be transported by another ship, and then the ship can immediately return to the Rhine. According to BLN, the congestion in the port of Rotterdam that leads to unreliability has meant that a large company that produces beer, originally transported by road to Alphen aan de Rijn and then put on a ship to Rotterdam and Antwerp, is now transported to Moerdijk instead of Rotterdam. In this way, delays in the chain are avoided.

"*So, that whole congestion thing with loading and unloading is Rotterdam's weak point and that has now also led to the container terminal there seeing Moerdijk grow*" – BLN

Multiple stakeholders mention saying that Moerdijk does have a possibility to take in the position of an extended hub of Rotterdam. The organization of Inland Waterway Transport Information Center says that they are sure that Moerdijk can serve as an extended hub for Rotterdam and CCT Moerdijk complements by saying that they are doing their very best to make Moerdijk an extended hub of Rotterdam. The Port of Rotterdam agrees with this by stating that a combination of issues such as cost, reliability, and environment (see section 5.2) is important to consider and that Moerdijk is a success story in that respect because it has proven that the costs are acceptable and that it is reliable. According to CBRB, Moerdijk specifically is considered a serious option as an extended hub and in terms of process, they have come quite a long way already. Total Produce complements by stating that they think that inland waterway transport in Moerdijk could be very interesting, even on such a short distance. If a warehouse in Moerdijk is located near the water, has an efficient way of unloading ships and containers, and does not have too much post-transportation, then Total Produce believes that the Maasvlakte - Moerdijk route will soon be a very good and practical alternative. It will also undoubtedly be more sustainable and probably cheaper.

Danser Group mentions saying that if there is a depot function within a hub, then there can be made a 'single trip' which makes multimodal transport sometimes really cheaper than road transport. ECT and the Inland Waterway Information Center namely says that road transport is very competitive in terms of price and convenience and on top of that when a container is picked up at the terminal on the Maasvlakte, the empty ones need to be returned to the depot within a short time or else there need to be paid money. That is what they call the 'demurrage costs' and they can run up quite high and they are never really taken into account, so people are anxious about that.

When speaking of Moerdijk, CCT sees Moerdijk as a hub, which is actually the starting point and endpoint of the containers, where everything is collected and not really as a stopover. This is because Moerdijk is the depot for all the major shipping companies. In fact, it is said by several parties that Moerdijk is already an extended hub for Rotterdam. Both MCA Brabant and the Port of Moerdijk mention that Moerdijk already has the function of an extended hub. Recently, several seagoing ships have been sailing to Moerdijk instead of Rotterdam. According to MCA Brabant, the question now is to look at how can Moerdijk be developed even further, instead of looking at whether Moerdijk can become an extended hub or not.

Although according to the Port of Rotterdam, Moerdijk as an extended hub helps to relieve the pressure on the port of Rotterdam, the deep-sea ships from, for example, China cannot go there. The port of Moerdijk is not as deep as the sea of course and has, therefore, more limited possibilities. As a side note, Danser Group mentions that Moerdijk is indeed well located geographically, it is between Rotterdam and Antwerp (see section 5.1), but it is not a comparable terminal or port that can solve problems such as those in the port of Rotterdam. For that, multiple nodes are needed.

"*Actually, you have to see the Maasvlakte as a very thick faucet from which a thick stream of water comes out and how can you collect it in buckets and distribute it so that you don't waste any water? And I think that has to be several places*" – Danser Group

The organization of CBRB mentions that a part of the congestion deliberation, they are involved in, is indeed to look at where hubs can be placed. Structurally, they are looking at where they can create a point where that is possible, and it seems that it is theoretically possible. However, it does result in a discussion about extra costs, transshipments, and responsibilities of who is going to do it? So, there are several things to consider when creating a hub.

5.3 Means to steer

Various means can be used to steer the modal shift, the organization TLN for example works on carbon footprinting, which means that the CO2 emissions are measured, not only per company but actually per shipment. In this way, there can be measured how much CO2-emissions the transportation of specific commodity costs. This can help companies to give them insights into their emission use and it stimulates them to look at other modalities. The Port of Rotterdam also agrees by this way of making companies aware of their emissions use. CCT also thinks that if there is showed how much CO2 emissions can be reduced by using inland waterway transport, this will convince the large parties to use inland waterway transport. The Inland Waterway Transport Information Center mentions that they want to organize a label system for inland waterway transport, to show shippers how much CO2 and fine particulates are emitted by their ships.

"*So, means that can help in the future are mainly awareness, information and communication*" – TLN

There are other tools to stimulate organizations/companies in making a modal shift. Promoting inland waterway transport by sharing success stories of shippers or by sending a project manager or a logistic agent to start the discussion with parties can also be successful.

"*You are more likely to accept something from someone you know than from someone you don't*" – Inland Waterway Transport Information Center

Digitalization also plays an important role in stimulating a modal shift following Danser Group and CBRB. Both mention the "Next Logic" program as an instrument that will take over the planning of the port. With this program, barge operators, on the one hand, can say "I want to be there at a specific time with that volume" and terminals on the other hand can say "I have that number cranes available". The computer behind it is going to lay down an efficient schedule that is built on algorithms. CBRB expects that Next Logic will improve in the capacity that is now disappearing due to a lack of clarity and miscommunication in the port of Rotterdam.

"*Next logic is one of the most ambitious plans the port of Rotterdam has come up with*" – Danser Group

Another application that can contribute to better planning is the "OffRoad" application of the Inland Navigation Information Center, which is already being used by LCB and MCA Brabant to set up joint corridors. Within this application, companies can see on which connection or motorways freight is actually being transported and where there is still potential, and then they can link up to such a connection. So, it gives an overview of all the initiatives from all the regions where a shipper can say "hello, there's a connection, can I connect to that?".

5.3.1 Stakeholder engagement

After the above examples of means that can help to steer towards a modal shift, it is also important to look at who is providing the guidance. Public or private parties, or does the free market decides? This will be further elaborated below.

Public steering

CCT thinks that large companies do not benefit from promoting the modal shift to win other parties over. They do however see that governmental organizations such as the Port of Rotterdam and the Port of Moerdijk do start initiatives and bring companies together. The Port of Moerdijk endorses this by saying that if no money is made available by the government or Europe, the barrier to make a modal shift will become very high. So, there will always have to be a financial incentive from that side and for the rest, it is a matter of market forces and the shipper himself feeling and experiencing it. Danser Group also agrees with this. They say that it is useful if a port authority or a ministry or another authority also promotes the modal shift. That is not just promoting it, but preferably also supporting it a little financially.

BLN, however, thinks that the government is unable to do so. It is not oriented, and it does not have that insight. CBRB also does not think that financial support should be the sustainable role of government in the end. The government does indeed play an important role in ensuring the infrastructure, which Evofenedex also agrees with. This is also seen by the Port of Rotterdam, which says that public investments are needed for sustainable transport and its infrastructure. These have to be financed jointly as a society, but they also ask the national government to contribute and expect the companies themselves to participate as well.

BLN mentions saying that the question is, "how am I, as a government, going to implement this?". Not by giving orders, but the objectives must be realized and that means that good thought must be given to them and there is still a lack of clear planning. The present minister has already said that he is going to convince the shippers, but then they must also be relieved of some of their worries. According to Danser Group, the government determines what direction is given. If the legislation is aimed at inland shipping, the sector will also change. Taking the first step in stimulating the modal shift is the task of the government. Terminal ECT agrees with this. They say that if the government wants to reduce the number of trucks on the road, it will have to take action itself, for example by charging for road transport. BLN agrees with ECT in this respect. If CO2 were to be included in the prices, it would make inland navigation attractive again. That is the kind of knob the government has to operate. Not IF but HOW.

MCA Brabant however mentions that there is already taking action in mitigating or subsidizing the start-up costs. Nationally, this is coordinated from Top Sector Logistics with

connect and the entire Off-road program. On a provincial level, this is done with MCA Brabant together with LCB (Logistics Community Brabant). The organization is slightly different in each province, but the primary goal is to think about how to get the small shippers to join.

Modal shift arrangement

The modal shift arrangement of the government launched last April, is a financial instrument to provide financial support (of 49 million euros) to companies willing to make a modal shift. According to CBRB, the modal shift arrangement is at least a starting point in making the modal shift, because they say that life is always about money. ECT says that more is needed than a modal shift arrangement to make a modal shift a success, the only thing that works is road pricing, because money talks.

"*With regulations, you can steer it, I think you should just steer it with money*" - ECT

The Port of Rotterdam also mentions the modal shift arrangement, but also says that they have used a similar kind of tool in the past that is similar in structure to the modal shift arrangement of the Ministry of infrastructure nowadays. They used a start-up loan, to get shippers through the first phase of the modal shift and it seems that the corridor that made use of the regulation is now successful and has also been able to pay it back, so it is also a financially profitable story. However, it is important to note that the effectiveness of such a scheme may differ from one location to another. The Province of Zuid-Holland, for example, mentions previously used modal shift schemes at the European level, the Marco Polo program where parties could receive subsidies to make certain investments. The expectation was that if these investments were made, scheduled services, for example, would be created and these scheduled services would then be filled automatically. According to the province, however, the European Court of Auditors eventually drew up a report that was quite harsh in its criticism of the program and showed that a top-down approach does not work.

Even though, there are questions about whether previous modal shift arrangements have been a success or not. Evofenedex notes that the current modal shift arrangement seems to be more necessary than was previously the case. The Port of Rotterdam accordingly indicates that nowadays, there is more congestion on the roads and the climate pressure is higher, which means that the step from road to water is more likely to be considered. Following the province of Zuid-Holland, the Port of Rotterdam, and the Inland Waterway Transport Information Center, the modal shift arrangement is set up with the aim of the infrastructure maintenance, replacement, and renovation task of Rijkswaterstaat. MCA Brabant adds another goal of the arrangement, which is to give small shippers the extra push they need to connect to the existing corridor. On the other hand, it also aims to create new connections via inland navigation and rail.

According to TLN, which has relations with different governments, entrepreneurs find it very important to get clarity from the government to make the right decisions. The modal shift regulation has namely been implemented, but what it means in concrete terms for a company that mainly uses trucks is not very clear. In addition, both Total Produce and the Port of Rotterdam express their concern about the long-term of the arrangement. What happens if the support stops after 3 years? Do companies continue transporting goods by water, or do they go back to road transport? They thus do not yet know whether the modal

shift arrangement will be effective enough in the long run. Evofenedex also says that the arrangement should be something of a long-term nature and that the government should arrange it for a longer period. Total Produce thinks that the main function of the government in this is to see if there are things that cannot be arranged by the business community. That could be infrastructure, for example. That is the most classic of course, but also the creation of a container terminal.

Private steering

Danser Group, the Port of Moerdijk, the Inland Waterway Transport Information Center, and CCT mention saying that steering in the modal shift from road to water needs to come from a combination of private and public parties. CCT notes that they think that the greatest initiatives so far have come from the companies themselves, for example, to start cooperation companies, but they are also being approached more and more by government agencies. The Port of Moerdijk thinks that the story is made strong if the shipper, preferably several shippers, tell about a modal shift and not an organization like CCT or Danser Group for example. CBRB complements by stating that it always works in the end when allies speak up instead of others saying it. The Inland Waterway Transport Information Center says that they can make many calculations, which are all theoretical and based on practice. But ultimately it is about those shippers and logistics service providers engaging in dialogue with each other.

Large organizations can share their success stories, which possibly has a positive effect on others. But on the other hand, the Inland Waterway Transport Information Center, mentions saying that that is unrealistic for the rest of the Netherlands. Large companies can provide great examples, but it is also very skeptical in practice for small companies. Evofenedex, in addition, says that they think that there is more success in approaching smaller groups rather than larger ones.

To convince shippers to make a modal shift, the Information Center for Inland Waterway Transport believes it is obvious to tell shippers about the pressure on the roads and the availability of trucks and drivers, but that it also has an effect to mention that a ship is greener per tonne-kilometer than a truck at the moment.

Several respondents said that the market should be the starting point. According to BLN, it is difficult to achieve goals because the market decides how things are for us. The market decides. The Inland Waterway Transport Information Center agrees with this by saying that the market will eventually solve it to some extent. Evofenedex thinks in this respect that, in principle, the demand has to come from the market and, as a government, there can be stimulated and said that it is important and that CO2 can be gained from it, but ultimately it is best to look at market parties. Does the market can play a leading role or not?

Small and medium-sized enterprises (SMEs)

The most interesting and striking finding is that almost all of the stakeholders recognize the challenge of how to get the SMEs on board with the modal shift from road to water. In a conversation with both a representative of the province of Noord-Brabant and the director of MCA Brabant, it seems that they notice that mainly large companies are willing to think about or make a shift in modality. An example is given of a large sugar beet company that has the ambition to switch its transport from road to water and show that the company is already taking steps in that direction. The representatives of Brabant do not stand alone in this

observation. As mentioned earlier, TLN also says that especially large companies are considering multimodal transport. According to BLN, this is because the larger parties simply have more time, people, logistics expertise, and money to think more strategically about the future of logistics than the SMEs do. The Dutch Inland Waterway Transport Information Center adds that courage and strength are needed to report that companies want to make a shift in modality. They, just like Total Produce, say that large companies often have project managers or someone else who is willing to take on that task, but the small companies do not. That makes it also more difficult for them to make the shift. Another thing where the large parties have an advantage, according to Port of Rotterdam, Total Produce and the Province of Zuid-Holland, is in offering enough volume. If there are enough large parties with enough volumes, small companies can easily get on board, but in an environment where there are many small parties, it takes much more effort to create enough volume. Total Produce agrees with this by stating that in persuading SMEs to use another mode, one arrives at the basic challenge of multimodal transport, which is to create thick flows and bundle them, and thereby create a positive business case for inland waterway transport.
So, on the one hand, we have companies that are already making use of inland waterway transport, the larger companies, the ones you want to push through and keep going. But on the other hand, there needs to be looked at how to get the SMEs along? How can they be tempted?

"*How do you get all those frogs in the wheelbarrow? And more importantly, how do you keep them in the wheelbarrow?*" – Total Produce

To attract SMEs, several incentives are mentioned by different stakeholders. According to CCT and ECT, for example, the SME is cost-driven. If inland waterway transport becomes financially more feasible, it becomes easier to get the SMEs along. Another problem, mentioned by CCT, BLN, and CBRB, is that there is a certain ignorance/unawareness or somewhat lack of knowledge of logistics among companies. A possible solution to get SMEs on board is to get shippers to promote inland navigation and share their success stories. In which communication has an important part to play. The port of Rotterdam plays a role in bringing SMEs over the line. What the port has already done is to use its networking role to bring parties around the table and have them talk to each other, get to know each other, and trust each other.

Actions taken by the stakeholders

Each of the respondents play their own role in the modal shift from road to water. Public parties perform different roles than private parties in this and thus take different actions in steering in the modal shift. The table below lists the actions carried out by each respondent.

Table 5.1: Current actions taken by each organization

RESPONDENTS	ACTIONS TAKEN
CCT	- Make arrangements with the shipping companies (the owners of the containers) which means that Moerdijk has become depot holder for these companies. Containers can be deposited in Moerdijk

PORT OF MOERDIJK	- Have lowered the inland navigation tariff - Of the companies that want to establish themselves in Moerdijk at locations that are still available, they are anticipating companies that use port-related activities.
PROVINCE OF ZUID-HOLLAND	- Are commissioning parties for the NewWays Zuid-Holland program, which is actually a programme manager that visits companies to set up joint corridors for inland waterways or rail.
TLN	- Are connected to, for example, Lean and Green Off road, but also to the normal Lean and Green and the modal shift arrangement. - Are working on carbon foot printing and that means measuring the co2 and not only per company but also really allocating it per shipment.
CBRB	- Are certainly looking for the combination with the forwarders (Fenex) and the shippers' organisations (Evofenedex) to see how we can organise the modal shift. - They see a certain value not only to discuss the structural solutions on a higher level, but also seek the connection with the operations level to find and talk about how to create and organise modal-shift more efficient. Therefore, they regularly organise a webinar or a seminar. - Make a case for infrastructure spending to be maintained in the forthcoming policy exercises. - In their congestion meeting two years ago, they issued so-called guidelines. That is actually information for shippers and forwarders on what is your role in container logistics and how can you contribute to making that container run more efficiently through that system?

PORT OF ROTTERDAM	- Work together with Rijkswaterstaat to make all digital information on the river available in a solid manner. - Have used their networking role to bring parties around the table to talk to each other, get to know and trust each other and specifically for Brabant they have also given a financial start. - Sit as a partner at the table of the modal shift arrangement, in order to provide insights and ideas and to show parties what is possible - Have chosen to participate in a start-up in battery containers, because there needs to be a market for battery container
INLAND WATERWAY TRANSPORT INFORMATION CENTER	- Together with a number of parties in the sector involved in 'all hands-on deck', to ensure that more young people and more shippers work on board. - With the OffRoad programme, they have actually connected all provinces and regions to a certain extent, with the aim of enthusing and stimulating as many shippers as possible for transport by water or rail. - Support with cost calculations, CO2 calculations and basic knowledge of inland navigation, as well as using their large network
DANSER GROUP	- Participate in certain European subsidies
ECT	- Have contributed a lot to the goal of the Port Authority, the environment and the government to get more modal shift. In fact, they have set up their own inland shipping and rail product - Are in the process of opening themselves up more to all kinds of other parties in the chain that want information and also want services
EVOFENEDEX	- Are involved in the implementation of the modal shift arrangement,

	because they have colleagues who approach parties that they say are interesting to see if a modal shift can be made. - Actively propagate that inland shipping is promising and that it is a good way to make sustainability possible and that it can sometimes also generate money.
MCA BRABANT *AND* *PROVINCE OF NOORD-BRABANT*	- MCA Brabant is very active in approaching the SME sector. - The province is looking into how to cover the investments in the modal shift.
BLN	- As inland navigation, they have been thinking about facilitating and supporting the shipper for a number of years. - Make efforts with provincial and local authorities to keep the (small) waterways open. (Preventing reverse modal shift) - Make efforts with waterway operators to increase the reliability of waterborne transport through better service and less disruptions. - Promote the principle of "Mobility as a service" (One service and goods must also switch) as a tool for increasing modal shift to water. - Conducts campaigns to promote the attractiveness of transport by water.
TOTAL PRODUCE	- Have tried with Greenwheels Port to bring together important companies in our sector, both service providers and agricultural companies, not the transport managers but the directors. - Have been busy with the relocation of our warehouse location. One of the main reasons for moving is that we had a water location where we could go by barge.

5.4 Focus group discussion

After the interviews were conducted and analyzed, a focus group discussion was organized to conclude the data collection process. In this way, the results of the interviews could be

validated or refuted. As can be seen in the set-up (*Appendix 3, table 1*), four statements were discussed. These were addresses one by one after the researcher's presentation in order to start the discussion. The four statements (all translated from Dutch) themselves, why they are chosen and the results from the discussion are discussed below.

5.4.1: Statement 1

"*The route from dock to dock is very interesting, and transport by inland waterway is then unbeatable in terms of costs*". This statement was chosen because there existed differences between the respondents on how profitable inland waterway transport is. Some respondents say that road transport is still very competitive in comparison with inland waterway transport, while others say that inland waterway transport can be competitive under certain conditions. The opinions on whether inland waterway transport is profitable differed in the results of the interviews and therefore the researcher wanted to measure this in the focus group.

All four respondents often agreed on the statements made in the focus group. For example, all respondents agreed with this first statement about the cost advantage of inland waterway transport on a dock-to-dock route. When warehouses are located close to the dock, inland waterways are indeed an advantageous mode of transport for goods according to the respondents. The pre-and post-transport are then eliminated or reduced, which reduces the costs of the transport route. But according to one of the respondents, post-transportation is always needed. In any case, it is clear that in addition to service, organization, and reliability, the pre-and post-transportation services play an important role in the transport of goods.

However, at the same time, an important bottleneck was mentioned here. Even though providing yourself with a location of your warehouse near the dock will make inland waterway transport more attractive, the demand for space plays a major role in this. There is only a limited amount of space available in terminals and that is a problem. According to the respondent from the province of Zuid-Holland, for example, there is not much space in his province where one could place warehouses next to a terminal. The respondents concur by saying that it is necessary to find out where the space is available. In addition, it seems that the limited availability of the docks in the port of Rotterdam, also causes companies to continue their journey by truck instead of by inland waterways. When a warehouse is too far away from the terminal, it is easier and more cost-effective to drive to the port by truck instead of using inland waterways.

5.4.2 Statement 2

"*The possibility of delivering empty containers to Moerdijk instead of Rotterdam strengthens the position of Moerdijk as an extended hub*". One of the remarkable findings revealed that Moerdijk is already an extended hub for Rotterdam and that the question now remains to what extent we can exploit Moerdijk even better? A respondent mentioned in an interview that Moerdijk has become a depot holder for some shipping companies and that this helps to make inland waterway transport more attractive and at the same time strengthens a hub like Moerdijk. Because this was said by only one respondent, a statement was included about this remark to see what other stakeholders think about it.

During the discussion of the first statement, one respondent commented that in addition to finding a good location for your warehouse by the water, returning your empty container to

the same location will make inland waterway transport more attractive as well. When there is a hinterland terminal, especially a large one as Moerdijk, where empty containers can be returned, that brings a great advantage. Not only will it be an advantage for the transportation itself but also in additional costs such as demurrage and detention costs that arise in the Port of Rotterdam due to long waiting times. These costs will then thus disappear, and then inland waterway transport is for sure attractive as a modality. The more attractive the modality becomes the easier it is to convince companies of inland waterway transport.

However, there is another side to this understanding as well. Although it is a good opportunity to make inland shipping more affordable and attractive and to make other nodes, such as Moerdijk, stronger, it is not always taken up. The respondents mention saying that shipping companies are reluctant to do so. Shipping companies want to keep the empty containers at the Maasvlakte, because lots of containers that arrive at Rotterdam also have to go back to, for example, Asia. If the containers then first have to go from Moerdijk to Rotterdam and then to Asia, that brings more time and costs with it. But the fact that the shipping companies want the containers back at the Maasvlakte is not only to position themselves towards the Far East but also to charge as much demurrage and detention as possible; that is simply a business model for them.

Concluding, it is also indicated that there are only a few places as a terminal where containers can be handed in. Because even at Moerdijk, not all shipping companies do that, there are only a few. So, this is another thing that makes it hard to accomplish this.

5.4.3: Statement 3

"*Although road transport is becoming more sustainable at a faster pace, inland waterway transport remains a more sustainable model*". This statement was chosen to place the modal shift from road to water in a broader context of sustainability. The results show that opinions differ as to which modality is more sustainable. Some respondents say that it is about finding the most efficient modality when needed and this can also be the cooperation of several modalities. Other respondents say that inland shipping or road transport is more sustainable. To make sure if inland waterway transport is a more sustainable modality this statement was formulated in the focus group discussion.

If there is only talk of inland navigation, it is a cleaner modality per container because, of course, more containers go on it, but a lot still has to be done to reduce the footprint of inland waterway shipping itself. Inland waterway shipping is of course already based on the fact that they can transport energy efficiency and that makes it also more attractive in terms of CO2 reduction. There are already numerous initiatives to make inland navigation more sustainable, initiatives such as battery containers, diesel-electric, or fully electric shipping.

A major threat that was mentioned, however, is the threat of the sustainability of road transport. The thing that makes road transport more sustainable is not necessarily the CO2 story, but local emissions, such as Nitrogen Dioxide and Particulate Matter. The moment inland navigation lags behind in this, a problem arises. Inland waterway transport has the potential to become more sustainable, but then the problem of the costs arises again. It is not desired for inland waterway transport to become much more expensive as a result. Next to the additional costs that may come with it, there is also the risk that needs to be taken into account. A ship lasts a long time and when it invests in a more durable ship/engine, it expects to be able to sail with it for a long time. But if after a few years the government changes the sustainability standards, the investor runs a high risk of loss.

A possible solution for this, mentioned by the respondents, is to create a consistent government policy. In this context, government policy is needed and, in the absence of this, the sector is not prepared to move. Danser Group, for example, is prepared to give long contracts to parties who want to become more sustainable, but then the policy has to be fixed and there has to be a clear perspective. This must be regulated on a larger scale, not a national government level but at the European level. On top of that, some things just move with the times. In the beginning, nobody wanted to drive an electric car either. Technology changes and therefore some things just need a bit of time.

5.4.4: Statement 4

"*Digital programs (e.g., Next Logic and the Off-Road app) will improve the planning of inland waterway transport*". Digitalization is also of importance when looking at the broader context. Congestion in the port of Rotterdam makes it hard to provide a reliable system according to some respondents. Planning is essential in making inland waterway transport attractive and competitive. Two respondents named the program Next Logic as a tool to better regulate planning in the port in the future and one respondent named the Off-Road application as a tool to make it easier for companies to participate in an inland waterway service. Since not all respondents had mentioned digitization as a possible solution to improve planning, this statement was used in the focus group to validate this assumption.
Next Logic has been mentioned as one of the examples of better planning of inland navigation, but the fixed windows that are already in use are also an improvement in the planning, by creating reliability. But what is also initially said is that the whole exchange of information in the chain simply has to be taken to a much higher level. The basis is that, in the case of a shipper, it is ultimately about knowing whether the goods will arrive at the warehouse on time, and if not, it must be informed in good time. A comment was made by a respondent that inland waterway transport is only working when there is a real system behind it. At the moment there are already some large parties that work together and have put a system in place that uses fixed windows and that ensures a good and reliable system. So, we have to think much more in terms of the system, make agreements, and have high reliability, because only then it will work. That does not mean that the SMEs will be seduced to make use of it, that will be the next step. In any case, it is necessary to set up a good system together.

However, one of the respondents mentioned saying that a program like Next Logic will not solve congestion in this respect. The actual problem with congestion is that anyone can request anything at all, and if anything can be requested, there will never be an ideal planning system. Another problem that was addressed is that too little attention is paid to who needs what information in the logistics chain. How do I know which party I should pass on the information to? Well, that's the way it is in the whole chain. Everyone is optimizing the work in their little compartment. All in all, it is transparency and communication that are of great importance.

5.4.5: Overall discussion

At the end of the focus group discussion, there have been addressed some other parts that belong to the modal shift. An interesting point that has been addressed is that if the percentage of inland waterway transport would rise from 30%-35% to, for example, 55%, then the system could not take it at all. However, it seems that all modalities have been

saying the same thing for years and yet it all grows. The division of the different modalities in percentage terms has remained the same for already years, which is remarkable. Although transport by inland waterway has indeed increased in recent years, other modes of transport, such as road transport, have also risen. As a result, the goal to get the pressure off the road has not been achieved, as the percentage remains the same.

Following on from this, fears have even been expressed of a reversed modal shift. Road transport could be expanded during the nights and at weekends, which reduces congestion. If this is exploited, it is expected that within a few years 70% of the trucks will leave Rotterdam. If road transport then also becomes more sustainable, this mode of transport will become even more attractive and it will be difficult for inland shipping to remain competitive. On top of that, the amount of capacity available in the port of Rotterdam needs to be considered. Deepsea is only going to increase because there will be made more crane movements, but if there will be looked at how much is available for a barge, the percentage is only somewhere between 10% and 15%.

Then the question is whether it is because of modal shift policy or despite it. At the European, national and provincial levels, a modal shift policy has been pursued already for years. The modal shift policy has helped according to one of the respondents, but whether it has been decisive is doubtful. As a governmental authority, the province of Zuid-Holland, says that policy on the provincial level is sufficient for the small steps, but there is always a need for pre-conditions, which are often brought about by the larger authorities. All in all, it takes a combination to make inland waterway navigation a success. Something has to be done on both sides. On the one hand, suitable infrastructure must be in place and, at the same time, there must be an inland shipping entrepreneur who is willing to invest. However, according to one of the respondents, we are already doing a good job together, but there is always room for improvement.

Chapter 6: Synthesis

In this chapter, a synthesis will be made from the outcomes of both the interviews and the focus group discussion (*See Chapter 5*). Finally, a revised conceptual model will be illustrated to provide a clear overall understanding of the synthesis.

6.1: Synthesis of interviews

To answer sub-question 2: "*what modal shift ambitions do stakeholders have?*", the interviewed stakeholder's ambitions are analyzed. The ambition for modal shift generally exists among the respondents, but the motivations differ. Sustainability is the most common ambition to make the modal shift, but it appears that governments have the ambition to take the pressure off the road. This makes it difficult to set the modal shift objective in a structured way. At the moment, inland navigation seems to be more sustainable than road transport. But the acceleration of sustainability on the road poses a major threat to inland navigation. Policy is therefore needed to give sustainability in inland navigation a boost so that it can compete with road transport. The risk that may arise, however, is that the sustainability of inland shipping increases too quickly, causing costs to rise, which means that inland waterway transport is still no better alternative than road transport. Sustainability is therefore both a motive for switching to waterborne transport and a factor in making a modal shift successful. Besides sustainability as a factor, several other factors are important in making a modal shift as well. The results showed that these are the factors transport costs, reliability, mental shift, infrastructure, transport planning, communication, and cooperation. It is a combination of these factors and different stakeholders that contribute to the success of waterborne transport.

Future challenges such as climate change with low and high tides, as well as the increase in online shopping, capacity, and lack of space, are challenges recognized by the majority of respondents. In addition, the COVID-19 pandemic, road congestion, and deep-sea ports are also mentioned as major challenges. This thereby answers sub-question 3 of this research: "*which future challenges should be taken into account?*". The problem of the congestion in the Port of Rotterdam, which goes together with reliability is explicitly mentioned by several respondents. The congestion in seaports such as the port of Rotterdam causes volumes to be bundled and fixed windows to be made to have priority in the handling of containers in the port. These fixed windows create a reliable system for inland waterway transport, which means that modal shift becomes more attractive. However, all separate companies can't achieve these volumes and agreements. SMEs have often trouble creating enough volume, while it is precisely important to get these small entrepreneurs on board to make the modal shift a greater success. A solution is the idea of joint corridors, where SMEs can connect to existing inland waterway services and let shippers promote their success stories. This will lower the barrier for SMEs to switch to inland navigation. There are already several examples of Joint Corridors, for instance, the West Brabant Corridor.

After taking into account these factors and challenges, it is possible to project this onto the Moerdijk-Rotterdam corridor and its function as an extended hub. The results show that Moerdijk already has an extended hub function for Rotterdam and that it is now necessary to look at how this can be even better exploited. Moerdijk is seen as a serious option as an extended hub. The strategic junction Moerdijk has a depot function for shipping companies so that empty containers can be collected in Moerdijk and can thus relieving some of the

pressure on Rotterdam. To implement this further, it may be necessary to equip several nodes with the same functionality as depot holders.

Finally, sub-question 4 is answered here: "*What means can be used to steer in these modal shift ambitions?*". Means such as displaying the emissions of transport, for example by using carbon footprinting, are mentioned to stimulate modal shift, but digital programs for improving the planning of inland navigation can also contribute to this. The opinions of the respondents however differ as to who should take the lead in steering the modal shift. It seems that public parties are important in stimulating modal shift, especially when it comes to financial support, of which the modal shift arrangement is an example. Private steering on the other hand is also of importance in steering, for example by sharing success stories. However, the respondents often see a combination of steering with both public and private parties as to the most effective way, and some even say that the market should decide.

6.2: Synthesis of focus group discussion

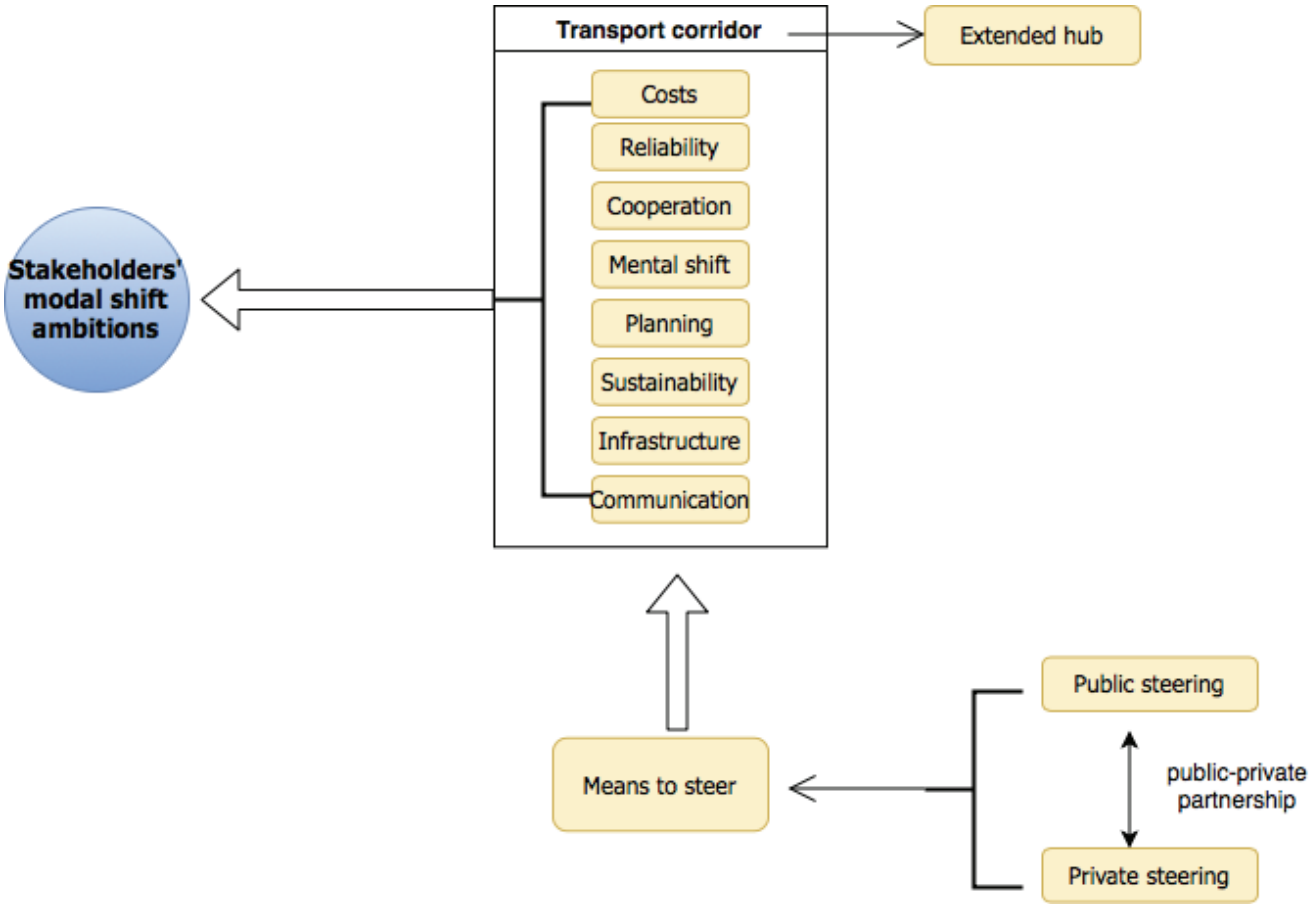
Many findings from the interview results were confirmed by the focus group discussion, but at the same time, some things remained unclear. It is, for example, interesting to notice that during the interviews it became clear that the inland vessels were not given priority over the deep-sea vessels and that they therefore often have to wait long periods at the port. However, the focus group revealed that it might be the other way around. The respondents claim that fewer and fewer deep-sea ships are given priority and that the inland ships are handled earlier, which is an interesting finding looking at the results of the interviews, which thus indicates the opposite.

Another remark can be made about the handling of empty containers in other hubs besides Rotterdam. This namely might be a solution to release some pressure of the port of Rotterdam. To achieve this goal, several nodes are required where empty containers can be returned, at the moment there are namely still not enough locations where this is possible. However, a remark has been made about this. One would namely like to keep the containers at the Maasvlakte instead of moving them to other nodes. This is because Rotterdam wants to have a good position with the Far East and because of the business model that the containers provide. So, an option would be to only look at the containers from inland waterway transport and let these containers return to other nodes. This will take some of the pressure off the port of Rotterdam and it will hardly affect its strong position.

Finally, to state that transport by inland waterway is the most sustainable mode of transport stays unclear. This is because many developments have an impact on this. Even though the respondents say that inland shipping is a more sustainable mode of transport, they also mention that it has many drawbacks. The main drawback is the quick development and the capacity possibilities of transport by road. The results from the interviews show that there is still enough capacity in the barge, while the respondents in the focus group say that there are still opportunities to expand road transport. The fear of a reversed-modal shift is even raised by the respondents. Road transport is thus confirmed as a very serious competitor to inland waterway transport. A possible solution is the creation of a consistent sustainability policy from the government. This will create transparency for stakeholders, and it will ensure that inland shipping becomes more attractive and can take a larger share as a transport mode.

6.3. Revised conceptual model

To structure the findings of the desk research, interviews, and focus group discussion, a revised conceptual model of the model in section 2.7 was established. The first thing to notice is that sustainability is positioned differently. Sustainability remains an important reason for making the modal shift, but the analysis shows that inland shipping needs to develop strongly in terms of sustainability to remain competitive with road transport. Sustainability has therefore been included here as a factor. Subsequently, is the position of the corridor and the extended hub relocated in the model. It is now overarching the factors. The corridor has to meet these factors to create a good inland waterway service and subsequently, as a whole, it is connected to the modal shift ambitions. Finally, two additional factors have been added to the model compared to the model in section 2.7. These are infrastructure and communication. These have not emerged from the literature as strongly as they have now emerged from the results as important factors.



Chapter 7: Conclusion

In this chapter the conclusion on the central question will be answered, the discussion will be set out, in which the results are interpret and linked to the literature from the theoretical framework and finally, recommendations for follow-up research will be made.

7.1. Answer to main question

From the literature findings as well as the results of the interviews, the answers to the sub-questions and the focus group discussion, an answer to the main question is formulated. The main question in this research reads as follows:

Why are the stakeholders' modal shift ambitions not achieved in the freight corridor between the port of Rotterdam and the strategic hub of Moerdijk, and what can these ambitions mean for Moerdijk as an extended hub?

So why have the ambitions still not been achieved? It turns out that there are already successes in inland navigation, of which the best known is the West-Brabant corridor. The corridor has become strong by bundling volumes and cooperating with competitors. But this is not a solution for every other corridor. There are many factors (e.g., cooperation, reliability, costs, infrastructure, planning, mental shift, and communication) and stakeholders involved in the process of modal shift from road to water, which makes it difficult to switch to inland navigation. One of the most important reasons why the modal shift has not yet been applied on a large scale is because SMEs are not yet on board. To make the modal shift a success, this is essential to achieve. However, this also seems to be a difficult challenge, because the SMEs are devoted to road transport and are often unfamiliar with the use of other modalities. They often see many obstacles on the road. Congestion in the port is also a major bottleneck for inland navigation. Reliability cannot be guaranteed and that is essential. Improving the planning of inland navigation, for example with the help of digital tools such as Next Logic, could improve this. Therefore, much attention will have to be paid to these challenges.

In general, however, the ambition to make the modal shift from road to water exists. Apart from road congestion, the most common motive for making the modal shift is from the point of view of sustainability. But it is questionable how sustainable inland waterway transport really is. After all, road transport is becoming more sustainable much faster than inland navigation and is still a cheaper mode of transport, which makes road transport a strong competitor.

Emphasizing the positive aspects of inland navigation and promoting inland waterway transport will help to involve several parties. Mapping the emissions of each transport mode, by carbon-foot printing or finding the right location (close to the water) for the storage and transit of containers will help to make inland waterway transport a more attractive modality. Reducing or eliminating the pre -and post-transport will make inland waterway transport way more attractive, affordable, and more sustainable as well.

Yet how and by whom will these modal shift ambitions be managed? It is often cooperation of private and public parties to stimulate companies to make the modal shift, but the tasks appear to be divided. Providing financial support, such as the modal shift arrangement, is mainly the task of public authorities. Private parties can stimulate better by sharing success stories of inland navigation and by communicating with each other.

It has become clear that we should not look at whether Moerdijk can be an extended hub for Rotterdam, but whether it can further exploit the function as an extended hub that it already has. Moerdijk, as a depot holder for many important shipping companies, has a strong position in this network and has sufficient properties to strengthen itself as a comprehensive hub. Even though inland navigation over short distances is questionable, Moerdijk's strong function makes this possible for the route between Rotterdam and Moerdijk. This is also related to the West-Brabant corridor in which Moerdijk is interwoven. This successful corridor shows that it is possible to transport many volumes by inland navigation. However, it also shows that it is not an easy task to achieve such success.

Container transport will thus be placed in a broader context of sustainability and efficiency, which is necessary to reduce the tunnel vision of using only one modality, which is often road transport. This is not to imply that inland shipping is always the most optimal modality, but it does encourage parties to think about other modes of transport. Moerdijk and the West-Brabant corridor can offer an example for inland navigation for certain corridors or junctions and when several strong nodes take on a function as an extended hub, inland shipping will be able to position itself more strongly and there is certainly potential for the future.

7.2. Discussion

Congestion on the road is named in the literature as an important bottleneck for freight transport by Veenstra et al. (2012). This creates a lot of traffic jams, making trucks have to wait with their containers, which slows down transport, which in turn is harmful to the environment. The literature shows that inland waterway navigation is thus a more sustainable mode of transport (Zhang et al., 2015; Rogerson et al., 2020), but the results however question which modality is the most sustainable. Road transport is namely becoming more sustainable faster than inland waterway transport does. Returning to road transport congestion, it appears that this is indeed a major bottleneck for container transport, but what is not mentioned in the literature is congestion in deep seaports. The results show that this is a major bottleneck for inland waterway transport. Congestion delays inland vessels and disrupts schedules, making inland navigation unreliable. To make inland navigation more attractive, this congestion problem needs to be addressed.

The most important factors for making a modal shift a success that was mentioned in the literature are reliability, cooperation, planning, mental shift, and costs. These were mentioned by a combination of the research of KiesZon (2020), Van Riessen (2018), Meers and Macharis (2015), and Kurtulus and Cetin (2020). It is interesting to see that from the results all these factors were confirmed as important factors, but more factors have been added to it. Communication was the most frequently referred to factor. This is important in making a modal shift, because at the moment communication between different stakeholders often does not run smoothly, while many stakeholders depend on each other's information flows. Infrastructure is another addition to the factors, which is however briefly mentioned in the literature by Kaack et al. (2018) and Van Geet et al. (2019). To establish a robust network of inland navigation, the existing infrastructure must be improved. This will make inland navigation more attractive. Finally, planning is indicated. This goes hand in hand with reliability. Sufficient planning of inland navigation is essential to persuade more parties to switch to waterborne transport. If the planning is good, the service becomes reliable and that is very important.

In terms of getting several parties on board, this mainly concerns SMEs according to the results. To make the modal shift a success, the SMEs must go overboard. These businesses need to be attracted. A possible solution to ease the step of SMEs to inland navigation that emerged from the results is to make use of the Joint Corridors. From the results, it also seems that through the use of joint corridors, parties can more easily connect to an existing inland shipping service. So, this is a good approach that already exists, and when it is extended further, it will be even more successful. Although the concept of joint corridors was not discussed in the literature review, there are references to corridors, by the research of Van Riessen (2018), and corridors in combination with inland terminals, by the research of Wilmsmeier et al. (2011).

When it comes to the means to steer, the literature shows that it is mostly the case of a combination of public and private steering. Having both parties regulate the modal shift is the best way according to Raimbault (2019) and Panayides et al. (2015). The results agree partly in this respect. It seems that the government as the public party has to take the role of supporting parties financially when starting waterborne transport. This is already done by bringing into force the modal shift arrangement. The arrangement referred to here is not discussed in the literature, but previous similar modal shift arrangements are cited by Tsamboulas et al. (2007) and Douet and Cappuccilli (2011). On the other hand, it seems from the results that private parties can play an important role in sharing their success stories and winning over parties in this way. All in all, it also appears that a combination of the parties, i.e., a public-private partnership, is also seen as a good way to steer a modal shift. In addition, digitalization and carbon footprinting are also mentioned in the results as means to stimulate the modal shift from road to water.

Barge operations in logistic corridors are expected to change according to the literature. Some strategically located terminals will maintain their hub function with important exchange functions (e.g., between barges), while other terminals will become subordinate to these hub terminals (Notteboom, 2007). Looking at Moerdijk, it seems that this node fulfills the function of a strong node. The results say that Moerdijk is already being an extended hub of Rotterdam in some ways. Already some ships sail straight to Moerdijk instead of to Rotterdam. Moerdijk has a good position to take on this role and is therefore already doing so. According to the literature of Van Riessen (2018), an extended hub is "a dry port for which the deep-sea terminal can choose to control the flow of containers to and from that inland terminal". This explanation thus corresponds to the function that Moerdijk already has to Rotterdam according to the results. It is now interesting to look at how Moerdijk can be further exploited as an extended hub. An extended hub, preferably multiple, is indeed a solution to release some of the pressure of the port of Rotterdam. In this way, the flow of goods can be distributed to different points in the hinterland.

7.3. Limitations and Recommendations

To improve the validity of this study, it would have been preferable to speak to more shippers. These stakeholders are key players in the process of modal shift. Identifying the ambitions and wishes of several shippers could have given more meaning and quality to the research. Unfortunately, it was not possible to approach several shippers; it is difficult to trace this target group. Furthermore, this study only focuses on the Moerdijk-Rotterdam corridor and Moerdijk as an extended hub. However, freight transport goes beyond this route and it is

therefore advisable to make a comparison with other hubs and corridors in follow-up research. This will place the modal shift from road to water in a broader context and increase the validity of the research.

For further research of the modal shift from road to water, it is interesting to consider the following points. At first, digitalization seems to be an important tool for inland navigation. As planning for inland navigation is not optimal in the present situation, digital tools can support the planning and improve it. In this way, it is possible to pass on and link information from shippers and terminals, which will make the process of inland navigation and the handling of containers much easier. This in turn will increase reliability and will make inland shipping a more attractive mode of transport. Since digitalization is becoming more and more important in today's society and thus also for inland navigation, it would be advisable to include it in future research.

Another recommendation for further research is to look more closely at the location of the ports, the surrounding warehouses, docks, and transshipment points. The research shows that the location is essential to the success of transport by inland waterway. The route from quay to quay is very interesting because it makes inland navigation unbeatable in terms of costs. So, if there is a choice of a new location, that is certainly something that should be looked at. A more extensive exploration of the theories of Christaller, Von Thünen, and Alonso can make a valuable contribution here. These theories are briefly mentioned in the literature review but are not extensively discussed in the results. It is important that these theories, or comparable theories, are discussed in greater detail in further research. This may contribute to finding solutions to make inland navigation more attractive for different parties, including SMEs.

As a final recommendation, it would be good to focus more clearly on the role of government in modal shift. If the government wants a modal shift, the rest will also join in more easily. It is important to ensure that the government continues to pay attention to the modal shift from road to water in its policy. A policy analysis of the existing policy would therefore provide added value in this respect.

Epilogue

I experienced writing this thesis as interesting and instructive. I am satisfied with the result that I have achieved, and I am happy that I can finish my study with this.

In general, I experienced the writing process as positive. After six months, I am still very interested in the topic I chose in February. I, therefore, envisage myself continuing in the maritime sector. I am also glad that I combined my master's thesis with an internship. SmartPort has shown me what a strong team can achieve and that thinking out of the box is good and should be encouraged. I could find myself in the way SmartPort operates.

What did not work out so well is that I had made rather tight planning for the writing of my research. I was not able to stick to this planning during the process. This sometimes gave me the feeling that I was not performing well enough. In the future, I will therefore make a realistic schedule, which will bring more peace of mind.

Saar Pijnenburg
Utrecht
September 2021

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Appendix 1: Topic list interviews private parties

Interview 1 *Bedrijven/verladers/vervoerders*	Datum: Begintijd: Eindtijd: Naam Respondent:
Inleiding	- Anonimiteit - Bedanken voor deelname - Vragen of opname gemaakt mag worden - Benomen op het recht om te stoppen/pauzeren
Algemeen	1. Hoe wordt de afstemming met binnenvaart en trucks georganiseerd binnen uw organisatie? 2. Wat zijn uw duurzaamheid doelstellingen (*CO2-reductie, energie neutraal, efficiënt ruimtegebruik*) voor de toekomst? 3. Hoe wordt er vanuit uw organisatie gekeken tegenover modal shift? En waarom staat u hier positief of negatief tegenover? a. Welke eerdere stappen heeft u al gezet in het maken van een modal shift van weg naar water? En waarom heeft u deze (niet) gezet?
Deelvraag1: *Wat zijn de kenmerken van de huidige goederencorridor tussen Rotterdam en Moerdijk?*	4. Hoe verloopt de samenwerking met Rotterdam en Moerdijk?
	5. Wat zijn de voor- en nadelen van het vervoeren van goederen over de corridor Moerdijk en Rotterdam?
	6. Waarom vervoert u uw goederen op deze corridor? En in hoeverre bent u bereid om op korte afstand te vervoeren?
Deelvraag 2: *Welke modal shift ambities hebben de stakeholders?*	7. Welke factoren (*kosten (externe kosten) en baten*) neemt u in rekening bij het kiezen van een transport modus? En waarom?
	8. Welke samenwerkingen gaat u op het moment aan in uw transportsysteem en met welke partijen?
	9. Wat zijn volgens u push (*systeemverandering/gemakzucht*) en pull (*duurzaam/betrouwbaarheid*)

	factoren om een modal shift te maken? 9.1 Waarom zijn dit belangrijke push en pull factoren?
	10. In hoeverre bent u bereid om de verandering te maken naar transport van weg naar water?
Deelvraag 3: *Met welke toekomstige uitdagingen moet rekening worden gehouden?*	11. Welke toekomstige uitdagingen (*klimaat*, *online shoppen*, *ruimtegebrek*, *capaciteit)* ziet u op u afkomen de komende 10/30 jaar en hoe anticipeert u hierop? 11.1. En wat betekent dit voor uw organisatie? 11.2. Wat betekend dat voor de kansen voor transport over de weg t.o.v. van kansen met transport over water.
Deelvraag 4: *Welke middelen kunnen worden gebruikt om deze modal-shift ambities te sturen?*	12. Welke middelen (*geld*, *informatie*, *betrouwbaarheid*) zijn u eerder toegereikt om de switch naar transport over water te maken? En zijn deze middelen effectief geweest? 12.1. En in hoeverre speelt, de mental shift hierbij een rol? 12.2. Ben je eerder gebaat bij steun van *financiële middelen/mental shift/betrouwbaar* systeem of met een combinatie?
	13. Welke middelen (*publiek/privaat*) zouden u voor de toekomst (wel) kunnen helpen bij het maken van een modal shift (*financieel/mental shift*)?
	14. Met welke partijen zou u uw kennis/middelen willen bundelen om over te gaan op modal shift / modal shift op een grotere schaal toe te passen?
Afronding	- Bedankt voor uw deelname - Heeft u nog vragen? - Anonimiteit benadrukken - Vragen of ze geïnteresseerd zijn in het resultaat

Appendix 2: Topic list interviews public parties

Interview 2 *Overheden en havenbedrijven*	Datum: Begintijd: Eindtijd: Naam Respondent:
Inleiding	- Uitleg onderzoek → wellicht dia met onderzoeksvraag/doel - Anonimiteit - Bedanken voor deelname - Vragen of opname gemaakt mag worden - Benomen op het recht om te stoppen/pauzeren
Algemeen	- Wat zijn jullie duurzaamheid (*CO2-reductie, energie neutraal, efficiënt ruimtegebruik)* doelstellingen voor de toekomst? - Waar kan modal shift aan bijdragen? / hoe kijkt u er tegenaan?
Deelvraag1: *Wat zijn de kenmerken van de huidige goederencorridor tussen Rotterdam en Moerdijk?*	1. Wat zijn de sterke en zwakke punten van de goederencorridor Moerdijk en Rotterdam?
	2. Hoe kijkt u aan tegen de relatie tussen Rotterdam en Moerdijk? 2.1. Waarom is de relatie zo belangrijk? 2.2. Hoe ziet u de positie van het knooppunt Moerdijk hierin?
Deelvraag 2: *Welke modal shift ambities hebben de stakeholders?*	3. In hoeverre stimuleert u het maken van een modal shift (niet)? Zo ja, welke middelen gebruikt u daarvoor en zijn ze effectief?
	4. Waarom zijn eerdere modal shift initiatieven nog niet overal op grote schaal toegepast?
	5. Wat zal de modal shift kunnen gaan betekenen voor de toekomst?
Deelvraag 3: *Met welke toekomstige uitdagingen moet rekening worden gehouden?*	6. In hoeverre ziet u nog kansen voor transport over de weg?
	7. In hoeverre zullen toekomstige uitdagingen (*klimaat, online shoppen, ruimte*) de modal shift beïnvloeden?
Deelvraag 4: *Welke middelen kunnen worden gebruikt om deze modal-shiftambities te sturen?*	8. Wie speelt volgens u een belangrijke rol in het stimuleren van de modal shift in de toekomst (*uzelf/de markt/privaat/publiek*)?

	8.1. Welke eerdere stappen heeft u in het verleden gezet bij het stimuleren van een modal shift? En waarom heeft u deze stappen (niet) gezet? 8.2. Hoe ziet u het voor zich dat deze organisatie het in de toekomst op zich neemt?
	9. Hoe zou d.m.v. samenwerking de modal shift ambities naar een hoger level getild kunnen worden?
Afronding	- Bedankt voor uw deelname - Heeft u nog vragen/opmerkingen? - Anonimiteit benadrukken - Vragen of ze geïnteresseerd zijn in het resultaat

Appendix 3: Focus group discussion

Table 1: Focus group set up and timetable

	FOCUS GROUP SET UP	ESTIMATED TIME IN MINUTES	ACTUAL TIME IN MINUTES
1	Presentation by researcher	10	15
2	Room for comments	5	0
3	Statement 1	10	10
4	Statement 2	10	5
5	Statement 3	10	10
6	Statement 4	10	10
7	Final comments	5	10
	Total	60	60

Figure 7: General findings

Figure 8: Remarkable findings