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Inland Waterway Transportation in Northern Europe

What Sweden could Learn from a Modal Shift Process in the Netherlands

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Supply Chain Management

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Abstract

Freight transportation is a requirement for a competitive society. Following for example globalisation, the demand for transportation has increased. Unfortunately, the environment is negatively impacted by the emissions and congestion caused particularly by road transports using fossil fuels. The European Commission therefore aims to shift from road transport to environmentally less damaging alternatives. It is challenging since 96% of all transports are oil dependent, which is why improving the efficiency of the transport sector is urgent. Inland waterway transportation is an option for replacing road transports with the prospects of improving the environmental performance. Sweden currently has no systematic strategies or policies for transports on inland waterways, and despite available capacity the waterways are barely utilised. In northern Europe, however, the waterway capacity is embedded in the transport system and utilised to a larger extent. The thesis qualitatively examines characteristics of inland waterway transportation in the Netherlands and Belgium in order to identify key learnings for Swedish transport systems.

The empirical study consists of interviews with companies located in the Netherlands and Belgium and the resulting data is contrasted with theoretical findings on the subject of inland waterway transportation. The findings include drivers, barriers and factors considered important when preparing for a modal shift from road transportation to inland waterway transportation. The main identified drivers are the less damaging environmental performance, reduced transport costs per tonne-kilometre and low level of congestion on waterways. The main identified barriers are slow pace of development of the maritime sector, high investment costs for equipment and infrastructure and poor hinterland connectivity. A modal shift process is proposed, where the most important factors are identified. The mental shift of stakeholders is crucial, which means acquiring a proactive mindset of sustainable transport solutions and the willingness to change current solutions. The mental shift is present in all steps of the modal shift process. Stakeholder motivation and the amount of effort that comes with it are significant in order to realise all potential benefits of inland waterway transportation. As a means to aid companies with the adoption and implementation of inland waterway transportation, a promotion agency could provide knowledge and guidance during the process. To further facilitate the adoption of inland waterway transportation, a joint administration system between the companies in the transport chain could simplify the complex process of intermodal administration.

Keywords: freight transportation, inland waterway transportation, intermodal transportation, modal shift process

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Terminology

AIS	Automatic Identification System. Used to track and monitor a vessel's position, speed and course.
Break-even	The point where costs and revenues of a project are equal.
Bulk cargo	Unpackaged cargo that is loaded directly onto a vessel without containment, as opposed to container cargo.
Consolidation	Shipment method where consignments from several sending companies are combined into one.
Economies of scale	The reduction of cost per unit as the output volume increases.
Pre-/end-haulage	Transport that is necessary in order to connect the main transport with the supplier and customer respectively.
Fill rate	Ratio of used capacity to total available capacity.
Intermodal transportation	Transport movement where the goods are stored within the same loading unit and carried by two or more transport modes.
Hinterland	The land behind coastal areas and river shorelines.
IWT	Inland Waterway Transportation. Vessels transporting goods on inland waterways, e.g. lakes and canals.
KPI	Key Performance Indicator. Performance measure of a company used for evaluating the success of a project or activity.
Modal shift	Transfer road freight to other modes of transport.
Network effect	Occurs when an increasing number of participants increase the value of the goods or services
Supply chain	The system of actors, resources and information involved when a product or service is distributed from a supplier to a customer.
TEU	Twenty-foot equivalent unit. A unit describing container capacity of ships and terminals.
Transport chain	All actors included in the transport, from goods supplier to receiving customer.
Transshipment	The process of unloading cargo from one vehicle/vessel/train/plane and loading it onto another during the same transport route.

1 Introduction

In this introductory chapter, the background of the master thesis is presented, followed by the purpose and research questions. Thereafter delimitations of the study are described and the thesis disposition is provided.

1.1 Background

Goods transportation is one of the requirements in order to sustain a competitive society following the increased demand for transport that has been realised in the past years (Cherrett et al., 2012). Globalisation has increased the amount of international transports, and today much more goods are transported at both greater speeds and longer distances (BVB, 2017). Transports are vital for welfare and growth, as few countries could survive on their own resources with today's way of living. To exemplify, in Sweden the export flows contribute to almost half of the gross domestic product, GDP (Regeringskansliet, 2018a). Regions that enjoy access to raw materials or markets put requirements on improved transport infrastructures to further increase accessibility and spur regional development (Schliwa et al., 2015). Unfortunately, it comes with an environmental price tag in the shape of emissions and congestion, particularly from road transports using fossil fuels. An objective for the European Commission is therefore to shift road freight transport to environmentally less damaging alternatives (Meers et al., 2017). Therefore, improving the efficiency of the transport sector is urgent. Also, the issue of the scarcity of fossil fuels make the improvement an urgent topic. Today 96% of all transports are dependent on oil, and due to the scarcity the price will increase continuously (European Union, 2018).

Throughout Europe on regional, national and international levels, policy makers have promoted intermodal transport as an option to the road transport. As defined by Monios and Bergqvist (2017) intermodal transport refers to a transport movement where the goods are stored within the same loading unit and carried by two or more transport modes. Inland waterway transportation, hereinafter IWT, is a concept where vessels transport goods on inland waterways, e.g. lakes and canals (Wiegmans & van Duin, 2017). Positive outcomes from increasing the share of intermodal transports in comparison to road transports are lower emission levels per transported volume, less congestion on roads, and reduced external costs (Garberg, 2016). One of the current challenges with IWT, as well as other intermodal alternatives, are the high transshipment costs that arise from unloading and loading of the goods (Regeringskansliet, 2018a). It is especially disadvantageous for short transport distances, since the added time and cost caused by transshipments make up a large share of the total transport time and cost respectively (Meers & Macharis, 2015). Reliability of transport time and frequency of the transports are other aspects that are important to take into account, as well as shipment size and product characteristics.

Sweden is currently lacking strategies and policies for managing transports on inland waterways (Garberg, 2016). Moreover, only 3% of all national transports are maritime transports, IWT included (ibid.). The inland waterways are barely utilised at all, despite

current available capacity. National sea transportation today is performed mainly with high volumes between one sender and one receiver, which is a quite narrow area of use. In regard to the situation in Sweden, there are many improvement areas. Other countries such as Germany, Belgium and the Netherlands are better at utilising the waterway capacity and IWT is embedded in the transport system to a larger extent. In 2015, these three countries were responsible for more than 93% of the total EU flow of full containers on inland waterways (Eurostat, 2018).

However, the potential of IWT in Sweden has gained attention in the past few years. Sweden aims to by 2045 become the first country free from fossil fuels among the world's developed countries (Regeringskansliet, 2018b). The government's plan includes increasing the efficiency of transports to reduce and eliminate emissions as well as developing new fuels and transport modes. In order to fully capture the potential of all kinds of sea transport, a national coordinator should be appointed with the mission to carry dialogues with relevant actors to share information and encourage energy-efficient solutions and sea transport, including IWT (ibid.). In addition, the Swedish Transport Agency has been given the mission to evaluate whether there is potential to classify several water areas as inland waterways.

1.2 Purpose and Research Questions

The purpose of this master thesis is to identify and describe the logistics concepts of inland waterway transportation in the Netherlands and Belgium where it is used to a larger extent. Characteristics of IWT systems are examined in order to identify key learnings for Sweden that are applicable when goods flows are moved from land to inland waterways. To fulfil the purpose, two research questions have been developed.

The first research question aims to identify companies' perception of IWT in an industrial setting as well as their approach towards a potential modal shift. The visited companies in the Netherlands are the focal points of this study, and the first question is formulated below.

RQ 1: What are the drivers and barriers identified for IWT?

The second research question is based on the key learnings from the first research question. Differing perspectives of IWT in the studied areas are taken into consideration. It is of interest to identify relevant factors that could be incorporated into Swedish transport systems during a modal shift of goods flows from roads to inland waterways, and the research question is formulated accordingly.

RQ 2: What factors could be considered for Swedish companies when preparing for a modal shift to IWT?

1.3 Delimitations

A delimitation is the studied geographical areas. This thesis will examine IWT in the Netherlands and Belgium due to their developed ability to include inland waterways in their national transport system. In Sweden, the area of application of the findings from Belgium

and Netherlands is mainly the inland waterway from the port of Gothenburg to lake Vänern in accordance with SSPA, the company at which this thesis is written. The geographical delimitation is necessary in order to contain the scope of the report and facilitate comparability of the studied areas.

1.4 Disposition

This thesis includes nine chapters of relevant information gathered in order to fulfil the purpose. The first chapter, *1 Introduction,* presents background and problem description in order to make the reader understand the purpose of the thesis. Following the purpose, research questions are stated, as well as delimitations. Chapter *2 Methodology* conveys information about how the study was conducted in terms of research strategy and research design as well as data collection and analysis. Chapter *3 Frame of Reference* renders studied literature as a means to gain knowledge of transport systems and IWT in particular. Chapter *4 Inland Waterway Transportation in Sweden* accounts for a description of today's IWT status, followed by an extract of discussions between industry actors. Chapter *5 Inland Waterway Transportation in the Netherlands and Belgium* encompasses information about the current situation and empirical findings from interviews with promoting organisations. Chapter *6 The Drachten Case* describes the IWT pilot and the participating companies. In chapter *7 Results*, the empirical findings are contrasted with the frame of reference. This is followed by chapter *8 Discussion*, where the results are discussed in accordance with the research questions. Finally, in chapter *9 Conclusions*, the research questions are answered and recommendations are proposed to the Swedish transport sector.

2 Methodology

In this chapter, the methodology of the project is presented. The methodology includes a description of the research strategy and design as well as how the data was collected and analysed.

2.1 Research Strategy

For this study a qualitative research approach was used. A qualitative strategy focuses on words in the data collection and analysis, as opposed to a quantitative strategy that emphasises numbers and measurements (Bryman & Bell, 2015). Qualitative studies are beneficial when they are used in knowledge-intensive environments, because this strategy allows for both wide and detailed outcomes (Jemielniak & Ciesielska, 2018). Denscombe (2014) explains that whether a research strategy is suitable or not depends on the research purpose, thus it is important to select an appropriate strategy. Additionally, the study can start open-ended with a wide scope and as more information is gathered the more it can be narrowed down to a detailed level, which is also suitable characteristics for this thesis (Hodkinson, 2016).

2.2 Research Design

Following the decision of a qualitative research strategy, it is common to use a case study research design (Denscombe, 2014). The author describes the purpose of a case study as a measure to understand complex relationships between factors operating within a specific setting. Case studies provide depth rather than breadth and relationships and processes rather than outcomes. The case study approach is used in order to gain deeper knowledge about a situation as well as to compare factor behaviour in different social settings (ibid.). Bryman and Bell (2015) also mention that the aim with case studies is to intensively examine a case, in relation to which a theoretical analysis is carried out. The question is then whether the findings of the case study will generate theory, rather than generalising the findings to a larger extent. These characteristics are the reasons why this research design was chosen for this project.

2.3 Literature Study

In order to create an understanding of the subject, a literature study was performed using the Internet to search relevant topics such as the current status of IWT within the Netherlands and Belgium and IWT in general, including infrastructure and operations. Articles of interest were found at Chalmers's online library, Google Scholar and through the Scopus database. Some of the articles were also provided by SSPA.

2.4 Data Collection

This empirical study consisted of several research interviews with relevant actors within the field. As described by Denscombe (2014), research interviews as a data collection method refers to using the interviewee's answers to the interviewer's questions as the source of data. Moreover, research interviews are focused on self-reports, meaning what people say they for example do or believe. The interviews in this study were semi-structured, which is common in

qualitative studies (Bryman & Bell, 2015). At semi-structured interviews, the interviewer has an interview guide with questions and issues to be addressed, where the interviewee can answer in any way he or she wants and elaborates points of interest (Denscombe, 2014). There is a possibility for the interviewer to ask follow-up questions based on the answers, resulting in a flexible interview process. Woodside (2010) argues that these kinds of case studies can illustrate deep nuances and capture dynamic interactions, whereas for instance close-ended mail survey responses are more likely to fail in this aspect. However, it is important to have some structure of the interview process in order for the results to be comparable (Bryman & Bell, 2015).

In order to improve the understanding of the current situation of IWT in Sweden, a reference group meeting of knowledgeable people from the industry was observed. The meeting took place in Karlstad September 20th 2018. At the meeting, the reference group of the Vänern project gathered to discuss the progress and issues surrounding the topic of IWT. The Vänern project is included in IWTS, Inland Waterway Transport Solutions, a project within the Interreg North Sea Region Programme that runs from 2017 to 2020 (SSPA, 2018). The aim of the IWTS project is to mobilise potentials to move freight to waterways that are not yet utilised (North Sea Region, n.d.). IWTS includes partners from Sweden, Belgium, the Netherlands, Germany and Great Britain. The Vänern project, which is the Swedish sub-project of IWTS, includes thirteen municipalities in two provinces, and a representative from each municipality was present as well as representatives from relevant industries and companies. It was presented that these meetings and the project as a whole is needed in order to improve efficiency and communication for decision-making, industry development and marketing of the possibilities for Vänern and associated transport solutions. Following the introduction, the reference group was split into smaller groups for discussing different transport solutions and their feasibility for different actors. This was followed by a discussion of transport determinants. Data collection was carried out during the whole meeting by making notes. The notes were thereafter compared and validated to ensure data quality.

After the reference group meeting it was time for data collection in the Netherlands and Belgium. During the 1st through 4th of October, eight companies and organisations were visited and semi-structured interviews were held with company representatives. The findings and analyses in this thesis are based on the data collected during this time period. If any circumstances surrounding the interviewed companies are changed, they are not regarded in the thesis. There was one interview with one interviewee per company. Table 1 presents the interviewees' positions in their respective companies. The interview with the project coordinator at the municipality lasted for 90 minutes whereas the scheduled time for the remaining interviews was 60 minutes per company. The interviewees had received an interview guide beforehand so that they could prepare some of the information. The interview guides for the municipality representative and the goods owners can be found in Appendix I and Appendix II respectively. The logistics consultant at Bureau Voorlichting Binnenvaart, which translates to the Dutch Inland Navigation Information Agency, received the interview guide presented in Appendix III. For the data collection in Belgium, there was only a brief meeting where a contact was established with a project manager at the Flemish waterway

organisation De Vlaamse Waterweg. A majority of the questions were instead answered afterwards through a written response. The interview guide for De Vlaamse Waterweg can be found in Appendix IV.

Table 1. Interviewed actors.

Position	Company / Institution
Project Coordinator	Municipality Smallingerland
Assistant Logistics Manager	Company A
General Manager	Company B
Technical Manager	Company C
Commercial Director	Company D
Owner	Company E
Production Site Manager	Company F
Logistics Consultant	Bureau Voorlichting Binnenvaart
Project Manager	De Vlaamse Waterweg

2.5 Data Analysis

Since qualitative research tends to rapidly generate an extensive amount of data in the form of interview transcripts, it could be difficult to find patterns in and interpret the data (Bryman & Bell, 2015). At the same time, there is attractiveness in this richness of the data but there are barely any well-established rules for how to conduct the data analysis (ibid.). Nevertheless, the first task during the analysis was to become familiar with the collected data by reading the interview notes several times, as proposed by Denscombe (2014). Although not much time passed between the data collection and data analysis, the aim of this was yet to refresh the memory of the interviews and explore the broad scope of available data. Thereafter the frame of reference was used for cross-reference in order to facilitate an understanding of the data in the specific context. By continuously rereading the data during the analysis as Denscombe (2014) suggests, the aim was to identify themes in it and ultimately derive concepts that capture the meaning of it.

There are some aspects that potentially could affect the results of the data collection that have to be taken into account. These include the fact that the interviews were not recorded, meaning there could be information that accidentally has been left out of the notes. However, the interview notes were processed while fresh and discussed not many days later to make sure that the risk was mitigated. There was only one interview per company, limited to a certain amount of time, which in turn limits the information that could be gathered. Also, the interviewees received the questions beforehand, which on the one hand makes it possible for them to prepare answers in order to make sure that they are able to answer all of the questions. On the other hand, this gives them time to prepare answers that are in line with what they think the researchers look for, thus conveying a biased attitude. However, this risk is considered small since there is nothing in it for them.

Due to the response from De Vlaamse Waterweg being received via email, the answers were considerably shorter and there was no possibility to discuss or ask follow-up questions in

order to capture the most interesting aspects. Lastly, since Bureau Voorlichting Binnenvaart and De Vlaamse Waterweg are promoting organisations, there is a risk that their opinions of IWT are somewhat biased.

3 Frame of Reference

This chapter encompasses a literature study of relevant areas within inland waterway transportation. Following the definition by Achmadi et al. (2018), inland waterway transportation is a transport of commercial cargo that goes from a main port and utilises canals and rivers to reach the hinterland. More specifically, the vessels that are used for these operations have not crossed any ocean. Having established that, the characteristics of IWT will thereafter be presented. Benefits and challenges are addressed, followed by infrastructural implications, cost competitiveness and governmental support.

3.1 General Benefits and Challenges of Waterway Operations

As for benefits, IWT does not have problems with congestion unlike other transport modes such as road or rail (Mircetic et al., 2017). This, in turn, brings reliability as opposed to the case of road transportation where highly congested roads result in poor reliability in some areas. Achmadi et al. (2018) also point out this, saying that IWT can reduce traffic density. Furthermore, IWT is generally regarded as a transport mode with high safety (Hendrickx & Breemersch, 2012). This is also confirmed by Caris et al. (2014) who mention that since IWT is considered secure, using barges for hazardous cargo is suggested to enhance transport safety both for the society and the cargo owner.

Maritime transportation in general is commonly considered to be one of the most sustainable transport modes (BVB, 2017). It is very energy efficient, where high volumes over long distances are factors contributing to the sustainable performance (Mircetic et al., 2017). Due to the high volume capacity of ships, the CO_2 emissions per tonne-kilometre is lower than for other modes running on fossil fuels (BVB, 2017). When it comes to other pollutants than CO_2, shipping is not as well performing. Maritime transports contribute to air pollution due to their emissions of NO_x and SO_x as well as particulate matter, especially in coastal areas. As an example, in the Netherlands and Belgium sea transports stand for 24% and 15% of the NO_2 emission share respectively (Viana et al., 2014). In Sweden, this number is reported to be 9%. Emissions caused by the European transport sector during 2016 can be seen in Figure 1, showing the share of emissions from the different transport modes for the different pollutants (EEA, 2018).

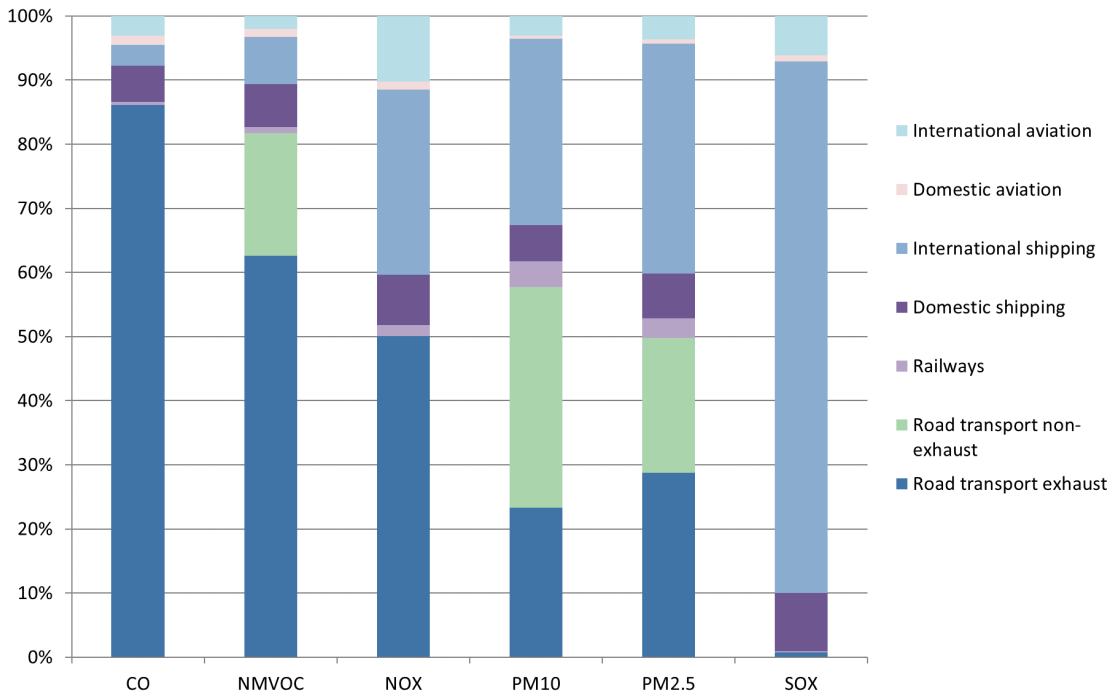

Figure 1. Contribution of each transport mode to total emissions of the main air pollutants (EEA, 2018, edited by authors).

A disadvantage is that the transport time is often elongated with IWT. This is due to increased time in transit, at terminals and from transshipments (Sommar & Woxenius, 2007). Transshipments, in turn, give rise to high costs from unloading and loading the goods (Regeringskansliet, 2018a). From an environmental point of view there is an evoked concern as well, especially due to the changing climate conditions with extreme weather. As described by Caris et al. (2014), there are issues in the winter since the traffic on inland waterways could be paralysed by ice formation. Other climate aspects are disturbances in terms of water swells and drops. As the water level fluctuates it restricts the load factor of the vessel, which in turn impacts the transportation costs and the reliability (Caris et al., 2014; Hendrickx & Breemersch, 2012).

The recent years' trends of changing production principles in combination with flexibilisation and globalisation imply that freight flows become smaller and deliveries have to be made with increased frequency and over longer distances (Caris et al., 2014). This tends to favour air and road transport, since inland navigation in general requires large volumes in order to be profitable (Garberg, 2016). The challenge then lies in enabling IWT for smaller shippers. What could pose as a threat of IWT is the slow pace of development of the transport mode (Rogerson et al., 2018), at least when comparing to road transports that are continuously improving its environmental performance and complying to current production trends.

Caris et al. (2014) argue that the share of inland waterway transportation has decreased in the past few years. This stagnation is a result of the shift away from industries that transport bulk cargo. Moreover, intermodal services can sometimes be inefficient and the infrastructure is aging (Mircetic et al., 2017), with bridges and locks that constitute obstacles (Wiegmans & van Duin, 2017). This limits the potential of IWT. However, containerisation with

consolidation of low volume flows has made it possible to achieve economies of scale, and thus still use IWT (Caris et al., 2014).

3.2 Infrastructure and Operations

Inland waterway infrastructure is defined as terminals, rivers, canals, bridges and locks (Wiegmans & van Duin, 2017). Maintenance of seaways, including bridges and locks, is an important activity usually financed by public sources (ibid.). Most common is that some sort of ministry of transport manages this, which in Sweden corresponds to Sjöfartsverket.

An issue with the infrastructure is that there is a capacity limit for canals, bridges and locks. For example, canals could be too narrow if the vessels become larger or if the traffic increases (Wiegmans & van Duin, 2017). Locks can create bottlenecks since ships have to slow down or even wait to pass them. To overcome the capacity issues, building operations with the aim to increase the capacity might be necessary. In addition to the maintenance costs that are already there, additional financing in terms of large investments is then crucial (ibid.). However, the lack of political support makes this difficult to realise, which also is confirmed by Baird (2007). Decision-makers tend to insist that roadways and railways should be funded, whereas this is rare when it comes to waterways. Accordingly, market distortions and reduced competitiveness of sea transportation occur. Also terminals regularly require maintenance and finance. In the case of terminals though, the owners are private operators rather than a ministry of transport.

Dimensions of the inland waterways constrain the dimensions of the vessels. How wide the canal is affects the allowed width of the vessels, and curves in the canal impact the length of the vessels (Achmadi et al., 2018). Consequently, there is a wide range of vessels that are categorised into different classifications depending on what kind of waterway a specific ship is suited for (BVB, 2017). As an example, a ship of class IV can carry 54 truckloads, whereas an upgrade to a class V ship can replace 120-160 trucks (ibid.). A list of relevant vessel classifications in the Netherlands can be found in Appendix V. Except for having different classifications, the goods characteristics affect what type of ship that is used for transport. There are tankers for transporting fuels, oils and chemicals, whereas for dry cargo transports other vessels are better suited. Ships for container transports can combine cargo flows efficiently. There are also convoys, with a towboat pushing up to six barges, which can be used for both dry bulk and containers. These can also be utilised for long-term floating storage. Unfortunately the towboats themselves cannot carry cargo (ibid.). In Europe, the ship owners, being the operators of the vessels that perform IWT, are usually small companies that have one to three vessels each (Wiegmans & van Duin, 2017).

Port infrastructure

In general, the literature regards ports as an obstacle to IWT and its development. This is partly due to the limitations of hinterland connectivity such as poor road and rail links to the ports (Medda & Trujillo, 2010; Caris et al., 2014). For example, Chacko et al. (2018) performed a study on water transportation and its potential in Devon and Cornwall in the U.K., where it was found that the ports suffer from poor hinterland connectivity and that there

are limited infrastructure investments. Accordingly, integration of IWT in the logistics chain becomes impaired. In addition, the level of reliability and capacity of the ports tend to be limited and it could therefore be difficult to adapt to IWT (Medda & Trujillo, 2010). It is also a question of whether a certain port can accommodate shipments of all kinds, since loading and unloading operations require equipment that might not be available at every port (Cimpeanu et al., 2017). Thus, when aiming to improve berth activity, a trade-off occurs between investing in equipment upgrades and developing the productivity in the present system. In northern Europe in particular, where IWT is of great importance in the transport system, space limitations and congestion in port areas have led to the emergence of inland ports along the waterways to enable more reliable connections as well as increasing the geographical scope (Caris et al. 2014).

Management operations
To carry out IWT processes, involvement of several actors is necessary (Wiegmans & van Duin, 2017). These usually include inland port and terminal operators, shippers, vessel operators, skippers, truck operators for pre- and end-haulage and logistics service providers.

In order to develop an efficient logistics chain that involves intermodal transport, the infrastructure in terms of administration is important as well (Medda & Trujillo, 2010). The administrative infrastructure of the maritime industry is somewhat complex since it involves a lot of inspections, controls and paperwork requirements, why efforts to simplify the process should be made. An example of a measure with the purpose to regulate this is the pilot project including barge transport at the ports of Antwerp and Rotterdam where they have enabled paperless sailing (ibid.). Another example of this is the introduction of a single electronic window in the Netherlands, meaning that when the ships enter a seaport the required information is sent out to all affected authorities to facilitate the administration. Regulatory instruments such as these are in general implemented by authorities on a national, regional or local level or by international institutions, being for example the EU. On the same topic is the Dutch initiative to stimulate IWT through online route planning via a programme called the Blue Road Map (BVB, 2017). The Blue Road Map offers consultation and coordination of several goods flows. This or similar online route planning tools could improve companies' possibilities to optimise their goods transports and have a more efficient supply chain. It could also improve planning at terminals resulting in reduced waiting times and higher capacity utilisation (ibid.). Another approach is the use of an automatic identification system, AIS. AIS transponders on ships are used to track and trace vessels, and thus goods (Randeniya & Hilliard, 2013).

3.3 Cost Competitiveness

In Europe, road transports are often considered to be the benchmark of transport costs and capabilities when companies are comparing different transport solutions (Wiegmans & Konings, 2015). Flodén (2017) mentions four key factors when selecting transport mode, namely cost, time, reliability and quality. Cost is presented as the most important factor when choosing a transport solution, in accordance with other studies (Wiegmans & Konings, 2015; Treiber & Bark, 2018). Therefore, IWT must become equally cost competitive as road

transports to be a valid alternative. The other three factors should also be aimed to be equally competitive (Flodén, 2017). Many aspects can be considered when calculating costs of IWT, such as hinterland connectivity, type of cargo impacting handling capacity of ports and surrounding facilities, transport time and distance, and vessel capacity (Wiegmans & Konings, 2015).

Connectivity

For transports where the supplier and customer are not located adjacent to the waterway terminals, pre- and/or end-haulage by trucks are needed. IWTs that must use trucks for both pre- and end-haulage are the least cost competitive transports when compared to road-only transports because of the two necessary transshipment operations and two distances transported by trucks in addition to the actual IWT (Wiegmans & Konings, 2015). As previously mentioned in this thesis, connectivity is one of the main issues for IWT to be competitive towards other transport modes (Medda & Trujillo, 2010; Caris et al., 2014). With better connectivity, however, the containers arriving at a seaport could be loaded directly onto a barge going on inland waterways, and the pre-haulage by truck would be eliminated. The same situation applies when the supplying company is located close to the inland terminal and no pre-haulage is needed, and vice versa.

Port facilities

At seaports and terminals, the time of collecting and distributing the cargo are factors that impact handling costs, and this is further impacted by the size and capacity utilisation of the seaport (Wiegmans & Konings, 2015). In some cases the seaport's equipment is not adapted to the smaller vessels or barges that operate on inland waterways, resulting in longer handling times and low productivity (Rogerson et al., 2018). Also for the inland terminals the handling capacity, equipment and size have large impact on the total transport cost (Wiegmans & Konings, 2015.).

Economies of scale

The size and capacity of the barge is another determinant of the transport costs, as in the case of vehicle capacity for other transport modes (Wiegmans & Konings, 2015). In general, higher load factors and volumes generate lower costs per tonne-kilometre. A higher volume per transport reduces the fixed costs such as infrastructure and personnel costs per transported tonne. In cases when transporting high volumes of goods, the IWT barges could most probably outcompete trucks in cost efficiency due to economies of scale. This also depends on the distance travelled as well as the time consumed, where generally IWT is more competitive on longer distances (Flodén, 2017). Today it is more common to transport goods over longer distances than to build more factories or warehouses locally, and this is a development that is benefitting IWT (BVB, 2017).

The transport time on the inland waterway could be determined by speed regulations as well as bridges that are too low pass, locks, and other traffic on the water that could delay the transport (Treiber & Bark, 2018). For distances ranging up to 150 km, IWT is considered to have a hard time being cost competitive compared to road-only transports (ibid.). The

European Commission is mainly focusing on the modal shift on longer transport distances. The objective is that 50% of the longer road transports, the ones over 300 km, will instead be carried by other transport modes before year 2050 (Meers et al., 2017). Currently the transports over 300 km correspond to 89% of the transported tonnes carried within Europe.

Supply chain coordination

Increased integration and coordination between supply chain actors could improve efficiency and environmental performance (Caris et al., 2014). Relationships and transparency between the companies are essential, since they offer opportunities to use one area to achieve effects in another area (Gadde & Håkansson, 1993). If for example the different actors were to combine their goods transports, they could benefit from economies of scale and scope. Production and inventory planning could be a basis for transport planning in order to exploit these benefits by for example consolidating transports and optimise transport volumes (Caris et al., 2014). Hence, companies with the most optimised network and supply chain will have a competitive advantage compared to others. What can increase the competitiveness of IWT and other intermodal options in regard to supply chain performance are the services that can be provided at an intermodal terminal instead of for instance in a warehouse managed by the manufacturer or customer (ibid.). These services such as packaging and labelling could be executed while the products are waiting for further transport at a terminal, hence the waiting time becomes value-adding and other supply chain actors would save costs on warehouse space and operations.

External costs

External costs are costs borne by the society that in this context arise from transportation. A study of external costs of different transport modes shows that for the included cost categories infrastructure, air pollution, climate change, congestion, noise, and accidents IWT is performing well compared to road transports (Caris et al., 2014). As written in the report by Treiber and Bark (2018) the socioeconomic external costs of sea transports, excluding infrastructure and congestion, are only 13% of what is generated by heavy-duty trucks. As stated in the article by Mircetic et al. (2017) the change from land transports, meaning road and rail, to waterways could be one of the important actions in order to reduce the carbon footprint of transports and overall supply chains. However, not all companies are willing to compromise existing transport solutions in order to become more sustainable. Flodén (2017) brings up numbers presenting that actors are not prone to changing from road transports into IWT if the costs are not reduced. Even if the environmental performance would be improved, the increased costs of the more environmentally friendly IWT would not be worth it. A 50% reduction of environmental impact is valued the same as a 2% cost reduction, which enhances the relative importance of the cost factor. Furthermore, 53% of the actors are resistant to change into an environmentally better option if the costs increase by 10% (Flodén, 2017). This situation is problematic for IWT since one of the main advantages compared to road transports is the better sustainability performance, given that the trucks run on fossil fuels. Thus, it is even more important to make IWT cost competitive so that it will not bring actors a larger cost to be sustainable.

3.4 Governmental Support

As previously mentioned in this report, the European Commission has an objective to replace a share of the road transport to more environmentally friendly alternatives (Meers & Macharis, 2015). There have been made several efforts by policymakers on both regional and national levels to realise a modal shift. The measures to initiate the changes include regulations, taxes, infrastructure as well as approving financial incentives (ibid.). Sea transportation is one of the alternative modes, but is also under pressure to improve its environmental performance for instance by implementation of stricter ship inspections and higher fees for unnecessary pollution (European Union, 2018). Investments in technology that reduces or prevents emissions can often also reduce costs due to less fuel consumption.

As opposed to land transports, sea transports have not received the same amount of financial support from governmental institutions (Baird, 2007). Flodén (2017) states that both carriers and forwarders included in a study meant that subsidised equipment for handling transshipments would be the most important factor for switching to intermodal transports. About 78% of the carriers and 52% of the forwarders were willing to use intermodal rail transports if it positively impacted their profits (ibid.). Although these figures concern intermodal rail transports they indicate that a shift from road is desired if there is financial gain, which could also be applied to intermodal IWT. The lack of subsidies and governmental support have impacted the cost competitiveness of sea transport compared to land transports, and has resulted in a lagging development for maritime infrastructure (Flodén, 2017).

4 Inland Waterway Transportation in Sweden

The share of IWT in Sweden is low even though there is potential to increase the use of existing inland waterways (Garberg, 2016). Out of all national transports during 2014, the share of maritime transports was only 3%, compared to 88% for road transports with heavy-duty trucks and 9% for rail (ibid.). The types of cargo mainly transported by IWT are liquid fuels, forestry and mining goods. The Swedish shipping fleet was in 2016 the smallest it had been since 1970 (Regeringskansliet, 2018a). In addition, the number of applicants to nautical education programmes in Sweden has decreased in the past few years, meaning the industry risks facing competence shortage (ibid.). However, the Swedish government has started to take action towards increasing the share of IWT. These actions include dialogues with municipalities, ports and other actors that might become involved and the objective is to find incentives and opportunities to find a collaborative way of integrating IWT in the transport chains instead of land transports. The efforts are also aimed towards informing and motivating single actors to take more responsibility of their own climate effects as well as evaluate how they could increase their share of sea transports. Furthermore, the government has ordered Transportstyrelsen to examine if more water areas could be used for transportation (Garberg, 2016). Also, Sjöfartsverket has been given the task to identify both obstacles and opportunities of IWT in Sweden and analyse the potential development and improvement areas.

One of the obstacles hindering IWT from developing is the poor coordination between the business sector and governmental authorities, resulting in conflicting objectives and contradicting actions (Garberg, 2016). The lack of coordination and development within the maritime transport sector also result in complicated administration, as can be recognised in the system of fairway and pilotage dues that Sjöfartsverket has put in place (Andrén & Rexius, 2017). Sweden also has the highest fairway dues in northern Europe, and is one of the few countries that has a national fairway due at all (Kågeson, 1999). All investments and maintenance of Swedish fairways is financed solely by the fairway dues (ibid.), as opposed to road maintenance that is financed by general taxes (Garberg, 2016). The corresponding costs for IWT is added to the transport price and thereby decreasing the cost competitiveness of IWT (ibid.).

Additionally, the pilotage due present for vessels cruising Göta Älv makes up a large share of the transport cost (Andrén & Rexius, 2017). This cost and surrounding regulation is based on shipping in the 1980s, when GPS systems and similar aids were not as developed as they are today. Therefore it can be recognised that this large cost that is making maritime transports an unattractive choice, is in some cases unnecessary with today's technology (ibid.). Garberg (2016) also mentions the high share of governmental fees of the total transport cost. In addition to fairway and pilotage dues there is also a mandatory fee for the ports. Garberg (2016) considers the public fees to be obstacles towards increasing the use of IWT. There are however a few financial aids in place for waterways in terms of pilotage exemptions that are valid on Vänern and Mälaren (ibid.). Regeringskansliet (2018a), supported by the national

government, presents measures to increase the share of environmentally less damaging transports. The idea is to use for example the fairway due as an incentive, and reward those who take action towards sustainability.

Intermodal transport solutions tend to be deselected in favour of unimodal transportation because of the high transshipment costs (Regeringskansliet, 2018a). As incentives for increasing IWT, some alternatives are discussed on a governmental level. One option could be to implement an eco-bonus with the purpose of shifting goods from land to waterway transports so that in turn the transports will become more sustainable (Andrén & Rexius, 2017). The eco-bonus would act as a financial aid covering up to 30% of the operating costs for the waterway part of the route or 10% of the investment cost of for instance transshipment equipment. The objective is that after a maximum of three years of support, the new transport solution will be financially profitable (ibid.). The government also aims to analyse how ports and surrounding facilities in general could be developed to spur IWT (Regeringskansliet, 2018a). This includes investments in infrastructure in order to increase the capacity and productivity of ports and contribute to congestion relief, as well as improving the environmental impact and regional development.

4.1 Contemplations of the Reference Group Meeting

This section presents the discussions by the Swedish stakeholders from the reference group meeting in order to provide an understanding of the situation in Sweden from the perspectives of the participating industry actors. The focal geographical area of the discussion is the waterway between port of Gothenburg and lake Vänern, Göta Älv, as it is considered to have potential for an increased amount of goods flows. The discussions during the meeting concerned different transport solutions and sustainability as well as transport determinants.

4.1.1 Lake Vänern

Vänern is the largest lake in Sweden and through the 93 km long river Göta Älv it is connected to port of Gothenburg (Santén et al., 2018). Most of the goods flows on Göta Älv and Vänern consist of bulk cargo, thus container transports and container handling is not common along this route. The type of cargo is mainly forestry products, paper and agriculture goods. When container goods arrive to port of Gothenburg there are only transshipments to land transport modes and not at all to IWT (ibid.). There is no inland feeder traffic between the larger Swedish seaports either (Garberg, 2016). To investigate the possibilities to increase goods transports between port of Gothenburg and Vänern is a part of the purpose of the IWTS project. The map below, Figure 2, shows where the goods would travel on Göta Älv.

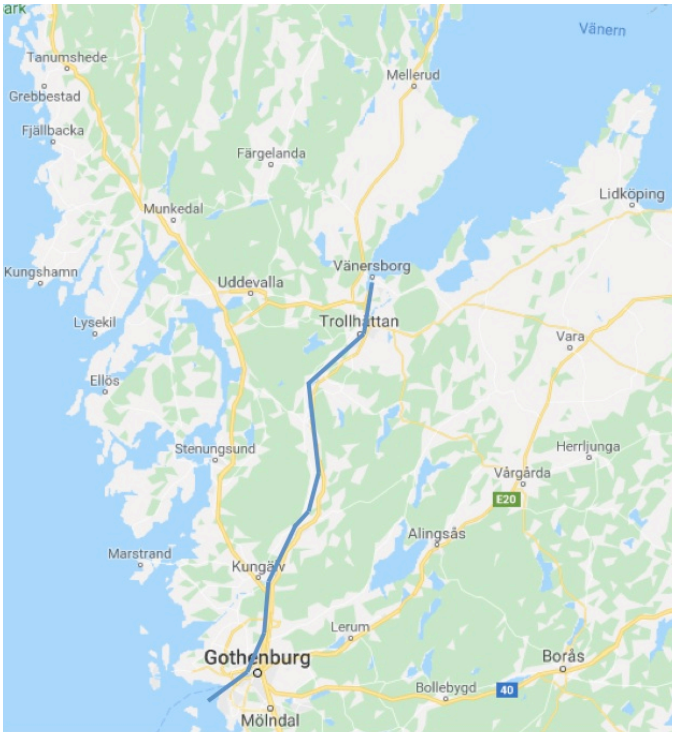

Figure 2. Map of Göta Älv, represented by the blue line between Gothenburg and Vänersborg (Google Maps. 2018a, edited by authors).

4.1.2 Transport Solutions

The two IWT solutions that were discussed during the meeting are a dedicated goods flow and a ship calling at several ports.

Dedicated goods flow

The setup with one supplier and one customer is called a dedicated flow and is shown in Figure 3. The group discussed the dedicated flow from the perspective of standardised deliveries as well as ad-hoc deliveries. When discussing standardisation of transport routes and schedules, the representatives agree that it is more efficient to organise standardised transports in terms of pick-up times and locations. It would then be easier for the supplying companies to plan their production and deliveries, and it would improve delivery accuracy to the customers. On the contrary, in cases where transports are non-standardised and made ad-hoc based on demand, it is considered particularly difficult to achieve high fill rates and the possibility to consolidate multiple companies' goods is limited.

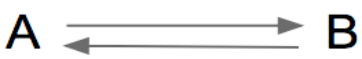

Figure 3. Dedicated goods flow between one supplier and one customer.

With a standardised transport route, the ports would be more likely to invest in the sufficient equipment and infrastructure in order to handle the flow. The incentive to invest is higher if there is a certain confidence that the investment is needed for a longer period of time as in the standard flow. If or when increasing the goods flows on inland waterways in Sweden, there are necessary investments to be made. Sometimes the municipality is included in port

investments, which is why it is important to include authorities in the business model from the beginning.

Ship calling at several ports

Another group discussed the option with a ship calling at several ports, similar to a bus with different stops as shown in Figure 4. Many participants found this suitable for city distribution to rid vehicles from the roads when there are such requirements, for example in cases of construction work. On the one hand, the distance between two ports cannot be too long, which would speak for city logistics. On the other hand, small volumes are implied since there are goods from different owners in the joint shipment. A prerequisite in this case would be to have the goods relatively close to the port, or it would not be competitive if the pre-/end-haulage distance would be too long. They then emphasised that a forwarding agent would have to offer this service as a complete solution and that there are technicalities to consider, such as setting up a flat-rate collaboration. It was also reflected upon if the port would be able to act as a forwarding agent and couple more services to the port, in terms of keeping stock, picking up and dropping off goods.

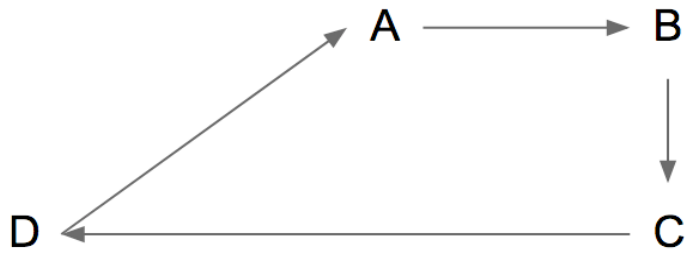

Figure 4. Goods flow with a ship calling at multiple ports.

The group also discussed the transport solution shown in Figure 4 from the perspective of industrial harbours in industrial areas, if all cargo is going to the same city either way. If the sending companies have their own quays, there would be no transshipments in that end.

Sustainability discussion

When discussing if customers are willing to pay a little extra for the products or transports that are more environmentally friendly the answers are that some of them will, but only if the other aspects of the delivery is the same or better. It is perceived by several representatives that the environmental performance is seldom prioritised if the customer does not specifically demand it. Nevertheless, there were beliefs that it is only a matter of time before it will be regarded as a competitive factor that companies have to relate to, as an increased interest in sustainable transports can be observed. As a means to encourage companies to conduct greener transports, an eco-bonus is discussed as this is a potential aid from the government. The representatives all agree that this kind of financial aid would work as an incentive for companies to transform their transport solutions.

4.1.3 Transport Determinants

The second part of the discussion concerned how goods owners and ship owners value transport performance respectively. Four determinants that measure performance were stated

beforehand, namely cost, efficiency, delivery service, and sustainability. The representatives discussed the most important aspects of the transport from these determinants and the findings are presented in Table 2. Explanations of the information in Table 2 can be found in Appendix VI.

Table 2. Determinants.

	Cost	**Efficiency**	**Delivery service**	**Sustainability**
Goods owners	Low cost as long as quality is ensured	Integration and transparency	Flexibility to meet customer needs	Hygiene factor, not prioritised unless customer demands it
Ship owners	Low entry barriers and operating costs	High fill rate, stable volumes and efficient port operations	Frequency, punctuality and overall reliability	Offer redundancy in the transport system

5 Inland Waterway Transportation in the Netherlands and Belgium

After receiving information about the current situation of IWT in Sweden, the journey continued to the Netherlands and Belgium in order to get an understanding of the IWT systems there. Firstly, the situation of inland waterway transportation in the Netherlands and Belgium is briefly accounted for, followed by empirical findings from the promoting organisations Bureau Voorlichting Binnenvaart and De Vlaamse Waterweg.

5.1 Current Situation in the Netherlands and Belgium

Konings (2009) describes that even though the IWT share is low compared to road transports, IWT by barge has still grown by 10-15% in the Netherlands over the past decades. When starting with scheduled departures and deliveries as well as extended service offerings at terminals, such as container storage, IWT became a more interesting option for transport buyers. By also adapting vessel and barge sizes to containers and required volumes the competitiveness increased. The ongoing barge transports in the Belgian and Dutch areas are mainly line network operations, where the seaport terminals are connected to terminals along the river Rhine (ibid.). The total share of IWT during 2017 in the Netherlands was 44.6% and the different kinds of goods that were transported are presented in Figure 5 (CCNR, 2018).

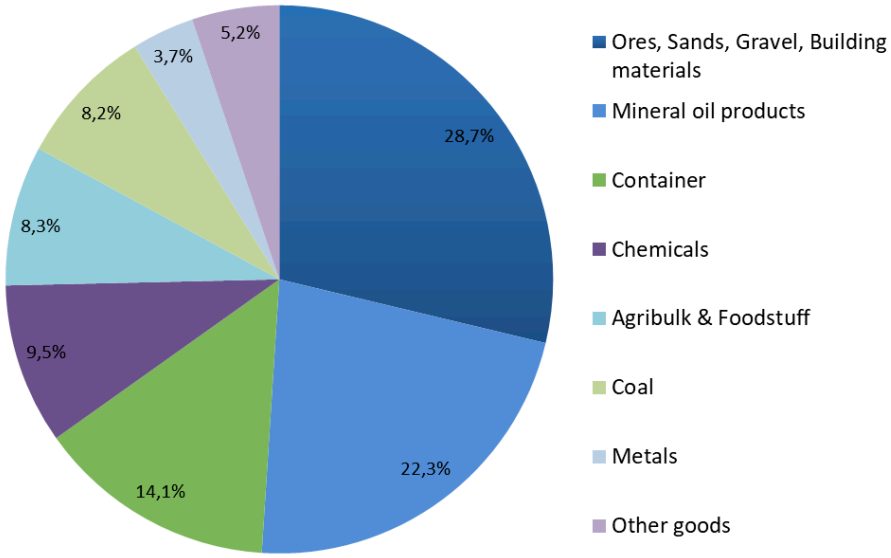

Figure 5. Share of goods types transported on inland waterways (CCNR, 2018).

Port of Rotterdam in the Netherlands and port of Antwerp in Belgium are two of the largest ports in Europe for both bulk and container cargo. The regions close to these seaports have a solid network of waterways, to a large extent because of the river Rhine (BVB, 2017). Port of Amsterdam is also connected to Rhine and due to the network between the three large seaports, the river and surrounding waterways have become important barge corridors (Wiegmans & Konings, 2015). Barge transports on inland waterways are still mostly connected to deep-sea transports. In 2013 the share of IWT for hinterland container transports from Antwerp and Rotterdam was 36% and 35% respectively, which is a very high number (BVB, 2017). It can be compared to the 2% share of container IWT from port of Hamburg,

which was the second largest container port the same year (ibid.). As an example of the IWT growth mentioned in the beginning of this section, the modal share of IWT from port of Rotterdam in 2017 was 55%, although this number includes both bulk and container cargo (CCNR, 2018). The remaining share was 37% by truck and 8% by rail in 2017 (ibid.).

In the Netherlands the fairway dues are included in the general taxes, meaning that investments and maintenance of Dutch waterways is financed by public measures (Kågeson, 1999). Port dues are paid by the transport buyer and are determined by the vessel's gross tonnage and the transshipment volume (Port of Rotterdam, 2018). There are four regional districts that carry out pilotage services (Eriksson et al., 2009). The pilotage due for rivers depends on the distance and the maximum vessel draft.

Subsidies could accelerate the development of IWT, for example by facilitating the establishment of terminals. In Belgium and the Netherlands the institutional financial aid of terminal investments is 80% and 25% respectively (Wiegmans & Konings, 2015). There are other subsidies to be found for IWT in Belgium as a means to increase the environmental performance (De Vlaamse Waterweg, 2018). These subsidies, however, are only valid for ships dedicated for transports on waterways with lower classification than class IV. As a barge owner it is possible to apply for a subsidy of up to 50% of the cost of a new engine and/or the installation thereof.

5.2 Bureau Voorlichting Binnenvaart, the Netherlands

Bureau Voorlichting Binnenvaart, hereinafter BVB, is sponsored by ship owners and has the aim to promote the sector to the government and for educational purposes. By arranging trips for the members of the government, the value of the sector can be shown and hopefully the government will be influenced. In addition, the business calls for skippers and ships, so the agency focuses on reaching out to a young crowd to make them enthusiastic about seafaring and shipping in general. Also shippers form an important target. Since there are opportunities to increase the use of barges, the agency aims to convey knowledge to transport planners in sending companies in order to create awareness. By helping shippers with implementation of barges in their logistics process, the aim can be fulfilled. Since 2012 about 40'000 TEUs have been shifted to IWT. This is the essence of what keeps the agency motivated.

5.2.1 Inland Waterway Transport Operations

The current status is that there are about 5'000 Dutch cargo vessels, accounting for 37% of the total European cargo fleet (CCNR, 2018). The Netherlands has the highest transported goods volume in Europe, followed by Germany and Belgium. The waterways in the Netherlands cover 4'400 km, out of the in total 51'700 km in Europe (BVB, 2017). The fairway, including locks and bridges, is maintained by the Ministry of Infrastructure and Water Management.

At BVB it is argued that IWT has many benefits, which makes it possible to take on goods flows from the roads. However, the importance of continuously innovating in order to stay competitive is also highlighted, since innovations in the automotive industry thrive. A

drawback is also that the sea vessels are getting larger, which means that they occupy more space and need longer visits for loading and unloading operations in the ports. A transfer could consume as much as up to 48 hours. Inland vessels then sometimes have to transfer to other quays due to space limitations, which is not very convenient and calls for a planning tool to connect forwarders and ship owners.

According to BVB, the ship owner is most often a separate company that has contracts with shippers that are renegotiated on a yearly basis. By and large, ship owners have maximum two vessels. Single ship owners usually live permanently on their ships. They could also be connected to a corporation. Corporations could have about 20-50 ships and then there are crews taking shifts for different periods of time. In some cases where the volumes are large, barges are owned by the goods owner. The goods owner then has a contract with a ship owner with a towboat, unless the barge is self-propelled. This brings an advantage since the towboat can leave immediately after the drop-off and ground staff can work on the barge without detaining the towboat and its crew, which improves the cost efficiency.

5.2.2 Long-Term Prospects of Inland Waterway Transportation

In Rotterdam, which is the largest port in Europe in terms of both handled TEUs and cargo gross weight, the modal split for hinterland container transport is 54% road transport, 35% inland navigation and 11% rail transport (BVB, 2017). The goal is to add to this share of IWT and reach 45% by 2030, as the sector of containerised goods is expected to grow. BVB also sees potential for increased demand in the industries of windmills, electrical power units and chemicals. However, the climate change imposes a challenge because of the fluctuating water levels. When the water level is low, the maximum loading volume is restricted and worst-case scenario would be to not realise a profitable fill rate. If the problem remains for longer periods, the way companies in the transport chain operate is severely affected.

Also BVB expresses a concern of single ship owners not being able to invest in new engines for the future due to the cost. This probably will make it difficult to keep up with the truck sector. Although there are governmental subsidies to some extent where ship owners receive support in terms of 30-50% of their investments in environmentally friendly solutions, such as filters, electrical batteries and energy tanks, it is still very expensive to be compliant and sustainable.

According to BVB, increasing the use and improving the function of AIS to achieve more efficient management processes of locks are also regarded as future prospects. Normally the process of passing a lock system could take about 45 minutes, and using AIS as a planning tool could make the process function more smoothly and queues could be avoided. A potential win from this could also be less fuel consumption due to the improved efficiency of the process. A last piece of advice from BVB is that companies should dare to change their logistics processes in order to improve transport performance.

5.3 De Vlaamse Waterweg, Belgium

De Vlaamse Waterweg, hereinafter DVW, is a governmental waterway operator in the northern Belgian region Flanders. This relatively small region has several sea and inland ports connected by an extensive network of navigable waterways. The responsibility and aim of DVW is to strengthen transport by inland shipping, ensure water management through building and maintaining waterways, and increase the attractiveness of the waterways for tourism. The infrastructure and areas of ports and terminals are not managed by DVW, but they maintain all waterways in between. The waterway network is viewed as an important factor for the economy and prosperity of Flanders.

5.3.1 Long-Term Prospects of Inland Waterway Transportation

DVW states that it is obvious that IWT is the favourable transport mode in the future following the advantages that are already realised today as well as predicted benefits. The share of IWT in Belgium is expected to grow with 10% by 2030. It is often perceived that shipping is a slowly developing transport mode, but DVW does not completely agree. At least in the Flemish region the inland navigation industry is innovative in terms of technology and communication measures. However, the environmental development of IWT is slower than for other transport modes (De Vlaamse Waterweg, 2018), to a large extent because of the long lifecycle of ships.

For IWT to become more attractive, flexibility is necessary in terms of connectivity to more destinations. In the future, transports are predicted to increase and the roads will be congested to a certain degree that using other modes is a requirement. IWT must then be able to perform transports previously done by trucks, and the flexibility is often seen as the main hurdle in such cases. To solve some of the flexibility issues that companies experience, DVW aims towards creating tailor-made IWT solutions for each company's transport needs by route planning and transport consultancy. In the Flemish region many companies are located near the waterways, resulting in higher demand and possibility of a well-functioning IWT system. Once the demand is high enough, investments in IWT infrastructure and terminal equipment is justified, and thus a positive spiral is created. An example of this is the company De Brabandere Group. They aim to make a modal shift to IWT and have realised the importance of the mental shift as well. They are now working on the cost calculation in order to ensure viability of the shift.

The greatest challenge facing IWT is the mental shift of companies that are buying and performing transport services. Even if shipping is present in today's transport system, it is still a step into the unknown (DVW). Companies must disrupt their current transport solutions and supply chains and create new ways of receiving and delivering goods without compromising their businesses. Nevertheless, transport price will always be the main priority for customers.

6 The Drachten Case

This chapter presents the case and the companies based on information from the interviews that were conducted in the Netherlands. Additional secondary data research is presented as well, to complement data from the interviews. Firstly, a presentation of the Drachten case is accounted for, which encompasses a project with the aim to expand the waterways in the region and the use thereof. Lastly, current situations of the involved companies are described.

6.1 Case Description

Drachten is a community in the municipality of Smallingerland, which is in the province of Friesland in the northern part of the Netherlands. Several industrial companies are located in an area adjacent to the waterway in Drachten. The waterway is connected to the ports of Amsterdam, Rotterdam, Antwerp and Hamburg, and this connection offers opportunities to reach a wide range of destinations in the world. Figure 6 is a map of the Netherlands to provide a sense of where Drachten is located.

Figure 6. Map of the Netherlands (Google Maps, 2018b).

The harbour in Drachten is included in the Frisian Ports, which is a cooperation between eight small harbours in Friesland. Together they qualify as the third largest inland port in the Netherlands in terms of handled goods volumes. This leverages their role as a port in the attempt of gaining importance in the transport system. Drachten only accommodates bulk cargo and maritime industry, whereas the containers to and from the province are accommodated by for instance the port in Leeuwarden. There are four container terminals in the northern area already, why it is not necessary to handle containers in Drachten. Through the cooperation, the possibility to receive subsidies and funding is increased. Small harbours are less likely to manage on their own since large ports tend not to deliberate small actors.

The Frisian Ports are important for the economy in the province and have the ambition to increase both national and international waterway transportation (Nederlandse Vereniging van Binnenhavens, 2018).

Drachten is part of the IWTS project with the ambition to realise a class V waterway. Today, the waterway in the area is classified as IV. An upgrade to class V would mean that bigger vessels are allowed to transport goods on the waterway, and that would in turn benefit the companies in terms of the possibility to increase their goods volumes per delivery. This would also impact the required frequency of deliveries and thereby potentially reduce transport costs. Moreover, this would facilitate the operations of the sending and receiving ports, since large inland vessels are preferred in for example port of Rotterdam due to economies of scale and present equipment. Water accessibility would also be improved, since most of the transports in the province are delivered to and from the southern parts of the country, meaning ports of Rotterdam and Amsterdam. Within the project it is also evaluated whether a shared computer system could facilitate consolidation of transports in order to further reduce costs and environmental impact. Other project objectives are to promote an increase of IWT and discourage the move from IWT to road transportation as well as to develop the knowledge of innovative concepts of transportation. shows where the companies currently transport their goods as well as the new transport route if the new waterway is built.

Figure 7. Waterways in Drachten. The solid line represents the current waterway, whereas the dashed line is where the new class V waterway would be. The circled area is the wetland that would be integrated in the waterway (Blue Road Map, 2018, edited by authors).

6.1.1 The Pilot

As a means to show the importance of the new waterway, some of the in total 16 companies involved in the project together with the Smallingerland municipality have initiated a pilot

project. Interviews were conducted at six of these companies, which are all located in the harbour as shown in Figure 8. Currently agriculture goods are delivered to Company F's feed mill in Drachten by barges as shown in Figure 9a. These barges then return empty to the port of Amsterdam to pick up new cargo. The aim of the pilot is therefore to investigate whether the other companies in Drachten could fill the return flow with goods that would have been delivered to Amsterdam either way, but transported with trucks. This solution would eliminate unnecessary empty driving of the barges as well as the road transports with diesel trucks, both of which generates pollution that could be avoided. It would also be beneficial for all companies involved from a financial perspective since they could share transport costs. The barge would conduct a milk-run at the Drachten companies since they are all located along the waterway and have their own quays, as shown in Figure 9b. This way there would be no need for pre-haulages and the goods could be loaded from the storages directly onto the barges. The shared computer system will be used in the pilot where the companies can input goods data such as volume and required delivery date. The system would facilitate the overview of the transportation demand from Drachten and the fill rate of the barge could be calculated for the return flow.

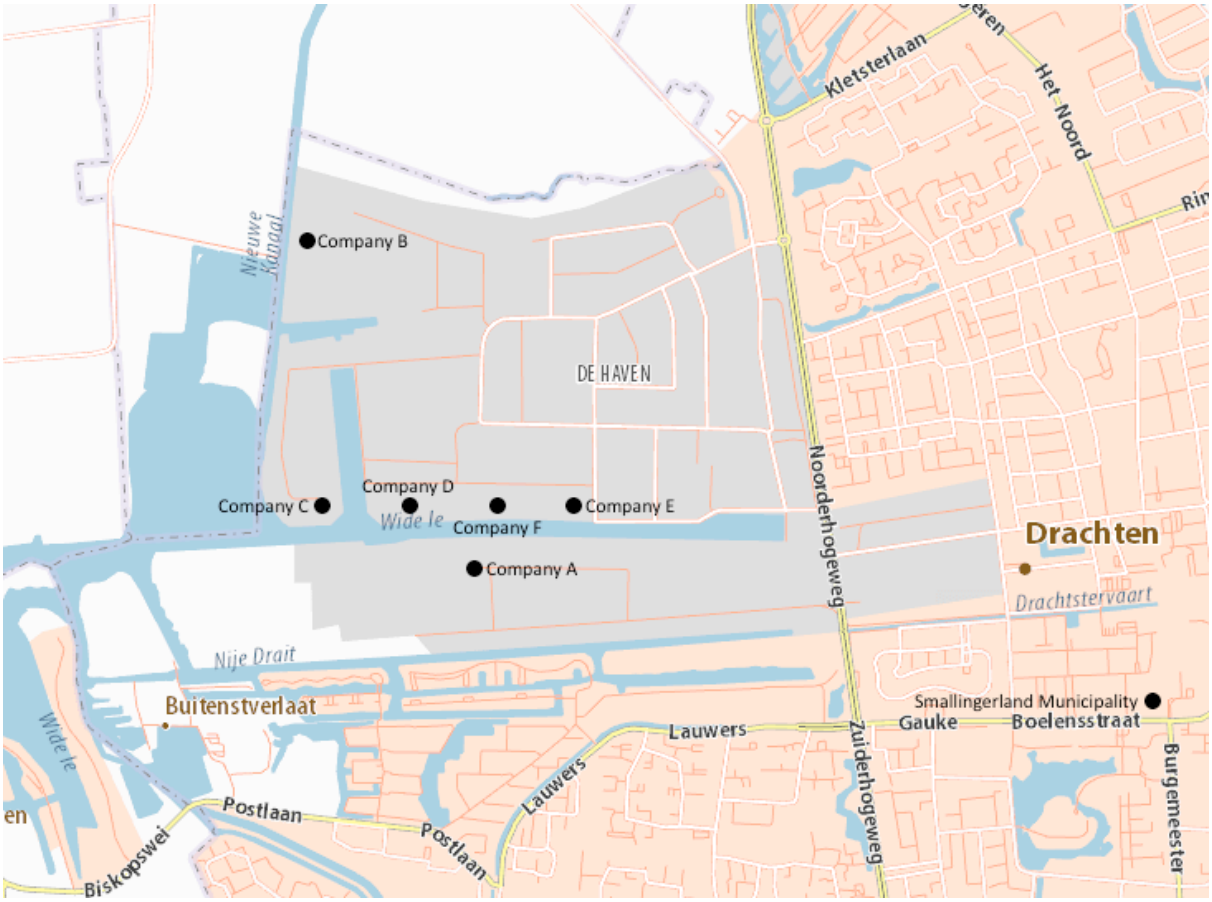

Figure 8. The industrial area of Drachten. The studied companies are located adjacent to the waterway (ViaMichelin, 2018, edited by authors).

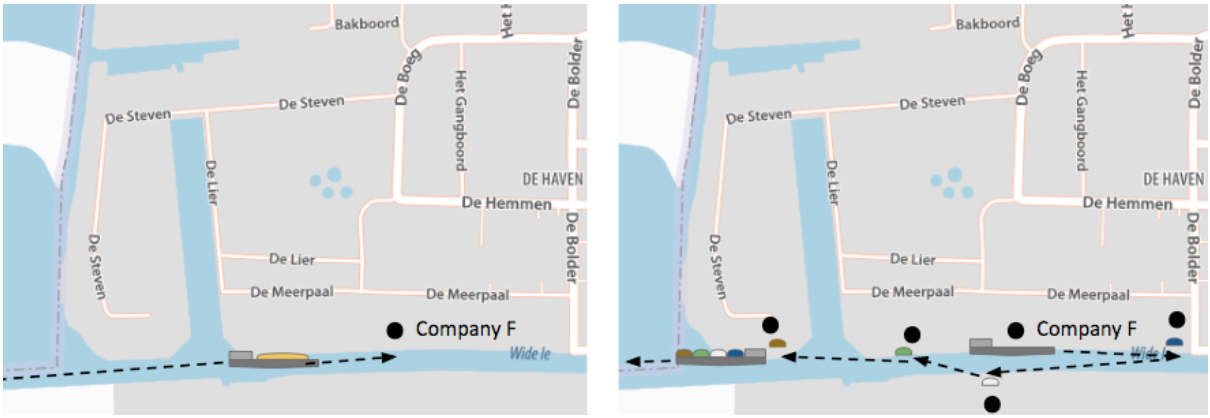

Figure 9a and 9b. Barge transport solution. Firstly, goods arrive at Company F. From there, the barge stops at other quays to pick up goods that are to be shipped to Amsterdam (ViaMichelin, 2018, edited by authors).

The first pilot will take place during the winter and a film will be made in order to show the authorities as well as potential and current customers how the new transport chain would function. If the pilot and the film thereof are well received, there is hope that the province and local authorities will approve the building of the new waterway and partially provide funding for it. The initial pilot is a one-off transportation coordinated by the companies that will use the barge to ship goods, meaning they will arrange the transport back to Amsterdam themselves without involvement of a forwarding agent or similar since they normally handle their transports by themselves. Thereafter the mission will be to decide who is responsible for loading the barges and how to do it effectively for the second pilot, which focuses more on data collection together with SSPA and other partners in order to convince more stakeholders to join. The optimal frequency and volumes are to be determined through the computer system where the companies input their transport data, but this information is also depending on the results of the pilot to evaluate feasibility and loading capacity.

The municipality representative mentions that they have not exercised pressure on involved actors to join the project. The case is rather that they started a conversation about existing problems with the actors, and what opportunities there are to cooperate in order to overcome them with the help of inland waterways. The involved actors meet every six weeks to discuss the project and its progress, and the interviewee from the municipality believes that they have good contact in this project.

As described by the project manager at the municipality, the involved companies are not responsible for contributing with financial means to a certain degree as such, but they contribute by investing in time and goods flows. However, the interpretation after the interviews is that the municipality is the driving force behind the project and pilot. The actual class V waterway would be too expensive for the companies to afford themselves, why they use the pilot and meetings as means to influence local government, provinces, national government and the EU to receive funding and make sure waterways are on the agenda. Resistance has not been present among the actors partaking in the project, but apparently there has been some resistance in terms of some stakeholders in the region that are against a class V waterway. The reason could be that there are individuals who benefit from keeping things the way they are, for instance the farmers who currently owns the land.

6.2 The Drachten Companies

This section describes the activities and current goods flows of the companies included in the project as well as their reasons for participating in the project. The information was received during the interviews and is summarised in Table 3.

Table 3. Company summary.

Company	Products	Customers	Potential project goods flows	Reason for participating in the project
Company A	Concrete pipes and elements, subcontractor	Wholesalers, contractors, municipalities	Outbound	Partakes in environmentally friendly solutions.
Company B	Soil and nutrients	Wholesalers, retailers	Outbound	Expects IWT to grow, but awaits better preconditions.
Company C	Steel sheet piles and cranes, subcontractor	Construction sites	Outbound	Aims to show the benefits of a larger waterway to Drachten.
Company D	Forestry, soil and sand, logistics services	Wholesalers and construction sites	Outbound	Expects environmental benefits from using IWT. Perceives that the new waterway would be good for business.
Company E	Asphalt and concrete, subcontractor	Construction sites	None	Partakes in construction of the new waterway. Provides software that aids consolidation of transports from Drachten.
Company F	Livestock feed	Farmers	Inbound	Increases capacity utilisation of the barges returning to Amsterdam.

Company A is a family business within concrete production. The company is the market leader of drainage concrete pipes and special concrete elements in the Netherlands. They can make customised pipes with a diameter of up to 2.5 metres. The raw material is sand and gravel, which is delivered to the production site in Drachten by ship. As the site is adjacent to the waterway, they have their own quay with a crane to empty the ships. In the factory, the concrete is mixed and moulded. The finished products are then delivered by trucks to the customers. They use open trailers with cranes for loading as long as the part weight not exceeds three tonnes. In that case a larger crane has to be used separately. The customers are partly wholesalers but mainly contractors and municipalities. Most commonly the customers are located in the Netherlands, exceptions are a few German and English customers. The outbound truck transports are carried out either by external transport companies or in collaboration with Company D, which is another Drachten company. The external companies cover the southern parts of the Netherlands, whereas Company D covers shorter distances in

the north. As Company A sees an environment-oriented mindset in the Netherlands, the objective of the project is to be at the cutting edge of environmentally friendly solutions.

Company B is a company that focuses on the growth of plants, land, and customers by delivering soil and nutrients. The raw material is mostly received from the Baltics and Sweden, where it first comes to the Netherlands by ship and is thereafter transported the last mile with trucks. Longer transports to customers are currently arranged by the customers themselves. Shorter customer deliveries are made by trucks. There are about 160-200 trucks per day loading and unloading goods at Company B during peak season as opposed to 20 trucks during off-season. Company B thinks that most development efforts have been given to road transport, but that waterway transports are growing now and will continue to grow in the future, which has much to do with the increasing demand of transports. Company B is however not very positive towards the current situation of IWT, and is instead waiting for better preconditions before shifting fully towards IWT.

Company C works as a subcontractor within steel sheet piling. They have cranes moved between different construction sites, most often by trucks but sometimes by IWT. At the site in Drachten, they stock sheet piles that they receive from a supplier by class IV vessels. The sheet piles are delivered by trucks from Drachten to the project locations. For transportation, Company C owns two trucks with cranes that are used for the sheet piles. The vast majority of the customers are located in the Netherlands and especially in the area of Amsterdam. Since Amsterdam is jammed, there is no possibility of keeping a stock of sheet piles there. The sheet piles are about 30 m long, which aggravates road transport through a city. The objective of the project from their perspective is to join forces to collectively influence the government to make investments in the waterway.

Company D is just like Company A a family-owned business, founded 65 years ago. The main operations are forestry and logistics services. Currently about 25% of their products are transported by ships, but the belief is that the future number will increase to 40-50%. This is one of the reasons for joining the project, along with the fact that most of their transports are long enough to be financially profitable through IWT as well as being the more sustainable option available. Thus, the building of a new, larger waterway is seen as highly beneficial for business as it looks today as well as the business opportunities the new waterway could bring to the area. The project is important for Company D since it could spread the notion that IWT is possible for different kinds of goods flows and the customers' understanding of the more sustainable transport chain would be improved.

Company E produces asphalt and concrete as main businesses, as well as contracting services. Company E receives some raw material and goods from the other companies in the Drachten area, such as concrete from Company A and sand from Company D. Minerals used in manufacturing arrive by ship from Germany. Customer deliveries are however mainly performed by road transports due to poor waterway connectivity to their customers, often being construction sites in the northern parts of the Netherlands. Company E is the company behind the software that could potentially be used to aid the consolidation of the transports

from Drachten. The software and its recognition is an incentive behind engaging in the project. Another incentive is that Company E would be one of the companies that would build the waterway. Therefore, it is a great job opportunity for them even if they later on do not plan on using the waterway to a large extent for transportation. They do however consider the waterway to be a good investment for the industrial area as it could bring new businesses and customers.

Company F is a company that produces livestock feed and is also the owner of the barges that are included in the project. There are in total six feed mill factories, and the one in Drachten produces 10’000 tonnes of feed per year. Raw materials used in their feed mills come from all over the world and are transported overseas with ships to Amsterdam. Thereafter they go by barges from Amsterdam to Drachten three to four times a week. They have their own fleet of barges, whereas the towboat is owned by a separate ship owner that is hired to move their barges. The outgoing goods volumes to Company F’s customers are however too small for IWT to be a profitable solution, so instead they are transported by trucks. Due to the available capacity on the barges that are returning empty from Drachten to Amsterdam, Company F realised the opportunity that the project could bring. The main objective of the project from their perspective is that the new waterway is built and that there are resources put into making IWT more efficient.

7 Results

In this chapter, findings from the interviews will be contrasted and analysed together with the frame of reference. The presented areas of analysis were emphasised the most by the companies, such as benefits and challenges of IWT, followed by regulation and legislation and pressure to realise a modal shift. Thereafter, the modal shift process as proposed by BVB is accounted for. Also, learnings as described by the companies are presented.

7.1 Expected Benefits of Inland Waterway Transportation

The companies identified several benefits expected from a modal shift to IWT. The findings are summarised in Table 4.

Table 4. Summary of the companies' expected benefits of IWT. An X means that the company mentioned that specific benefit.

Company/ Institution	Conge-stion relief	Reli-ability	Fewer accidents	Truck driver shortage	Barge storage	Cost reduction	Consol-idation	Sustain-ability
Municipality	X		X			X	X	X
Company A	X		X					X
Company B	X		X	X	X	X		X
Company C	X	X	X			X	X	X
Company D	X						X	X
Company E		X				X		
Company F	X	X		X	X	X	X	X

A majority of the companies enhance the highly congested roads as problematic in their transport operations, which they mean affect the planning and reliability of the transports. Based on this, IWT would be an option since the waterways are not congested as Mircetic et al. (2017) and Achmadi et al. (2018) point out. This also facilitates reliability, which implies that delivery approaches such as Just-In-Time can be applied as DVW argues. An advantage described by a couple of the companies is that there are fewer accidents on water than road. This can be supported by the statements of Caris et al. (2014) and Hendrickx and Breemersch (2012). Companies state that because of the amount of traffic the deliveries by trucks are harder to plan and are not as reliable as the customers require. There is also a shortage of truck drivers. Although the delivery time might increase with IWT compared to road transports, the improved reliability and delivery accuracy would make IWT a preferable choice, according to one of the companies. It is implied that by adapting production planning and coordination the drawbacks of longer delivery times could be eliminated. It is not, however, only up to the manufacturing companies in Drachten, but also concerns the production planning of the customers receiving the goods. One company also highlights this as an opportunity of realising big flows on a structured basis. However, better coordination between companies is required to realise the benefits of IWT.

The barges can be used as storage areas instead of for example silos or additional warehouses. The advantage of using barges instead of other ships is that a barge cannot drive on its own,

and thus does not require shipping personnel to be present on the ship at all times (BVB, 2017). Convoys with several barges could also be good for combining cargo flows. The barges can therefore lie at berth as storage areas when loading and unloading, and when it is time for departure the shipping personnel arrives with a towboat that pushes the barges to their destination. This storage opportunity could help the companies in Drachten, since they could benefit from storage relief in addition to reduced transport costs. It would also not be as critical to load or unload as fast as possible, and more products would have the time to be loaded on the same barge. It is informed during one of the interviews that a barge could stay at the berth for about one to two weeks without damaging the raw material in these cases.

One company further argued that IWT has potential to be cheaper than truck transportation in cases where the transported volume is large enough. As an example, 70-80 truckloads of their goods going to the same destination could easily be put on a ship, which would be cost efficient and better for the environment. This is confirmed by Wiegmans and Konings (2015) who mean that IWT with larger volumes can benefit from economies of scale and can thus be more cost efficient than trucks. All companies but one emphasise the sustainability aspect of IWT, which is further accounted for in chapter *7.4 Pressure to Realise a Modal Shift*. It is important to consider the transport distance, as IWT is more competitive on longer distances according to Flodén (2017). As the shipping distance between Drachten and Amsterdam is slightly over 150 km, it is just over the limit that Treiber and Bark (2018) consider IWT to be competitive towards road. Company F alone bears the expense of the empty barge transport back to Drachten, and would therefore enjoy a benefit from the consolidated return flow in terms of decreased transport costs, since the other companies will then be charged for utilising the return flow for transport of their goods.

7.2 Challenges with Inland Waterway Transportation

Several challenges expected from a modal shift to IWT were identified by the companies. The findings are summarised in Table 5.

Table 5. Summary of the companies' expected challenges of IWT. An X means that the company mentioned that specific challenge.

Company/ Institution	Conserv-ative business	Invest-ment cost	Product character-istics	Facili-ties and capacity	Volumes	Connect-ivity	Delivery time	Weather condi-tions
Municipality	X	X	X	X				
Company A			X	X	X		X	
Company B		X	X	X		X	X	X
Company C		X	X		X	X	X	X
Company D		X	X	X	X		X	
Company E	X	X			X	X		X
Company F					X	X	X	X

A general issue raised in a couple of the interviews is that shipping is a conservative business where innovations take more time as opposed to the truck business. This slow pace of development is regarded as a challenge by Rogerson et al. (2018) as well. The large

investments in ships are usually made with the hope of using the ship for about 60 years. The diesel engine itself is a large portion of the cost. Research on alternative fuels and electrification experience inertia since few ship owners are prone to making new technical adjustments to switch fuel, as it takes a long time to break even due to the large investment (BVB, 2017). That is why younger people in the industry are more likely to be willing to invest, since they usually have more time in the business ahead of them. A statement from one of the companies implies that for a manufacturing company it is a much smaller investment and risk to buy trucks instead of ships, which has also led to the slower pace of development and utilisation of IWT. The stricter ship inspections and pollution fees introduced by the EU could also discourage investments in ships because the investment risk to be outdated before break-even is reached (European Union, 2018).

Some companies are likely to experience troubles due to the characteristics of their products. For example, their products might be too large to fit into the barge with a reasonable fill rate and there are difficulties in how to load the barge without damaging the concrete pipes. A problem with this kind of goods is that you would not want to make too many transshipments in terms of moving the goods around, as it might cause damages. This could also be time consuming and add to the transit time, which leads to increased costs (Regeringskansliet, 2018a; Meers & Macharis, 2015). Additionally, the long hardening time for the concrete goods has to be dealt with. It is realised by one company that there is a potential to have the last part of the hardening process taking place at the barges, but then the issue would be how to transfer the brittle goods. Metal damage on the other hand would not be as severe as metal goods are durable. Soil and forest goods in general are not at risk of being damaged either.

How to load and unload the vessel is seen as a challenge by a few of the companies. The trucks that for example Company A uses can load themselves, whereas loading ships in their own quay on the other hand is an operation that would require costly cranes. It is not feasible for every port to have all available loading and unloading equipment, why a trade-off occurs between investing in new equipment and developing the productivity in the present system (Cimpeanu et al., 2017). Fixation of goods on the vessels is another aspect that has to be taken into account. As a means to facilitate IWT and make it a more attractive option, it is believed by some companies that cranes and other necessary equipment will become more adapted to IWT and the hope is that there will be automatic loading and unloading operations in the not so distant future. This would, however, require investments in equipment that is optimally suited for the capacity needs (Rogerson et al., 2018). The cranes should also be able to handle both bulk and containers at the same time, which would further facilitate the use of IWT. One of the companies plans to build new cranes and invest in other equipment useful when handling goods at berth. Their aim would be to buy an automatic loading and unloading machine to save costs of manual labour.

It is argued by some of the companies that if the new waterway is built, challenges will arise concerning existing infrastructure and available capacity. Having a larger waterway would allow larger ships to enter, according to Achmadi et al. (2018). Particularly bridges along the waterways could be too low to pass, and also locks would have to be built, as argued by

Wiegmans and van Duin (2017). It would require much effort to get new investments in such infrastructure due to the generally poor political support for IWT (Baird, 2007).

Since customers tend to want one truckload at a time, there could be an issue because of the large quantities required to fill an entire ship, according to one of the interviewees. The challenge lies within coordinating several deliveries and convincing customers into accepting such deliveries. Another interviewee experiences the same issue regarding the volumes of sheet piles that have to be processed. The managers thus argue that IWT requires coordination with the other actors to compensate for the longer delivery times, which implies that customers have to make efforts as well. This is confirmed by BVB (2017), where it is said that transparency and coordination of the supply chain can bring a competitive advantage of transport operations. There are also possibilities to coordinate goods flows between several supply networks in order to consolidate shipments for optimal transport volumes. In both cases, production and inventory planning are crucial in order to succeed as described by Caris et al. (2014). The efforts of coordination can be challenging, but they could bring benefits if overcome.

The companies in Drachten are located adjacent to the waterway, meaning that deliveries to Drachten are not affected by the generally poor hinterland connectivity (Medda & Trujillo, 2010). The challenge, however, is that the customers and the construction sites to where the companies deliver rarely are located near a port, which would then require extra handling and road transport for the last mile if IWT was to be used. Transshipment impacts the competitiveness of IWT in terms of cost and time (Regeringskansliet, 2018a), as end-haulage does as well (Wiegmans & Konings, 2015). Company F realised the issue of end-haulage by trucks and has adapted to the waterway network by building their factories along the waterways in order to eliminate the need for end-haulage by trucks. Instead, the raw material is unloaded directly into the factories and both transport time and costs are reduced. Connectivity issues like this are one of the main challenges for IWT (Medda & Trujillo, 2010; Caris et al., 2014), since it impairs the integration of IWT in the logistics chain (Chacko et al., 2018). Moreover, customers usually require the goods with a few days' notice, which companies believe could be difficult to realise with IWT as far as transport time and coordination go. Sommar and Woxenius (2007) argue that transit and terminal operations, including transshipments, consume a lot of time. Two of the companies in Drachten explicitly mention that communication is key and that customers have to be convinced that a modal shift is necessary from an environmental perspective.

The often longer delivery time could be an issue for some customers when using IWT instead of road transportation. Especially during the winter when there is a risk of ice on the waterways, which is a critical issue as described by Caris et al. (2014). Fortunately for the companies in the investigated geographical area, the weather is mild and only for a few days during the past years ice has been an issue. Fluctuating water levels due to weather disturbances could also impact the IWT performance (Hendrickx & Breemersch, 2012). The risk of delays because of the weather is also mentioned in an interview. As an example, going

to and from Amsterdam requires crossing the inland bay IJsselmeer, which could be problematic in some weather conditions.

7.3 Regulation and Legislation

Legislation such as road taxes works as an advantage of IWT, as described by Meers and Macharis (2015). In the Netherlands, every owner of a vehicle pays taxes in order to drive on the roads, which one company perceives to be an incentive to go by boat instead of truck. However, the fact that there is only road tax and no congestion fee is briefly touched upon as if this could inhibit a shift to IWT. A future regulation predicted by an interviewee that would gain IWT before road transports is that the government will ban heavy-duty trucks in large cities. Since the company has its own truck fleet, they do not plan more investments in heavy-duty diesel trucks. Instead it is believed that electric trucks are a future solution, at least for shorter distances. The company wants to be proactive in regard to sustainable solutions, so that when the regulations arrive they have competitive advantage towards other companies.

It is challenging to become more sustainable, and a particular challenge with IWT to and from Drachten would be if the class V waterway is not built, states one of the companies. Thus, a pressing regulation for this project is the class regulations for vessels entering the waterway network around Drachten. The fact that it is currently class IV reduces the possibility for the companies to work as efficiently as possible. Company F is the company that uses IWT the most today and it is said that class V ships instead of class IV would decrease their transportation costs due to economies of scale and the potentially lower frequency of deliveries. Allowing larger ships into the Drachten area could also bring more customers and new business opportunities, according to multiple companies.

The outcome of the pilot in Drachten depends to a large extent on the public authorities' attitudes and beliefs in the demand of the new waterway. The extended waterway has been on the agenda for the past 20 years or so, and one of the issues is that not many mandates are willing to make decisions. There is an election coming up in March 2019 that has put this request on hold, since at least the companies are under the impression that the current administration does not want to make decisions and drive this forward until the next mandate period. This is, according to the companies, because they do not want another administration finalising a project that they started themselves, so usually the pace of decision-making is slowed down during the third and fourth year.

7.4 Pressure to Realise a Modal Shift

When asked whether they wanted to participate in the project, one company decided to join since it is believed that their customers will gain influence in terms of putting pressure on them to operate sustainably to a greater extent and encouraging measures to reduce the CO_2 emissions. According to Mircetic et al. (2017), changing from land transports to waterways could be one of the important actions in order to achieve this. However, up until today the customers of the company have not demanded it. During the interview, it is mentioned several times that the customers have a central part in realising IWT and that there is an ongoing dialogue with them on how to implement it. Another company also sees a trend that their

customers, being the contractors that they work for, increasingly demand sustainability in their operations. Few of the companies believe that their customers would be willing to pay more for IWT despite being the more environmentally friendly option, which follows the reasoning of Mircetic et al. (2017). Some companies mean that their customers are cost-oriented and would choose transport mode mainly based on costs and that there is not much to do about that. Another company, on the other hand, means that it is critical to make the customers realise the importance of sustainable transports, and that potential extra cost of transports is a low price to pay for a good cause. Nevertheless, the study by Flodén (2017) shows that a 50% reduction of environmental impact is valued the same as a 2% cost reduction. It is challenging to change the customers' mindsets to see the added cost as an investment in the environment. By conducting the pilot project there is hope that the consolidated transports would decrease transport costs enough to make it competitive towards road-only transports, even if end-haulage is needed.

Company B delivers to both gardening companies and supermarkets, and especially at the supermarkets they have received requests for more sustainable products. They see a current trend that the consumers become more conscious of the products they purchase. This trend is also realised by Company F, where they have had to change their raw material in some products in order to make them free of genetically modified organisms. However, Company F and some of the other companies have not experienced pressure from stakeholders for greener transports. Nevertheless, there is some pressure from within the company to strive for better environmental performance, such as using less energy and use IWT when possible. These actions are also made in order to cut costs, hence win-win measures. Company E on the other hand has experienced that some customers require them to perform greener transports. They have not however experienced pressure to switch transport mode altogether. In cases where they have a full boatload and the transport distance is long enough, IWT is preferred over road transports.

One of the companies means that the transportation costs of the firm will increase with IWT, but that the extra costs are necessary in order to be more sustainable and prepared for the future. The interviewee continues to say that if the external costs are included in the transport cost, meaning costs resulting from pollution and congestion, the total costs are reduced with IWT. This can be supported by Caris et al. (2014) who bring up results from a study showing that external costs are higher for road and rail transport. The reduction in CO_2 emissions is the most important advantage of IWT compared to road transport by diesel trucks, one company argues. This is a result from the energy efficiency, as argued by Mircetic et al. (2017). There is also the possibility to combine the two modes in intermodal transports but instead of diesel trucks for the last mile, electric trucks could be used since the distances are often relatively short. This aspect is discussed at another company as well.

7.5 The Modal Shift Process

A modal shift can be complicated, which is why BVB has developed a modal shift process that guides companies through their implementation of IWT. BVB views intermodal transportation as a means to collaborate in the transport chain instead of being competitors.

They work to create less chaos and complexity in the involved actors' supply chains through connecting goods owners with transport carriers. Companies that are prospects for a modal shift can either contact BVB for help with evaluating and performing the shift, or BVB contacts potential targets. The process includes criteria evaluation and activities.

7.5.1 Modal Shift Criteria

When attempting a modal shift to IWT, there are several aspects to take into account. According to BVB, there are both hard and soft criteria that are of importance when realising a modal shift, and they are presented in Figure 10. The hard and soft criteria must be evaluated before the actual process to shift can begin. These were touched upon during the interviews in Drachten and could be identified in their pilot project.

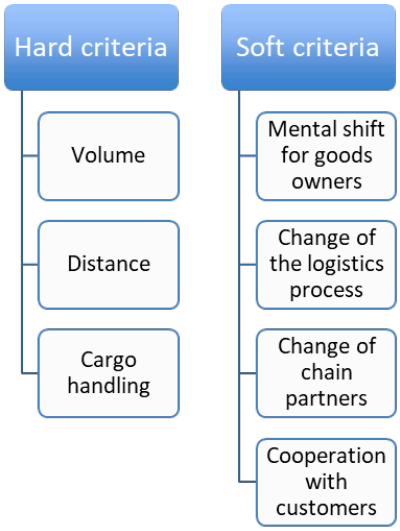

Figure 10. Hard and soft criteria.

Volume. The volume has to be sufficient. BVB suggests that volumes under 50 tonnes are better suited for road transportation. Larger volumes could lower the transport cost per kilometre. The companies in Drachten argued in a similar way, which is why they do not plan on using IWT for their outbound flows if the volumes remain the same as today. There is the possibility to adapt goods flows in order to achieve higher volumes, but this requires production and inventory planning for both goods owners and customers. Consolidation of goods flows could also be discussed between some of the companies that are working on the same project, such as a construction site. This would also make it possible for the consolidating companies to transport smaller volumes respectively.

Distance. For transport distances exceeding approximately 200 km, BVB suggests intermodal transportation by waterways. It can, however, depend on volumes and transshipment time. This particular issue was not discussed in Drachten, but since the distance to Amsterdam is 150 km it could be evaluated further. On the other hand, Company F currently uses IWT from Amsterdam to Drachten, which seems to be a profitable solution. This could be why the distance is not perceived to be an issue.

Cargo handling. It is argued at BVB that the actual transport cost per tonne-kilometre for barges is lower than for trucks in the Netherlands. This statement can be questioned as different circumstances can affect the transport costs. An assumption is made that the calculation is based on similar fill rates over the same distance, which would then cohere with Wiegmans and Konings (2015) statement that barges outcompete trucks in cost efficiency due to economies of scale. What also add to the barge transport are transshipment cost and potential pre- and end-haulage. Since the planning for the pilot in Drachten was in a very early stage, these costs had not yet been calculated so a cost comparison between road and barge transportation was not possible at the time of the interviews. Port facilities and equipment can also impact costs depending on their cargo handling capacity, but the costs had not yet been calculated for these operations. Cargo handling equipment has to be available and at a cost that makes IWT competitive with truck transport.

Mental shift for goods owners. The importance of the mental shift in order to accomplish a successful modal shift is emphasised (BVB and DVW). Companies sending and receiving goods may not be unhappy with their current transport solutions and they may believe that existing processes are sufficient, flexible and relatively cheap while satisfying customer needs. BVB points at the need for these companies to consider the future. In the Drachten case, some of the companies have started to adopt a proactive mindset, acknowledging the importance of customers and that they probably will demand sustainable operations in the future. BVB says that it is important to have a long-term perspective when planning future transport solutions. For example, in the future the cost of truck transport is likely to increase due to a growth in transport demand. In light of this, companies should be proactive and change in anticipation of this. Some of the companies have realised that they have to make a change, whereas others do not realise the urgency. In this case, the municipality is the driving force towards the modal shift, and thereby contributes to the mental shift of the included companies. It is highlighted by some of the interviewees that it is valuable to have a supporting municipality as it plays a significant role in the transport system.

Change of the logistics process. For a prosperous modal shift, the employees have to be on the same page and support the manager in having an efficient process (BVB). A modal shift could impact multiple activities within a company, such as production logistics and administration, which is why it is important for affected employees to be convinced that the change is necessary. In the Drachten case however, some companies seem uninterested in a modal shift at this point in time and carry on with their activities as usual, which then inhibits the implementation.

Change of chain partners. When transferring to IWT instead of truck transport the actors involved in the transport change and the companies sending and receiving goods will need to develop long-term relationships with other actors in a transport chain, such as a skipper, barge owner and port (BVB). BVB emphasises that it is all about trusting each other. Since the Drachten project is in an early stage, the companies have not given this much thought. For the pilot, the companies already have a relationship and do not have to tie new bonds with external actors. They do not perceive the potential change of supply chain partners to be a

problem. However, they have not yet considered solutions for the last-mile deliveries and it is unclear to what extent the current transport chain will be disrupted. Some of the companies have their own truck fleet so from a long-term perspective, if they were to implement IWT, they have to consider how truck drivers would be impacted and what to do with their trucks.

Cooperation with customers. As mentioned by BVB it is still important to be able to guarantee the same service levels after a modal shift, which is also supported by Flodén (2017). The company has to keep its customers happy and guarantee pick-up and delivery times, or they are less likely to choose that service (BVB). A majority of the companies mention that their customers' understanding of the modal shift is important, but few of them are actively working with their customers to potentially implement IWT. There is an inherent risk that if the customers do not have a say in the change of the transport chain that affects their business, they could look for other suppliers. A few interviewees are of the opinion that if IWT was to be implemented, the affected customers would have to adapt their operations to the new transport solution. For example, IWT could affect lead times and frequency (Meers & Macharis, 2015). The lack of communication with customers could for some companies depend on them not aiming for a long-term modal shift in the near future. Nevertheless, most of the companies experience an increasing demand for sustainable operations from their customers. In these cases, the cooperation with the customers to realise a shift to IWT is more likely to function smoothly, as opposed to cases where the customers do not at all request improved environmental performance.

7.5.2 Activities in the Modal Shift Process

When the criteria have been evaluated, the modal shift process proposed by BVB can begin. The process activities are presented in Figure 11.

Figure 11. Activities in the modal shift process.

Firstly, the logistics consultants at BVB *scan the company's current logistics process* in order to identify what goods to shift and what arrangements there are with customers. They sort out

which stakeholders are affected and what they might think. A common problem is that the employees resist the change, which is why then the logistics consultants pay a visit to the company to inspire them. The interviewee perceives that an external party conveying the message can gain more trust among the employees, than if the supply chain director were to do it. Following this, a *cost-price calculation* is done in order to evaluate the feasibility of a modal shift. Then a *bottleneck analysis* is carried out to capture what difficulties there are, such as for instance customers not wanting to cooperate and thus keeping the modal shift from going. Up until this point, the sending company has basically only had contact with a truck company, which is why the agency uses its sponsors, that is to say ship owners, to *connect a ship owner with the sending company*. Being provided a contact is valuable for the sending company, as they rarely have that knowledge about inland waterway partners. Following this, a *pilot phase* is carried out where different chain partners provide necessary documents to share information. The pilot is often a smaller tryout to be able to evaluate the performance of the new transport solution. Lastly, the *pilot is evaluated* in terms of what went well and what needs to be improved.

All criteria were not evaluated thoroughly by the companies in Drachten, which in turn affects the modal shift process. The companies seem to have not fully gone through the initial process activities including identification of goods flows, affected stakeholders as well as cost and bottleneck analyses and instead went directly to the pilot. This could be why they are not completely aware of how to realise a long-term modal shift and its future potential for their respective companies.

7.6 Learnings from Preparing a Modal Shift Pilot in Drachten

The companies shared their key learnings from the preparations of the IWT pilot in Drachten. These are summarised in Figure 12.

Figure 12. Key learnings from the pilot preparations.

One interviewee says that one of the most important things to keep in mind when conducting a similar project is to be decisive. As for this project, it took several years before anything

definitive was decided, which has prolonged the project more than necessary. It is perceived that it would have been easier if decisions were made early on and if challenges appear they should be handled along the way instead of trying to plan everything in detail before making the decisions. However, several companies emphasise the importance of looking at the long-term perspective, in this project meaning how the future field of transportation would be assumed to look. This is important in order to realise long-term benefits of the project and not only focus on the short-term gains.

One company representative means that changing the mindset of the actors and stakeholders involved is one of the main issues and criteria for being successful in projects similar to this one. It spans from production planners within the manufacturing company to the customers receiving the products as well as prioritisations of the municipality's budget. The realisation that everyone must contribute to a more sustainable society is an important success factor, because if the sustainable environment is a priority, then actors could work together and instead of arguing about the potentially higher initial costs, they should work together to shape a well-functioning and efficient supply chain that in the long-term perspective can decrease both internal and external transport costs. So far in the project it has been a challenge getting everyone on board with the new mindset and view on transportation, but after the pilot there is a bigger possibility to spread awareness and prove to actors involved that IWT is a valid option. The support they get from the local government in conducting the project is also important, as is mentioned in an interview. Another interviewee mentions the importance that stakeholders understand the possibilities that IWT could bring. Thus, communicating the potential benefits to involved and affected parties is a key aspect when conducting these types of projects.

It is emphasised during one interview that if starting to shift from road transports towards IWT, the companies should evaluate the pros and cons of different types of ships and equipment. At Company F, the barges are superior since there are no personnel costs while at berth, and they could be used as storages. A regular motor ship has higher personnel costs hence are more expensive while at berth and they are therefore not used as storages for a longer period of time. A recommendation from Company F is for companies to start with driving the whole trucks onto the barges just to see how the IWT would fit into the goods flow. If the goods flow works properly with IWT, then the loading and unloading operations could be started and the shift from road to IWT would be complete. It is also stressed that if a barge is going to a destination whether it is loaded or empty, the companies should not worry so much about volumes and fill rates and just load anything that is possible.

8 Discussion

Significant aspects of the gathered information are discussed in this chapter. The discussion is divided into four main areas following the logic of the research questions. Firstly, drivers and barriers of a modal shift are discussed. In order to address the second research question and highlight what Swedish companies could consider when preparing a modal shift, differing perspectives of IWT and the modal shift process are discussed.

8.1 Drivers of a Modal Shift

As can be seen in Table 4 in chapter *7.1 Expected Benefits of Inland Waterway Transportation*, the main benefits of IWT brought up by the companies are congestion relief on roads, cost reduction and sustainability. The fact that congestion relief is commonly seen as a benefit implies that the congestion issue on roads is severe in the studied area. Also, the Swedish stakeholders addressed this as one of the main drivers for IWT in Sweden. The reliability of road transports is thereby becoming more insecure, and reliability is a factor that was deemed as important by both the companies in Drachten and by the Swedish stakeholders at the reference group meeting. It can be interpreted that the deteriorated performance of road transports drives the development and adoption of IWT. This reasoning can also be applied for the truck driver shortage, meaning that the performance of road transports is impaired and this could be an opportunity for IWT to gain shares of the transport sector.

Konings (2009) argues that extended terminal service offerings are means to attract transport buyers to IWT. The Swedish stakeholders were positive towards that as well, and believed that ports could expand their services to include for instance storage and last-mile deliveries in order to facilitate IWT. Companies that are not adapted to IWT solutions could experience a lowered threshold of the modal shift if for example a forwarding agent could take care of those aspects. Based on the reasoning by Caris et al. (2014), as more companies engage in IWT, additional inland ports along the waterways are necessary to be able to cope with the increased goods volumes and offer reliable connections. The improved infrastructure and connectivity along the waterways could in turn drive more companies to adopt IWT. Hence, a network effect is generated by more actors using IWT.

Consolidation is regarded as an important benefit as well. The reason can be that a few companies sometimes are supplying the same projects and customers, being construction sites. Instead of having multiple trucks going to the same customer, the companies see the value of performing a joint shipment. This then comes back to being an opportunity to reduce the costs, which was considered an important benefit of IWT. However, the potential cost reduction in Sweden is affected by the high fairway and pilotage dues and require more thorough planning for a profitable transport solution. Another aspect of consolidation is that it is possible to have different kinds of goods on the same vessel. The Swedish stakeholders discussed consolidation as well in terms of a ship calling at several ports. It is believed to be suitable for city distribution and industrial clusters, of which Drachten is an example. Along the transport route between Gothenburg and Vänern there seem to be possibilities for

consolidation since goods from different suppliers are going in the same direction, especially if the destination is port of Gothenburg.

As can be seen in both the Netherlands and Sweden, there is a trend in customers increasingly asking for sustainability. Many of the companies in Drachten believe that customers will gain influence and put pressure on them to operate sustainably. Sustainability is mentioned many times both by the companies and in the literature. The eco-bonus that could act as a driver of a modal shift mentioned by Andrén and Rexius (2017) was also discussed by the Swedish stakeholders, and they were speaking very positively about it. This is an incentive for investing in sustainable solutions and can be a Swedish driver equivalent to the subsidies for green investments in the Netherlands and Belgium. Some of the companies in Drachten expressed a will to be proactive in terms of environmentally friendly transport solutions. Not only because of the customers, as mentioned above, but also because they believe regulations will be enforced, as pointed out by Company D. In this regard, it can be interpreted that the government's regulations are putting pressure at companies to prepare for stricter environmental regulations. The anticipation of such regulatory measures could be a driver for sending and receiving companies to transform transport solutions even before regulations are in place.

The general perception seems to be that IWT is one of the most sustainable transport modes, and always performs better environmentally than road transports. However, the companies and their customers might not be considering for instance the transport distance, truck fuel or load factor when stating that IWT is more sustainable. When talking about environmental footprints, it seems like CO_2 is the most frequently mentioned pollutant. There are however other emitted pollutants and particulate matters that negatively affect the environment that in many cases are higher for maritime transports than road transports, for example SO_x and NO_x. The knowledge about these pollutants and their environmental impact is not as widespread as for CO_2, which could be a reason why sustainability is considered among the main benefits of IWT. Since this is the case for most customers and consumers as well, the predominant focus on CO_2 emissions could be an underlying driver for increasing the share of IWT.

8.2 Barriers of a Modal Shift

Previously in the thesis it is brought up that IWT is a slowly developing transport mode, at least compared to road transports. This is not something that the companies are familiar with based on the interviews, which could to some extent be explained by the fact that only Company F has invested in vessels while the other companies have bought shipping services from external transport carriers and thereby has limited knowledge of the shipping industry. DVW argues that the slow development is mostly concerning environmental aspects, which could also be a reason why it is not obvious to the companies. The slow development could however be realised to have had an impact when discussing future alternatives to diesel trucks. Multiple companies believed that electric trucks will be a valid option in a few years, but they are insecure about IWT's ability to comply with their transport requirements. The expectation that electric trucks will perform sufficiently is a demonstration of the continuous development of road transports, whereas the maritime development is at least not as well

known. The emergence of new transport solutions on roads could discourage companies that are already comfortable with their road transport chain to replace them with IWT. When road transports become more environmentally friendly in regard to emissions, the environmental advantage of IWT decreases. In that case, an important driver of a modal shift will be neutralised.

The companies in Drachten have expressed an urge for large ships, which is why they are reluctant to invest in class IV ships before a decision has been made regarding the class V waterway. Tedious governmental decision-making processes can thereby slow down the expansion of IWT. However, the urge to use larger ships contradicts the transport trends showing higher frequencies and lower volumes of each transport. It is also contradicting for them to want larger ships since they claim to not have large enough outgoing volumes to benefit from the economies of scale that IWT could bring. On the other hand, inbound goods flows generally consist of larger volumes for each delivery and would then benefit more from economies of scale and a class V waterway.

The investment factor was seen as a challenge among the Drachten companies, as can be seen in Table 5 in chapter *7.2 Challenges with Inland Waterway Transportation*, as well as it is a concern expressed by both BVB and the Swedish stakeholders. There are efforts to mitigate this to a larger extent in the Netherlands and Belgium, such as financial support when investing in new ships, provided that they are environmentally friendly. In Sweden, the eco-bonus is the financial aid that is offered, but since it expires after three years companies can be reluctant to invest despite the bonus. Even if subsidies are received, the large remaining cost would make it difficult for especially single ship owners to invest as argued by BVB. Corporations, however, possess more power to go through with these investments.

Product characteristics is not seen as an issue by Company F, perhaps due to their goods being livestock feed that is not fragile and therefore easily can be loaded or unloaded without being damaged, and the fact that they already have acquired equipment for that purpose. On the other hand, the reason why companies such as Company A and Company C perceive product characteristics to be a problem can be that their goods are cumbersome, which makes it difficult to achieve a reasonable fill rate and find equipment for smooth loading and unloading operations.

As can be seen in Table 4 in chapter *7.1 Expected Benefits of Inland Waterway Transportation*, cost reduction is mentioned by several of the companies as a benefit, but neither of them use, or plan to use, IWT for their outbound flows in the near future. Their explanations contain reasons such as connectivity issues and not large enough outgoing volumes. These issues are among the main challenges of IWT according to the companies in Drachten. However, as argued previously in section *8.1 Drivers of a Modal Shift*, the connectivity will be improved when more companies engage in IWT. An increased number of companies along the waterway could generate more loading and unloading points, more possibilities for consolidation, and a higher requirement for the government to put efforts into the waterways as they are utilised to a larger extent. DVW exemplifies this, saying that the

Flemish region experiences well-functioning IWT systems since companies are located near waterways, hence demand and development is spurred. This is why pilot projects as this one are important, so that companies not currently familiar with IWT can see how it could be applied in a supply chain. Companies are assumed to be more likely to try a new concept if it has been proved to be successful for other companies.

Another reason for the perceived connectivity issue could be that the companies believe that it is difficult to coordinate and find suitable contractors for end-haulages. This is similar to the complexity issue brought up by BVB. It also comes down to being a trust issue when the companies have to share important information with each other in order to carry out the transport efficiently, which is an issue present in all transport chains. A facilitator could be inland navigation promotion agencies, such as Bureau Voorlichting Binnenvaart in the Netherlands.

8.3 Differing Perspectives of Inland Waterway Transportation

This section will present discussions concerning governmental support, cost structures, transport solutions and knowledge of IWT. The discussions are focused on how the differences between the studied countries and companies could impact the attitude towards IWT. A comparison of Sweden and the Netherlands is presented in Table 6.

Table 6. A comparison of Sweden and the Netherlands with identified learnings.

	Sweden	**The Netherlands**	**Learnings**
Governmental support	Eco-bonus valid for three years. IWT starts to gain focus in the transport sector.	Subsidies for sustainable investments. Terminal investment subsidy of up to 25%. IWT is a significant part of the transport sector.	Governmental support encourages IWT.
Cost structure	Waterway maintenance and construction is financed through fairway and pilotage dues.	Government finances waterway maintenance and construction (fairway due included in taxes).	Could be an obstacle when high dues are put on each delivery.
Transport solutions	Stakeholders prefer standardised routes over ad-hoc solutions.	Stakeholders prefer standardised routes over ad-hoc solutions.	Easier to plan efficient transports with standardised routes. Consider vessel and equipment options.

The presence of waterway networks differs greatly between different geographical locations. This means that longer transport distances might be disrupted by poor waterway networks, meaning in turn that the probability that the companies choose IWT decreases because of necessary transshipments and the need for trucks to cover some of the transport. The high share of IWT in Belgium and the Netherlands can partly be explained by the natural waterway networks, but it can also have something to do with the encouragement and financial aid from the countries' respective governments. As in the Drachten case, the municipality is considered the driving force behind the project. Many of the companies expressed the value of having support from the local authority, since they otherwise would not have joined the project. For the companies to be confident to make an effort towards a modal shift, it is encouraging to know that the local authorities are supportive, so that there is no risk of making the efforts and not be able to go through with them. As discussed by the Swedish stakeholders, it is important to have the municipality on board, especially in cases where investments from their part are required. Sweden has started to improve this cooperation between the business sector and municipalities to integrate IWT in transport chains (Regeringskansliet, 2018a), which is promising for the future.

However, there is a difference in cost structures between Sweden and the Netherlands. In the Netherlands, there is no fairway due for each transport, whereas Sweden has the highest fairway dues in northern Europe (Kågeson, 1999). The Swedish stakeholders also regarded this as an issue. It was expressed that the fill rates and volumes had to be very high in order to conduct a profitable transport since the dues make up a large portion of the costs, which put higher demands on Swedish IWT operations than the Dutch in terms of volumes. The larger share of mandatory costs makes the threshold for a modal shift higher in Sweden, which could be another reason for the low adoption rate of IWT.

The inland waterway operations in the Netherlands are mostly connected to deep-sea transports (Wiegmans & Konings, 2015), which is also the case for the inbound transports to Company F. A seaport is a good starting point for line network operations that provide hinterland connectivity (Konings, 2009). Sweden and port of Gothenburg in particular have good preconditions to apply this concept, with line operations going along Göta Älv to Vänern. The possibility of such transport is followed with interest by the IWTS project. The Swedish stakeholders argued that standardised routes and timetables are preferred over ad-hoc transports, and that would also facilitate investments in facilities and equipment. To evaluate the options of vessels and equipment is considered to be important by Company F and is stated as one of their main learnings from the pilot preparation. When there is no continuity of goods flows, the situation becomes more complicated. An example from Drachten is that Company A, Company C and Company E act as subcontractors and/or deliver their products and services to construction sites, meaning that all of their respective customers are found in scattered locations across the country. It can be argued that this is a reason why they are less positive towards using IWT, since ad-hoc solutions are required.

An aspect that has to be taken into account is that companies' knowledge of IWT prior to actually using it could range widely. For example, the reason why a company does not believe

there are that many challenges to consider with IWT could be that the company in fact lacks knowledge about the subject and therefore is not able to identify them. It could also be the reverse, meaning that the actor could exaggerate the impact IWT would have in a negative way. Table 4 in chapter *7.1 Expected Benefits of Inland Waterway Transportation* shows that Company F is the company that mentions the most benefits expected from IWT. They also score among the lowest for challenges of IWT in Table 5 in chapter *7.2 Challenges with Inland Waterway Transportation*. This could have something to do with their prior utilisation and knowledge of IWT. The fact that they own the barges that are going to be used in the pilot and that they do not have to change their existing goods flows could also be reasons for this result. Company F would get to split the transport costs of the barges back to Amsterdam with the other companies, whereas the others would have to rearrange existing transport solutions. The other companies are alike in terms of the industrial area, bulk cargo, customer locations and road transport solutions, which is why their preconditions for IWT are similar. The efforts and investments required by the companies can taint their perception of what benefits and challenges IWT could bring.

Industry-promoting organisations could be seen as a means to convey information in order to increase actors' knowledge of IWT. Increased knowledge could bring light to new opportunities and solutions to challenges that previously could have hindered a modal shift. BVB puts effort into promoting IWT to a young crowd. As stated above, the companies in Drachten lack knowledge about IWT and that could impact their attitudes towards a modal shift. If people are educated in the beginning of their careers, they might approach transport solutions differently. Additionally, since it is often considered a life-long investment to buy a vessel it is beneficial if young people are educated, so that they are informed about the opportunities that the business holds. This educational approach could be applied in Sweden to spread the knowledge about how IWT works and how it could be implemented.

What has to be kept in mind as well is that the inland navigation promotion organisations where interviews were conducted are somewhat biased because of their industry-promoting nature. This means that they focus more on the benefits of IWT rather than addressing the challenges. In addition, BVB focuses the calculations of the modal shift to IWT on cost price instead of market price. This means that what seems to be a feasible modal shift could face difficulties on the actual market.

8.4 Modal Shift Process

The companies in Drachten were at the time of the interviews preparing for conducting a pilot for a modal shift, but they did not meet all criteria for a successful modal shift process as proposed by BVB. A reason for the limited preparations could be that a modal shift to IWT in the near future is not interpreted to be the main purpose of the pilot for most companies. Instead, they seem more interested in the new waterway that could bring future business opportunities. This attitude could nevertheless change after the pilot where they have had the experience of barge transports and its surrounding operations. A risk is that not enough effort is put into the pilot and that it therefore is not as successful as it could have been, and in turn the companies do not realise all of the potential benefits and are instead discouraged from

adopting IWT to a larger extent. When conducting a pilot, and modal shift process as a whole, it is important for the involved stakeholders to be enthusiastic and motivated about IWT, and that they are willing to invest in the process.

As opposed to the companies in Drachten, the Belgian company De Brabandere Group was more enthusiastic about the potential of IWT. They have made initial investigations concerning the applicability of IWT in terms of costs, volumes and connectivity. In Sweden, the way to a modal shift seems longer based on the discussions by the Swedish stakeholders. Since there are barely any inland waterway solutions in place, many actors must cooperate and make a change to realise this. A single actor has not the same possibilities to on its own decide to adopt IWT. There are no established networks of shippers, ship owners or line network operations that offer these services for container transport on inland waterways. An example from the Swedish stakeholders was to have a forwarding agent that offers the complete solution. In the Swedish case, it could be helpful to have an organisation similar to BVB that conveys knowledge to transport planners in sending companies and guides them through the process, for example through consultancy services. This could facilitate the implementation of IWT and connect goods owners with ship owners that are willing to expand their operations.

What could also facilitate the implementation of IWT is a joint administration system between companies in the transport chain. Even though the companies in Drachten have not yet utilised the software, they perceived it to be feasible for potential consolidation efforts in the future. Coordination and transparency that a joint administration system could bring to a transport chain is considered to improve efficiency and thereby competitiveness (BVB, 2017; Caris et al., 2014). Transparency is also important since efficiency in production planning is perceived to increase, according to the Swedish goods owners. Efficient logistics require administrative efforts to simplify the process of the otherwise complex intermodal administration (Medda & Trujillo, 2010). The software developed by Company E could be seen as a means to achieve this. If the pilot is successful and the software is aiding consolidation and overall transport operations it is planned to be used if and when a long-term modal shift is in place. Currently the administration for maritime transports in Sweden is considered very complex (Andrén & Rexius, 2017), which is why similar tools could be used as facilitating means to improve the administrative infrastructure.

When reflecting upon the hard and soft criteria, it becomes clear that all play a significant part of the modal shift preparations. The evaluation of the hard criteria can impact the mindset of the involved actors. If the outcome suggests that a modal shift could be feasible, it would encourage the actors to continue the work. Regarding the soft criteria, the mental shift is one of the most difficult to realise as it is integrated in all of the other criteria, as well as in every step of the modal shift process. Changing the chain partners could be difficult depending on the current situation. In Drachten for example, some of the companies already worked together and there was an existing barge solution, which is why the change of chain partners was not considered an obstacle. In the Swedish case it could be more challenging because there are often intermediaries between goods owners and carriers, meaning that more

relationships are broken and that the goods owners need to negotiate new transport agreements with actors that are scarce on the Swedish market.

In the modal shift process proposed by BVB, there are some activities that are of the utmost importance. The stakeholder analysis tells the company what actors are required to be closely involved in the process. Their input and encouragement of the process could steer the course of the modal shift. Especially the customers must be approving of the new transport solution and the changes that will follow. The cost-price calculation is a deal breaker as it could show the prosperity of the modal shift, or lack thereof. Nevertheless, the calculations are based on estimations, hence they can be deceiving. Bottleneck analysis paralysis should be avoided. It could be difficult to realise beforehand what bottlenecks actually occur, which is why the pilot could be carried out before a more thorough bottleneck analysis is conducted. After the pilot the challenges and bottlenecks that occurred can be targeted more specifically. During the pilot evaluation the activities should be revisited and decisions should be made regarding the continuation of the modal shift process. A well-conducted process leading up to the pilot presumably generates fewer surprises in the evaluation, which in turn could make actors more inclined to permanently implement IWT in their transport chains.

To summarise, the most important factors of the modal shift process work together as intertwined cogs for a smooth IWT adoption and can be found in Figure 13.

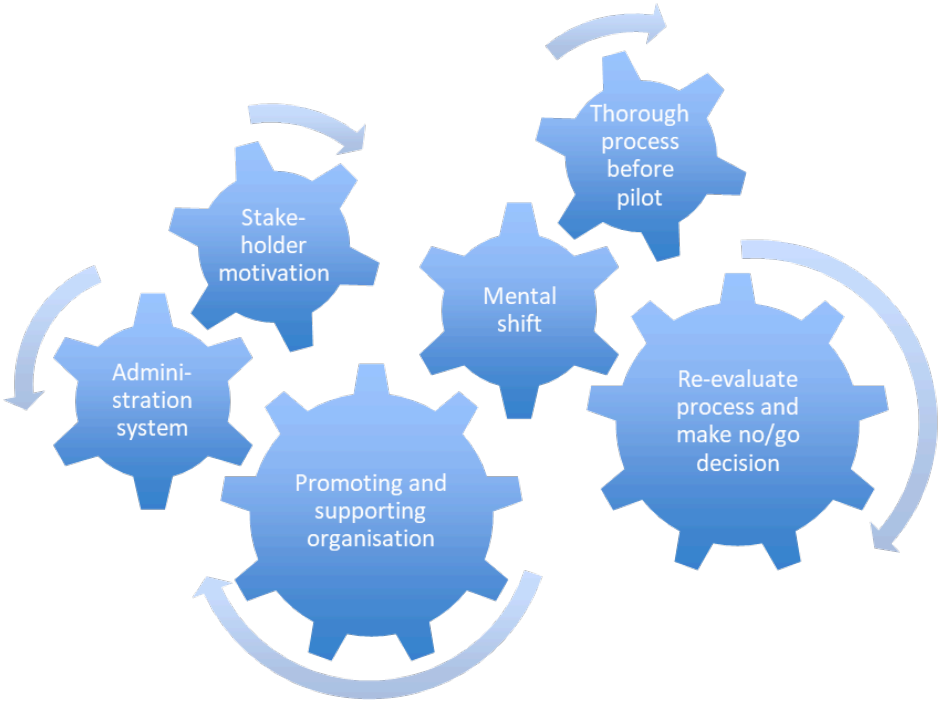

Figure 13. Important factors of the modal shift process.

9 Conclusions

Before conducting a modal shift, it is important to realise what drivers and barriers there are that could impact the outcome. Several drivers and barriers of IWT were identified during the thesis work, and the most significant ones are presented below in order to answer the first research question *What are the drivers and barriers identified for IWT?* In Sweden, the drivers could be used as marketing arguments for IWT since they could positively affect both companies and the society. The identified barriers are of a somewhat greater dimension that could need attention and support from public authorities.

Drivers include congestion relief, cost reduction and sustainability. As transport demand is growing, the road congestion will eventually require increased use of other transport modes. From this aspect, IWT is a suitable option as there is unutilised capacity of waterways. As found in the Drachten case, the delivery time might increase but it is easier to ensure delivery reliability since traffic jams on waterways are rare. Another driver of IWT is cost reduction, accomplished with a high fill rate over a long distance and thereby generating a low cost per tonne-kilometre, yielding economies of scale. In Sweden however, the mandatory dues make IWT less cost competitive compared to land transports. Lastly, sustainability is identified as an important driver, considering the reduction of CO_2 emissions. It is recognised that consumers are becoming increasingly aware of environmental issues, which is why sustainability should be used as a marketing argument for IWT in Sweden.

Barriers of IWT are the slow pace of development, high investment costs and poor hinterland connectivity. The slow development and improvement of IWT allow other transport modes to look more attractive for both transport buyers and the society as a whole. This is damaging especially regarding the anticipation of future environmental performance of IWT compared to other modes. The high investment costs of vessels and equipment discourage companies and transport carriers from shifting to IWT. The long lifecycle of ships makes them a lifelong commitment, which seemingly increases the risk of the investment. The possibility of having to comply with future regulations and environmental standards makes it unattractive to enter the navigation business. Finally, poor hinterland connectivity is considered to aggravate the adoption of IWT because of the requirement of pre- and/or end-haulage.

The second research question *What factors could be considered for Swedish companies when preparing for a modal shift to IWT?* is answered by summarising learnings and recommendations. Before initiating a modal shift of goods flows from land to inland waterways it is recommended that the involved actors ensure that they evaluate the criteria presented in chapter *7.5 The Modal Shift Process*. Following the criteria assessment, it is suggested that the companies consider the modal shift process proposed by BVB for a successful implementation. Consider in particular the factors presented in Figure 13, as they are the most important factors of the modal shift. Differing conditions of IWT between the Netherlands and Sweden include financial aid and support from the government and different cost structures. The companies in Drachten emphasised the importance of having support from the local government. These are aspects that could be considered by the Swedish

government in order to encourage IWT adoption in the transport system. Even though the countries are different in governance as well as topographical aspects, the modal shift process is not constrained to a specific setting.

Learnings stated by the companies in Drachten could be useful for Swedish companies to consider when preparing for a modal shift, especially goods owners since they were represented in Drachten. Governmental support has been touched upon above and the importance of evaluating equipment and changing the mindset of both customers and employees are included in the modal shift process as formulated by BVB. Being decisive is a piece of advice that facilitates the progression of the modal shift process. If no decisions are made and the process is stalled, the involved actors could lose motivation and be less willing to continuously put effort into the project. Lastly, both the Drachten companies and thesis authors suggest having a long-term perspective, since it could take a certain amount of time before the investments break even and the benefits are realised. Additionally, what should be kept in mind is that in the long-term perspective a network effect with improved infrastructure and connectivity could be generated as more companies engage in IWT, resulting in increased value for the participants.

What is also helpful when preparing for a modal shift is to implement a joint administration system, in order to facilitate information sharing. It is recommended that an actor external to the company sending or receiving goods, such as a forwarder, aids in the transport planning and consolidation of goods. An organisation similar to BVB that conveys knowledge to transport planners in sending companies and guides them through the process is also recommended.

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Appendix I - Interview Guide Smallingerland Municipality

General information

- What do you do at your workplace?
- How does the utilisation of inland waterways within the region look today?
- What benefits and challenges do you perceive with inland waterway transports (IWT)?

About the project

- What is your role in the project?
- What are the reasons behind initiating the project?
- Who is the initiator of the project?
- How many actors are involved?
- What is the planned duration of the project?
- Does it concern bulk or container cargo?
- Have you experienced pressure from stakeholders?
    - To become more aware of the sustainability aspect of transports?
    - From whom?
- Have you exercised pressure on involved actors to join the project and to shift to IWT?
- How does the project impact the relationships with current transport carriers?
- What are the drivers that make companies interested in joining?
- Is there a central forwarding agent handling the goods flows?
- What challenges are there in the project?
- Which actor is most interested in the project? Who enjoys the most benefits?

Budget

- How is the project financed?
- Is the waterway transport in general financed by taxes or other institutional fees?
- Are there any plans for subsidising the transport modes included in the project?

Regulation and legislation

- Are there any regulations from your side that impact the project?
- Are there current regulations that could aggravate the transition into waterway transportation?
- Are there any regulatory incentives to promote a shift to IWT?

Evaluation

- What is the final objective of the project?
- How will the project be evaluated and followed up?
- How will you know if the project is successful? KPIs?

Appendix II - Interview Guide Goods Owners

General information

- What is your role in the company?
- How does the supply chain look in terms of involved actors?
- Please describe your company's goods flows, both inbound and outbound flows.
    - What are the products?
    - To whom does your company deliver the products? Wholesalers, retailers, consumers etc.
- At what frequency do you deliver and receive goods? What are the volumes?
- How does your company arrange transports on a daily basis?

Transport solutions

- Why did your company join the project?
- When choosing transport mode, what are the determinants?
- How do you work with the other actors involved in the project?
- How does your company negotiate the terms of transports?
    - Are there any factors that are more important than others?
    - Compromising with other project partners?
- How does pricing work for the new transport solution?
    - How many companies are involved in one transport?
    - How do you share transport and transshipment costs between partners?
    - Will it impact the product price?
- How do you think joining the project will change your transport tactics?
    - What do you think that the customers' reactions will be?
- How does the project impact the relationships with current transport carriers?

Regulation and legislation

- Have you experienced pressure from stakeholders to comply with environmental regulations?
- Are there any regulatory incentives for using inland waterway transportation (IWT) to a larger extent?
- Are there any taxes or fees that discourage the transition into IWT?

Expectations of the project

- What are your views on IWT in your specific supply chain?
- Do you expect any changes in KPIs?
- Does the project impact production planning?
- Have you considered any quality and/or safety aspects?

Evaluation of the project

- What is the final objective of the project?
- What has been the hardest part of the project so far?
- How are you going to follow up and evaluate the project?
- How will you know if the project is successful?
- What can others learn from what you are doing?
- What are the long-term prospects of IWT within your company? Are you working to increase the use of inland waterways?

Appendix III - Interview Guide Bureau Voorlichting Binnenvaart

About BVB

- Please tell us about your organisation.
- Is BVB a governmental organisation?
- What is your personal role within the organisation?
- What is BVB's role within the transport system?
- In what areas are you present?
- How does BVB work towards increasing the use of IWT?
    - How does BVB create awareness of IWT?
    - Collaborations?
    - Are you included in projects where companies are shifting to IWT?
- Do you receive feedback from companies that have shifted to IWT?
    - In that case, is it most often positive or negative or something else?

IWT in the Netherlands

- Generally in the Netherlands, how does the cost structure look for IWT?
- Who is financially responsible for building and maintaining the waterways?
- How does it work with investments in ports and terminals?
- Who are usually the ship owners?
- How do the companies involved in a consolidated transport negotiate the terms of the transports?
    - Are there any factors that are more important than others?
    - Compromises between different actors?
    - How many companies can be involved in one transport?
    - How is sharing of transport and transshipment costs usually done between actors?

Regulation and legislation

- Does BVB have the influence to pressure companies to comply with environmental regulations?
- Will there be any restrictions regarding utilisation of ships with older classifications?
    - How could that impact the current IWT operations?
- Are there any subsidies when investing in new, more environmentally friendly ships?
- Are there any regulatory incentives for using IWT to a larger extent?
    - Do you have any ideas how policies and regulations could be used to increase IWT?
- Are there any taxes or fees that discourage the transition into IWT?

Perception of IWT

- What do you see as the general benefits of IWT?
- What are the general challenges with IWT?
- What do you think are the main reasons for companies to consider IWT?
- What difficulties do companies experience during the actual shift to IWT?
- What circumstances are optimal for implementing a well-functioning IWT system?
    - In terms of companies, waterways, terminal infrastructure, product type, climate
- How could a shift to IWT impact the company's relationships with current transport carriers?
- How are different KPIs affected by IWT?
    - Such as lead time, cost, reliability, frequency, volumes etc.

- How does IWT impact quality and/or safety?
- What are the long-term prospects of IWT in the country?
- What can others learn from IWT in the Netherlands?

Appendix IV - Interview Guide De Vlaamse Waterweg

About De Vlaamse Waterweg

- Please shortly describe your organisation.
- What is your personal role within the organisation?
- What is DVW's role within the transport system?
- In what geographical areas are you present?
- How does your organisation work towards increasing the use of IWT?
- Do you receive feedback from companies that have shifted to IWT?
    - In that case, is it most often positive or negative?

IWT in Belgium

- Generally in Belgium, how does the cost structure look for IWT?
    - Who is financially responsible for building and maintaining the waterways?
    - How does it work with investments in ports and terminals?
- Who are usually the ship owners? (Is it a separate company, individuals, manufacturers…?)
- How do the companies involved in a consolidated transport negotiate the terms of the transports?
    - Are there any factors that are more important than others?
    - How is sharing of transport and transshipment costs usually done between actors?

Regulation and legislation

- Does DVW have the influence to pressure companies to comply with environmental regulations?
- Will there be any restrictions regarding utilisation of ships with older classifications?
    - How could that impact the current IWT operations?
- Are there any subsidies when investing in new, more environmentally friendly ships?
- Are there any regulatory incentives for using IWT to a larger extent?
    - Do you have any ideas how policies and regulations could be used to increase IWT?
- Are there any taxes or fees that discourage the transition into IWT?

Perception of IWT

- What do you see as the general benefits of IWT?
- What are the general challenges with IWT?
- What do you think are the main reasons for companies to consider IWT?
- What difficulties do companies experience during the actual shift to IWT?
- What circumstances are optimal for implementing a well-functioning IWT system?
    - In terms of companies, waterways, terminal infrastructure, product type, climate
- How could a shift to IWT impact the company's relationships with current transport carriers?
- How are different KPIs affected by IWT?
    - Such as lead time, cost, reliability, frequency, volumes etc.
- How does IWT impact quality and/or safety?
- What are the long-term prospects of IWT in the country?
- What can others learn from IWT in Belgium?

Appendix V - Vessel Classification

Vessel classification in the Netherlands (BVB, 2018).

Class		
I	 **Spits** Length 38,5 meters - width 5,05 meters - draught 2,20 meters - cargo capacity 350 tonnes	 14 x
II	 **Campine vessel** Length 55 meters - width 6,60 meters - draught 2,59 meters - cargo capacity 655 tonnes	 22 x
III	 **Dortmund-Ems canal vessel** Length 67 meters - width 8,20 meters - draught 2,50 meters - cargo capacity 1.000 tonnes	 40 x
IV	 **Rhine-Herne canal vessel** Length 85 meters - width 9,50 meters - draught 2,50 meters - cargo capacity 1.350 tonnes	 54 x
Va	 **Large Rhine vessel** Length 110 meters - width 11,40 meters - draught 3,00 meters - cargo capacity 2.750 tonnes	 120 x
Vb	 **Large Rhine vessel** Length 135 meters - width 11,40 meters - draught 3,5 meters - cargo capacity 4.000 tonnes	 160 x

Appendix VI - Contemplations from Reference Group Meeting

Transport determinants

From the *cost* perspective, the goods owners agree that the cheaper the better, as long as there is sufficient equipment along the way and secured quality. Different requirements of the goods owner can impact the price of the transport service. When it comes to *efficiency* there is a need for more integration and transparency between the companies within the transport chain in order to reduce administration and facilitate planning. Efficiency should also be measured through relevant KPIs so that improvement efforts can be realised. Most efficiency efforts can be made in the goods handling operations and not so much during the actual transport, which is why goods owners want the goods handling to be performed as quickly as possible, but without risking to damage the goods. The *delivery service* implies being able to quickly respond to a customer need, meaning that the goods owner must be flexible. *Sustainability* is not considered a priority except when the customer demands it. Many companies have environmental policies but they are not always followed if other aspects of the transport are lacking because of them. The environmental aspect can be seen as a hygiene factor for consumer goods. This means that the sustainability factor is not necessarily an aspect of the product that makes the customer buy it, but it would be missed if it is not included at all. It is also seldom something the company gets paid for, but they can get a poor reputation and lose customers if not being environmentally conscious.

A similar analysis was carried out in the group of ship owners. Main issues that were brought up regarding *costs* were high entry barriers and how fill rates must be extremely high in order to reach break-even. Even when the initial investment in the ship has been made, there are operating and maintenance costs. Additionally, there are several fees that must be paid, such as port, fairway and pilotage dues. This can make the business somewhat unattractive. From the *efficiency* perspective the fill rates were brought up again, and more specifically the endeavour of having stable and sufficient volumes in both directions. Furthermore, the port efficiency was mentioned as an important aspect as well since they want to charge and discharge quickly. When it comes to *delivery service*, the ship owners agreed that they prioritise frequency, punctuality and overall reliability. What also was mentioned was the wish to be met with increased flexibility in the port. For example, they might have to pay for more time than the service actually takes. Regarding *sustainability*, the ship owners viewed it as they could offer redundancy in the transport system with their business in the event of limited availability of the other modes of transport.