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# Drivers and Barriers for Inland Waterway Transportation

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## ABSTRACT

Inland waterway transportation (IWT) in Sweden could be a substitute for road transports with the prospects of improving the environmental performance. Sweden currently has no systematic strategies or policies for transports on inland waterways (IWW), and despite available capacity the waterways are barely utilized. In the Netherlands, for example, the IWW capacity is embedded in the transport system and utilized to a large extent. For a successful modal shift it is important to understand the drivers and barriers for the shift and develop strategies to leverage the drivers and mitigate the barriers. This study aims to identify drivers and barriers for IWT based on successful benchmark cases in the Netherlands. Furthermore, based on the learning from these benchmarks the study aims to point out strategic actions for Sweden regarding IWT. The data for this study was collected from IWT organizations, shippers and local administrations in the Netherlands. The results showed that main drivers for IWT are congestion relief, cost reduction and lower environmental impact. On the other hand, main barriers are slow pace of development, high investment costs and poor hinterland connectivity. For a successful modal shift in Sweden, it is crucial to prepare governmental support, a change in stakeholders' mindset, decisive attitude to modal shift process and a strong long-term perspective.

**Keywords:** *inland waterway transportation, intermodal transportation, modal shift, drivers, barriers, Sweden*

## 1. INTRODUCTION

An objective of the European Commission is to shift road freight transport to environmentally less damaging transport alternatives (Meers *et al.*, 2017). The issue of the scarcity of fossil fuels makes this shift an urgent topic since 96% of all transports today are dependent on fossil fuels (European Union, 2018). Throughout Europe, on regional, national and international levels, policy makers have promoted intermodal transport as an option to the only road transport. One of the shifts is planned to be to inland waterways (IWW), which 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).

German, Belgium and the Netherlands were accountable for more than 93% of the total European Union (EU) flow of full containers on IWW (Eurostat, 2018). A modal shift from road to IWW and coastal shipping is a

prioritized strategy outlined in national strategies in Nordic countries as well, as part of EU goals. Main motivation for this modal shift derives from the need to use more energy efficient transport modes, and consequently reducing greenhouse gas emissions, as well as congestion on roads, local pollution and noise from trucks. IWW in Sweden are underutilized (Garberg, 2016). Less than 1% of the goods are transported by IWW, which is a contrast to the Netherlands' figures of almost 20% (Eurostat, 2018). Even though the Netherlands' figures are high in comparison to Sweden's, there is still a challenge of competing with attractive road solutions, and a potential negative modal shift to road. Thereby, there is strong motivation to increase the usage of IWW as well as to prevent a negative modal shift to road, especially considering that both of these actions support the ability to reach long-term national sustainability goals.

IWT has been successfully studied from different perspectives, e.g. integration with other modes of transport (Caris *et al.* 2014); barriers to implementation (Meers & Macharis, 2015; Mircetic *et al.* 2017), cost analysis (Wiegman and Konings, 2015), network perspective and infrastructure issues (Wiegman & van Duin, 2017). However, achieving a modal shift from current flexible road solutions to IWW is a challenging task with various barriers (Meers & Macharis, 2015), which requires several actors to take action; and which has a lot of contextual determinant as well. Therefore, analyzing successful cases would contribute to current understanding on ways to achieve a modal shift. Furthermore, such an analysis would also provide a framework to improved understanding on different contexts of IWT.

Building on this discussion, the purpose of this paper is to identify drivers and barriers for IWT based on a benchmark case in the Netherlands and based on those findings the study aims to point out strategic actions for Sweden regarding IWT. Finally, a conceptual model of the modal shift process is proposed.

Two research questions are developed to operationalize the purpose:

**RQ1:** *What are the drivers and barriers for IWT based on the benchmark case?*

**RQ2:** *What are the necessary steps to take for enabling a modal shift to IWT in Sweden based on the learning from the benchmark case?*

The paper is structured as follows. After the introduction comes an overview of methods for data collection which is followed by literature review section on IWT characteristics. Then IWT in Sweden and the Netherlands are analyzed and described based on the characteristics reviewed and the data collected. After that description, analysis and findings from Drachten case are introduced. The paper ends with a critical summary of findings and a discussion in relation to previous studies on IWT.

## 2. METHOD

In order to grasp an in-depth understanding of the current situation regarding IWT in Sweden, a reference group meeting of an ongoing IWT project was observed. The

reference group consisted of 13 representatives from municipalities in Sweden, Belgium, the Netherlands, Germany and Great Britain; as well as representatives from relevant industries and companies. The purpose of the meeting was to discuss the progress and issues surrounding the topic of IWT and how to mobilize potentials to move freight to IWW that are not yet utilized in Sweden. Notes from this meeting inspired further data collection in the Netherlands via interviews with relevant actors involved in the pilot project for Drachten case. This data was supported by site visits and relevant literature.

The interviews were of semi-structured nature, which is common in qualitative studies since there is a possibility for the interviewer to ask follow-up questions based on the answers, resulting in a flexible interview process (Bryman & Bell, 2015). Eight companies/organizations were visited, and semi-structured interviews lasting 60-90 minutes were held with their representatives: Project Coordinator for a municipality, Assistant Logistics Manager from Company A, General Manager from Company B, Technical Manager from Company C, Commercial Director from Company D, Owner of Company E, Production Site Manager from Company F and Logistics Consultant at Bureau Voorlichting Binnenvaart (BVB).

## 3. IWT CHARACTERISTICS

IWT in this study is defined as freight that is moved on IWW such as canals, rivers and lakes either during the whole transportation process of an order or during part of this transportation process. IWT, therefore, takes place either between a deep-sea port and an inland port or between inland ports themselves. From IWW perspective and as defined by Wiegman *et al.* (2015), inland ports are transportation infrastructures along waterways with facilities and equipment for loading and unloading ships. 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).

In general, IWT doesn't face the congestion problems like road or rail transportation are challenged by (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) argue that IWT can reduce traffic density. Furthermore, IWT is generally regarded as a transport mode with high safety (Hendrickx & Breemers, 2012) which is also confirmed by Caris *et al.* (2014) who state that since IWT is considered safe and secure, using barges for hazardous cargo is suggested to enhance transport safety both for the society and the cargo owner. Maritime transportation is commonly considered to be one of the most sustainable transport modes (BVB, 2017). It is very energy efficient, where high volumes transported over long distances are factors contributing to more sustainable performance (Mircetic *et al.*, 2017). Due to the high-volume capacity of vessels, the CO<sub>2</sub> emission per ton-kilometer is lower than for other modes running on fossil fuels (BVB, 2017).

When it comes to other pollutants than CO<sub>2</sub>, shipping is not as well performing. Maritime transports contribute to air pollution due to their emissions of NO<sub>x</sub> and SO<sub>x</sub> 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<sub>2</sub> emission share respectively (Viana *et al.*, 2014). There are also disadvantages associated with speed/transport time as well as transshipments at the terminals (Khaslavkaya and Roso, 2019). As discussed by Caris *et al.* (2014), some problems might arise in winter since traffic on IWWs could be stopped due to 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 & Breemers, 2012).

Caris *et al.* (2014) argue that the share of IWT has decreased in the past few years. This decline 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; Baroud *et al.*, 2014), with bridges and locks that constitute obstacles (Wiegman & van Duin, 2017). However, containerization with consolidation of low volume flows has made it possible to achieve economies of scale, and thus still utilizes IWT (Caris *et al.*, 2014).

Ports are also regarded as an obstacle to IWT and its development, 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.

To carry out IWT processes, involvement of several actors is necessary (Wiegman & van Duin, 2017) such as 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 maritime industry is complex since it involves a lot of inspections, controls and paperwork requirements.

In Europe, road transports are often considered to be the benchmark of transport costs and capabilities when companies are comparing different transport solutions (Wiegman & Konings, 2015). Flodén (2017) mentions four key factors when selecting transport mode: cost, time, reliability and quality. Cost is presented as the most important factor when choosing a transport solution, in accordance with other studies (Wiegman & 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 (Wiegman & Konings, 2015), making it rather complex transport chain. (BVB).

#### 4. IWT IN SWEDEN

The share of IWT in Sweden is very low; in 2014 the share of coastal maritime transports was 3%, compared to 88% for road transports with heavy-duty trucks and 9% for rail (Garberg, 2016). The types of cargo mainly transported by IWT are liquid fuels, forestry and mining goods. Swedish shipping fleet in 2016 was the smallest it had been since 1970 (Regeringskansliet, 2018a). In addition, the number of applicants to nautical education programs in Sweden has decreased in the past years, meaning the industry risks facing competence shortage (Regeringskansliet, 2018a). However, the Swedish government has started to take action towards increasing the share of IWT. These actions include dialogues with municipalities, ports and other related actors and the objective is to develop incentives and opportunities for finding a collaborative way of integrating IWT in the transport chain so that a modal shift from land to IWW occurs. 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 waterborne transports.

One of the obstacles for IWT development is the poor coordination between business sector and governmental authorities, resulting in conflicting objectives and contradicting actions (Garberg, 2016). The lack of coordination and development within maritime transport sector also result in complicated administration, which might be observed in the system of fairway and pilotage dues that Sjöfartsverket has put in place (Andrén & Rexius, 2017). Sweden 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 are 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 are 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 recognized 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 in total transport cost. In addition to fairway and pilotage dues there is also a mandatory fee for the ports. Garberg (2016) considers these public fees among obstacles to increase 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

transport modes that have less negative impact on the environment. 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 abandoned in favor of road 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 analyze how ports and surrounding facilities in general could be developed to facilitate IWT (Regeringskansliet, 2018a). This includes investments in infrastructure for increasing the capacity and productivity of ports and contribute to congestion relief, as well as improving the environmental impact and regional development.

## 5. IWT IN THE NETHERLANDS

In 2017, the total share of IWT in the Netherlands was 44.6%. Different types of goods were transported on IWWs where bulk cargo (ore, sand, mineral oil) had the largest share by 50%, and containers had a share of 14% (CCNR, 2018). In Rotterdam, 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). Konings (2009) describes that even though the IWT share for containers is lower than road transport, it has still grown by 10-15% in the Netherlands over the past decades. Following 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. Ongoing barge transports are mainly line network operations, where the seaport terminals are connected to barge terminals along the river Rhine (*ibid.*). Furthermore, when the figures are combined for container and bulk cargo, then the share of IWT from port of Rotterdam increases to 55% (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 (Wiegman & Konings, 2015).

In the Netherlands, fairway dues are included in general taxes, meaning that investments and maintenance of Dutch waterways is financed by public sector (Kågeson, 1999). Port dues are paid by transport buyers and are determined by the vessel's gross tonnage and transshipment volume (Port of Rotterdam, 2018). There are four regional districts that carry out pilotage services (Eriksson *et al.*, 2009). The pilotage fee 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 the Netherlands the institutional financial support for terminal investments is 25% (Wiegman & Konings, 2015). BVB is sponsored by vessel owners and has the aim to promote the sector to the government and for educational purposes. Since there are opportunities to increase the use of barges, the agency aims to convey knowledge to transport planners and help shippers to include IWT in their logistics processes. Since 2012, approximately 40,000 TEUs have been shifted to IWT from road which keeps the agency motivated.

## 6. THE DRACHTEN CASE

Drachten is a community in the municipality of Smallingerland, which is in Friesland province in northern Netherlands. Several industries 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. The harbor 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 throughput. Drachten handles only bulk cargo, whereas containers to and from the province are handled by one of four container terminals in the northern area. With the help of cooperation between these ports and industries, the possibility to receive subsidies and funding is increased. 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).

Six companies (for confidentiality reasons called A, B, C, D, E and F in this study) involved in the project together with Smallingerland municipality have initiated a pilot project. Currently agricultural goods are delivered to Company F's feed mill in Drachten by barges. These barges then return empty to port of Amsterdam for loading new cargo. The aim of the pilot is to investigate whether 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.

**Table 1** The companies involved in the case

Company	Products	Customers	Goods flows	Reason for participating in the project
Municipality	-	No customers, targets the citizens in the region	None	Seeking financial support in the improvement of IWW infrastructure Lobbying at a national scale based on IWT benefits
A	Concrete pipes and elements	Wholesalers, contractors	Outbound	Partakes in environmentally friendly solutions.
B	Soil and nutrients	Wholesalers, retailers	Outbound	Expects IWT to grow, but awaits better preconditions.
C	Steel sheet piles and cranes	Construction sites	Outbound	Aims to show the benefits of a larger waterway to Drachten.
D	Forestry, soil and sand	Wholesalers and construction	Outbound	Expects environmental benefits from using IWT, it would be good for business.
E	Asphalt and concrete	Construction sites	None	Partakes in construction of the new waterway. Provides software that aids consolidation of transports from Drachten.
F	Livestock feed	Farmers	Inbound	Increases capacity utilisation of the barges returning to Amsterdam.

The barge is to perform a milk-run at Drachten companies since they are all located along the waterway and have their own quays. Consequently, there will be no need for pre-haulages and the goods can be loaded directly onto the barges from the storage areas. A shared computer system will be used in the pilot where the companies can provide cargo data such as volume and required delivery date. The system is expected to facilitate the overview of the transportation demand from Drachten and fill rates for the barge can be calculated for the return flow.

The first pilot will be filmed when it takes place during winter and the film will be shown to the authorities as well as potential and current customers. If the pilot and the film thereof are well received, there is hope that the province and local authorities will approve building the new waterway and provide partial funding for it. The initial pilot is a one-off shipment coordinated by the companies involved which means that 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. The optimal frequency and volumes are to be determined through the information technology (IT) system to where the companies provide their transport data. Involved actors meet every six weeks to discuss the project and its progress. These companies are not contributing with financial means, but they contribute with their commitment and shipment flows.

## 7. FINDINGS AND ANALYSIS

Benefits and challenges presented below show potential for IWT implementation but the recent trends of changing production principles in combination with flexibility and globalization 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 towards 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 to IWT is the slow pace of its development (Rogerson *et al.*, 2018), when compared to road transports where major developments take place for improving its environmental performance and complying to current production trends.

### 7.1 Identified Benefits Acting as the Drivers Towards the Modal Shift

All companies involved in the project identified different benefits from using IWT. These benefits imply some drivers for the modal shift. The findings are summarised in **Table 2**. Majority of the companies emphasize the highly congested roads as problematic in their current transport operations. They particularly focus on congestion's negative impact on the planning and reliability of their 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. 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). There is also a shortage of truck drivers. Although transit time will be longer 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. One company highlights this as an opportunity to manage large shipment flows on a structured basis. However, it's not only up to the manufacturing companies in Drachten. Their customers also need to align their production planning and supply processes. Better coordination between companies is required to leverage the benefits of IWT.

**Table 2** Summary of the benefits of IWT identified by the companies/organizations

Company/ Institution	Congestion relief	Reliability	Fewer accidents	Truck driver shortage	Barge storage	Cost reduction	Consolidation	Sustainability
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

Barges can also 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 does always not require big crew to be present on the vessel (BVB, 2017). Convoys with several barges could also be beneficial for combining cargo flows. Barges can therefore lie at berth as storage areas during 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.

One company further argued that IWT has potential to be cheaper than truck transportation in cases where the transported volume is large enough. A barge replaces approximately 70-80 truckloads going to the same destination which creates cost efficiencies and positive environmental performance. This is confirmed by Wiegman and Konings (2015) who argue that IWT with larger volumes can benefit from economies of scale and can thus be more cost efficient than trucks. 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 in comparison to road. Currently, Company F bears the expense of the empty barge transport back to Drachten alone and would therefore enjoy a benefit from the consolidated return flow in terms of decreased transport costs, since the other companies will then be paying for the return flow for transport of their goods.

### 7.2 Identified Challenges Acting as the Barriers Towards the Modal Shift

The companies identified several challenges expected to result from using IWT which could act as the barriers towards the modal shift to IWT (see **Table 3**). 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 road transportation. 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 investments needed (BVB, 2017). That's why younger people in the industry are more likely to be willing to invest, since they usually have more time in 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. Problems with this kind of goods are multiple transshipments as it might cause damages. This could also be time consuming and increase transit time, which leads to increased costs (Regeringskansliet, 2018a; Meers & Macharis, 2015). Additionally, the long solidification time for the concrete goods has to be dealt with. 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 by their own quay is an operation that would require costly cranes. It is not feasible for every port to have all available loading/unloading equipment and 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 near 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 for handling goods at berth. Their aim would be to buy an automatic loading and unloading machine to save costs of manual labor. Infrastructure in general was a concern.

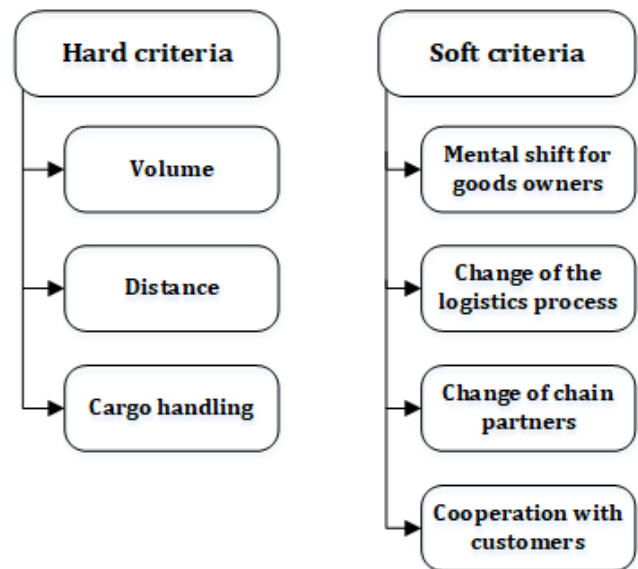
Since customers tend to want one truckload at a time, there could be an issue because of the large quantities required to fill an entire barge. The challenge lies within coordinating several deliveries and convincing customers into accepting such deliveries. The same issue might arise regarding the volumes of sheet piles that have to be processed. 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. Transparency and coordination of the supply chain can bring a competitive advantage of transport operations. Possibilities to coordinate goods flows between several supply networks could facilitate consolidation of 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 noticed the end-haulage problems 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. Instead, 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 with 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 achieve with IWT due to transit time and required

coordination. Usually transit and terminal operations, including transshipments, are time consuming activities. The longer delivery time could be an issue for some customers when using IWT instead of road transportation. It is a critical issue especially during winter when there is an ice risk on waterways (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. On the other hand, fluctuating water levels due to weather disturbances could also impact the IWT performance (Hendrickx & Breemersch, 2012).

### 7.3 The Modal Shift Process According to BVB

A modal shift tends to 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 competing. When attempting a modal shift to IWT, there are several aspects to be taken into account. According to BVB, there are both hard and soft criteria that are of importance and they are presented in **Figure 1**. The hard and soft criteria must be evaluated before the actual process of shift can begin.



**Figure 1** Hard and soft criteria for modal shift according to BVB

**Table 3** Summary of the companies/organizations expected challenges of IWT

Company/ Institution	Conservative business	Investment cost	Product characteristics	Facilities and capacity	Volumes	Connectivity	Delivery time	Weather conditions
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



BVB suggests that volumes for IWT have to be sufficient; volumes under 50 tons are better suited for road transportation. Larger volumes could lower the transport cost per kilometer especially for distances exceeding approximately 200 km. It can, however, depend on volumes and transshipment time. It is argued at BVB that the actual transport cost per ton-kilometer for barges is lower than for trucks in the Netherlands. This statement can be questioned as different circumstances can affect transport costs. An assumption is made that the calculation is based on similar fill rates over the same distance, which would then cohere with Wiegman and Konings (2015) statement that barges outcompete trucks in cost efficiency due to economies of scale. What also adds to IWT are transshipment cost and potential pre- and end-haulage.

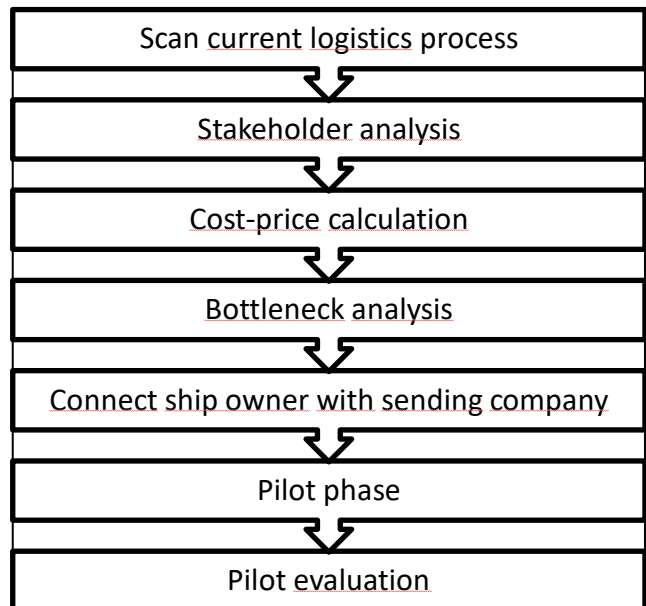
Among the soft criteria, the importance of mental shift in order to accomplish a successful modal shift is emphasized. Companies sending and receiving goods may not be unhappy with their current transport solutions and they may believe that existing processes are sufficient, flexible and relatively cheap while satisfying customer needs. BVB points that these companies need to consider the future. For a prosperous modal shift, the employees have to be on the same page and support the managers for an effective transition. 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. When shifting to IWT instead of truck transport the actors involved in shipment processes 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.

Furthermore, it is still important to be able to guarantee the same service levels after a modal shift (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. 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 this change 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. On the other hand, most of the companies observe an increasing demand for sustainable operations from their customers. In such cases, the cooperation with the customers to achieve a modal shift is more likely to function smoothly, as opposed to cases where the customers do not at all request improved environmental performance.

After the evaluation of both hard and soft criteria, the modal shift process may begin. Different process steps are presented in **Figure 2**. Firstly, logistics consultants at BVB scan the company's current logistics processes in order to identify what goods to shift and what arrangements there are with customers. They sort out which stakeholders are affected and how. A common problem is that the employees resist 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, rather than a supply

chain director.

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 unwillingness of customers to cooperate and thus blocking the modal shift. Up until this point, the shipper has had contact with only a truck company, which is why the agency contacts with its sponsors and connects a ship owner or an operator with the respective shipper. Being provided a contact is valuable for the shipper, as they rarely have that knowledge about IWW 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 try-out for being 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.



**Figure 2** Activities in the modal shift process according to BVB

## 8. DISCUSSION AND CONCLUSION

The discussion clarifies 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 4**. The presence of waterway networks differs greatly between different geographical locations. This means that longer transport distances might be disrupted by poor waterway networks, which, in turn, decreases the probability that the companies choose IWT because of required transshipments and the need for trucks during pre- or post-haulage. The high share of IWT in the Netherlands can therefore be reasoned with the natural waterway networks.

On the other hand, the availability of natural waterway networks is complemented with other factors such as public authorities' encouragement and financial support. Research provides similar inputs not only from local authorities but also from international organizations such as EU funds released for projects that aim to improve IWT, for example on Danube River and the region surrounding it (Mihic *et al.*, 2011). Based on the results from Drachten case, the municipality is 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. Local authorities' support is valuable for developing trust and confidence among companies which consequently reduces the tension regarding the failure risk of the project. Discussions with Swedish stakeholders indicated the importance of having the local authorities on board, particularly when they are expected to invest as well. 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, the involvement of public authorities should be at the policy-making and encouragement level instead of operational and management level. Li *et al.* (2014) provide evidence from Yangtze River in China where institutional change that allows private involvement in operational and managerial decisions is strongly required for improved IWT.

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). Swedish stakeholders highlighted this with reference to high fill rates and volumes required for achieving profitability. Since the dues constitute a large portion of the costs, they 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 IWT 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 have good preconditions to apply this concept, with line operations going along Göta Älv to Vänern. Swedish stakeholders argued that standardized routes and timetables are preferred over ad-hoc transports. That would also facilitate investments in facilities and equipment because the stakeholders would be confident in a steady flow of ships and goods. 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

are subcontractors that distribute their products and services to construction sites which are scattered across the country. This is one of the reasons why they are not in favor of shifting their transportation activities to IWT as ad-hoc solutions are required to satisfy their demands. Caris *et al.* (2014) emphasize the importance of integrating intermodal transportation decisions with supply chain decisions which clearly shows itself in this case with the scattered distribution structure for some of the stakeholders. The satisfaction of demand raised by scattered construction sites is dependent on cost/price calculations at the moment. However, if environmental sustainability goals are imposed in a stricter way to these supply chains then they will have a motivation for the modal shift to IWT. Complementing what Caris *et al.* (2014) underline for IWT's role in creating greener supply chains, findings of this study shows that sustainability is still a hygiene factor in the current case. Then policy makers need to increase the role of sustainability in decision making with some policy tools. Such an action would change the perceptions of actors towards a modal shift.

When compared with Wiegmans *et al.* (2015) study where they analyzed the antecedents of inland port success in the Netherlands, results here complement those antecedents by providing more in-depth analysis. Wiegmans *et al.* (2015) have found that as diversity of goods handled by an inland port on waterways increases, the throughput of those port will also increase. They also claim that if this inland port is highly accessible by road then this will also stimulate a growth in port throughput. Although these statements may hold true in certain conditions, the results in this study indicate that diversity of goods would require high investments in handling equipment and also higher commitment to the modal shift by a larger number of actors. Within Swedish context, these conditions don't prevail at the moment. Furthermore, considering the ad-hoc nature of good flows in current context, having a highly accessible road network could encourage a resistance for a modal shift because it would be convenient for the shippers to use the easily accessible road networks instead of dealing with many changes for utilizing IWT. Therefore, this study proposes that for pilot zones, having similar products which can be handled with the existing port equipment and having somewhat limited access or difficulties with access to road networks could act as demand generators for IWT.

**Table 4** 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.

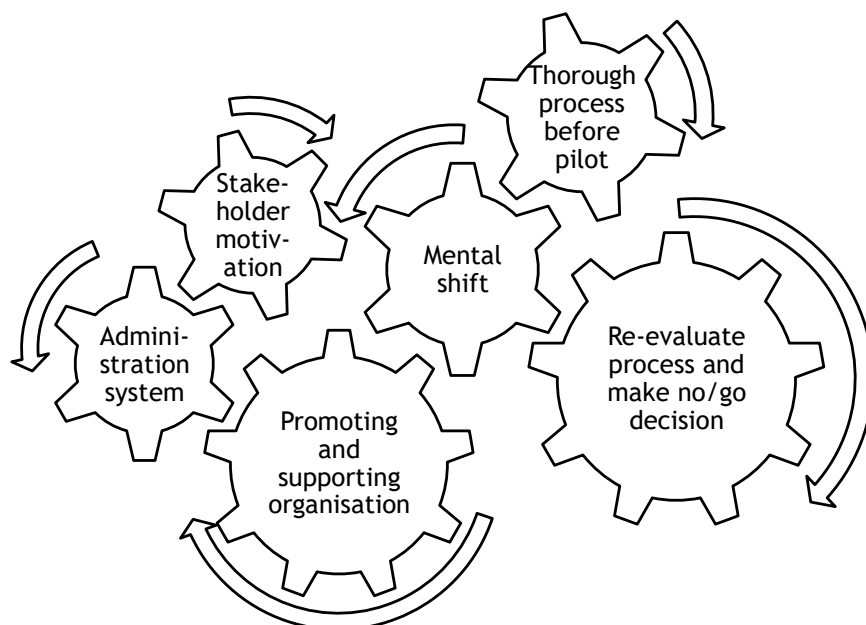
An aspect that has to be taken into account is that companies' knowledge of IWT prior to actually using it could range widely as was the case in the study (see **Table 2** and **Table 3**). Company F was the most positive towards the pilot, due to their prior utilization and knowledge of IWT. The fact 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 is also another reason. Company F will have the opportunity to share the cost of transportation back to Amsterdam with other companies, whereas the others will 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 organizations could function 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 have hindered a modal shift. 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 could also facilitate the implementation of IWT is a joint administration system between companies in the transport chain. In early IWT studies, this joint administration idea was associated with a new enterprise that aims to combine land and IWT for developing door-to-door services that utilizes the services provided by multiple parties involved in combined transportation (Seidenfus, 1994). Now this doesn't need to be a new company which could increase the transaction costs of organization; instead, with the help of information technology and software, involved stakeholders can manage this themselves. Even though the

companies in Drachten have not yet utilized 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 would improve efficiency and thereby competitiveness (BVB, 2017; Caris *et al.*, 2014). Transparency is also important for increasing the efficiency in production planning, 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 is one way of achieving this. It will be used for the long-term modal shift if the pilot is successful. On the other hand, the administration for maritime transports in Sweden is very complex (Andrén & Rexius, 2017), which is why similar tools are needed to improve the administrative infrastructure.

Reflecting on the hard and soft criteria, it becomes clear that all play a significant role on 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, then actors would be more willing to continue with the change. Regarding the soft criteria, the mental shift is one of the most difficult to achieve 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 there were no massive changes in the composition of actors. 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 limited in number in the Swedish market.

BVB proposes several most important factors for a successful modal shift process (**Figure 3**). These work as intertwined cogs for a smooth IWT adoption.



**Figure 3** Important factors of the modal shift process

Stakeholder analysis helps to identify which actors are required to be closely involved in the process. Their input and encouragement could steer the course of the modal shift. Of special importance are the customers who need to approve the new transport solution and the changes that will follow. Cost-price calculation is a deal breaker as it indicates the potential 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 realize beforehand what bottlenecks actually occur, which is why the pilot should be run before a more thorough bottleneck analysis is conducted. Following that, it is possible to target the situation-specific challenges and bottlenecks in a more effective way. Evaluation of the pilot phase would provide the inputs for making a go-no go decision with the modal shift process. A well-conducted planning and application process for the pilot phase presumably generates fewer surprises in the evaluation, which in turn could make actors more inclined to permanently implement IWT in their transport chains.

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