



CHALMERS
UNIVERSITY OF TECHNOLOGY

NAVIGATING BARRIERS AND OPPORTUNITIES

THE FUTURE OF BREAKBULK SHIPPING IN
KRISTINEHAMN POST-TROLLHÄTTE CANAL LOCKS
UPGRADES

Master's thesis in Shipping and Marine Technology

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Abstract

Historically, Sweden's inland waterways have been critical for heavy transport of goods. However, the goods flow on lake Vänern has declined gradually since the 1990s. Sweden's geographical layout possesses great potential for utilizing inland transport with coastal ports in Sweden and around Europe. This thesis investigates the impact of the Trollhätte canal locks upgrades on breakbulk cargo shipping in Kristinehamn, focusing on the potential transformation of Sweden's inland waterways as a viable mode of freight transport. The study utilizes a qualitative case study methodology, employing semi-structured interviews with key stakeholders in the maritime and logistics sectors to explore potential barriers and the possible effects of the new locks in the Trollhätte canal.

Significant findings suggest that the lock upgrades will likely enhance vessel capacity and operational efficiency, thereby promoting Kristinehamn as a strategic hub. Economically, the upgrades are projected to attract more industrial activities to the region and potentially reduce transportation costs due to increased cargo volumes. Multiple challenges within the shipping of breakbulk to and from Kristinehamn were found. High operational costs, unjust competitiveness against other modes of transport, infrastructural limitations, and regulatory complexity. These barriers inhibit the competitiveness of the breakbulk goods flow.

Keywords: Breakbulk Shipping, Port of Kristinehamn, Trollhätte Canal, Lock Upgrades, Inland Waterway Transport, Shipping Barriers

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List of Abbreviations

AI – Artificial Intelligence

IWT – Inland Waterway Transport

MSP – Modal Shift Potential

PPI – Port Performance Indicator

RIS – River Information Services

SSS – Short Sea Shipping

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1 Introduction

The introduction chapter presents background information regarding the transportation of breakbulk cargo via inland waterways in Sweden and its barriers today, as well as focuses on the Trollhätte canal locks upgrades and their possible impact on Kristinehamn. Additionally, the introduction outlines the case description, purpose, research questions, as well as scope and delimitations of the study.

1.1 Background

From the 17th century to the late 19th century, Sweden's inland waterways were crucial for transporting heavy goods, forming the backbone of the nation's industrial and commercial sectors. The emergence of railways and trucking in the 1860s began a shift, challenging canal transport's dominance (Gunnarson, 1997). The following decades saw a continued shift towards rail and road transport, affecting the economic viability of canal companies (Gunnarson, 1997). Yet, the Vänern route's volume increased with industrial society's growth in the 1950s and 60s, peaking in the mid-1970s when the canal opened for year-round traffic. Despite a stable period in the 1980s and early 90s, volumes have gradually declined to today's levels, from 3.5 million tons in 1990 to 1.6 million in 2015 (Persson & Vuorenmaa Berdica, 2017).

Sweden's maritime landscape offers significant opportunities for optimizing cargo transport by linking inland ports with coastal ports and their European counterparts, enhancing nearshore logistics (Garberg, 2016). Research indicates a crucial role for inland waterways in North-western Europe, with these routes handling 42% of the modal shift potential (MSP) for non-containerized goods in 2018, highlighting their potential to decrease road transport dependence (Jonkeren et al., 2023). Future projections maintain the importance of these waterways, suggesting they could significantly lower transportation costs due to reduced external and infrastructure expenses compared to road transport, despite possible increases in costs related to air pollution (Jonkeren et al., 2023).

The problem central to this thesis concerns the current inefficiencies and limited capacity of the waterway system, impaired by outdated infrastructure that hinders the competitiveness of breakbulk shipping. These inefficiencies are significant as they not only impact the local economy but also contribute to broader environmental concerns by pushing freight to more carbon-intensive transport modes like trucking (Domagała & Kadłubek, 2022).

This thesis focuses on the Port of Kristinehamn in the lake Vänern region. A major part of inland waterways in Sweden is lake Vänern and the canal to reach there, known as Trollhätte canal. The anticipated upgrades to the Trollhätte canal locks represent a pivotal development that could transform the logistic landscape in the region by enabling the passage of larger vessels and therefore, improving the overall effectiveness and appeal of inland waterway transport (IWT). This research aims to outline the existing barriers to effective maritime operations in Kristinehamn and to assess the transformative impact of the new locks.

A pivotal point in Sweden's inland shipping infrastructure are the locks in Trollhätte canal. Currently, these locks accommodate vessels within specific size limits. The vessels must adhere to measurements of up to 89 meters in length, 13.4 meters in width, and a maximum draft of 5.4 meters (Trafikverket, 2024a). Anticipating the end of their technical lifespan by 2030, new, larger locks have been approved. These new locks are set to accommodate vessels up to 110 meters in length and 16.5 meters in width while maintaining the same maximum draft. This impending development holds the potential to transform the dynamics of inland shipping in the region (Trafikverket, 2024a).

1.2 Purpose

The primary aim of this research is to delve into the nuances of breakbulk shipping operations to and from the port of Kristinehamn in lake Vänern. The study seeks to comprehensively examine the possible barriers impeding efficient inland shipping operations in the region and to analyze the potentially transformative impact of the newly approved locks in Trollhätte canal on breakbulk shipping dynamics. By identifying and understanding these barriers, ranging from logistical constraints to infrastructural limitations and regulatory hurdles, the study aims to offer valuable insights into the complexity of breakbulk cargo transportation within inland waterway shipping.

Furthermore, assessing the anticipated changes in vessel size limitations, and operational efficiencies following the new locks, the study intends to provide stakeholders with a nuanced understanding of the future potential of breakbulk shipping in the region. Overall, this research attempts to contribute to the scholarly discourse surrounding breakbulk shipping and IWT, particularly within the context of Sweden's maritime infrastructure.

1.3 Research Questions

What challenges with shipping breakbulk cargo to and from Kristinehamn exist today?

How will the new locks in Trollhätte canal affect the breakbulk shipping to and from the port of Kristinehamn?

1.4 Limitations and Delimitations

In terms of delimitations, this research focuses on the breakbulk shipping segment and does not study other modes of shipping. While the thesis acknowledges the broader implications of modal shift policies and trends in freight transport within North-western Europe, it primarily examines their relevance to breakbulk shipping operations to and from the port of Kristinehamn. The analysis of the potential impact of the new locks in Trollhätte canal is based on projected future outcomes and does therefore include a factor of uncertainty. The research does not extend to detailed technical aspects of lock construction or engineering considerations beyond their implications for breakbulk shipping operations. While the study aims to provide valuable insights into the challenges and opportunities of breakbulk shipping, it does not propose specific policy or infrastructure development plans.

Additionally, this research focuses on breakbulk shipping operations involving vessels traveling to and from the port of Kristinehamn in lake Vänern. It explores the challenges and opportunities associated with breakbulk cargo transportation in the port of Kristinehamn. The study emphasizes the direct trade relationships between Kristinehamn and other European ports and does not include feeder traffic. This approach enables a comprehensive examination of the complexities involved in breakbulk shipping within the specific context of Kristinehamn's maritime trade network. The study's focus will not be on any fairway limitations, however it is a crucial part of the development of shipping to and from lake Vänern. The new max size for vessels in the locks is approved however future developments in the fairway to meet these new standards are under investigation.

2 Frame of Reference

This chapter presents a comprehensive literature review relevant to this study, with the purpose of creating an in-depth explanation of the subject with support of previous studies.

2.1 The Breakbulk Concept

Notteboom's (2020) examination of the breakbulk sector reveals its evolution from a general cargo essential to trade history into a specialized niche in the face of containerization's dominance. Historically, breakbulk cargo, shipped as individual or bundled pieces without containerization, was fundamental to global trade. This method, prevailing the container era, involved a labor-intensive and time-consuming process of loading and unloading diverse cargoes, including bulk and liquid bulk, in mixed shipments (Notteboom et al., 2020).

The transition from the pre-container era's reliance on manual labor, known as the man load concept, to the unit load system marked a significant shift. This evolution, beginning in the 1950s, saw ports adapting to handle bulk commodities and general cargo more efficiently through specialized vessels and terminal equipment (Notteboom et al., 2020). In 1956 containerization revolutionized cargo transport, offering standardization, reduced handling times, and a liner system that replaced the traditional tramp trade. This shift not only streamlined operations but also catalyzed a move towards specialized and highly segmented breakbulk sectors for cargoes unsuitable for containerization (Notteboom et al., 2020).

Despite the universal influence of containerization, the breakbulk market persists, specializing in cargoes too challenging for containers (Notteboom et al., 2020). This sector now efficiently moves a wide range of goods, from heavy industrial equipment to palletized cargo, employing specialized vessels like heavy-lift ships and employing innovative loading techniques to handle oversized items (Notteboom et al., 2020).

The breakbulk fleet has adapted to these changes, with newer vessels offering increased lifting capacity and versatility (Notteboom et al., 2020). Different segments of the breakbulk market, including project cargo, steel, and forest products, have seen varying impacts from technological advancements and market trends. Examples of this have been project cargoes benefiting from the specialized capabilities of modern vessels, and the steel and forest products sectors by global trade dynamics and environmental policies (Notteboom et al., 2020).

Moreover, the logistics and operational aspects of breakbulk shipping have evolved, with increased reliance on skilled labor for handling specialized cargoes and the use of advanced equipment for loading and unloading (Notteboom et al., 2020). The sector has also witnessed significant developments in terms of environmental performance, consolidation, and logistics integration, affecting the competitiveness of ports and terminals (Notteboom et al., 2020).

The existing literature highlights several key aspects relevant to the complexity of breakbulk cargo transportation. Firstly, the infrastructural attributes of inland waterways, such as lock and canal dimensions, critically determine the size and type of vessels that can be utilized (Wiegmans Bart & Konings Rob, 2017). This directly impacts the efficiency and cost-effectiveness of breakbulk cargo transportation. Secondly, the integration of IWT into broader logistic chains is crucial for optimizing supply chain management and ensuring seamless multimodal transportation solutions (Platz, 2009).

2.2 Impact and Adaptation Strategies in Transport Logistics

The expected impact of climate change on IWT, including lower water levels and increased transport costs, underscores the need for adaptable and resilient transport strategies (Jonkeren et al., 2014). These considerations are crucial for assessing the future viability and efficiency of breakbulk shipping routes that rely on inland waterways. The adaptation and measures show the potential shift towards alternative transport modes and highlight the importance of flexibility in the face of environmental changes (Jonkeren et al., 2014).

The study by Munim and Schramm (2018) underscores the pivotal role of port infrastructure quality and logistics performance in promoting economic growth through seaborne trade enhancement. Their analysis, spanning 91 countries, reveals that improvements in port infrastructure directly contribute to increased trade volumes, which in turn stimulate economic development (Munim & Schramm, 2018). This relationship is particularly pronounced in regions where port enhancements facilitate more efficient logistics chains, underscoring the critical economic benefits of such investments (Munim & Schramm, 2018).

The study by Paulauskas et al. (2022) found that integrating road transport with rail and IWT, including "last mile" solutions, significantly enhances the efficiency and sustainability of cargo transportation from ports to regional destinations. The term "last mile" refers to the final segment of a transportation network where goods are delivered to their destination. This phase is often considered the most challenging and expensive part of the shipping process. This approach minimizes energy consumption and environmental impact, advocating for a multi-

modal transportation system as a viable solution for optimizing logistics and reducing costs associated with freight movement (Paulauskas et al., 2022). The findings underscore the importance of strategic planning in transport infrastructure to accommodate diverse modes of transport, aligning with sustainability goals.

Hossain et al. (2019) outline a comprehensive study on the development and application of a novel dimensionless metric known as the Port Performance Indicator (PPI) for assessing port performance. The key findings from the study highlight the creation of a model to evaluate PPI, the identification of six main determinants of port performance, the testing and validation of the model, and the efficiency of Bayesian Networks in managing uncertainties related to port performance. Specifically, the study found that while all identified factors significantly impact the PPI, port service emerged as the most critical element, suggesting that port management should focus on service improvements to enhance overall port performance (Hossain et al., 2019). This study offers valuable insights for stakeholders in port supply chain and infrastructure management, emphasizing the importance of a structured approach for measuring and comparing the port performance under various conditions (Hossain et al., 2019).

Domagala and Kadlubek (2022) provide a comparative perspective on the environmental and economic performance of different transport modes. Highlighting the significant energy consumption and greenhouse gas emissions of road transport and underscores the necessity of integrating more sustainable, low-carbon solutions within the transport sector. These findings reinforce the importance of considering alternative, more eco-efficient transport modes for increasing urbanization and trade (Domagała & Kadłubek, 2022).

The research by Santén et al. (2021) underscores the strategic prioritization of modal shifts from road to IWT within the European Union and its member states. By highlighting the potential for significant reductions in greenhouse gas emissions, congestion, and urban pollution. The study defines the underutilization of IWT due to competitive pressures from road transport and outlines key actions for stakeholders to facilitate a successful modal shift (Santén et al., 2021). These actions encompass understanding current situations, identifying potential solutions, testing these solutions, and promoting them to relevant stakeholders.

The findings from Santén et al. (2021) are instrumental in formulating strategies that not only advocate for a modal shift but also for the integration of such shifts within the broader logistics and transportation planning efforts in Sweden. This includes recognizing the

importance of multi-actor engagement and the readiness to adapt to emergent solutions, which are crucial for navigating the logistical, infrastructural, and regulatory complexities in optimizing breakbulk cargo transportation (Santén et al., 2021). The study emphasizes a structured yet flexible approach to stakeholder involvement, as well as solution promotion and the need for comprehensive planning and policy support (Santén et al., 2021).

2.3 Modal Shift in Freight Transport

IWT has long been a foundation for efficient cargo movement, offering financial and environmental advantages over other transport modes (Wu et al., 2014). Historically, inland waterways have been critical for trade and economic development, providing a less costly and more sustainable mode of transporting goods (Wu et al., 2014).

The modal shift from road to rail and inland waterways in freight transport offers a compelling economic proposition, especially within specific corridors in North-western Europe (Jonkeren et al., 2023). Jonkeren's et al. (2023) study reveals that a substantial portion of goods currently transported by road could achieve cost reductions of at least 10% if shifted to rail or inland waterways. This MSP, ranging from 35% to 55% depending on the transport segment and timeframe, underscores the competitive advantage of rail and inland waterways over road transport within these corridors. Such shifts not only promise economic benefits but also align with broader sustainability objectives by mitigating various external costs associated with road transport, including emissions from fuel production and vehicle operation (Jonkeren et al., 2023).

The comparative analysis of external and infrastructure costs per transport performance highlights the cost-effectiveness of rail and IWT over road transport (Jonkeren et al., 2023). By focusing on the MSPs, it is estimated that realizing these shifts could lead to significant annual savings in both external costs and infrastructure wear and tear, amounting to millions of euros. These findings advocate for the efficiency of policy interventions aimed at promoting modal shifts, potentially yielding substantial economic and environmental benefits (Jonkeren et al., 2023).

The European Union's focus on sustainable mobility and the decarbonization of transport by 2050 highlights the critical role of IWT (Grzelakowski, 2019). Despite its potential for low-carbon logistics, IWT faces competitive challenges due to globalization and technological advancements. The situation of IWT, including its integration into efficient and sustainable

logistics chains, is crucial for understanding the broader context of breakbulk shipping, especially in light of new infrastructure developments (Grzelakowski, 2019).

Another research highlights how government policies in Serbia have successfully promoted the adoption of IWT, underscoring its viability as a sustainable option for enhancing urban mobility and trade within Europe (Mihic et al., 2011). The study also points to the significant challenges faced by IWT, such as the impact of climate change on water levels in Belgium, which poses risks to cargo capacity and transportation costs (Hendrickx & Breemersch, 2012). The research further explores the importance of adequate infrastructure and investment, as seen in Japan and France, where rail and river transport emerge as promising solutions for urban logistics (Diziain et al., 2014).

Moreover, findings from Poland highlight local authorities' initiatives to support IWT development, such as the National Program for IWT and the establishment of a dedicated agency, emphasizing the need for public-private cooperation (Grzelakowski, 2019). Similarly, the study underscores the role of IWT in Brazil as a sustainable mobility solution that contributes to reduced traffic congestion, noise, and environmental pollution (Tobias et al., 2019). In Holland, the transportation of perishable food products via IWT has led to a decrease in CO₂ emissions and road congestion, although challenges such as infrastructure development and high initial costs remain (Nepveu & Nepveu, 2020).

Key strategic factors identified for the implementation of such systems include user- and operator characteristics and behavior, investment in infrastructure, regulation and taxation, and government involvement (Pratas et al., 2023). The research underscores the necessity for further investigation in infrastructure and strategic planning, particularly in developing efficient routing strategies that consider navigability, vessel capacity, traffic management, and transshipment locations. Additionally, the study emphasizes the importance of intermodality and the integration of waterway transportation into the broader multimodal network (Pratas et al., 2023). It suggests that enhancing connectivity and information sharing between different transport modes could significantly improve the efficiency and attractiveness of waterway transportation within the urban ecosystem (Pratas et al., 2023).

An article written by Sys et al (2020) delves into the multifaceted challenges and potential strategies for enhancing the sustainability and efficiency of European IWT. It outlines a holistic approach to revitalizing the sector, emphasizing not just immediate economic concerns but also long-term sustainability, technological innovation, and regulatory

adaptation. The analysis reveals critical insights into how the IWT sector can navigate its current challenges, such as overcapacity and fluctuating freight rates, through a combination of technological advancements, operational improvements, and strategic industry-wide collaborations (Sys et al., 2020). The research suggests that addressing the fragmentation within the industry both in terms of operations and economic models is vital for creating a more cohesive and resilient sector. Sys et al. (2020) advocate for encouraging stronger cooperation among IWT stakeholders and related sectors to unlock synergies and enhance the overall competitiveness of IWT. Such collaboration could also extend to shared initiatives for technological innovation, aiming at both ecological sustainability and operational efficiency (Sys et al., 2020).

Regulatory frameworks are identified as a pivotal area for reform, with a call for more dynamic and forward-looking policies that can adapt to the evolving needs of the IWT sector and support its sustainable development (Sys et al., 2020). This includes not only environmental regulations but also safety standards, operational guidelines, and market regulations that encourage innovation while ensuring fair competition (Sys et al., 2020).

The article provides a comprehensive roadmap for the sustainable evolution of the European inland water transport sector, highlighting the importance of innovation, collaboration, and regulatory flexibility in overcoming current challenges and capitalizing on future opportunities (Sys et al., 2020).

2.4 Technological Advancements

The introduction of automation in cargo loading/unloading processes signifies a transformative shift towards enhancing operational efficiency and safety within breakbulk shipping operations (Carlan et al., 2023). In the article by Carlan et al. (2023) the adoption of unmanned technologies is set to streamline operations. This technological evolution aligns with the broader objectives of increasing a port's capacity and adaptability to handle larger cargo volumes efficiently (Carlan et al., 2023).

Lambrou et al. (2019) write in their article that digital solutions in breakbulk shipping are poised to increase visibility, efficiency, and coordination across the logistical chain. This digital transformation is instrumental in ensuring competitiveness and responsiveness to the evolving demands of maritime transport and logistics (Lambrou et al., 2019).

The study by Durajczyk and Drop (2021) offers significant insights into enhancing the efficiency of urban and interurban freight transport through the use of inland waterways and the River Information Services (RIS) system. Their findings suggest that inland navigation, when supported by advanced information systems like RIS, can serve as an effective, cost-efficient, and environmentally friendly alternative to conventional road transport. This approach addresses the logistical complexities associated with cargo transportation and also aligns it with sustainable logistics practices (Durajczyk & Drop, 2021). The adoption of the RIS exemplifies how digital tools can significantly improve the efficiency of urban and interurban freight transport by facilitating better communication and information exchange among stakeholders (Durajczyk & Drop, 2021).

The potential of digitalization in the IWT sector extends to the optimization of logistics and supply chains, as highlighted by the review conducted on integrating IWT into the intermodal supply chain (Caris et al., 2014). The systematic identification of research challenges and technological trends reveals a growing emphasis on employing digital solutions to address logistical constraints and enhance the competitiveness of IWT (Caris et al., 2014). Supported by initiatives such as the European Commission's project Digital Inland Waterway Area, (DINA) for investigating the digitalization of IWT, underscores the sector's move towards modern, innovative, and efficient freight transport systems (Fumuso, 2019).

2.5 Trollhätte Canal

Trollhätte canal stretches 82 kilometers long, 10 km of which are artificially made, while the rest is part of Göta river. Along the canal twelve bridges cross, while three of them are fixed bridges (Sjöfartsverket, 2023). The total height difference for the canal is 44 meters, this is managed by the six locks along the canal. One in Lilla Edet, four in Trollhättan, and one more in Brinkebergskulle (Vänernsborg) (Sjöfartsverket, 2023). The maximum allowed vessel size in the locks today is 87 x 12,7 x 4,7 meters. This can be increased up to 89 x 13,4 x 5,4 meters with special permission from the Swedish Maritime Administration (Sjöfartsverket, 2023).

The shallowest water depth in the fairway of Trollhätte canal is 6.3 meters, at the lowest water level. The lowest water depth in the locks is 5.7 meters (Sjöfartsverket, 2023). The lowest fixed bridge is Stallbackabron which has a sailing clearance of 28 meters. The lowest point for power cables crossing the canal is 27 meters above the water level (Sjöfartsverket, 2023).

The locks in Trollhättan, Lilla Edet, and Vänersborg will by 2030 exceed their technical lifespan. Renovating them up to standard is deemed too complicated and they will instead be replaced (Trafikverket, 2024a). The Swedish Maritime Administration oversees maintenance of the locks today, until the new locks are in place. Building of the new locks will be a collaboration between Trafikverket, and the Swedish Maritime Administration. By increasing the locks to 125 meters in length and 18 meters in width the locks will be safer, more efficient, and have less impact on the environment since fewer vessels can transport the same amount of cargo as today (Trafikverket, 2024a). The new locks will be able to fit vessels of a size of 110 x 16.5 meters, the depth of the locks will be the same as today. By increasing the size of the locks Trafikverket hopes not only to make it safer and more efficient but to continue the development of shipping to and from lake Vänern (Trafikverket, 2024a).

Only the locks will be upgraded to meet the new vessel sizes, the rest of the canal and fairway, including the fairways to the ports, will not be improved to match the new measurements. No decision has been made concerning these upgrades for the future, it is part of an ongoing investigation according to B. Garberg at Trafikverket (personal communication, 15/2-2024).

The total cost for all new locks in Trollhättan, Lilla Edet, and Vänersborg is estimated to be 6.1bn SEK, calculated from 2021's price level (Trafikverket, 2024a). The new locks will be built in different locations from the present locks so the shipping and tourism will be able to continue while the new locks are being built. The locations for the locks in Trollhättan have been settled, but for Lilla Edet and Vänersborg a decision for exact locations have not been made yet. (Trafikverket, 2024a)

The ongoing development plans for new locks in Trollhättan, have settled on the Nord alternative, marking a significant step in the upgrade of Sweden's inland waterway infrastructure (Trafikverket, 2024b). A detailed investigation has been made, both on land and within the Göta älv. The aim of the investigation is, to thoroughly assess the conditions for the construction of the new locks, including the examination of soil for clay or contaminants and evaluating the rock's condition (Trafikverket, 2024b). This detailed investigation ensures the project's feasibility and environmental safety.

The decision to proceed with the Nord alternative was made after compiling feedback from a consultation period in Autumn 2023 (Trafikverket, 2024b). This alternative spans approximately 2.3 kilometers, connecting Göta älv and Bergkanalen north of Västergärdet,

and ties into the existing fairway at Olidebron in the east and out to Göta älv in the west. It includes significant engineering efforts, such as widening the passage from Olidebron to Klaffbron and establishing a new meeting point for ships east of the lock staircase, facilitating smoother navigation in Göta älv (Trafikverket, 2024b). The construction period is estimated to last about five years and may require the acquisition of around five residences to accommodate the new infrastructure (Trafikverket, 2024b). Importantly, the Nord alternative will pass through the “Älvrummet” a nature reserve and impacts areas of high natural value while doing so (Trafikverket, 2024b). It will also affect the national interest for cultural environment near Västergårdet and the northern part of Bergkanalen, which are a part of the national monument. Despite these challenges, the Nord alternative promises a 25% reduction in climate impact and a 30% lower energy use during construction compared to the Syd alternative, it will also align with broader environmental and sustainability goals (Trafikverket, 2024b). With an estimated cost of around 3.1bn SEK, this initiative represents a significant investment in Sweden's maritime infrastructure, aiming to enhance the efficiency and sustainability of IWT while carefully considering environmental and cultural impacts (Trafikverket, 2024b).

2.6 Vänerhamn AB

Shipping in lake Vänern has been a crucial part for the regional commercial sector spanning over centuries, providing transport options for goods worldwide (Vänerhamn AB, 2024).

Vänerhamn AB founded in 1994 is a major port operator in lake Vänern, handling an annual goods volume of approximately 3 million tons (Vänerhamn AB, 2024). The company operates through five inland terminals located in the middle of Sweden. Its facilities are found in Vänersborg, Lidköping, Otterbäcken, Kristinehamn, and Karlstad, with additional operations in Hällekis, Gruvön, Trollhättan, and Åmål. Vänerhamn AB infrastructure includes sea transport, rail and road integration (Vänerhamn AB, 2024).

Their core business involves the transportation and handling of goods, offering services such as forwarding, clearing, combined transports, sorting, processing, packaging, and storage.

Vänerhamn AB is also a co-owner of Vänerexpressen, a rail service for containerized goods, offering regular departures to the Port of Gothenburg (Vänerhamn AB, 2024). Additionally, the marine department of the company provides operations services such as icebreaking, towing, and marking of navigational canals to keep the ports accessible all year round (Vänerhamn AB, 2024).

2.7 The Port of Kristinehamn

The port of Kristinehamn is a part of the Vänerhamn AB business concern. The current stage of the port according to an action plan done by Kristinehamns municipality states that the overall condition of the infrastructure varies (Kristinehamns kommun, 2023). The jetties and ground areas are old and few projects investing in the infrastructure have been done over the last few years. Inspections show that only some parts of the areas can withstand heavy weights of four tons per square meter. Some areas are limited to two tons per square meter resulting in a less efficient goods handling capacity (Kristinehamns kommun, 2023). Due to the limitations found during the inspections, additional inspections and a management plan have been made. If the plan is followed and continuous inspections are completed in vulnerable areas the operations are thought to be able to continue for a minimum of 10 years (Kristinehamns kommun, 2023).

To ensure the continuous use of the port of Kristinehamn as a logistics hub and adapt the facilities for the future, investments are required. In the action plan by Kristinehamns municipality, two scenarios are presented: The first scenario entails the necessary steps and investment needed to ensure continuous use of the port with the same amount of goods and vessel sizes as today, improving the intermodal capabilities and sustainability profile. This set of investments will ensure continuous operation for 10-15 years (Kristinehamns kommun, 2023).

The second scenario includes the completion of the new locks in Trollhätte canal and therefore an increase in goods and larger vessels will pass to and from the port, increasing requirements in the port. In the action plan, the municipality estimates a cost for investments required to meet these changes of 300 million SEK. Included in these investment costs is the introduction of container handling (Kristinehamns kommun, 2023).

According to Vänerhamn AB's ownership deeds the company is to be considered a municipal company and will need to act as such when planning investments for the future (Kristinehamns kommun, 2023). Making sure the investments made also will be covered.

The Kristinehamn terminal, managed by Vänerhamn AB, stands out as one of the largest facilities focusing on the handling of general cargo, bulk goods, and timber products. It is equipped for stevedoring, forwarding, and customs clearance activities (Vänerhamn AB, 2024).

This terminal includes a storage space of 21,000 square meters and an additional outdoor storage area of 96,000 square meters (Vänerhamn AB, 2024). The terminal is equipped with various machinery, including four rail-mounted cranes, one stationary crane, and two mobile cranes, with the capability to lift up to 42 tons. Included in the infrastructure is two kilometers of railway tracks (Vänerhamn AB, 2024). For the movement and management of goods within the terminal, a fleet of forklifts, loaders, and skid steer loaders (bobcats) are available. An icebreaking tugboat is part of the terminal's assets, to keep the terminal operational regardless of ice conditions (Vänerhamn AB, 2024).

Figure 1 and Figure 2 below include the data from Vänerhamn AB (personal communication, 4/4-2024) showing the number of port calls and type of cargo:

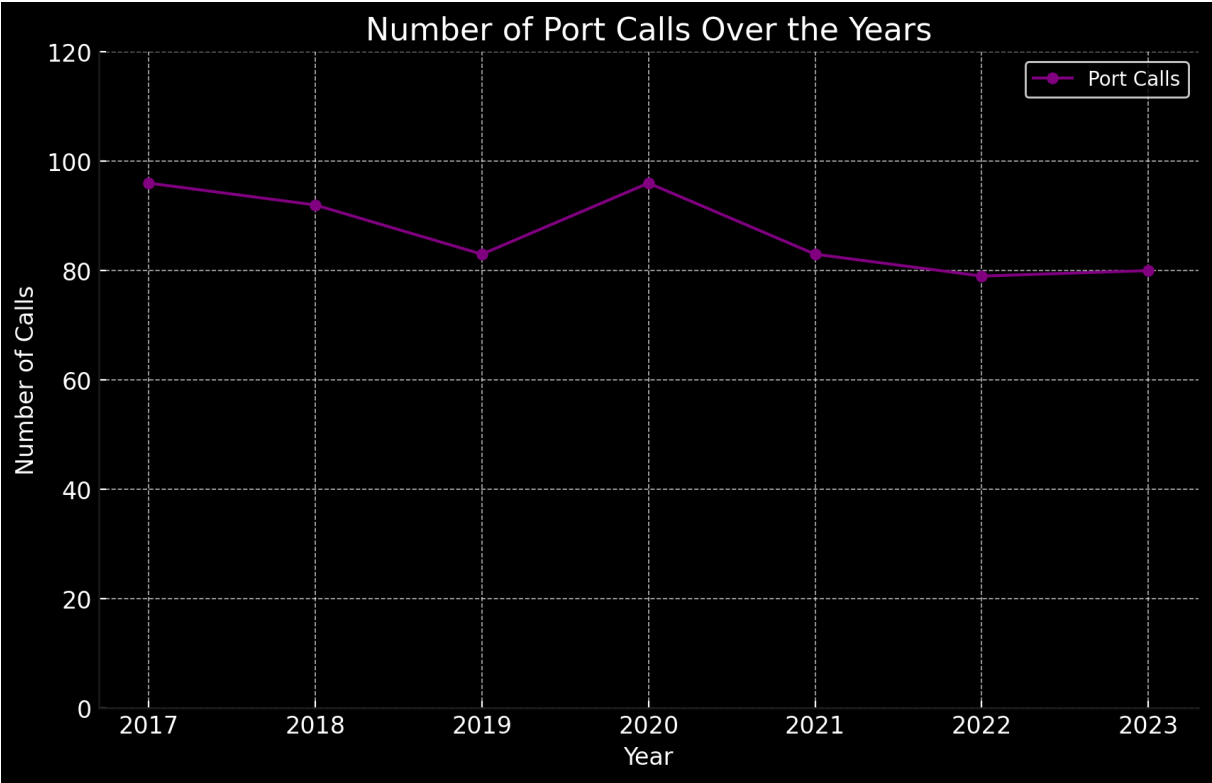


Figure 1 Number of Port Calls Over the Years Vänerhamn AB (Personal communication, 4/4-2024)

The graph shows the number of port calls in Kristinehamn from 2017 to 2023. In 2017, there were just over 90 port calls. This number slightly decreased to just below 90 in 2018, then dropped to around 75 in 2019, the lowest point. In 2020, port calls peaked at about 95. There was a decrease to around 80 in 2021, and it fell slightly below 80 in 2022. By 2023, the number rose again to approximately 80. Overall, the port calls fluctuated between 75 and 95 during these years Vänerhamn AB (personal communication, 4/4-2024).

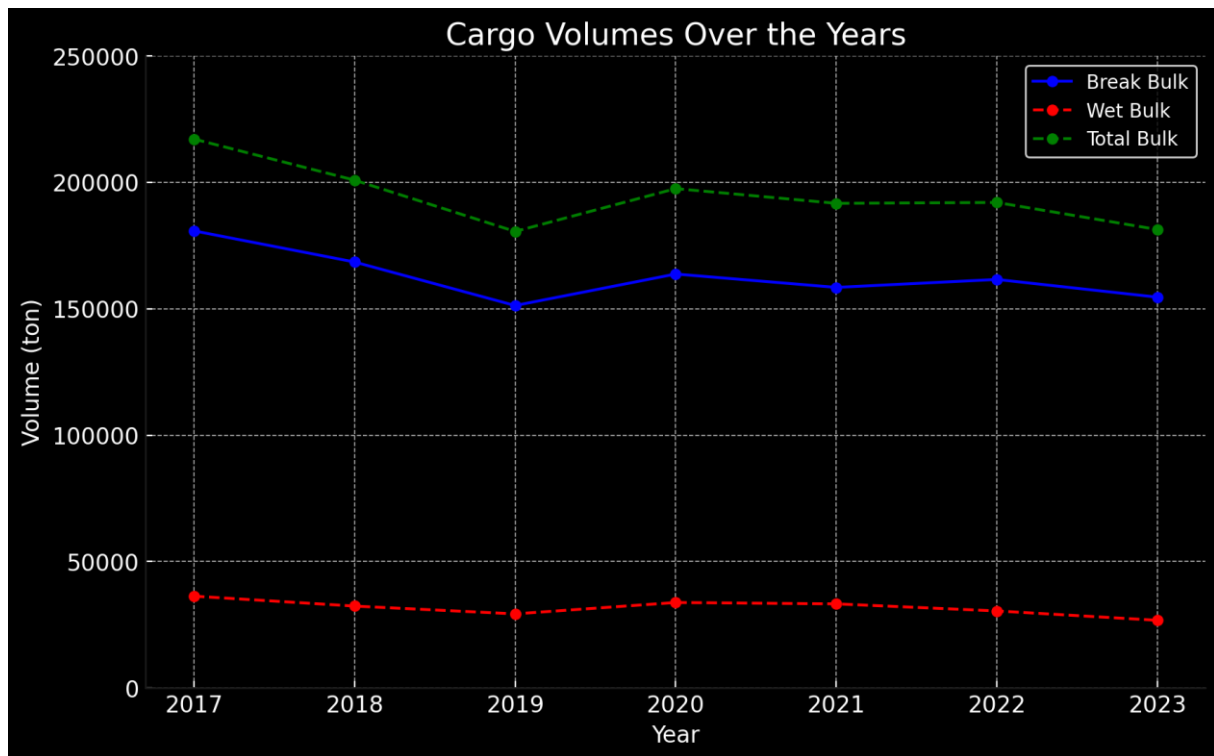


Figure 2 Cargo Volumes Over the Years Vänerhamn AB (Personal communication, 4/4-2024)

In 2017, the port of Kristinehamn managed 180,800 tons of breakbulk cargo. A gradual decline was observed over the next two years, with volumes dropping to 168,500 tons in 2018 and further to 151,300 tons by 2019. However, 2020 marked a turning point, as volumes increased to 163,700 tons. Despite a minor dip to 158,500 tons in 2021, there was a subsequent rise to 161,600 tons in 2022. Yet, the trend did not hold, as 2023 witnessed a slight decrease in breakbulk cargo handling to 154,600 tons by Vänerhamn AB (personal communication, 4/4-2024).

2.8 Policy

The rules and regulations applicable to each vessel depend in general on the area they operate in. A vessel can be certified for shipping internationally as well as nationally or for inland waterways, depending on which, different rules apply to the vessel (Garberg, et al., 2019)

Regulations for shipping on inland waterways were adopted in Sweden in the year 2014. They include a technical directive for the vessels operating on the inland waterways. At the same time, the following areas: The Port of Gothenburg, Göta älv, and lake Vänern as well as lake Mälaran, Södertälje, and Stockholm were classified as inland waterways (Garberg, et al., 2019). These directives are for the most part enforced by the Swedish Transport Agency's regulations and guidelines (Transportstyrelsens Författningssamling 2014:96) later replaced

by (Transportstyrelsens Författningssamling 2018:60). Vessels operating in these areas have less strict design requirements and can therefore, in general, be of simpler construction and by this also cost less to run (Garberg, et al., 2019).

Apart from the regulations mentioned for vessels operating in these areas, they will need to adhere to some of the other rules applicable to global shipping. The rules applicable to each vessel are complex and Trafikverket has made a proposal to clarify this (Garberg, et al., 2019).

This above-mentioned proposal is a part of the 62-step action plan to strengthen the national and short-sea shipping (SSS) made by Trafikverket. The action plan is a part of the mission statement given by the Swedish government to appoint a national coordinator for national and SSS (Berglund, 2019).

Each year Trafikverket presents an update on the 62-step action plan. Table 1 includes a short description and the status of a few of these steps relevant to this study (Garberg, 2023).

Proposal	Description	Status
Proposal 29	The Swedish Transport Agency will work with simplifying rules for vessel registration and one-stop-shop.	One-stop-shop part completed, simplifying rules still ongoing.
Proposal 35	The Swedish Maritime Administration will investigate the possibility of reducing and digitalizing reporting for national transportation.	Completed for Maritime Single Window reporting; overall problem may persist.
Proposal 54	Trafikverket and the Swedish Maritime Administration will investigate the possibilities for a traffic-crossing information-sharing system for inland waterways.	Ongoing, focused on Göta älv and lake Vänern. A pilot study completed. Internal discussions at Trafikverket continue.
Proposal 56	The Swedish Transport Agency will make distinct information readily available concerning applicable rules for shipping in inland waterways.	Divided into four steps: 1) Overall description (ongoing), 2) Cost description (ongoing), 3) Detailed digital description (postponed), 4) Assessment of barriers and improvements (postponed).
Proposal 57	Trafikverket will make an overall comparison between the Swedish and European rules for inland waterways.	Ongoing; a thesis from 2023 is used as the base for completion.
Proposal 58	Trafikverket, The Swedish Transport Agency, and the Swedish Maritime Administration will investigate if the rules for shipping work well or if new rules specifically for barges are necessary.	Ongoing; current rules deemed sufficient but adjustments may be needed. Fee reduction collaboration made.

Table 1 *Trafikverket proposals composed by authors - 62 step plan* (Garberg, 2023)

2.8.1 Classification of Swedish Inland Waterways

Vessels built to operate in the inland waterways can only do so in the zone specified in their certificate. The inland waterways of Sweden are split into four zones: 1, -2, -3 and -4. The zones are divided by the significant wave height, where 1 has the largest wave height and 4 the smallest. The significant wave height definition for the zones is as following: The average height of 10% of the highest waves measured in the area, measured from the wave crest to the wave trough (Transportstyrelsen, 2023). Only in these areas it is allowed to operate vessels

certified for inland waterways. The Swedish Transport Authority is analyzing other coastal areas, potentially resulting in more inland waterways. (Transportstyrelsen, 2023)

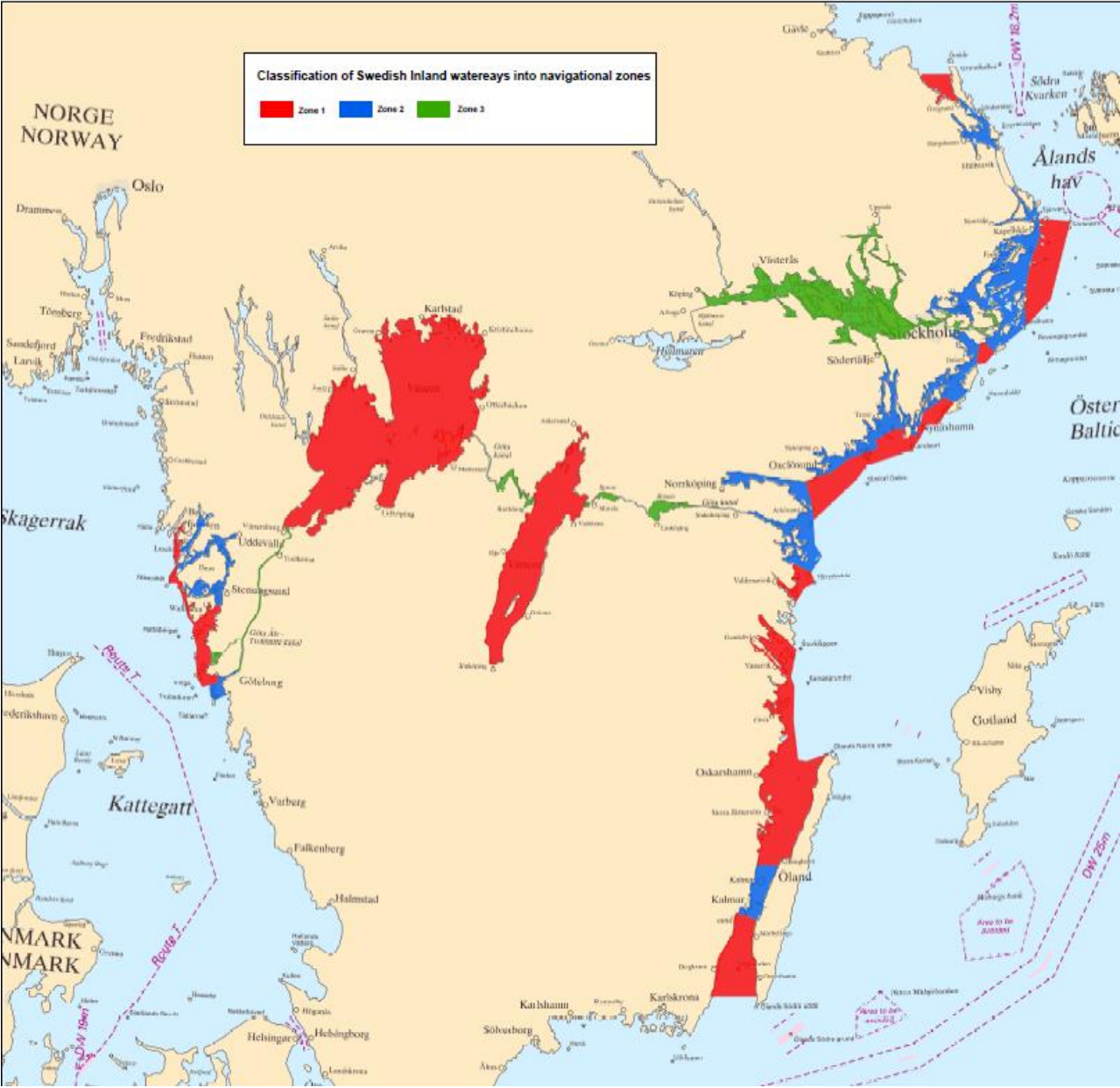


Figure 3 Classification of Swedish Inland waterways into navigational zones (Transportstyrelsen, 2023)

2.8.2 Pilotage and Fairway Fees

The fees for navigating through Trollhätte canal to lake Vänern are listed in the 2024 price list for fairway dues and pilotage charges (Sjöfartsverket, 2024). These fees vary based on several factors, including the ship's environmental class (A, B, C, D/E), its draft class, and the number of calls made to ports.

The fairway dues range varies significantly, for each class. The lowest being 335 SEK for gross tonnage class 1 and environmental class A. The highest being 217,525 SEK for class 10 and environmental class D/E. There is an additional readiness charge that varies similarly, starting from 100 SEK per call for Class 1 and environmental class A, to 65,055 SEK for Class 10, environmental class D/E (Sjöfartsverket, 2024).

Included in the pilotage fee is a starting fee as well as a variable pilotage fee charged per half hour. The starting fee ranges from 6,115 SEK to 28,725 SEK from the lowest to the highest draft class. The variable fee for each half-hour ranges from 1,865 SEK to 8,880 SEK again depending on the draft. There are additional charges for booking of the pilot, and a 30% discount available for passages through Trollhätte canal and lake Vänern as well as other discounts for long pilotage exceeding 7 hours (Sjöfartsverket, 2024).

Additional charges are applied for goods and passengers: High-value goods (3,06 SEK/ton), low-value goods (1,52 SEK/ton), passengers (2,30 SEK/person), and private vehicles (3,06 SEK/unit) (Sjöfartsverket, 2024).

Vessels will receive a discount on the readiness fee when calling ports multiple times per month, after calling five times the readiness fee will be reduced to 0% for each call. As an example, the fourth call will be reduced by 50% (Sjöfartsverket, 2024).

Environmental incentives offer reductions in dues based on the Clean Shipping Index CSI classification of the vessel, ranging from 90% - 0% depending on the class.

A temporary 15% discount is applied on the total fairway dues as a part of the climate compensation for the year 2024 (Sjöfartsverket, 2024).

These fees and charges cover about 73% of the funding for the Swedish Maritime Administration. The Swedish Maritime Administration is tasked with ensuring a safe and accessible infrastructure for shipping in Sweden and the fees and dues contributes a large part in this (Sjöfartsverket, 2024).

Table 2 Fairway fees 2024 (Sjöfartsverket, 2024)

The Swedish Maritime Administrations fairway fees from 2024-01-01

Net tonnage class	Lowest net tonnage
1	0
2	1 000
3	2 000
4	3 000
5	6 000
6	10 000
7	15 000
8	30 000
9	60 000
10	100 000

Vessel based fee per environmental category (sek/call)			
A	B	C	D/E
335	1 010	3 020	3 360
1 285	3 850	11 535	12 815
2 515	7 555	22 645	25 165
4 015	12 040	36 110	40 120
7 370	22 115	66 315	73 675
10 710	32 120	96 375	107 090
13 720	41 145	123 420	137 130
15 730	47 175	141 545	157 270
18 410	55 240	165 705	184 115
21 740	65 250	195 770	217 525

Readiness fee** per environmental category (sek/call)			
A	B	C	D/E
100	305	910	1 010
385	1 150	3 445	3 830
755	2 260	6 780	7 535
1 200	3 600	10 800	12 000
2 205	6 615	19 840	22 045
3 200	9 605	28 820	32 025
4 100	12 305	36 920	41 020
4 705	14 110	42 330	47 035
5 510	16 525	49 570	55 080
6 505	19 515	58 550	65 055

** Reduction according to regulation 2023:5***

Transit goods discount
Loaded transit goods are exempt from freight charges*

*Fee reductions and fee exemptions are reimbursed after an application for a refund has been received by and granted by the Swedish Maritime Administration

Frequent traffic
Frequency reduction, based on number of calls per month applied on the vessel based fee and readiness fee:

Call 1: 100% Call 4: 50%
Call 2: 100% Call 5: 25%
Call 3: 75% Call 6+: 0%

Reduction according to environmental incentives, CSI classification:

- A: 90 %
- B: 70 %
- C: 10 %
- D/E: 0 %

Goods and passenger fees

- High value goods 3,06 sek/ton
- Low value goods 1,52 sek/ton
- Passenger fee 2,30 sek/p
- Private vehicles 3,06 sek/each

***A reduction of 15 % on the fairway fee will be issued on every invoice as a result of the climate compensation during 2024

Related regulations:
Regulation 2023:2 on fairways due
Regulation 2023:5 on temporary climate compensation for shipping



The printed Swedish version of the statutes takes precedence in a conflict problem with interpretation, or dispute

Table 3 Pilotage fees 2024 (Sjöfartsverket, 2024)

The Swedish Maritime Administrations pilotage fees from 2024-01-01

Net tonnage class	Lowest net tonnage
1	0
2	1 000
3	2 000
4	3 000
5	6 000
6	10 000
7	15 000
8	30 000
9	60 000
10	100 000

Pilotage fee for pilotage in pilotage fairways (sek)	
Start fee	Per ½ h
6 115	1 865
7 890	2 455
9 665	2 970
10 940	3 405
12 210	3 810
16 515	5 080
18 800	5 835
20 580	6 350
22 615	7 020
28 725	8 880

Ordering charges*	
Time before requested or confirmed time	Amount, sek
0 hr – 59 min	3 845
1 hr – 1 hr 59 min	3 065
2 hrs – 2 hrs 59 min	2 290
3 hrs – 3 hrs 59 min	1 525
4 hrs – 4 hrs 59 min	755

*Fee regardless of net tonnage class

Other pilotage fees
Additional Pilot sek 11 470

Travel expenses
Cost for pilots and assistants trips are excluded, see the Swedish Maritime Administration's regulation 2023:3

Reduction to pilotage fees in designated pilotage fairways

- 30 % in Trollhätte kanal and Vänern
- 10 % in Mälaren
- 40 % for pilot time over seven hours

Fees for open sea pilotage and Sound pilotage

For fees regarding voluntary pilotage, see the Swedish Maritime Administration's regulation 2023:3

Reduction of ordering fees in the event of a delay

Fee reduction is issued in accordance with § 36 in case of delay, see the Swedish Maritime Administration's regulation 2023:3



Related regulation:
Regulation 2023:3 on the provision of pilots, ordering of pilots, allocation of pilots and pilotage fees

2.9 Barriers in Inland Waterways

Garberg and Bengtsson (2019) address barriers expressed in the interviews they made with different parts of the shipping sector and logistics sectors. Some of the interviewed parties were goods owners, vessel owners, and forwarding agents. One of the barriers mentioned is the lack of options available for shipping through the inland waterways. The shipping frequency on inland waterways is limited compared to roads, however, the potential for an increase is available compared to shipping on longer distances (Garberg & Bengtsson, 2019).

Another barrier mentioned in the interviews is the increase in cost. An increase in fairway and pilot fees and a new way to calculate this cost was introduced in January 2018 by the Swedish Maritime Administration resulting in difficulties for shipping on inland waterways to stay competitive with other shipping methods (Garberg & Bengtsson, 2019).

The article by Durajczyk and Drop (2021) outlines several barriers in using inland navigation for urban and interurban freight transport, emphasizing the role of infrastructure limitations and navigational challenges as major obstacles. Key issues include insufficient waterway depths and widths, which cannot accommodate larger vessels or handle variable water levels that affect navigability. Seasonal fluctuations in water levels further impair these challenges, making some waterways non-navigable at certain times of the year, thus hindering reliability (Durajczyk & Drop, 2021). The study also hints at environmental and administrative barriers, though specific regulatory hurdles and compliance issues are not detailed extensively.

Overall, these barriers present significant challenges to leveraging inland navigation as a dependable and efficient transportation method in urban settings (Durajczyk & Drop, 2021).

2.9.1 *Regulatory and Financial Barriers*

In Sweden, regulatory uncertainty significantly impedes the operation of IWT. The developing and untested regulations generate uncertainty around critical aspects such as cabotage, which has not been firmly established (Garberg, 2016). Additionally, operational costs are disproportionately influenced by pilot fees and fairway dues, which are regulated by the authorities, further straining the economic viability of inland waterways (Garberg, 2016).

These regulatory challenges also apply to the costs of stevedores which are mandated by regulations (Garberg, 2016). Moreover, the existence of separate regulatory frameworks for other transport modes, such as railways, introduces inconsistencies. These frameworks often prioritize infrastructure investments and fee structures in ways that disadvantage IWT (Garberg, 2016). The issue of regulatory barriers is not unique to Sweden but is also

established across Europe. For example, when inland transport crosses several national borders, the arising paperwork can be both complicated and time-consuming (Pfoser et al., 2018).

2.9.2 Market Barriers

The market for IWT, Rogerson et al. (2020) describe, is characterized by significant barriers related to volume and handling requirements. The relatively low volume of goods transported via inland waterways in Sweden limits the economic feasibility of this mode, particularly when additional costs for handling and transshipment are considered (Rogerson et al., 2020). The competitive landscape, which includes well-established road and rail networks, often offers more cost-effective and flexible options for shippers, reinforcing the preference for these modes over IWT (Rogerson et al., 2020).

In a study made by Maritimt Forum (2017) 20 in-depth interviews were done with a wide range of goods owners, including both importers and exporters. The study's focus was the goods owners' perspective on SSS as a logistics solution for their need for transportation (Maritimt Forum, 2017). Positive aspects highlighted were the use of SSS as a tool to reach a more sustainable way of transportation and to reach the goals of reduced emissions set by the government. SSS was highlighted as an area with great potential for moving transportation from land to sea. Furthermore, it was underlined as a way to reduce the vulnerability in the transport chain and increase security (Maritimt Forum, 2017).

Some of the barriers identified by the goods owners were reliability issues, time of transit, frequency, stability issues, the uncertainty of fee costs in fairways and ports, lack of SSS knowledge, coordination and balance of goods flows, and price (Maritimt Forum, 2017).

2.9.3 Overcoming Barriers

The study by Rogerson et al. (2020) underscores the importance of recognizing and facilitating the contributions of various stakeholders, particularly policymakers, in overcoming barriers to IWT. By addressing regulatory challenges, providing financial incentives, investing in infrastructure, and promoting collaboration, policymakers and stakeholders can work together to make IWT a more viable and attractive option for cargo transport (Rogerson et al., 2020).

3 Methodology

The research began with the selection of a topic, which was facilitated through detailed notebook entries by the authors, culminating in a brainstorming session. This process led to the identification of several relevant topics worthy of further exploration. A comprehensive literature review was then conducted to assess previous studies, identify gaps in existing research, and ensure the chosen topic's relevance and feasibility within the given time constraints as well as considering the authors' expertise and prior experience within the selected subject. Subsequent engagement with a company closely associated with the topic, and similar projects, allowed the authors to refine their preliminary research questions and establish a clear direction for the study.

Considering the research questions' nature, a case study methodology was deemed the most appropriate approach. Data collection was conducted through semi-structured interviews featuring open-ended questions, enabling a rich, qualitative exploration of the subject. The data analysis was undertaken using a thematic approach, enabling a structured interpretation of the interview data. The findings were then thoroughly examined and analyzed by the authors. This chapter elaborately delineates each aspect of the methodology, offering insights into the systematic approach adopted for this research.

3.1 Case Study

A case study methodology is applied to provide an in-depth analysis of the subject matter. A case study approach is preferable when the work is contemporary, the research questions are posed with a why or a how, and if the researchers do not control the behavioral aspects of the research (Yin, 2014). This was deemed the most suitable option considering the complexity of the subject and the ongoing studies and work being conducted within the scope of the chosen case.

Yin (2014) describes a case study in two parts. “*The scope of case study and the features of a case study.*”

1. “A case study is an empirical inquiry that:
 - Investigates a contemporary phenomenon (the “case”) in depth and within its real-world context especially when
 - The boundaries between phenomenon and context may not be clearly evident.
2. A case study inquiry:

- *Copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result*
- *Relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result*
- *Benefits from the prior development of theoretical propositions to guide data collection and analysis.*” (Yin, 2014)

In the scope and features of the case study he explains that the case study approach covers all aspects of a research method, not only as a method for data collection (Yin, 2014).

The authors' planned study falls well within this description as an extensive investigation of a case within the context of the real world, the effect of the future lock on breakbulk shipping to Kristinehamn. As well as having boundaries or in this case study barriers that are both clearly and not so clearly connected to the effects of the new locks.

Yin (2014) describes five main components necessary in the research design of a case study, the case study questions being one of them. Yin (2014) suggests forming the study questions with “who”, “what”, “where”, “how” and “why”. Where how and why is the most common for case studies as previously mentioned. This suggestion was followed when composing the research questions for this study, choosing “what” and “how” for the two research questions. The second component are the study propositions. These are generally specified as part of the scope of the study and are necessary to specify and expand the focus of the study. Not all studies require propositions, however, they do require a purpose (Yin, 2014). Propositions were deemed unnecessary for this case study, a well-defined purpose as well as clear limitations were considered adequate by the authors.

The third component is the definition of the unit of analysis or “*the case*”. This can be done by explaining the case or cases you have chosen for your study to a colleague or friend. By explaining the question chosen for the study and why these questions are best addressed by the case or cases. By doing this the unit of analysis can be more easily identified (Yin, 2014). Being two authors of the study as well as having one mentor and one supervisor helped with the explanation and reasoning along the definition for the case.

The fourth component, linking data to propositions, can be done with analytic techniques such as time-series analysis, logic models, and pattern matching. In the analysis stage of the study, the data collected will be combined or connected to the study's propositions (Yin, 2014). The

analytic method used was thematic analysis, and the data was linked to different sub-categories developed from the research questions of the study.

The fifth and last component is the criteria for interpreting a case study's findings. In a lot of studies the interpretation of findings is verified through statistics. This is normally not the situation for a case study. Instead the use of "rival explanation" is an alternative strategy that can be used. Addressing and taking rivals into consideration can help with the data collection of the study (Yin, 2014). Rival explanations were considered in the research design stage of the study, such as investigator bias and others were applied throughout the process.

The methodology adopted in this study was grounded in the qualitative research design, specifically utilizing a case study approach to explore the intricate dynamics of breakbulk shipping in relation to the Trollhätte canal lock upgrades. This approach was pivotal for a comprehensive understanding of complex phenomena within their actual settings, enabling an in-depth analysis through various data sources such as interviews, documentation, and observations. The choice of case study methodology was supported by Alpi and Evans (2019), who illuminate its capacity to delve into real-life, bounded systems over time, highlighting its suitability for studies aiming to capture the richness and complexity of specific contexts.

3.2 Literature Review

While researching the topic and studying existing previous research in the field several search engines were used such as Scopus, Chalmers Library, Google Scholar, and Research Gate as well as the use of physical libraries and books. The use of keywords related to the topic and research questions, several different sources, and search engines, made the search as wide as possible. Research within the maritime sector is fairly limited compared to other research areas, especially when narrowed down to IWT, breakbulk, and Sweden. This gap in research resulted in few peer-reviewed articles relevant to this thesis. Considering this, some information had to be collected from other sources to fill the gap, including reports and articles from government agencies. The quality of this type of work was deemed adequate considering the agencies mission to serve the public and their strive towards objectivity.

Using already existing knowledge is a foundation for all future research in all fields. A literature review can address research questions as well as provide an overview when the knowledge is widespread and mismatched (Snyder, 2019).

3.3 Data Collection

Primary data was gathered through semi-structured interviews, targeting professionals involved in breakbulk shipping to Kristinehamn, including port authorities, shipping companies, and cargo brokers. This method was selected for its flexibility, allowing for a deeper exploration of participants' perspectives on the selected research questions.

Yin explains in his book (2014) that when making a case study, a set of attributes is desired to get a good result. These are:

Ask good questions - The need to ask the right questions is key when making a case study, more so than when using other research methods. To ask good questions it is necessary to remember that it is not always about the answer but the question. A cautious answer can in turn lead to important inquiries (Yin, 2014). The questions asked in this case study were carefully considered and adapted for each interviewee considering each person and their experience.

Be a good listener - A good listener is able to receive large amounts of information without being biased. This includes not only listening to the exact words used but also the mood and emotional aspects in which the words are conveyed. Trying to understand the perspective of the interviewee and any implied meaning of the words (Yin, 2014). The authors tried to consider the meaning and perspective of the answers given when collecting and analyzing the data.

Stay adaptive - The researchers need to be adaptive to whatever changes might occur. It is however necessary to remember the original thoughts and focus of the study and while doing so stay flexible towards change (Yin, 2014). Unexpected changes throughout the process were handled with the purpose of the study in mind and with a desire to achieve the best possible outcome.

Have a firm grasp of the issues being studied - It is key to understand the purpose and to remember it throughout the study. If you do not have a clear understanding of the purpose it is easy to miss important aspects like when a deviation of course is required or desired (Yin, 2014). Throughout the various stages of the process, the authors circled back and made sure the purpose aligned well with the desired plan forward.

Avoid biases - The above-mentioned conditions are irrelevant if the researcher uses the case study to strengthen an already predetermined position. Contrary data need to be considered

and if there is supporting evidence they need to be part of the conclusion in the case study. Unbiased work is not the only important aspect of research ethics. A case study researcher should strive towards the highest ethical considerations while performing the research. Including parts such as honesty, owning up to the written work, and refraining from plagiarism (Yin, 2014). All collected data was considered equally, and all relevant findings were presented in the results and done so by the best possible efforts of the authors.

3.3.1 Interviews

The interviews contained open-ended questions designed to gather in-depth insights into the challenges and opportunities associated with the lock upgrades. Interviews were conducted until data from the set-out spectrum had been reached.

Data collection was carried out through semi-structured interviews with various stakeholders in the maritime sector. The interviewees were selected, based on their field of work and expertise within the subject. The numbers of stakeholders operating within the range of this thesis were limited, narrowing the possible candidates for data collection. Some of the stakeholders were selected by the authors and others were suggested by chain link referral. In these interviews, the prepared questionnaire served as a guiding framework, with follow-up questions added when considered necessary. The questionnaire remained mainly consistent across all interviews but was adapted slightly for the different stakeholders. The conversations varied based on the interviewer's follow-up inquiries and the interviewees' responses. Despite potential challenges, this method of conducting interviews was favored over unstructured interviews, which might not yield the desired quantity of useful data, and structured interviews with closed questions, which could restrict interviewees from fully expressing their viewpoints.

When developing the questionnaire, emphasis was placed on crafting open-ended questions. These types of questions allow interviewees to respond in their own words and provide detailed descriptions of the subject as specified by the interviewer, a technique found preferable due to the complexity of the subject matter (Roulston, 2010).

The questionnaire was sent to the interviewees two days prior to the interview, providing them sufficient time to prepare. This email also included a consent form addressing the ethical considerations of the case study and seeking approval for recording the interview. No recording occurred without the interviewee's consent. At the beginning of the interview, the ethical considerations of the study were repeated, and interviewees were reminded that

participation was voluntary. They were informed they could withdraw at any time and that any personal information disclosed would be managed in compliance with the GDPR.

3.4 Data Analysis

The interview data was transcribed translated to english and then split up using thematic analysis. This process included coding the data and pinpointing themes relevant to the research questions.

Braun and Clarke (2006) explain the concept of a theme in their work, reflecting significant elements of the collected data that align with the research question and represent patterns observed within this data. Thematic analysis, being qualitative, does not prescribe a correct or incorrect approach regarding the extent of data required to establish a theme. It requires the researchers' judgment to discern what constitutes a theme (Braun & Clarke, 2006). The coding tool Nvivo 2020 was used for these purposes. Coding or dividing the data collected into different themes based on main and sub-categories centered on the purpose and research questions of the study. The coded data was then further analyzed by the authors and incorporated into text.

3.4.1 Use of AI Tools

In the digital age, the utilization of artificial intelligence (AI) tools has become increasingly prevalent across various sectors, including academic research. This thesis acknowledges the importance of leveraging technology to enhance the quality and accuracy of academic writing. Specifically, the authors have integrated an AI-based tool to assist in writing and spelling, thereby ensuring the clarity, coherence, and professionalism of the research document (Tang et al., 2024).

The AI tool OpenAI was selected based on its comprehensive features that support academic writing, including grammar checking, spell checking, sentence structure analysis, and suggestions for vocabulary enhancement. The tool's AI algorithms are designed to understand the context of the text, making it an invaluable asset for identifying and correcting errors that might elude traditional proofreading methods.

The AI tool was employed at various stages of the thesis writing process, from drafting chapters to finalizing the manuscript. During the initial drafting of the thesis, the OpenAI was used to check for spelling mistakes and grammatical errors in real-time. This immediate feedback allowed for on-the-spot corrections, significantly reducing the accumulation of

errors, and improving the overall writing quality from the outset. The AI tool was also used when compiling large amounts of data to help with sorting and categorization. Utilizing this tool made the data relevant to the study easier to identify.

The integration of the AI writing and spelling tool offered several advantages. The tool significantly sped up the editing process by automating the identification of common errors, allowing the researchers more time to focus on content analysis and interpretation.

While the AI tool proved to be an asset in the thesis writing process, ethical considerations were considered. The tool was used as an aid, complementing the researchers' skills rather than replacing the intellectual effort required in academic writing. Furthermore, it is acknowledged that AI tools have several limitations, including the potential for oversimplification of complex ideas or missing nuances specific to academic discourse. Therefore, all suggestions made by the AI tool were critically evaluated before acceptance.

3.5 Ethical Considerations

Ethical considerations have been made while this study was conducted. Participants, including professionals from the shipping industry, port authorities, and logistics providers, was fully informed about the study's objectives, the voluntary nature of their participation, and the measures in place to ensure the confidentiality of their responses. Informed consent was obtained from all participants, underscoring the voluntary basis of their contribution and their right to withdraw at any time without consequence.

The authors acknowledged potential biases in participant selection and the challenges of generalizing findings from a case study approach. Recognizing these limitations was crucial for maintaining the integrity and credibility of the research.

The ethical approach of this research was intrinsically linked to its subject matter, the exploration of the transformational potential of the Trollhätte canal locks upgrades. This commitment to ethics reflects the broader goals of the research: to inform strategic decision-making, policy formulation, and infrastructure development efforts that align with sustainability objectives and the welfare of the community.

4 Results

This chapter will present the results from the qualitative semi-structured interviews conducted to answer the posed research questions of the study.

Table 4 List of Participants

Short Name	General Position Description
Interviewee A	Infrastructure Specialist
Interviewee B	Port Specialist
Interviewee C	Vessel Operator
Interviewee D	Cargo Owner
Interviewee E	Vessel Operator
Interviewee F	Strategic Planning

4.1 Breakbulk Barriers: Kristinehamn's Shipping Challenges

Below will follow a presentation of the result focusing on the potential barriers within breakbulk shipping in Kristinehamn today.

4.1.1 Infrastructure and Operational Limitations in Kristinehamn

Kristinehamn faces infrastructural challenges that hinder the port's operational capacity and future growth according to one interviewee. The interviewee also stated that the limitations on the jetties today can be managed by spreading cargo to other ports. However, the need for upgrades and adjustments if larger vessels will call the port in the future was emphasized.

“Of course, in the future, if we receive larger vessels, we have limitations in the jetties capacity” (Interviewee B, 2024) Along with the development of the jetties a possible need for dredging the fairway was expressed as well.

Furthermore, the impact of these infrastructural shortages was pointed out, that they have led to stagnation in traffic growth: *“We have reached a point where the existing limitations, particularly in the lock and canal systems, have not only restricted vessel size to around 4000 tons but have also led to a stagnation in traffic growth.”* (Interviewee A, 2024) The importance of comprehensive redevelopment to improve facilities and sustain future growth was also expressed. The existing limitations, particularly in the lock and canal systems which restrict vessel size to 4000 tons, were seen as a major constraint by most Interviewees. These

restrictions significantly reduce the port's ability to process large volumes of cargo, affecting its competitiveness on an international scale.

One interviewee elaborated on the operational aspects of the port, stating that improvements in the handling of cargo could be made if there was a will and volumes to support it. Another interviewee shared this viewpoint and stated that: *"There are limitations, they have adapted their operations to the existing flow if it were to increase by 30-40% it would probably become a problem with longer waiting times and so on."* (Interviewee C, 2024).

The need for jetty upgrades to handle greater cargo volumes effectively was highlighted: *"The current jetty configurations are not sufficient to meet the increasing demands of cargo throughput. Upgrading these facilities is essential not only for handling more cargo but also for accommodating larger vessels that bring in significant economic benefits."* (Interviewee D, 2024). This perspective was shared by another Interviewee, who added that deeper fairways are also necessary to allow these larger vessels to navigate the port's waters safely. Without deeper fairways, there is a risk of turning away larger vessels, which could easily find accommodation in other competitive ports that have the required infrastructure.

The necessity for infrastructure enhancement is beyond just expanding capacity, it also includes modernizing the port's capabilities to handle other cargo types, as one interviewee emphasized: *"I get the impression that companies, at least within paper and pulp, are moving away from breakbulk."* (Interviewee D, 2024) The interviewee further conveyed their perception that breakbulk is declining and suggested that in the future the focus should be on containerization as the preferable method for shipping.

Enhancing the port's infrastructure will likely encourage investments in the local area. Improved facilities can attract more business, leading to job creation and economic growth. This potential for economic development was highlighted by one of the interviewees. However, these improvements require significant investment, and securing adequate funding is a major challenge.

Potential sources of funding for these projects were mentioned, including government grants, private investments, and public-private partnerships. *"Exploring various financing options is key to achieving our infrastructural goals without placing undue financial strain on the port's budget."* (Interviewee F, 2024)

The role of both, hard and soft infrastructure, improvements and the importance of government involvement in facilitating efficient cargo transfer from road to sea was mentioned by one of the interviewees. An integrated approach was suggested to address these infrastructural challenges, highlighting the need for a collaborative effort between public authorities and private stakeholders to develop effective solutions that align with regional economic strategies.

It was further noted that resolving these infrastructural issues was not just about physical upgrades but also about optimizing operational processes to make the port more agile and responsive to market needs. The potential for using advanced data analytics to improve throughput efficiency and reduce wait times was mentioned.

4.1.2 General Operational Barriers

It was argued in one of the interviews that the absence of sufficient pilots not only raised costs but also led to scheduling inefficiencies and operational delays. Affecting the customer's local businesses negatively in the lake Vänern region: *“There are barriers on lake Vänern in the form of a pilotage shortage for a long time, causing troubles.”* (Interviewee C, 2024).

Another interviewee expressed similar opinions, stating that they have been treated poorly by the Swedish Maritime Administration regarding the pilotage services. The lack of pilots had also caused long waiting times and posed a barrier to further increase traffic: *“We have a customer satisfaction rate of 60% on lake Vänern, in the rest of the country I believe it is around 97%.”* (Interviewee E, 2024). Similar opinions were stated by others concerning the Swedish Maritime Administration. They said that regards to the increased costs and the lack of pilots, the Swedish Maritime Administration has not been doing their job properly.

One interviewee further voiced the challenges of the bridges in the canal, the waiting time for opening, and the “blocking times” where no opening of the bridge is allowed. The trip to lake Vänern posed challenges, with the risk of complications in the locks along with the long waiting times and skill required to sail in the canal. Two of them agreed that addressing these issues were important for enhancing Kristinehamn’s competitiveness in the global shipping market. They argued that without these improvements, the port will struggle to attract and retain international shipping clients.

Environmental considerations of infrastructural upgrades in ports were mentioned, stressing the importance of enhanced coordination across various modes of transportation to mitigate disruptions. The interviewee further detailed the collaborative efforts with the Swedish

Transport Agency and the Swedish Maritime Administration aimed at bolstering system synchronization and reducing ecological impacts. The strategy was designed to facilitate the seamless integration of escalating traffic from diverse transport sectors, all while upholding environmental stewardship.

One of them described that the port's current capabilities to manage incoming vessels were not problematic at their current size. However, it was acknowledged that while the port currently could handle these challenges by distributing different types of cargo to other nearby ports when needed, this workaround was not a viable long-term solution. Another interviewee reiterated the need for improvements in jetties to handle more goods effectively and pointed out that the canal/fairway and lock size limitations were significant bottlenecks for scalability. Furthermore, it was claimed that the port of Kristinehamn's remote location lacked the potential for development in a geographical sense. Another interviewee also agreed on how these infrastructural limits were affecting shipping operations at Kristinehamn. According to both of them, without significant infrastructural investments, the port's potential as a future major logistical hub was hindered. This underscored a need for strategic planning and action to ensure sustainability and growth in operations.

4.1.3 The Economic Challenges of Breakbulk

The increased pilotage costs on lake Vänern present a significant barrier to Kristinehamn's competitiveness in the maritime sector, as described by one of the interviewees. In 2018 these fees saw a substantial increase, effectively doubling, which has posed challenges to the port's ability to compete with other coastal ports. The combination of longer pilotage times and smaller cargo volumes at Kristinehamn disproportionately escalated the cost per ton of cargo. Another interviewee continued with the description of the pilot fees, and stated that on the Swedish side of the trade, they are a substantial part of their costs and that the pilot and fairway fees are the major part of the total port call costs.

“There was a very substantial discount, so you could go all the way up in lake Vänern with the goods. This was changed in 2018 and then it was approximately 100% more expensive with pilotage in lake Vänern.” (Interviewee B, 2024)

Additional complications related to the availability of pilots were mentioned, arguing that the scarcity of pilots not only worsens the issue of high pilotage costs but also contributes to operational unreliability. Many shipping companies, frightened by the unpredictability and

extended waiting periods for pilot services, choose to dismiss contracts in lake Vänern, opting for more reliable alternatives.

“We have had very long waiting times during the summers. So in good times, some shipping companies choose not to take contracts in lake Vänern” (Interviewee B, 2024)

Another interviewee resonated with their concerns and pointed out the operational disruptions caused by this pilotage shortage. The frequent delays not only affect scheduling but also force shipping lines to increase their pricing to compensate for the heightened risks and possible additional costs, such as those related to pilot fees and the operation of bridges along the route. These increased operational costs are passed down the logistics chain, affecting overall market prices and potentially reducing the attractiveness of Kristinehamn as a shipping hub.

“It is established that all added barriers that affect us. We need to compensate for this, and the client will need to pay a higher price.” (Interviewee E, 2024)

Another interviewee expressed the same concerns about the negative effect on the costs of long waiting times due to pilotage shortage. This interviewee was also critical of the current fee structures, describing them as prohibitively expensive and a major deterrent for shipping companies considering shipping to Kristinehamn.

Two of the interviewees mentioned how trucks and trains are not only cheaper but also increasingly favored due to the high costs and inefficiencies related to maritime transport. The competitiveness is extremely tough, and shipping is the last choice for transporting cargo.

“The first-hand choice is truck, as a second choice you take another vessel from the coast. As a third choice, when the other options are full, yes then we get a booking. That is how it is, unfortunately.” (Interviewee E, 2024)

Another barrier and aspect raised by several of the interviewees was competitiveness and the effect on SSS by the other transport options, such as truck and railroad. One said that the industries are very set on their railroad transportation and unlikely to change this. However, this person also mentioned that if you want to build reliable transports over time, there are many aspects in favor of using shipping. This interviewee explained that in shipping the operators cover their own costs but in railroad, it is the taxpayers covering the cost for the operators with maintenance and investments.

4.1.4 Regulatory Challenges

The compliance costs and the need for regulatory reforms at Kristinehamn's port were expressed by two of the interviewees which explained the significant concerns over the strict pilotage and environmental regulations that impose high costs and create operational challenges. Both advocated for substantial regulatory reforms to lighten these burdens, suggesting that simplifying the regulatory landscape could reduce compliance costs significantly and make the port a more attractive destination for breakbulk shipping.

"Navigating the regulatory landscape here is quite challenging. The multitude of international shipping regulations we must comply with adds a significant burden to our operations." (Interviewee E, 2024).

Another interviewee reinforced the idea that simplifying the regulatory framework is crucial for improving the attractiveness and operational efficiency of Kristinehamn. It was argued that such reforms would not only make the port more appealing to new businesses but could also significantly enhance economic outcomes by stimulating increased commercial activity. Reducing the complexity and burden of existing regulations could lead to a more streamlined, cost-effective operation that attracts a larger volume of shipping traffic.

Adding to this perspective, another interviewee advocated for a cooperative approach to these regulatory challenges. The importance of collaboration between governmental bodies and industry stakeholders to effectively address and reform the regulatory issues that currently impede the port's efficiency and economic potential was stressed. By working together, these groups can identify key areas of regulatory excess and work towards creating a more balanced and practical regulatory environment that supports business growth and operational agility.

The relationship between Kristinehamn's location on lake Vänern and its stringent environmental regulations was stated: *"The port faces specific disadvantages due to its location, which are worsened by stringent regulatory requirements."* (Interviewee D, 2024). Further on it was advocated about reforms to alleviate these challenges, including reducing fees and easing pilotage rules, thus turning geographical disadvantages into competitive strengths. Another interviewee pushed for a dynamic regulatory framework that adjusts to the maritime industry's evolving needs, promoting fairness and global competitiveness. A third interviewee continued on the same subject, stating the importance of a green transition within shipping, however noting that these changes and new standards put a strain on the financial

resources of the company. It was advocated for a balanced approach that maintains high standards while being realistic about operational capabilities and economic impacts.

The outdated and inefficient pilotage system at Kristinehamn was highlighted as a major bottleneck that increases costs and complexity. The interviewee called for a comprehensive modernization to align with international standards. A need for a traffic management system that integrates rail, road, and maritime traffic to optimize operations and maintenance planning was also expressed.

The establishment of a continuous review mechanism for regulations, involving various stakeholders to ensure that the rules remain relevant and do not inhibit innovation or economic growth was stated. Similar ideas which further advocated for a more integrated regulatory framework that not only tackles direct compliance costs but also takes into account the broader economic impacts on the region's logistics and trade sectors were added.

4.1.5 Barrier Solutions

Multiple solutions to the barriers mentioned in this chapter are expressed by the interviewees. Most of them made suggestions on how to cut costs and how to increase the competitiveness of the region and operators trading there.

Three of them questioned the need for a pilot on lake Vänern at all. One mentioned mandatory double hull for all vessels trading in lake Vänern as a possible way to simplify the pilotage regulations to increase redundancy in case of an accident. Another interviewee argued that the Swedish Transport Agency focuses too much on the probability part of the risk analysis and that the shippers will need to pay for their caution and lack of action.

“Considering that this is a water protection area and so on, the government wants to cherish it. But at the same time the question is if this cost should be put on the shippers.”

(Interviewee A, 2024).

The pilotage fees and how to reduce their negative impact was addressed. It was argued that a new pricing model needs to be made where one should subsidize or remove the pilotage fees. However, it was stated that it is up to the government to consider the suggestions presented to them. But at the time of the interviews no investigations concerning pilotage and fairway fees are ongoing. *“I have not received any signals whatsoever that there is any change or investigation underway from the political side regarding the pilotage and fairway fees.”*

(Interviewee F, 2024).

To increase the goods flow one of them argued that it is important to consider a few questions: “*What type of economic area is there? What type of businesses can we surround ourselves with? What export volumes are there? How can the in and outbound flows be balanced?*” (Interviewee D, 2024). A strategic industrial planning, inviting companies to place their business in the region and close to the port was mentioned as a solution as well.

4.2 The New Locks’ Impact on Breakbulk Shipping

In this section the results focusing on the impact of the new locks on breakbulk shipping will be presented.

4.2.1 Welcoming Larger Ships

It was expressed by one interviewee that the new locks in Trollhätte canal will change the conditions for shipping in lake Vänern. The strategic value of these infrastructural changes and that the ability to accommodate larger vessels will reduce shipping costs per ton, and thereby increase competitiveness was pointed out.

“We can distribute the substantial cost we have for the pilot, along with other costs over a larger set of cubic or tons.” (Interviewee E, 2024).

Two interviewees discussed their respective organizations' readiness for the new locks. One highlighted proactive measures being taken to ensure that their fleet can effectively navigate through the upgraded lock dimensions, indicating a strategic adaptation to the anticipated changes. Similarly, the other interviewee emphasized the adjustments being made to their newer vessels, preparing for a smooth transition once the new locks are operational. Both expressed a forward-looking approach, aiming to align their operations with the new infrastructure and mitigate potential challenges.

Considering the technical aspects, a majority elaborated on the enhanced throughput capabilities and the reduced wait times that the new locks are expected to provide: *“The new locks are expected to significantly reduce the wait times by enhancing the throughput capacity.”* (Interviewee F, 2024). The improvements are crucial as they will likely make Kristinehamn an attractive hub for international shippers was added. One mentioned how the increased capacity might double the traffic to and from Vänern by 2030, significantly boosting regional logistics and trade.

“It's critical that we not only enhance our capacity but also improve our operational strategies to handle the increase in scale efficiently.” (Interviewee F, 2024).

The diverse possibilities that the expanded capacity could unlock, including the ability to handle a wider variety of cargo types was stated. This flexibility was seen as key to attracting new business across different industries, enriching the port's client base. One interviewee was also positive about the introduction of container traffic due to the increased size of the vessels.

Another interviewee identified a strategic opportunity for Kristinehamn to integrate more deeply into global shipping networks: *“By drawing new investments, the port can foster local economic growth, creating a ripple effect throughout the community.”* (Interviewee B, 2024). The road to realizing these benefits is not without its challenges. The potential hurdles such as the need for deeper and potentially wider canals and fairways to fully utilize the new lock capacities was added.

A possible need for operational adjustments in the ports to be able to handle the larger volumes of goods accompanied by larger vessels, and the risk of waiting times if no operational adjustments are made was mentioned as well. However, this would probably not happen overnight but over time. One looked at the broader strategic context and stressed the importance of collaborative efforts between port authorities, local governments, and shipping companies to ensure that these benefits are fully realized.

4.2.2 Enhanced Efficiency and Capacity

The new locks will open new possibilities for the port of Kristinehamn. Both with the advantage of economies of scale as well as being able to call feeder vessels already going to the Port of Gothenburg, extending their routes. Another possibility expressed was that vessels could load and unload themselves if the ports do not have the required capacity.

Another solution mentioned made possible by bigger locks and vessels was the use of RO-RO vessels with a side gate. Larger vessels could make it profitable to go all the way to Europe the same interviewee explained. This solution is discussed with paper manufacturers today, wanting to improve the costly use of the CQ box.

The larger vessels will lead to fewer port calls needed for a certain amount of cargo, increasing the optimization which will in turn have ripple effects on pilotage and other services. This could over time lead to an increased goods flow from actors in the region.

The new dimensions in the locks will give the interviewee greater flexibility, since they will be able to use a larger part of their fleet. The increased vessel size will also make it easier for them to make efficient combinations of port calls in lake Vänern. *“The majority of our vessels*

trade outside of lake Vänern today, 6-7 vessels. And they would be able to go to lake Vänern. Giving us an entirely different flexibility” (Interviewee E, 2024)

One of them said that the port’s capability to handle more diverse cargo, and to be able to do so efficiently is crucial for future development. A hope for high-valued goods was expressed as well, but that containerization was a probable necessity for this.

4.2.3 Sustainability Effects from the New Locks

As Kristinehamn embraces the potential introduced by the new locks one interviewee acknowledged the capability to accommodate larger vessels. While this could theoretically enhance environmental efficiency through economies of scale, it is imperative that these benefits are clearly demonstrated and not assumed, was added.

The strategic advantages of environmental upgrades were emphasized. By enhancing Kristinehamn's appeal to eco-conscious businesses, the port could qualify for international green funding one of them said. This type of funding supports projects that demonstrate clear environmental benefits, potentially providing significant financial resources to expand the port's infrastructure and services further.

The need for strict environmental controls and monitoring systems is recognized in response to the increased capacity the new locks provide was mentioned as well. These systems aim to maximize environmental benefits by enforcing stricter emissions standards for ships. This strategic approach seeks not only to affirm the port's commitment to ecological responsibility but also to enhance its economic profile by linking sustainability with financial and business growth opportunities.

Achieving these benefits, however, is not without its challenges. Two other interviewees caution that a sustained commitment to sustainability practices across all port operations is essential. This involves ongoing investments in green technologies and maintaining high environmental standards, a sentiment supported by most interviewees.

Moreover, the importance of community and stakeholder engagement is highlighted by one of the interviewees as a critical component in ensuring that the port's environmental strategies are effectively supported and implemented. There is a shared vision among interviewees that the new locks will significantly impact Kristinehamn's environment in the long term. They are expected to facilitate not only increased cargo volumes and more diversified operations but also to propel the port to the forefront of global sustainable industrial practices.

5 Discussion

This chapter delves into the comprehensive analysis of the findings presented in the previous sections. It aims to provide a detailed discussion on the implications of the results, focusing on the key issues impacting breakbulk shipping to Kristinehamn, particularly in the context of the pilot fee changes and the future upgrades to the Trollhätte canal locks. The chapter also critically evaluates the methodologies used, considering their strengths and limitations, and reflects on the validity and reliability of the study's outcomes. Through this discussion, the authors aim to offer a nuanced understanding of the current barriers and future opportunities for enhancing the competitiveness and efficiency of IWT to Kristinehamn.

5.1 Result Discussion

The pilot fee changes made in 2018, have severely impacted shipping to lake Vänern, including the breakbulk to Kristinehamn. This specific change was highlighted during one interview, as the reason for reducing the competitiveness of Kristinehamn compared to other coastal ports. During most of the interviews, the pilot fees were mentioned as one of the most substantial barriers to competitive shipping in lake Vänern. The Swedish Maritime Administration plans no investigation of the fee model, this lack of change could play a vital role in the further development of breakbulk shipping to Kristinehamn as well as play a big part in the impact of future upgrades of the locks.

According to the interviews the pilot services provided by the Swedish Maritime Administration are an integrate part of the shipping to Kristinehamn. The lack of availability of pilots causes delays and lack of reliability, increasing the prices of transport and reducing competitiveness for shipping by inland waterways. The lack of reliability is supported in the report by Rogerson et al. (2020) as a reason for reducing the attractiveness of IWT. Increasing the number of pilots and the reliability could prove a vital part in the development of IWT. The impact of larger vessels and bigger locks will be less significant if there are no pilots to pilot them. One of the interviewees highlighted the need for a traffic management system to tackle this and improve efficiency in the canal which was supported by Durajczyk & Drop (2021).

Another barrier addressed during interviews is the balance of the goods flow. Corresponding well with the study made among goods owners by Maritim Forum (2017) highlighting the balance of flow as a barrier within SSS. Suggestions to overcome this barrier were addressed

during one of the interviews and included a more thorough look at the economic area and to focus on both the import and export of goods. When increasing the vessel sizes more cargo can be shipped to and from Kristinehamn and the lake Vänern region. Further research into how to better utilize import and export could play an important part in the increase of goods flow today, and when the locks have been upgraded.

The infrastructure in the port of Kristinehamn can handle the flow of breakbulk cargo today, however, they do have restrictions on some of the berths and grounds. This was confirmed through the data collection as well as by the action plan done by the municipality of Kristinehamn. Investments to meet an increased goods flow are necessary, including a large investment in the fairway. A possible upgrade of the fairway is being investigated along with other ports and fairways in lake Vänern and the outcome of this review will have a major impact on the future development of Kristinehamn. If future investments in fairways in lake Vänern do not include the port of Kristinehamn, a potential increase in breakbulk goods will likely be limited to a ripple effect of more cargo going into the other ports of lake Vänern.

The competitiveness between the transport modes is seen as both a barrier and an injustice by most of the participants in this study, favoring the rail and road operators with lower or no cost for maintenance and investments of the infrastructure. Today the inefficiency and higher costs make shipping by inland waterways the least desirable option. This result does not completely match the result in the study made by Jonkeren et al. (2023) about the modal shift potential, which showed a reduction in costs when shifting to rail and inland waterways from road transport. The difference between the results could be because the study only covered certain zones and the shipping on inland waterways varies considerably between various parts of Europe.

The regulatory challenges and environmental concerns raised by the stakeholders play an important part in shaping the competitive landscape for Kristinehamn's port. Interviewees have pointed out that stringent environmental and pilotage regulations, although vital for maintaining sustainability and safety, impose significant operational burdens which increase costs. These regulations often require investments in cleaner technologies, while beneficial in the long term, can be expensive for shipping companies in the short term. Simplifying the regulatory framework, as suggested by interviewees, could enhance the port's attractiveness to new business, thus stimulating economic activity and potentially leading to greater shipping traffic and revenue.

The upgrades to the Trollhätte canal locks are expected by the majority of interviewees to increase the cargo volume capacity per transit by allowing larger vessels to navigate through. They were optimistic that an increase in the economics of scale could have a positive impact on the goods flow and might increase the competitiveness against the other modes of transport. As discussed by Jonkeren et al. (2023) the shift towards larger volumes being transported via IWT will lead to more economic competitiveness and less emissions.

The operators in the region have prepared their organizations for the upgrade of the locks, making sure they will be able to benefit from the increased dimensions. All apart from one interviewee are optimistic that the goods flow will increase following the upgrade, although some argue it will potentially take time before an increase is apparent. The optimistic view on the future bodes well for continued traffic of breakbulk to and from Kristinehamn and with a possible boost as a prospective outcome of the investments being made.

5.2 Method Discussion

One of the main focuses of the study was the possible impacts of the new locks in Trollhätte canal on breakbulk shipping to Kristinehamn. Considering the locks have not yet been built the answers from the participants of the study were to a large part based on speculation considering the completion of the project lies far into the future. Taking this into account the barriers affecting breakbulk shipping were added to get a broader approach to the effects on breakbulk shipping to and from Kristinehamn today, considering it would be easier to understand the new locks' effects on the future with the barriers existing today.

The qualitative approach was chosen due to the complexity of the case, however, a quantitative approach could have provided a more substantial result covering more stakeholders operating in Kristinehamn and the lake Vänern region. The interpretation of quantitative data could prove difficult considering the various aspects of this study and the details required to describe the research problem, making the qualitative approach the most suitable option.

The reliance on stakeholder interviews may have introduced bias, as the data collected could be seen as subjective since it was influenced by individual perspectives and experiences. To mitigate these limitations, multiple persons from each field were interviewed when possible, and questions posed during interviews were as open and unbiased as possible.

The literature review was done to better understand the subject and research problem. A wide amount of previous studies were found on breakbulk and shipping on inland waterways, however, few of them included the Swedish inland waterways, and none of them the port of Kristinehamn. Most of the included studies were from Europe, where the rules and legislations for inland waterways differ from Sweden. Even though the data found was deemed reliable and relevant this aspect is important to consider when reading the conclusions of this study.

5.3 Validity and Reliability

Validity in this study addresses whether the authors have approached the subject correctly. To ensure a high degree of validity, several strategies were employed. A comprehensive literature review on breakbulk shipping, inland waterways, and the specific context of Kristinehamn and the Trollhätte canal was conducted. This alignment with established knowledge ensured that the research questions were relevant and accurately selected. Semi-structured interviews were carefully designed to capture a wide range of perspectives from key stakeholders in the maritime and logistics sectors. The open-ended questions allowed for detailed responses, tailored to each interviewee's expertise, ensuring comprehensive coverage of relevant issues. Multiple sources, including interviews, documents, and previous studies, were used to verify findings, enhancing the study's validity by confirming that the results were consistent across different data sources and perspectives. Feedback from supervisors and mentors who are experts in the field helped refine the research focus and ensure a continuous alignment of the purpose.

Furthermore, all articles, books, and data used for the study were thoroughly examined and deemed scientifically viable and of acceptable quality. All interviewees were asked to explain their experience of the selected subject, increasing the validity of their answers. The authors of this study are not unaffected by subjectivity or partiality, which could have affected the conclusions of this case study.

Reliability addresses the certainty with which the conclusions made in this study are true, evaluating the consistency and dependability of the research findings. Measures taken to ensure high reliability included the consistent methodology provided by the case study approach, which ensured that data collection and analysis processes were replicable and dependable. Detailed documentation of all research steps, from interview protocols to data analysis techniques, allow other researchers to follow the same procedures and verify the

results. Interviewing multiple stakeholders from different segments of the maritime and logistics sectors helped mitigate individual biases and ensured a broader and more reliable understanding of the challenges.

The integration of AI tools for writing and spelling checks maintained high standards of accuracy and professionalism in the documentation of research findings, minimizing human errors. However, considering the subject is broad and current, there are many variables that could change over a short period of time, affecting the results, such as changes in the national plan and fluctuations in the trade market. Therefore, the data collected becomes less reliable over time. Despite these efforts, certain limitations must be acknowledged. The reliance on stakeholder interviews introduces a degree of subjectivity, as responses are influenced by personal experiences and perspectives. Efforts were made to mitigate this through careful question design and triangulation, but some bias is inevitable. The specific focus on Kristinehamn and the Trollhätte canal limits the generalizability of the findings to other contexts. While the insights are valuable for this case, they may not fully apply to different regions or types of shipping operations. However, barriers in IWT are likely similar across the different vessel and cargo types as well as in other geographical locations.

By addressing both validity and reliability comprehensively, this study aims to provide robust and dependable insights into the future of breakbulk shipping in Kristinehamn, considering the upgrades to the Trollhätte canal locks. Although the authors have tried to maintain a high level of quality and professionalism throughout the work of this report, the reader will have to make their own assessment of the validity and quality of this study.

6 Conclusion

This chapter will answer the posed research questions, and communicate the recommendations made by the authors for future research.

What challenges with shipping breakbulk cargo to and from Kristinehamn exist today?

Today, the shipping of Breakbulk cargo to and from Kristinehamn faces several challenges. Infrastructural limitations in the port, as well as locks and fairway dimensions, limit the size of vessels that can call the port. High operational costs such as pilotage and fairway fees, and costs added by the operators due to operational delays are also a major challenge. The competitiveness against other modes of transport is considered unjust due to the skewed distribution of costs among the different transport operators. The goods flow balance is also seen as a hinder. Regulatory constraints add layers of complexity and costs increasing the operational difficulty for the operators. A scarcity of pilots creates instability and delays. These barriers hurt the overall competitiveness of shipping breakbulk goods to and from Kristinehamn.

How will the new locks in Trollhätte canal affect the breakbulk shipping to and from the port of Kristinehamn?

The new locks in Trollhätte canal will be able to accommodate larger vessels, likely to increase the operational efficiency and goods flow to the port of Kristinehamn. More cargo can be shipped per voyage, this increase in capacity may reduce the cost per unit of cargo transported, thereby enhancing the shipping operator's competitiveness and Kristinehamns position as a logistics hub. The larger locks will increase flexibility and increase the number of vessels available to trade in the region. These changes will potentially attract more customers to the region and contribute to economic growth. The new locks can contribute to a more level playing field, allowing Kristinehamn to compete more effectively with coastal ports and other modes of transport by offering quicker, more cost-effective, and more sustainable options, as well as making the shipping operators more cost-effective.

6.1 Further Research

The authors suggest a study examining the potential for new pilotage regulations including exemptions for parts of the canal or lake of Vänern, and an adapted fee model for long pilotage on inland waterways. Such a study could examine the benefits these changes could have on breakbulk shipping to Kristinehamn and shipping in the lake Vänern region. These

were some of the main barriers highlighted in this study so the potential for future development is high.

Furthermore, a quantitative report studying the result of the new locks and potential fairway expansion could be interesting, comparing the results from this case study as well as examining the potential benefits from the large investments made.

The authors suggest that the impact regarding greenhouse gas emissions from vessels could be studied post the locks upgrades.

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8 Appendix

Appendix 1

Intervjufrågor

1. **Beskriv din roll inom inlandssjöfart och breakbulk shipping och organisationen/företaget du arbetar för?**
2. **Hur ser er trafik till och från Vänern ut idag? Vilken storlek på fartyg? Frekvens? Specifikt för Kristinehamn?**
3. **Finns det några begränsningar för in och utflödet av breakbulk gods till Kristinehamn idag?**
4. **Om så inte är fallet hur kan breakbulk flödet förbättras?**
5. **Om så är fallet hur påverkar dessa begränsningar eran verksamhet?**
6. **Kan du föreslå några strategier eller lösningar för att övervinna dessa utmaningar?**
7. **Hur bedömer du infrastrukturen i Kristinehamns hamn för hantering av breakbulk-gods?**
8. **Hur ser du på samarbetet mellan olika aktörer i hamnen, inklusive tull, speditörer, och lastägare, för att underlätta breakbulk-flöden?**
9. **Hur påverkar internationella partnerskap och nätverk er position inom breakbulk-shipping?**
10. **Hur påverkar aktuella och framtida regelverk för sjöfart och miljö eran verksamhet?**
11. **Hur kan politiska initiativ eller stöd underlätta utvecklingen av breakbulk-flöden till och från Kristinehamn?**
12. **Hur ser du/ni på effektiviteten och hållbarheten i inlandssjöfarten i Vänern för breakbulk-laster idag?**
13. **Hur kommer utvecklingen av slussarna påverka eran verksamhet i /till och från Kristinehamn? Har ni planer för att anpassa er till förändringarna? Ekonomiskt, operationellt och storlek på fartyg? Eventuella stopp?**
14. **Har ni några specifika utvecklingsprojekt eller expansionsplaner för att stärka er position inom breakbulk-shipping?**
15. **Vad tror du om framtiden för breakbulk-shipping i Vänern och specifikt till och från Kristinehamn?**