MASTER THESIS

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Transshipment hubs in Arctic conditions: A case study of Kirkenes

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Sammendrag

Denne masteroppgaven studerer karakteristiske faktorer ved Arktiske omlastningsterminaler og hvordan disse forskjellige faktorene vil forme fremtidig havneutvikling i Arktis. Gjennom en casestudie av Kirkenes bruker oppgaven kvalitativ analyse for å utforske disse faktorene. Videre blir et generelt rammeverk for Arktiske omlastningsterminaler avledet fra funnene, og dette er det største bidraget til litteraturen. Følgelig er hovedfunnene fra oppgaven organisert i to sammenhengende deler.

De viktigste funnene fra casestudien belyser hvilke muligheter, begrensninger og usikkerhetsmomenter som finnes for utviklingen av en Arktisk omlastningsterminal i Kirkenes. Basert på vurderingen av flere rapporter og dokumenter hentet fra prosjektet, foreslås også et program for videre utvikling av havneprosjektet. Oppgaven konkluderer med at Kirkenes kan innta en fundamental posisjon på den nordlige sjørute i Arktis, hvor de største fordelene er en isfri havn og dens strategiske beliggenhet. Andre positive faktorer inkluderer et stort eksportpotensial fra både petroleum og gruveindustri i tillegg til sterk støtte fra myndighetene. Motsatt inkluderer de negative faktorene høye byggekostnader, usikker økonomisk forankring og sensitive miljøinteresser. I skrivende stund er ikke byggingen av den nye havnen påbegynt og det har ikke blitt foretatt en full miljøkonsekvensutredning.

Det generelle rammeverket for Arktiske omlastningsterminaler består av tre forskjellige faktorer; beliggenhet, infrastruktur og drift. Oppgaven finner at omlastningsterminaler i Arktiske forhold har begrenset behov for lokal markedstilgang på grunn av mye eksportbasert skipsfart på den nordlige sjørute. Følgelig er det også et begrenset behov for innlandsforbindelser, ettersom ny jernbaneinfrastruktur i Arktis fremdeles er lenge fra å bli realisert. Arktiske omlastningsterminaler anses dessuten å ha identiske infrastrukturbehov som normale omlastningsterminaler, med unntak av at skip til skip omlastning vil være mer brukt i Arktis. Avslutningsvis er et stort funn at disse Arktiske omlastningsterminalene stort sett vil operere som et mellomledd i verdikjeden sammenlignet med den normale nav- og eikemodellen som finnes i større knutepunkter andre steder.

Preface

This master thesis marks the end of my studies at Nord University undertaking an M.Sc. in Energy Management. Being a joint degree in collaboration with Moscow State Institute of International Relations, the program has taken me to both Bodø and Moscow for two exhilarating years.

I have been fortunate enough to be given this opportunity to undertake a research project that encompass both said countries, namely the Northern Sea Route. With a keen interest in both logistics and the High North, I am ever grateful for the support from my benefactors at the Centre for High North Logistics. Their financial support enabled my field trips to Kirkenes and Murmansk and ensured I got a better perspective of the case personally.

Before anything, I would like to offer my strongest words of appreciation to all the staff of the Centre for High North Logistics for sharing their network and profound insights. In particular, my sincere thanks goes to Sergey Balmasov at the Murmansk office for access to the quantitative data and enlightening perspectives on Arctic shipping. Lastly, special gratitude is given go my supervisor Dr. Roberto Rivas Hermann whose unrivaled academic and proficient support elevated this research to inconceivable heights. With his decisive guidance, he has illuminated an orderly path amidst the chaotic nature of academic writing.

Kongsberg, May 22nd 2020

Morten Hals

Abstract

This master thesis examines the distinctive characteristics of Arctic transshipment hubs and how these different factors will shape future port development in the Arctic. Through a case study of Kirkenes, the research uses qualitative data analysis to discover these characteristics. Moreover, a general framework for Arctic transshipment hubs is derived from the findings, adding to a gap in the literature. Accordingly, the main findings is organized in two separate parts, though perforce interlinked.

The main findings from the case study elucidate the enabling, constraining along with uncertainty factors for transshipment hub development in Kirkenes. Based on the assessment of multiple reports and documents derived from the project, a transitory program for the development is also proposed. The research concludes that Kirkenes can take a fundamental position in NSR traffic, through the advantage of an ice free port and strategic location. Other enabling factors include a massive export potential from both petroleum and mining industries besides determined support from the government. Conversely, the constraining factors include high construction expenses, uncertain financial backing and sensitive environmental interests. At the time of writing, construction of the new port has not commenced and a full environmental impact assessment has not yet been undertaken.

The general framework for Arctic transshipment hubs comprise of three different factors; location, infrastructure and operations. The research finds that transshipment hubs in Arctic conditions have limited need for hinterland access due to export focused shipping on the NSR. Consequently, there are also limited need for inland connections, as new railway infrastructure in the Arctic is still far away from being realized. Moreover, the infrastructure of these hubs is deemed to have identical infrastructure needs as normal transshipment hubs, with the exception that ship to ship transshipment will be more prominent in the Arctic. Finally, a major finding is that these Arctic hubs will operate with an intersection model as compared to the normal hub and spoke model found in major hubs elsewhere.

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1 Introduction

1.1 The backdrop for Arctic transshipment hubs

As the ice in Arctic waters is disappearing faster than ever before, new opportunities arise for many industries, including increased shipping traffic. In Northern Norway, and among the other Arctic nations there are increased initiatives for utilizing the opportunities that coincides with the changing climate. As a direct consequence, the Northern Sea Route (NSR) becomes an ever more feasible alternative for shipping companies. The increased exploitation of Arctic natural resources is also driving this development, where maritime transportation is the only means to transport these commodities from remote Arctic locations (CHNL, 2019).

As of today, increased shipping in the Arctic still have technological and economic constraints. For example, Arctic shipping employs very expensive purpose built vessels such as ice-class ships and icebreakers (Milaković et al., 2018). One actor, the Russian gas company Novatek is now contemplating transshipment operations as an efficient way to secure adept utilization of these expensive ships and to ensure efficiently delivery of Arctic liquefied natural gas (LNG) to the global markets (Staalesen, 2018). The alternative to transshipment hubs along the route, would be to circumvent the transshipment operations, and pass directly through the Arctic waters. This however, would increase costs for the shipping companies as ice-class vessels would need to navigate the entire journey from Asia to Europe, instead of focusing their capabilities in the Arctic conditions only. However, such a model would also require extensive use of ice breaker support, which is both an expansive and scarce resource (Milaković et al., 2018).

According to the Centre for High North Logistics (CHNL) the transshipment hubs' main function would be to offer transshipment of cargo at each end of the NSR, with one or two hubs in the Kirkenes/Murmansk area (CHNL, 2019). On the other side, plans are now in place for the construction of a terminal on the Kamchatka peninsula, backed by ever growing interest in the NSR from the Russian government (Humpert, 2019). Between the two hubs high ice-class Arctic shuttles would transport cargo on a year-round basis following a predictable shipping schedule. Non-ice strengthened general cargo ships would then transport cargo to and from those hubs. This model for the NSR will solve many operational issues and make the sea route a practicable option for shipping companies, and would also bring positive economic benefits to the local Arctic communities (Gunnarsson, 2017).

1.2 Motivation for research

My motivation behind choosing this particular field of research is diverse. Coming from a bachelor in logistics, a thesis that will combine this field of study with another important topic, namely the High North is a fine opportunity to conduct a relevant and important research project. My master program in Energy Management has had huge emphasis on international governance and business in the Arctic, through which I have developed a keen interest for the opportunities and challenges in this area of the world. After studying abroad in Moscow, I also gained interest in Russian Arctic policies and their interests in increased traffic along the NSR. This not only includes wishes for economic development, but also geopolitical dominance over other Arctic as well as non-Arctic states.

During our master program, courses on topics like geopolitics and energy has encouraged me to further investigate the role of international politics in the Arctic and how new energy markets are changing the world's transport systems. This is especially noticeable in the Arctic, with the region being the target of both emerging geopolitical tensions and newborn opportunities out of climate change, and I am certain that the NSR will play a fundamental role in these matters.

This master thesis is part of a research project called Significance of Eurasian Arctic Transshipment Hubs for Arctic Shipping, undertaken by the CHNL. The overall goal of this project is to analyze which market conditions and infrastructure and logistics system is required to develop efficient transshipment hubs in the Arctic. Moreover, this thesis is relevant because little research has been conducted on transshipment hubs in the Arctic. According to prominent scholars on the field, the modeling of a new maritime transport and logistics system should be a joint exercise between the industry and research community (Gunnarsson, 2016). This statement justifies continued research on the topic, and also calls for deeper investigation at the intersection between industry actors, academics and governmental policies. This thesis aims to fill this gap, and contribute to a deeper understanding of transshipment hubs along the NSR. Since existing literature on the selection factors for transshipment hubs do not cover any special factors for Arctic conditions, the aim of this research is to investigate specific characteristics of Arctic transshipment hubs, as compared to existing hubs in warmer waters.

1.3 Research question

The thesis will revolve around the potential establishment of a transshipment hub on the western side of the NSR, and examine which conditions that needs to be in place for this hub. The research will analyze the significance of strategic location and connectivity, natural conditions, storage and port services and overall infrastructure and logistics system criteria, including both onshore and offshore infrastructure components. Through investigating the distinctive characteristics of an Arctic transshipment hub, this thesis aims to clarify which factors that needs to be in place in order to establish a successful hub along the NSR. Thus, the following research question is proposed:

What are the distinctive characteristics of an Arctic transshipment hub?

The NSR shipping system is complex and is spanning over many research areas. Thus, a clarification of the focus in this thesis is needed. I have refrained from any direct financial discussions in the research, mainly because the development is at an early stage and so the economic ramifications is yet imprecise. However, the research focus on developing different economic foundations for Arctic transshipment hubs in order to provide a feasible solution from a commercial perspective. The technical and distinct infrastructure specifications are also excluded from this research, as these topics fall outside of my own expertise as a student in business and energy management.

This research is constructed as a case study, where Kirkenes is proposed as a promising location for a transshipment hub. Herein, I will assess the enabling and constraining factors through a profound analysis of the existing development plans in Kirkenes. The first case study question then emerges:

What are the enabling and constraining factors for the establishment of an Arctic transshipment hub in Kirkenes?

As mentioned, this research has some clear limits of which aspects to include in the analysis of the case study. As the first question mostly encompass local factors, I have also decided to include a brief discussion of geopolitical impediments. This is a pressing issue, as many nations find increasing interest in Arctic affairs. For example, China seeks newfound influence in the region through large investments in different projects involving both petroleum extraction and container transshipment from its manufacturing industry (CHNL, 2019). Thus, another important question arises:

What are the geopolitical impediments for transshipment hub development in Kirkenes?

1.4 Outline of the master thesis

Chapter 1 presents the backdrop for transshipment hubs in the Arctic and their intended function in the overall NSR shipping system. The chapter also delineates the study and define the limits of the research area. Consequently, the main research question and two case study questions are proposed.

Chapter 2 consists of a brief literature review on the research topic. First, the relevant terms and logistical concepts are presented. Then, two frameworks from the literature is presented with the purpose of applying these later in the research. Finally, an overview of Arctic shipping and port development is presented to provide context to the research area.

Chapter 3 introduce the chosen research design of the case study, together with the data material and collection procedures. The limitations of the research are also explored through the assessment of validity and reliability.

Chapter 4 explore the case study in full, with emphasis on the other competing ports in the region. Then, the LNG transshipment potential is explored through a quantitative analysis.

Chapter 5 display the empirical findings from the case study material in four dimensions for port development. Conclusively, a list of enabling and constraining factors for development in Kirkenes is established.

Chapter 6 seeks to discuss the empirical findings on a deeper level with emphasis on how the said factors influence port development in Kirkenes. To conclude, the two case study questions are assessed.

Chapter 7 concludes with the generalized results from the case study and provides a framework of distinctive characteristics of Arctic transshipment hubs. Finally, the contribution of the research is presented and topics for further research is proposed.

2 Theoretical framework

In this section, I will present the most important selected literature regarding transshipment hubs, port operations and shipping. The theory is derived mainly from journal articles and peer reviewed books, but also includes “grey literature” such as governmental regulations, international conventions and reports from NGOs. This is an intentional choice, because the systems and principles affiliated with transshipment are more governmentally driven. This literature review will explain the main issues and illuminate the regulations that increasing shipping and port development will face in the Arctic. First, a standard explanation of shipping terminals is provided, to clarify the concept of a terminal. Building of this is a discussion on the features of transshipment hubs, and their role in the transportation chain. Second, the specific regulations and principles for shipping activity in the Arctic is explained, with emphasis on how these regulations affect port services in the area. Lastly, a brief discussion of existing Arctic ports is presented, in order to map the existing maritime infrastructure in Norway and Russia and the suitability for increased shipping in the two countries.

2.1 Transshipment hubs

In order to understand the role of transshipment hubs in the supply chain, I will present a broad and general definition of a terminal. In the book *The Geography of Transport systems* (Rodrigue, Comtois, & Slack, 2013, p. 127), a terminal is defined as:

Any location where freight and passengers either originate, terminate or are handled in the transportation process. Terminals are central and intermediate locations in the movements of passengers and freight. They often require specific facilities and equipment to accommodate the traffic they handle.

Moreover, three major attributes are linked with the success of transport terminals: Location, Accessibility and Infrastructure. For maritime transportation terminals location is especially important, because they are particularly contingent on local conditions (Rodrigue et al., 2013). A transshipment hub is essentially a terminal with a designated purpose: the transshipment of goods. In this context, this would be moving containers or bulk (oil and gas) from one ship to another using a port as a temporary buffer.

In the literature, there are two main categories of transshipment hubs which will be studied in this thesis. Firstly, **intersection transshipment** is where the transshipment hub acts as a point of interchange between several long-distance shipping routes. Usually, it involves the movement of cargo between large ships since deep sea routes are prone to economies of scale (Rodrigue, 2015). This would be the case for normal container traffic going through the Arctic, with intersection transshipment at each side of the NSR. More commonly, **hub-and-spoke transshipment** connects short distance feeder ships with long distance large deep-sea lines, linking regional and global shipping networks (Rodrigue, 2015). Two good examples of this is the two major shipping hubs Shanghai and Rotterdam. Here, smaller feeder ships and other transportation modes supply the hub (Shanghai) with goods before it is transshipped to very large vessels and sent onwards to Rotterdam. Then, the goods are transshipped again and distributed across the European continent (Notteboom, Pallis, & Rodrigue, 2020).

Another important aspect of any terminal or transshipment hub is the concept of intramodality. Intermodal transportation can be defined as: the movement of freight from one mode of transport to another, commonly taking place at a terminal specifically designed for such a purpose. In our case, a transshipment hub along the NSR will serve a purpose of interchange in the supply chain. The intermodal function takes place at such terminals whose purpose is to provide an efficient continuity within the transport chain (Rodrigue et al., 2013). In the case of Kirkenes this is particularly interesting, with the plans for an Arctic railway connecting the NSR to Finland and eventually the core of the European market. A detailed discussion of this aspect will be undertaken later in this thesis.

Figure 2.1: Illustration of intermodal transportation (Stock photo)

In the context of this research, the transshipment model proposed by (Milaković et al., 2018) specific for the NSR is worth examining. They propose an operational model with two hubs on each side of the NSR, and ice-going cargo vessels sailing between them. The article also claims that there is a strong interest amongst Russian authorities and stakeholders to explore this possibility further, justifying the relevance for continued research on the topic.

The main idea and the advantage of transshipment hubs is the fact that companies would not need to build their own ice-strengthened or ice-going cargo vessels. Rather, they would only need to deliver the cargo in the open water to one of the hubs and collect it at the other end for a fee. In this way, transshipment hubs could be used not only for transit shipping but also to support destination shipping along the NSR (Milaković et al., 2018). This would also ensure year-around operation of the NSR, and not just seasonal activities like today. In essence, this is a form of intersection transshipment, as previously discussed. A pressing question is if this intersection model can be combined with the hub-and-spoke model found outside of the Arctic, and this will be discussed later in the research.

2.1.1 Selection factors for transshipment hubs

Before moving on to other aspects of Arctic port development, a deeper explanation of selection factors for the establishment of transshipment hubs is needed. The literature has displayed consensus over these selection factors, and accordingly, I will present two coinciding views on this topic.

The book *Port Economics, Management and Policy*, lists Location, Infrastructure and Operations as the three main selection factors (Notteboom et al., 2020). Regarding **Location**, the proximity to major shipping routes is a key factor. This is important in order to keep both distance and costs at a rational level. In maritime shipping this distance is also called deviation. The higher the deviation from a main maritime route, the more reluctant ship owners will be to use transshipments hub (Rodrigue et al., 2013). A port seeking to act as a transshipment hub also need an intermediary location connecting feeder and deep-sea services, with geophysical factors often being the main limitation (Notteboom et al., 2020). Moreover, transshipment ports require limited inland investments since most of the cargo is transshipped from ship to ship with temporary warehousing onshore. The footprint such transshipment hub terminals have on the local or regional transport system is thus limited. In other cases, the transshipment hub can also benefit from handling a significant share of local cargo in its area. This confers the advantage to shipping operators of combining the benefits of using the transshipment hub to access transit goods combined with the benefit of a local cargo base. More succinct, an intersection transshipment hub is not dependent on hinterland access, but any added local cargo capture serves as a bonus for the operators (Notteboom et al., 2020).

Considering **Infrastructure**, the main constraint is normally berth depth. Modern transshipment hubs should have greater depth in order to accommodate modern ship drafts, coming with a technical advantage over many older ports with more constraining settings. When establishing a transshipment hub, the selection often includes the consideration of growing ship drafts and the future capacity. More precisely, about 13.5 meters (45 feet) is considered a minimal requirement to be an effective deep sea transshipment hub (Notteboom et al., 2020). A large yard area for the temporary storage of containers and bulk cargo is also a prerequisite for efficient operations, because transshipment involves consolidating shipments from multiple smaller ships to a bigger vessel in a limited amount of time. As a result, high capacity equipment both onshore and on the ships is also essential in order to optimize the flow of containers or liquid bulk cargo between ship and port (Notteboom et al., 2020).

Since transshipment is an activity that does not add any value to the cargo, costs and productivity are highly important factors for the **Operations** of a transshipment hub. Transshipment costs of $100 per twenty-foot equivalent unit (TEU) are considered to be within an acceptable range, and costs below $100 improve the competitiveness of the hub. Since ships aim to spend as little time as possible at the hub (turnaround time), a high level of productivity for the terminal equipment is needed. Moreover, most terminals are owned in whole or partly, by a global terminal operator which are efficiently using these facilities and have flexibility in deciding future developments, ensuring a high berth productivity. If operated properly, transshipment hubs tend to be responsive and adaptable to market changes, with the right service level needed at all times (Notteboom et al., 2020).

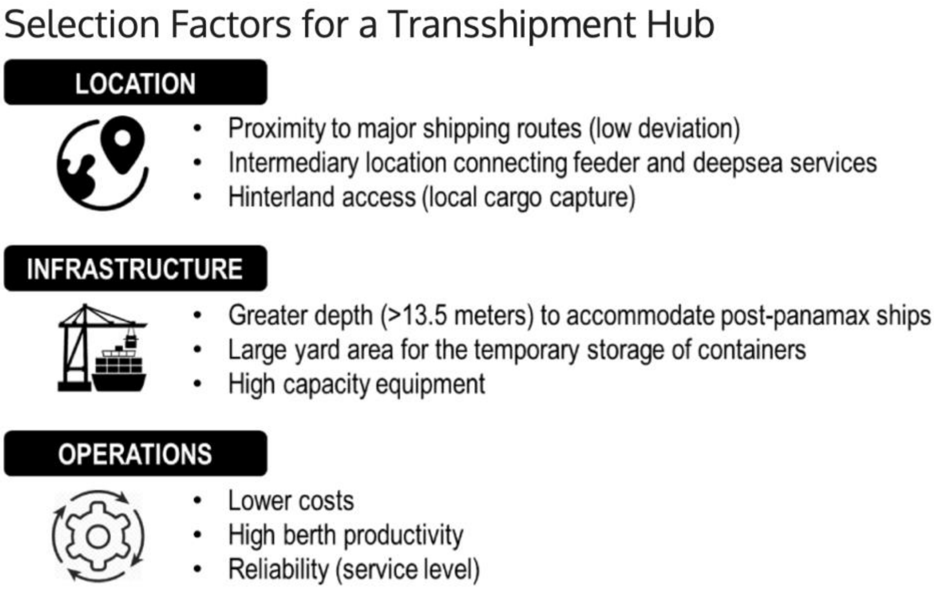


Figure 2.2: Selection factors for transshipment hubs (Notteboom et al., 2020)

The previous model from Notteboom focus mainly on the “hard infrastructure” of transshipment hubs. That is, the physical and operational aspects of transshipment hubs. The next model is an important supplement to the discussion, where Gritsenko & Efimova in the journal Polar Geography have developed a new model for Arctic port development (fig. 2.3). This model is taking more of a “soft infrastructure” approach, where they hold that port development can be characterized by four structural dimensions: **Physical** (location and materiality), **Economic** (finance and competition), **Institutional** (politics and administration), and **Environmental** (natural conditions and anthropogenic influences). Further, the authors claim that these four structural dimensions are the sources of rules and resources, in other words, the factors that determine port activities (Gritsenko & Efimova, 2017). This is also the framework that will be applied to the case study of Kirkenes (more on this in chapter 3).

As shown in the figure, this framework mostly coincides with the other literature, with some additional interpretations, especially within political and environmental factors. This model is developed for Arctic ports, but does not encompass transshipment operations. This is contrasting to the previous model, which focus on transshipment hubs, but not in Arctic conditions.

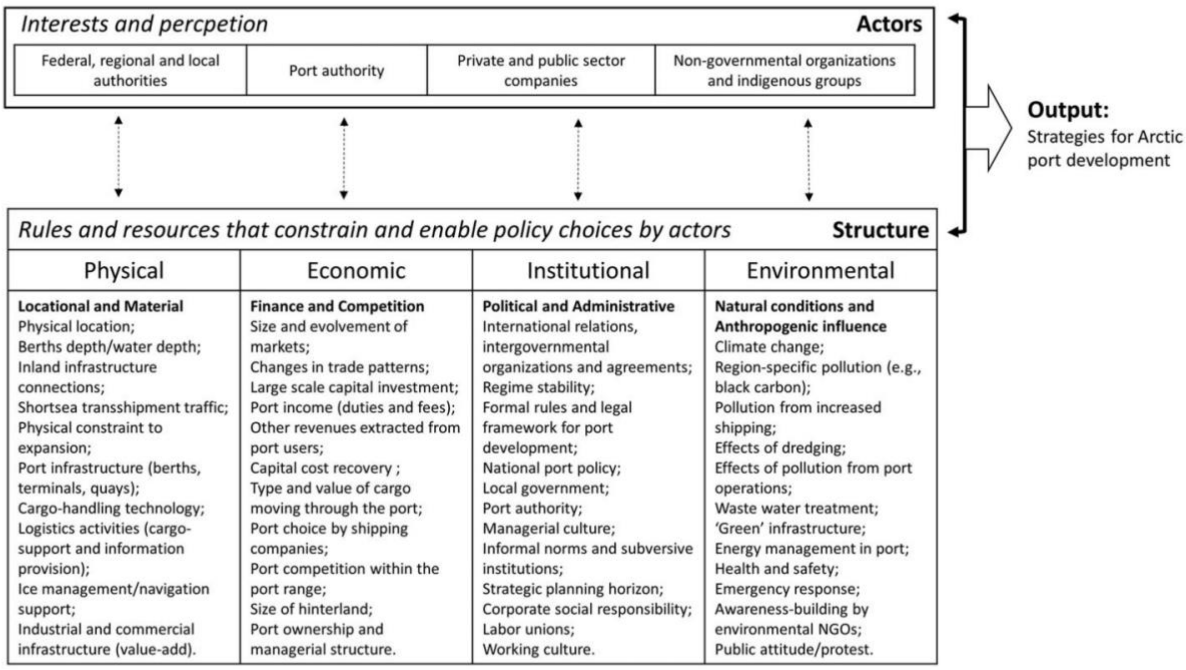


Figure 2.3: Analytical model for Arctic port development (Gritsenko & Efimova, 2017)

As just mentioned, figure 2.2 focus particularly on transshipment hubs, whereas figure 2.3 is a general framework for Arctic port development. Thus, it would be most interesting to see how the model from Notteboom et al. can be adapted to encompass transshipment hubs in Arctic conditions. The goal of this master thesis is to extend the model from Notteboom et al. with findings from the case study of Kirkenes in order to produce a model with the distinctive characteristics of transshipment hubs in Arctic conditions. The result of the research will not be a full theoretical model, but instead an exploration of the distinguishing factors for Artic transshipment hubs, as compared to "normal" transshipment hubs in southern waters.

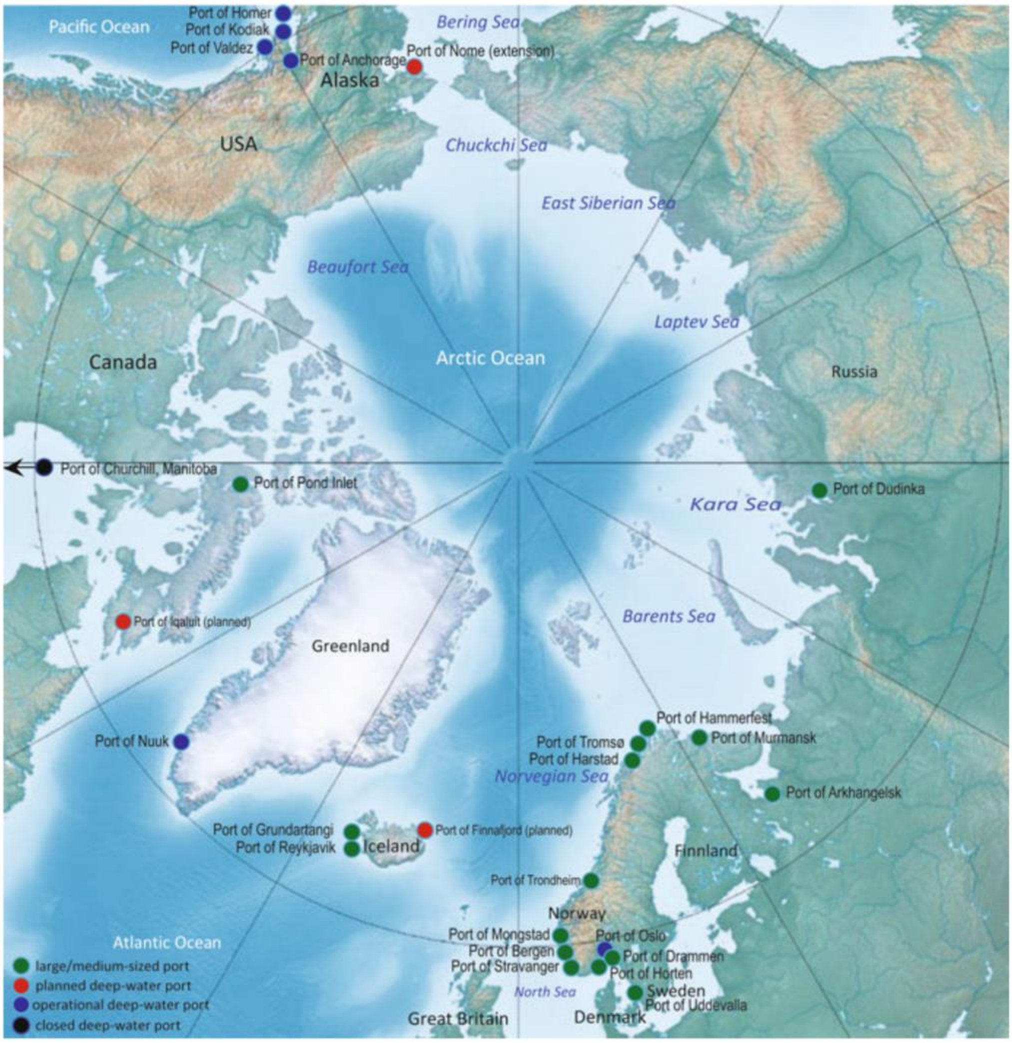
2.2 Arctic port development

This section will present a general picture of Arctic port development with particular emphasis on Norway and Russia, as these two countries are involved in the Northern Sea Route shipping system. A deeper discussion of Kirkenes and its competitors is provided in chapter 4. The development of Arctic shipping as an international transport system in the future will require significant investments in new polar port infrastructure. As of now, the literature points out two transport directions that are actively developing in the Arctic; the export of crude oil and liquid natural gas (LNG) and transit shipping during the summer navigation period. Accordingly, it is essential to develop Arctic ports that can handle these kind of operations (Garibin & Ol'Khovik, 2019).

The literature has identified three obstacles to the future success of maritime Arctic port development. Firstly, maritime safety has been, and still is an issue, undermined by low satellite coverage, poor navigational information, and low search and rescue capacity (Østreng et al., 2013). Second, indirect costs associated with Arctic operations, such as icebreaking and ice management, pilotage, insurance in combination with little availability of ice-strengthened equipment have negatively impacted financial viability (Gritsenko & Efimova, 2017). Lastly, the absence of suitable onshore infrastructure, primarily ports, and terminals is as an obvious obstacle. Although there is extensive literature on port development worldwide, little research has been applied to assess the present conditions and future potential for the development of Arctic ports (Gritsenko & Efimova, 2017).

Norway is already one of the best prepared Arctic countries with respect to port infrastructure. As of today, Norway has three medium sized ports in the Arctic that are well oriented toward Arctic use, including some deep-water ports (Pahl & Kaiser, 2018). On the other hand, Russian ports require modernization to be able to host and provide service to international traffic, such as deep-draft access, refuge and salvage services as well as cargo handling and passenger/crew facilities. Currently, there are no Russian Arctic deep-water ports (Gunnarsson, 2016). However, Russian ports are moving ahead of its Arctic competitors in terms of safety and security, making both potential tourism and other economic and military activities less risky (Pahl & Kaiser, 2018).

As shown here the literature seems to disagree on the position of Norway and Russia, in terms of their ability to accelerate activities along the NSR. At the moment, Norway has the best onshore infrastructure in the Arctic, while Russia, with superior ice breaker capacity has the best preconditions for safety and security.



Map 2.1: Operating and planned medium-sized and/or large-sized ports in the Arctic Ocean (Pahl & Kaiser, 2018)

In Russia, the most important port along the NSR is the port of Murmansk, which is located on the coast of the Barents Sea, in the Kola Bay, and constitutes the biggest port hub in the western part of the Russian Arctic. This port serves as an intermediary function in the import and export of cargo between domestic and international ports (Pastusiak, 2016). More importantly, it also plays an important role in the export of minerals and fossil fuels from the Russian Arctic. The region has now become a key area for exporting both oil and gas (including LNG) from the Kola Bay and Kara Sea areas. The fairway to the port however, is only 10 meters deep, which may cause limitations to future development with larger ships. The port of Murmansk is also an important icebreaker base with a number of operating shipyards (Pastusiak, 2016).

2.3 Shipping in Arctic conditions

Of the many regulations that influences shipping activities, the Polar Code is the most dominant in Arctic waters. The code was constructed by the United Nations body International Maritime Organization (IMO) in 2014 and came into force in January 2017. The main requirements are related to safety, protection of the environment, and seafarer competence. The purpose of the code is to: "…provide for safe ship operation and the protection of the Polar environment by addressing risks specific for the Polar regions and not explicitly considered by other instruments of the Organization." (IMO, 2014). The IMO Polar Code covers matters relevant to Arctic and Antarctic shipping, from ship design, construction, and equipment to operational and training concerns. Confirmed by the accredited registrar DNV GL, the Polar Code also address matters such as ship certification and design, safety equipment and systems and additional environmental regulations (DNV GL, 2020).

Most importantly, as the Polar Code comes into action ships operating in the Arctic will be required to lower CO_2, NO_x and sulfur emissions drastically. As of today, liner shipping is heavily reliant on heavy fuel oil (HFO) which comes with massive sulfur and CO_2 emissions. In order to mitigate the local emissions of black carbon, the IMO has set a cap for sulfur emissions in the Polar Code (IMO, 2014). With a future ban on this squalid fuel in the Arctic, shipping companies are likely to switch to LNG propulsion, because it burns much cleaner in the engine, and consequently eliminates all sulfur emissions and reduce other NO_x particles drastically. Thus, Arctic ports will need to accommodate new facilities for LNG bunkering in order to provide fuel to the ships that operates in the Arctic.

At the time of writing, the IMO is now moving forward with a ban on Arctic HFO, as its Sub-Committee on Pollution Prevention and Response agreed on a draft text which proposes a ban on the use and carriage of HFO by the middle of 2024. However, it is also clear that some exemptions will be made, with a complete ban not effective until the year 2029 (Humpert, 2020b). HFO represents the most-consumed marine fuel in the Arctic accounting for almost 60 percent of all fuels and environmental organizations now hope that a ban from the IMO will trigger a green shift to LNG fuels, despite the extensive timeframes (ICCT, 2017).

2.3.1 Ice breaker capacity

A key prerequisite for shipping in Arctic waters is ice breaker support. Generally, ice breakers carry out the following supporting services: maintenance of shipping tracks in ice-covered waters, close escort of shipping in ice, search and rescue, environmental response, harbor breakout and electrical power supply. They can also serve as small cargo ships themselves, with re-supply and logistic support functions for rural settlements in the Arctic (Østreng et al., 2013). The vast distances in the Arctic may impact the extent and consequence of an accident. Thus, the distance to ports is a safety concern to the shipping industry, particularly in areas, such as the Arctic, where maritime infrastructure is sparse and disconnected. The ability for authorities to reach a ship, provide search and rescue operations, salvage a wreck and clean up oil spills is essential, in order to limit the impact from a potential catastrophe in the fragile ecosystems in this part of the world (Christensen, Georgati, & Arsanjani, 2019).

At the operational level, the Arctic ice causes reduced speeds, poorer economy detours and damage to ships. In addition, navigation is usually conducted by ice breaker escorted convoys. Moreover, the supply of ice breakers is likely to constitute hindrance to growth of Arctic shipping due to ageing of the ice breaker fleet combined with few new ships being constructed (Tiina Kiiski, 2015). Aging of the ice breaker fleet and the forthcoming of new vessels will have implications for major logistical hubs in the Arctic, as these ports will need to accommodate maintenance service for icebreakers. This is further complicated by the Russian nuclear-powered fleet, as these ships requires engineer skilled in nuclear maintenance and safeguarding.

To solve the issue with an aging icebreaker fleet, Russia is also investing heavily and is taking delivery of three powerful new generation ice breakers in 2020. The main activities of these new vessels are icebreaking support through the NSR and to the frozen ports of Russia, together with support for high-latitude research expeditions such as expeditions to Polar research stations (Rosatomflot, 2020). The literature articulate that Russia has significantly invested in building icebreakers and its current number of vessels available is certainly able to easily handle the current level of traffic. This has positioned Russia as the leading facilitator for future activity in the Arctic, especially on shipping and port operations along the NSR, with more capabilities already lined up (Dalaklis, Drewniak, & Schröder-Hinrichs, 2018).

A recent and relevant case of development on this field is the Yamal LNG and Arctic LNG projects in Russia. There, gas company Novatek has plans to open four new LNG projects around the Yamal Peninsula in this decade. This adds to the already ongoing projects in the area, to an estimated total of 80 million tons produced annually by 2030 (Humpert, 2020a). Instead of relying on regular ice breaker support, Novatek aims to operate ice-strengthened vessels. To enable the transport of LNG, they will rely on ice-capable Arc7 LNG carriers. Arc7 is type of ice class carrier classified by the Russian Maritime Register of Shipping (RMRS). According to RMRS, Arc7 is capable of independent navigation in cohesive annual Arctic ice with a thickness of up to 1,4 m in the winter-spring season. When sailing in the canal behind an icebreaker they can handle Arctic ice up to 2 m thickness.

Most interesting, is that Novatek will shorten the distance these special built vessels have to sail by constructing transshipment hubs at each terminus of the NSR, just as proposed by Milaković et al. (Humpert, 2020a). Instead of having to sail the Arc7 vessels all the way to the global market, they will sail to the end of the NSR and transfer the LNG to normal carriers which then undertakes the rest of the journey. This shows the realism of such a model, only with focus on tanker transport, instead of container traffic. It would be interesting to see how both tanker and container traffic can be combined at a single intermodal transshipment hub, and is something I will discuss in the case study.

2.4 Summary of literature

The aim of this literature review has been to clarify transport logistics concepts, such as a terminal, intermodal transportation and transshipment hubs. The difference between hub-and-spoke and intersection transshipment has also been elucidated. Most importantly, the selection factors for transshipment hubs has been discussed in great detail from different, but congruent sources of literature. These will form the framework for further analysis, as there is little literature on transshipment hubs in Arctic conditions. The first model will be applied to the case of Kirkenes, and the second will be expanded with the case study findings to discover the special characteristics of Arctic transshipment hubs.

Furthermore, a brief introduction of Arctic port development in Norway and Russia were presented. In order to fully understand the case and its context, a more detailed description will be presented in chapter 4. Moving on, special legislation and prerequisites for arctic shipping were also introduced. Most important is the IMO Polar Code, which requires compliance from all actors in the Arctic by 2029. Ice breaker support and its impact on the logistical systems were also explained with emphasis on how Russia is increasing its capacity in order to assert its dominant position in the region. Lastly, the Yamal LNG project and its logistics system was as an example of how expensive special built ice carriers can be best utilized by making use of transshipment hubs at each side of the NSR. These operations are also a part of the case study in this master thesis.

3 Methodology and research design

In this chapter, I will explain the chosen research design for the case study. A description of the data collection methods is also provided, in order to clarify both qualitative and quantitative data sources. Lastly any limitations to the research is also explored, based on the assessment of validity and reliability.

3.1 Research design

The essence of research design is about making choices about what will be observed, and how one observes it, also known as the study object. There are however, many other choices to be made and features to be specified. A research design should explain and justify what data is to be gathered, how and where from. It also needs to clarify how the data will be analyzed and how this will provide answers to the research questions put forward by the researcher (Easterby-Smith, Thorpe, Jackson, & Jaspersen, 2018). For this master thesis, I have chosen a single case study of Kirkenes, which will be described in chapter 4.

The renowned scholar on case studies, Robert K. Yin states that *"a case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident"* (Yin, 2018, p. 13). In other words, a case study is fitting if you want to understand a real-world case and assume that such an understanding is likely to involve important contextual conditions pertinent to the case. Further, Yin adds that this method is in contrast with an experiment, where the phenomenon is supposed to be isolated from its natural context (Yin, 2018).

With reference to the notes from Yin, a case study approach of Kirkenes, would enable me to explore transshipment hub development within the Arctic context. Based on a case study, this will inherently be a constructionist research design. Such designs are linked to the relativist and nominalist ontologies, which means they start from the assumptions that observations are potentially subject to very different interpretations. This conveys that the job of the researcher should be to illuminate different actualities and to establish how various claims for truth and reality become constructed in everyday life (Easterby-Smith et al., 2018).

Further, this research will also be based on a grounded theory approach. This is when the theory emerges from the data itself or from the interaction with data. Grounded theory, in its different appearances is one of the most popular qualitative methods in business and management research, and fits well with an exploratory case study (Easterby-Smith et al., 2018).

According to Yin, there are normally five important components to a case study research design (Yin, 2018):

1. A case study's questions
2. Its propositions, if any
3. Its case
4. The logic linking the data to the propositions
5. The criteria for interpreting the findings

Most importantly, one need to identify the case to be studied and define the boundaries of the case study. I have chosen Kirkenes and their plans to establish an NSR terminus transshipment hub as my case study, and will explain the case in detail in chapter 4. The propositions have already been discussed at the end of the literature review.

The logic linking the data to the propositions will mostly rely on a technique called explanation building. The iterative nature of explanation building involves making an exploratory proposition, comparing the data from the case study against this statement, revise the initial proposition and compare other details of the case against the revision (Yin, 2018). Notice that this process is partly deductive (based on the propositions at the start of the case study) and partly inductive (based on the data from the case study). Built on this, Yin says that if only a single-case study is conduced, the procedure would not necessarily end conclusively (Yin, 2018).

The fifth step revolves around how you analyze the collected data, and it is important that you have a systematized approach to this strategy. Here, Yin suggests that you search for patterns and insights, and put them into different arrays of different themes. For this purpose, I have developed a predefined coding scheme to categorize the data. One can also make use of visual displays, which I use throughout the thesis with maps and other graphics to better present the findings.

3.2 Case study questions

The main research question of this thesis is already presented in the introduction as:

What are the distinctive characteristics of an Arctic transshipment hub?

This case study will make use of critical case sampling. This sample strategy is normally used to narrow the range of variation and focus on similarities. This kind of sampling can facilitate logical generalizations with the reasoning “If this is valid for this case, then it applies to all cases” (Flyvbjerg, 2011). With this reasoning, I have developed two separate case study questions and since I argue that this is a “critical case”, I can extract and generalize the results from these case study questions to answer the main research question. The objective of this case study is to undertake a profound exploratory research of Arctic transshipment hubs, where Kirkenes is proposed as a fitting location for such a hub. There are many reasons for this, some arguments already presented in the introduction and the rest in chapter 4.
The proposed case study question reads as follows:

What are the enabling and constraining factors for the establishment of an Arctic transshipment hub in Kirkenes?

Through this discussion, the case study aims to discover any special factors for a transshipment hub to be established in Arctic conditions. Building of the literature review, this research will apply the framework of Gritsenko & Efimova to the Kirkenes case. Through this case study the four dimensions of port development will be analyzed in the context of Kirkenes and explore the local possibilities and barriers. Consequently, the physical, economic, institutional and environmental dimensions will be analyzed.

A brief market analysis to investigate the demand for a transshipment hub will also be conducted, through a study of potential LNG transshipment activity as a commercial and profitable basis for the Kirkenes transshipment hub. However, these operations will require multilateral cooperation and conjoint acceptance between the Arctic nations. Another question then arises:

What are the geopolitical impediments for transshipment hub development in Kirkenes?

3.3 Data collection procedures

This research is designed as an embedded single case study with multiple units of analysis. For example, a single case study can map formerly inaccessible phenomena, demonstrate the importance of the research questions or inspire new ideas. Examples of different units of analysis includes organizations, partnerships, projects and processes (Miles, Huberman, & Saldaña, 2014). In this case study, the units of analysis are the different reports and documents related to port development in Kirkenes. They also include information from other sources such as international and national legislation. Another important part of the study is the market analysis, where the LNG transshipment operation is the central unit of analysis.

Moreover, there are some challenges in identifying and applying the appropriate purposeful sampling strategy for a study. Often, the range of variation in a sample from which purposive sample is to be taken is often not really known at the outset of a study. Consequently, an iterative approach of sampling and re-sampling to draw an appropriate sample is usually recommended to make certain the theoretical saturation occurs (Miles et al., 2014). That saturation process may be determined prior to the research on the basis of an existing theory or conceptual framework, or it may emerge from the data themselves, as in a grounded theory approach (Palinkas et al., 2015). The latter approach with grounded theory will probably be most prominent in this case study.

The data collection procedures should cover the roles of people to be interviewed together with any documents to be reviewed. First, I undertook a research trip to Kirkenes, for some preliminary insights and to find the exact scope of the case study. This exploratory phase was done in order to meet with people central to the Kirkenes port development. These informal interviews and meetings involved industry actors such as the CEO of the Tschudi Group, a Norwegian shipping and logistics company. Their subsidiary Tschudi Arctic Transit offers transshipment services for LNG, crude oil and petroleum products and during the past years, transshipments have been carried out by ship-to-ship solutions at Sarnes Bay, near the North Cape and Kirkenes. Further, an excursion to Murmansk allowed me to visit the information office of CHNL and collect the quantitative data needed for the LNG analysis. There, I had informal meetings with the people responsible for collecting the NSR transit data in order to get a deeper understanding of the data material. Meeting with the head of the CHNL information office also shed light on the Russian perspectives and thoughts on future NSR development.

Moving on from the exploratory phase, I did a context and market analysis of Kirkenes. Here, the central output is the LNG export study done with primary data from the CHNL. This is the only quantitative analysis in this thesis, and is included to add feasibility to the case as a whole. The last phase in this research is the analysis of different reports and documents that describes the port development plans in Kirkenes. This is organized through the framework of Gritsenko & Efimova (figure 2.3 from the literature review) with its four different dimensions. The data collection method applied in the case study is qualitative coding and will be described in the next section.

*Figure 3***Error! No text of specified style in document.***.1: The research process and its different phases*

3.3.1 Coding scheme for document analysis

The central data material of this case study is the different governmental and industry documents related to port development in Kirkenes. There are multiple reports available from governmental entities such as the Norwegian public roads administration (Statens Vegvesen) and the Norwegian Coastal Administration (Kystverket). These reports are commissioned from Norway's parliament and government, which also order reports from external actors such as Multiconsult. Private actors also show initiative in the port development in Kirkenes and have published reports and analyses. Governments from other countries (notably Finland) have also published reports on Arctic Railway development. Lastly, documents from entities such as the Arctic Council and the IMO are included in the analysis to incorporate the relevant multilateral legislation.

Following is an overview over the most important documents and its authors:

Name of document	Author	Reference in text
Farledsutredning KVU Kirkenes	Norwegian Coastal Administration	Kystverket, 2015
KVU E6 Høybuktmoen - Kirkenes	Norwegian Public Roads Administration	Statens Vegvesen, 2015
Konseptskisse stamnetterminal	Multiconsult	Multiconsult, 2019
Planleggingstjenester havnearealer Høybukta vest - markedsmuligheter	Multiconsult	Multiconsult, 2018
An Arctic railway vision	Sør-Varanger Utvikling	Sør-Varanger Utvikling, 2018
Arctic Railway Rovaniemi - Kirkenes	Arctic Corridor	Arctic Corridor, 2019
Arctic Ocean Railway Report	Finning Transport Infrastructure Agency	FTIA, 2018
Final Report of the Joint Working Group Between Finland and Norway on the Arctic Railway	Finnish and Norwegian Governments	LVM, 2019
Joint Barents Transport Plan	Barents Euro-Arctic Council	Barents Euro-Arctic Council, 2019
Nordområdestrategi - mellom geopolitikk og samfunnsutvikling	Norwegian Government	Arctic Strategy, 2017
Nasjonal Havnestrategi	Norwegian Government	National Port Strategy, 2015
Nasjonal Transportplan	Norwegian Government	NTP, 2017

Table 3.1: Data material of the research: reports and documents to be analyzed

In order to analyze and extract relevant data from these documents, I will make use of qualitative coding. A code is a word or a short phrase that summarizes the meaning of a chunk of data, such as a statement or a sentence in the data material (Charmaz, 2014). However, a code is more than a filing system. Coding is also an interpretative exercise; it involves not simply labelling data but also linking them, thereby leading researchers from their data to the idea, and from the idea to all the data pertaining to that idea (Miles et al., 2014).

Most approaches to analyzing qualitative data involve some kind of coding method. In grounded analysis, they are usually the first step for the development of categories and concepts (inductive coding). Moreover, in content analysis, codes are often used to frame data according to a predefined coding scheme (deductive coding). As the research progresses, researchers compile an annotated list of codes, and later a more systematic codebook that includes definitions and examples for all codes (Saldaña, 2013).

The renowned expert on qualitative coding Johnny Saldaña suggests that the codes should be divided into categories and eventually themes or concepts. Applying a deductive coding approach, I have predefined a coding scheme that builds of the theoretic framework at use in this case study. Consequently, the four dimensions from the framework of Gritsenko & Efimova can be found in the scheme (see appendix) with the different categories. Seeing that I have coded in both Norwegian and English language, I have not included the actual codes at work in the table.

This case study uses a sampling technique called descriptive coding. Descriptive coding summarizes in a word, most often as a noun the basic topic of a passage of qualitative data. Saldaña claims that description is the foundation for qualitative inquiry, and the primary goal of descriptive coding is to assist the reader to see what you saw and to read what you read in general (Saldaña, 2013). When analyzing the reports of this case study, I have developed three categories for each dimension based on the data material and my informal interviews from the exploratory phase. The scheme can be found in the appendix and contains these categories to at least give an idea of how I have processed the data material. This coding scheme is only intended as a tool for myself as a researcher, and the results of this content analysis is fully presented in chapter 5; empirical findings.

Lastly, I want to argue for choosing a deductive approach with a predefined coding scheme and the reasoning behind this. Some methodologists, among them Saldaña advise that such an approach should be used in order to harmonize with the study's conceptual framework and research goals (Saldaña, 2013). Seeing that this coding scheme is used to categorize reports into an already existing framework of Gritsenko & Efimova, I think this is the most natural approach. After the categorization of the case information, I can then proceed to discuss the findings in the succeeding chapter.

3.3.2 Quantitative data

The quantitative data has been brought in to this research in order to show a selection of the current traffic on the NSR. As an example of the traffic demand, I have chosen to analyze the traffic of LNG carriers from 2018 and 2019. This is important because it is the only primary data used in the research, that I have collected with great help from the Centre for High North Logistics (CHNL). LNG export is chosen as a sample because Russian companies already operates ice-classed vessels in the Arctic, with the need for transshipment of this LNG before transporting the gas beyond Arctic waters to the global market. Thus, the traffic of LNG export in the Arctic gives a factual and valid analysis of the traffic base of a resource based transshipment hub.

In order to track any vessels position, real time AIS data is used. AIS is an automatic identification system enforced by the International Maritime Organization. The basis of CHNL's analysis is AIS data from the Canadian company exactEarth and their ShipView tool (www.exactearth.com). Transmitters onboard every major vessel worldwide send out information every 5-20 minutes about the ship's identity, position, speed and course. For example, a journey from Sabetta to Rotterdam in winter takes 10 days, during which AIS data is recorded about 1400 times. In our case, the information on the movement of ships is derived from the official website of the Administration of the Northern Sea Route (www.NSRA.ru). From their databases, one can find all the ships with permission to sail on the NSR, with a designated number from the Administration of the Northern Sea Route. Then, on basis of the list of NSR transits, combined with the movement of ships on the NSR (daily ship reports), an actual list of ship voyages is formed by the CHNL.

The result of this process is multiple .cvx files containing all relevant information for analysis. Moving on, these files are processed using the SAS Planet mapping program. A set of tracks is formed on a map for each chosen vessel operating on the NSR. This allows for the visualization of shipping traffic with specific parameters, for example all LNG carriers and their voyages. The data tool Power BI is also used in order to generate charts and graphs for expedient reporting of the results.

3.4 Validity

In a constructionist research design, the question of validity comes down to insuring that a sufficient number of perspectives have been included. In essence, validity is to which extent a test accurately measures what it is supposed to measure. Apart from including multiple sources of evidence, another tactic to increase the validity of the research is to have the draft case study report and preliminary results reviewed by key informants (Yin, 2018).

Further, Yin presents two divergent types of validity, internal and external. Internal validity, also known as credibility is concerned with if the conclusion of the research is correct, and if you have identified the correct cause. Internal validity is tackled in the data analysis part of the research process and can be enhanced by doing pattern matching, explanation building and addressing rival explanations. External validity, also known as transferability is concerned with if the results from the study can be generalized. External validity is improved by a robust research design and can be enhanced by replicating the study, use established theory and describing the context (Yin, 2018).

Regarding this case study, multiple measures have been taken in order to improve the validity of the research. In the introduction of this thesis a detailed explanation of the context of the NSR and transshipment hubs is given in order to understand the relevance of the research and also increase the validity. Continuous dialogue with key informants from my CHNL network and industry actors will also recognize any future inclinations.

Another action taken is to supplement the case study with a quantitative analysis of LNG traffic analysis. As any transshipment hub needs a sufficient traffic base for commercial operation, an analysis of potential traffic is of great value. This touches on the financial aspects of establishing a transshipment hub, and will help to add feasibility to the analysis. All together, these measures should sustain a sufficient level of validity, even with a single-case study like this research.

3.5 Reliability

The objective of reliability is to ensure that if another researcher follows the same procedures as described by an earlier researcher and conducts the same study, the later researcher will arrive at the same findings and conclusions. Overall, the goal of reliability is to minimize the errors and biases in a study. Thus, in a constructionist design, the question comes down to if similar observations be reached by other observers (Yin, 2018). Further, Yin propose some ways to enhance the reliability, such as doing the study in operational steps. He also holds that documentation of the study is essential and to describe the data sources properly.

The data in this study is considered to be largely reliable for multiple reasons. First of all, the secondary data originates from governmental bodies as described earlier. These are both standardized and coming from public entities, should be free of any bias or other interests. Other documents and data originate from shipping industry leaders with many years of experience of transshipment. Many of these reports are extensive and provide thorough descriptions of the context and background material used in the reports. Thus, any later researchers that uses the same reports for future studies should arrive at the same conclusions.

The quantitative data of this study is collected by myself in cooperation with the CHNL information office. This data is continuously cross-checked with their sources from the Northern Sea Route Administration. Their database is also considered to be highly reliable with multiple users of the data for research projects around the world. CHNL also have four people working full-time correcting errors, removing any double data entries and bugs in the data material. In total, these measures should ensure that the reliability of the study is sufficient for this research format as a master thesis.

3.6 Methodological limitations

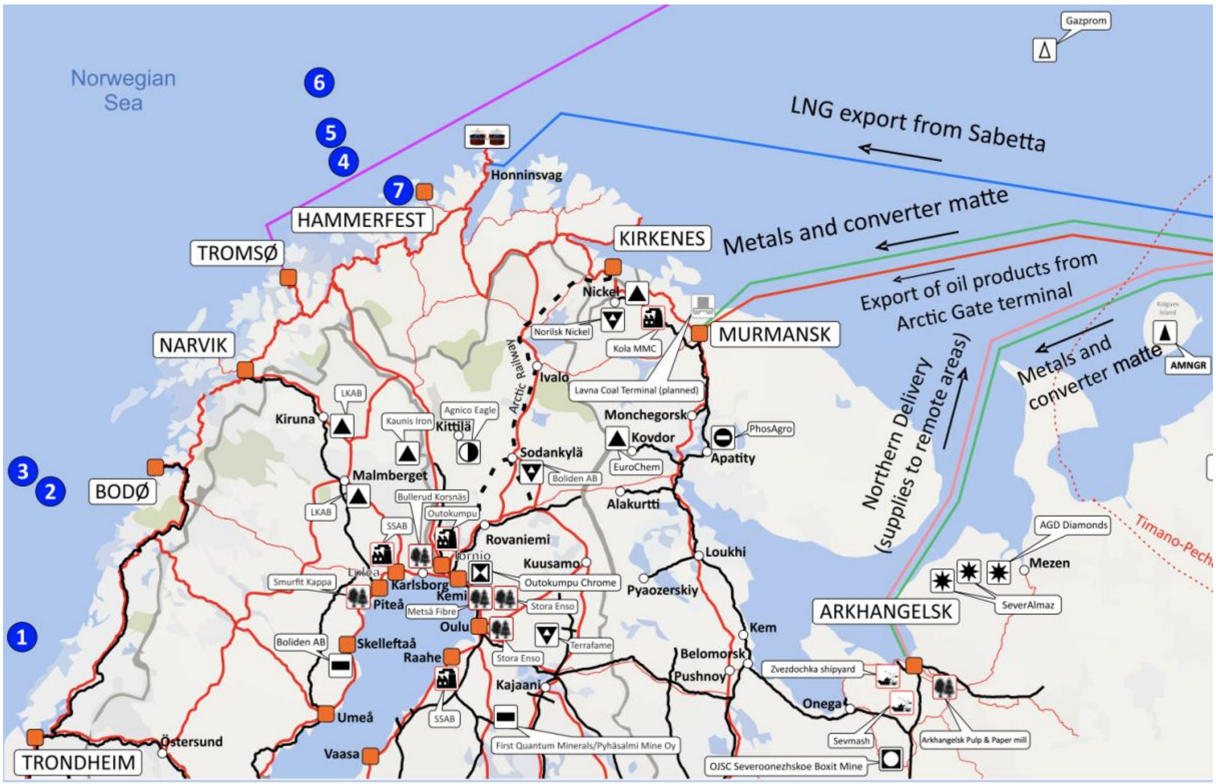
As just discussed, both the validity and reliability of the research is deemed sufficient, but the empirical results reported herein should be considered in the light of some limitations. Firstly, I had planned to include systematic interviews with different actors and shipping companies in order to increase the validity and improve the study. For practical reasons, this has not been possible to organize due to the situation in Norway and the rest of the world the last months. Being unable to meet interviewees in person, combined with the fact that these people are highly busy with their own difficulties, I have refrained from any interviews in this research. However, I am relying on publicly available reports which are consistent and will yield the same results regardless of the research design and approach. Moreover, a multiple case study including other ports than just Kirkenes would be favorable, but I have chosen to limit this research to just Kirkenes because of language barriers, data insecurity and the practical limitations already discussed.

This study mostly focus on Norway and it would be interesting for future research to include other Arctic nations such as Russia or Iceland. Again, these choices are made from time and language constraints, with Russian policies and plans being especially hard to analyze. Refraining from any direct economical and geopolitical investigations, this research will instead focus on other drivers such as the infrastructure and development plans. However, to add feasibility to the study, a study of Arctic LNG export will be undertaken, to add some economic aspects regarding the traffic base of a transshipment hub in Kirkenes. The reason for limiting this analysis to only LNG is that a complete study on all types of cargo on the NSR would be a whole different research project in itself.

Lastly, I am compelled to explain any auspices linked to this research. As already mentioned, this research is written in cooperation, and with support from the Centre for High North Logistics. As a master thesis fellow, I have received a scholarship for data collection support, and also relied on their researchers and network for undertaking this study. Thus, this master thesis is part of a bigger research project focused on NSR shipping.

4 The case of Kirkenes: competitors and opportunities

In order to get a clear understanding of the research, a presentation of Kirkenes and the context is needed. Kirkenes is chosen as a case study for multiple reasons. Firstly, it is the easternmost port of Norway, and sits right in the shipping lane of future NSR traffic. It is also strategically located on Norway's border to Russia, less than 150 km from Murmansk. Kirkenes is also centrally located in an area of the Arctic with many resources, such as fish, oil and gas and minerals close by. More interesting is also the plans for an "Arctic Corridor", a proposed transport corridor linking the Finnish city of Rovaniemi and Kirkenes via railway connection. This would establish a direct land connection between the western end of the NSR and Europe, and make a transshipment hub in Kirkenes even more significant. Lastly, there are already many public plans studying the possibility of expanding and relocating the port of Kirkenes. Although on an early stage, these reports will be an interesting subject of research, and this thesis will examine the governmental and private initiatives for port development in Kirkenes.



Map 4.1: Shipping lanes, ports and terminals and other transport infrastructure in the Barents Sea (CHNL, 2019)

Map 4.1 shows the strategic location of Kirkenes and different kinds of export possibilities. Particularly, the LNG export from Sabetta via transshipment outside of Honningsvåg, Finnmark is of great interest and will be discussed in the case study.

4.1 Other transport hubs in the region

In order to understand this case study, one should also understand the context of Kirkenes in NSR shipping. There are many ports in the area battling for becoming the foremost transshipment hub on the western side of the NSR. The largest and most prominent competitors is the port of Murmansk in Russia and the port of Tromsø in Norway. Kirkenes, being the smallest of the three with around 10 000 inhabitants consequently also possess the smallest port. Being relatively isolated, with large distances to small towns of similar size, the hinterland access from Kirkenes is also limited.

Year	Kirkenes	Tromsø	Murmansk
2017	133 000	1 218 300	51 700 000
2018	78 200	1 285 700	60 700 000

Table 4.1: Amount of goods (tons) handled by select Barents ports (Source: the ports' annual reports)

Murmansk is by far the biggest city in the Barents region, which is also clear when you look at the amount of goods shipped through its port. Table 4.1 shows the amount of goods shipped for these three cities, but the numbers for Murmansk includes multiple ports that makes up the Murmansk Transport Hub. Moreover, a very large portion of the goods to and from Murmansk is coal and oil products, which makes the numbers remarkably high and hard to compare to the other ports. Traditionally being focused around shipment of coal, oil products from Siberia is beginning to accumulate large volumes through the port, and accounts for most of the growth in the recent years (Staalesen, 2016). This manifests its position as the most important shipping hub in the region, and its development will certainly play a central part in future development of NSR shipping.

The idea of shipping containers to an Arctic port and sending TEUs on rail southwards is an interesting concept and could drastically change a transshipment hub in the region if the plans are realized. In this regard, only Murmansk is the real competitor to Kirkenes. Unlike Kirkenes, Murmansk already has a railway connection southward all the way to Moscow through St. Petersburg. This railway is already operating, and is set to be extended with a second track by 2022 (Nilsen, 2020). This also shows the ambition Russia has with their Arctic ports, as these investments follows other recent upgrades of the port of Murmansk.

In Norway, Tromsø seems to be the only viable competitor to the proposed transshipment concept to increase NSR shipping. There are multiple factors that would enable Tromsø to take a much more active part in the future activity on the NSR. Firstly, both the city and port of Tromsø are considerably larger than Kirkenes, with a population of around 77 000. This also enables a greater hinterland access, with more of the goods going through the transshipment hub landing in the local area. This factor would possibly also strengthen the financial margins of a transshipment hub in Tromsø compared to much smaller places such as Kirkenes.

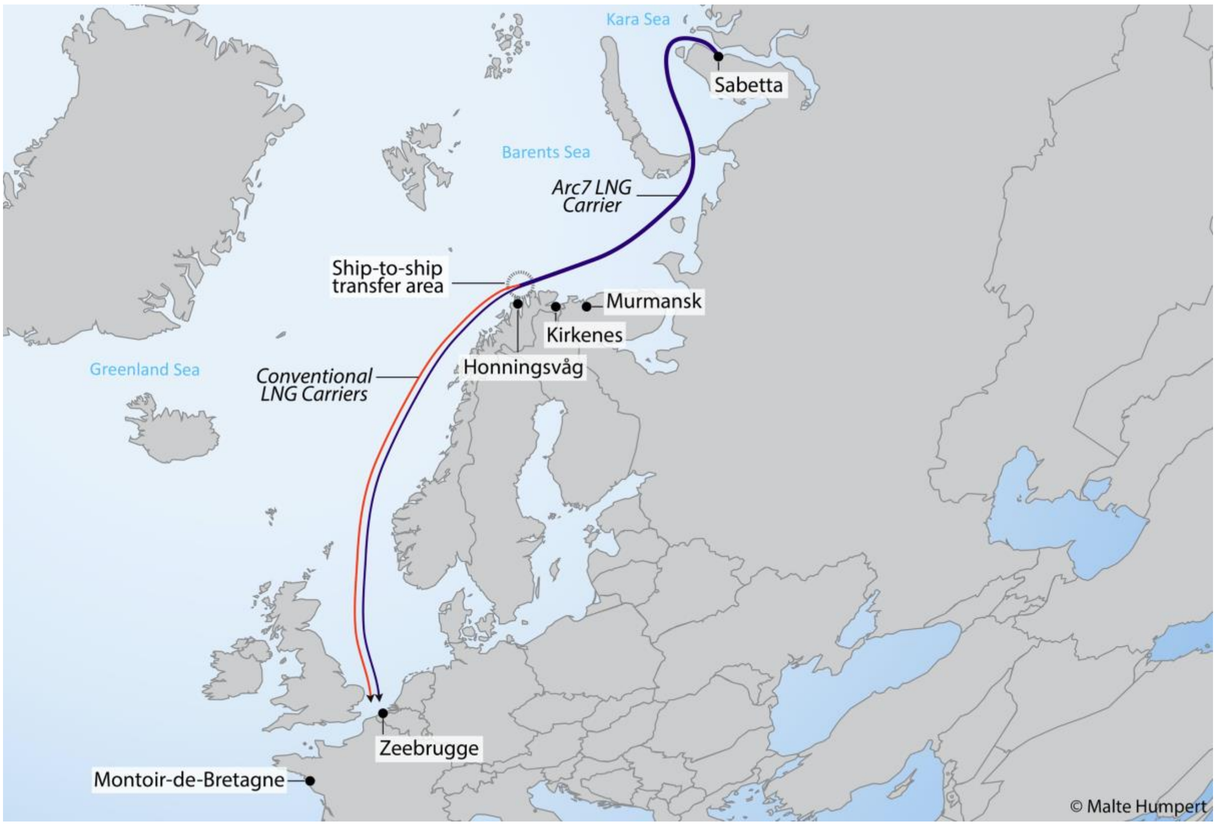
The port of Tromsø is already a major hub in Northern Norway and is especially important to the fishery and energy industries. The location close to the fishing fields in the Norwegian and Barents Seas has made Tromsø the largest fishing port in Norway. The port also offers several cold storage warehouses to accommodate the large fishing fleet in the area (Tromsø Havn, 2019). In recent years, the port has also developed a larger logistics area outside of the city that pertains to the local service industry for oil and energy development. Looking forward, the port has ambitions to take a larger role in the NSR development and have additional areas available for expansion for transshipment or container activities. (Tromsø Havn, 2019).

A shortcoming for Tromsø however, is the complete lack of railway connection to and from the port. Whereas Kirkenes has concrete plans for the development of a railway to Finland, a similar solution from Finland to Tromsø has been deemed insurmountable. Reports from the Norwegian and Finnish transport authorities have investigated alternative routes for the railway, for example to Tromsø. The conclusion is that a route from Rovaniemi to Tromsø would need to tackle the rough topography around Tromsø and require plenty of tunnels and bridges. Moreover, this route would pass through even more valuable and protected areas on the Finnish side and require expensive tunnels. All of these factors, combined with devastating impacts on environmental and Sámi interests certifies that a railway in the area will never be realized (FTIA, 2018). This fact is a major constraining factor for Tromsø to establish a truly intermodal transshipment hub. Combined with a location possibly too far west and south well beyond the end of the NSR (see map 4.1), this decreases the chance for a successful hub in Tromsø. Looking on the map I also thank that shipping companies would want to transship their goods further east, and that is a major reason that I instead have chosen Kirkenes as a case study.

4.2 LNG transshipment potential

A considerable opportunity for Kirkenes to establish itself as a major transshipment hub in the area is the transshipment operations of LNG that is occurring off the coast of northern Norway right now. In November 2018, Russian LNG exporter Novatek started the transshipment of LNG close to the North Cape in Norway. According to High North News, the Norwegian shipping company Tschudi, which operates a logistics base in Kirkenes has been contracted to develop a temporary reloading area where westbound LNG is transferred from ice-capable Arc7 carriers to conventional LNG carriers (Humpert, 2018a).

Between November 2018 and June 2019 Tschudi and Novatek partnered in transferring 123 loads of LNG from the massive Yamal LNG project at Sabetta. In total, more than 9 million tons of LNG were transferred (Humpert, 2018b). As discussed in the introduction, these transshipment operations take place in order to reduce the distance special ice-class vessels navigate in open waters, as this fleet of vessels is relatively small and expensive to operate. Map 4.2 illustrates this, as the distance from Sabetta to Northern Norway is relatively short, compared to the rest of the journey to the European and global markets. All tables and figures in this section is my own work, if nothing else is specified.



Map 4.2: Map showing Novatek's winter operation delivering LNG from Sabetta to Europe onboard Arc7 carriers or conventional carriers after ship-to-ship transfer off northern Norway (Humpert, 2020)

Working from the quantitative data made available from the CHNL, I have analyzed the traffic of LNG carriers on the NSR from 2018 and 2019. At the moment, all LNG carrier traffic on the NSR originates from Sabetta and the Yamal LNG project. Since the ships return to Sabetta from their destination without any cargo, these trips have been excluded from the data material manually. As seen in table 4.2, the number of transshipment operations in the Norwegian waters grew drastically in 2019, as the cooperation between Tschudi Logistics and Novatek gained momentum. The amount of LNG transshipped however, is still relatively low compared to the total LNG traffic on the NSR. Consequently, there is a huge potential to expand these operations in order to maintain a traffic base for a transshipment hub.

	Trips from Sabetta		Westbound traffic		Transshipped in Norway	
	Trips	**m^3 of LNG**	**Trips**	**m^3 of LNG**	**Trips**	**m^3 of LNG**
2018	109	18 813 400	105	18 123 000	20	3 452 000
2019	254	43 840 400	232	40 043 200	102	17 605 200

Table 4.2: Ship traffic and LNG export from Sabetta on the Yamal Peninsula

The data collected from the CHNL only provides the number of voyages by LNG carriers. However, the material is quite detailed and the size of the ships measured in dead weight tons (DWT) is almost exactly the same, implying that the capacity of the ships are the same. This is also confirmed from secondary sources. For example, the frequently used LNG carrier "Christophe de Margerie" has a DWT of 9 6779. Further, the freight capacity of this vessel is 172 600 m^3 of LNG (Ship Technology, 2020). To calculate the amount of LNG transported in a year, one need to assume that the carrier where sailing fully loaded at all times and simply multiply the number of trips taken with the capacity of 172 600 m^3. The results of these calculations are also displayed in figure 4.1.

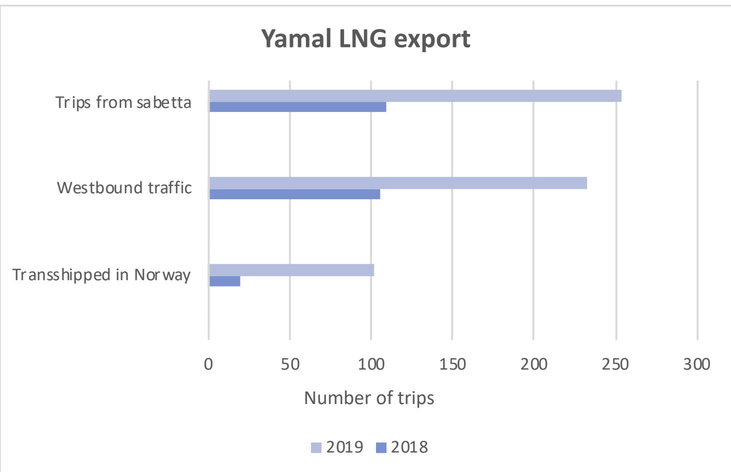


Figure 4.1: Number of trips by LNG carriers on the NSR

From the data material one can also examine the most frequently visited ports of the LNG carriers. Figure 4.1 shows that over 70 % of westbound traffic goes to the big European LNG hubs in Saint-Nazaire, Rotterdam and Zeebrugge or to transshipment outside of Honningsvåg. The transshipment operations however, only account for 18 %. In 2019, this number had grown to 44 %, clearly showing that the operators want to minimize the use of the expensive LNG carriers in open waters. Instead of going directly to these hubs in Europe, I propose that establishing a transshipment hub for LNG in for example Kirkenes or Murmansk would drastically increase the efficiency of the total operation and the use of these Arc7 carriers.

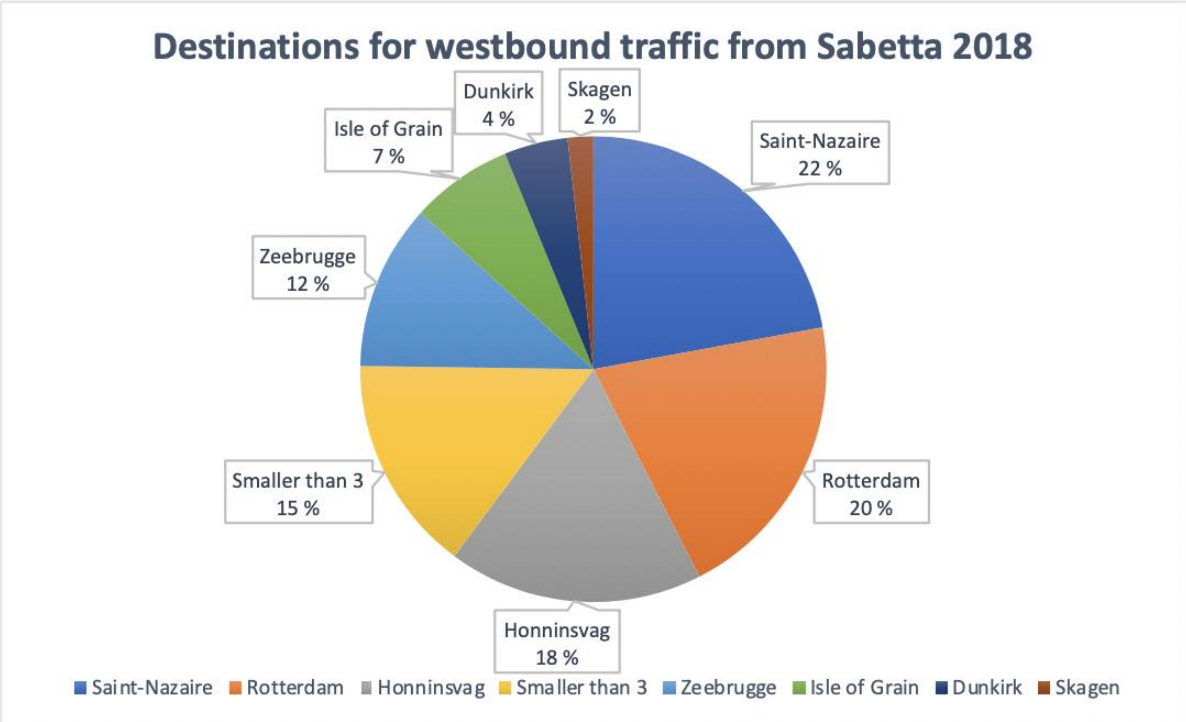


Figure 4.2: Most frequent destinations for Yamal LNG carriers

According to Novatek, they carry out these transshipment operations outside of Honningsvåg due to capacity constraints at Yamal peninsula. As these operations are done ship to ship, and not on land they are quite flexible as a short term solution. Moreover, Novatek are looking to establish a permanent transshipment hub for their LNG on land near the western end of the NSR as a long term solution (Humpert, 2020c). Thus, an LNG transfer station would make a good export base for a transshipment hub, with other services being established later on, such as the plans already discussed in Kirkenes. Judging by this analysis, I think that the growing LNG industry in the Arctic will certainly play a major role in forming a financial foundation for anyone who wants to establish a transshipment hub along the NSR.

As just seen, the potential for LNG transshipment in the Barents area is massive. The numbers from my analysis is only based on the Yamal LNG project, which have not even reached maximum capacity. To give an idea of the full potential, one must also consider other impending LNG projects in the Yamal district and following I have compiled some of the largest ones.

Firstly, Novatek reports that the proved and probable reserves of the Yamal LNG project are estimated to 926 billion cubic meters (bcm) of natural gas. Moreover, the production potential of the entire project amounts to around 27 bcm of LNG every year with the duration of plateau production of more than 20 years (Novatek, 2020b). Closely related, the nearby project named Arctic LNG 2 will soon entering production. The project is also operated by Novatek and will further increase the volumes shipped from the port of Sabetta. Being even larger than its forerunner, the Arctic LNG 2 project has proved and probable reserves of 1 978 bcm and the annual production is estimated to reach 19,8 million tons at peak capacity (Novatek, 2020a). Finally, another project on the Yamal peninsula is the smaller Ob LNG project located further south than the two larger developments. Anyways, the fields linked to this project holds a total of 157 bcm of gas and the plant will produce around 5 million tons of LNG every year (Staalesen, 2019).

The accumulated loads of LNG from these projects will certainly require transshipment operations at a whole different level than we see in the area today. As I already have proposed, there lies a huge potential to establish a full transshipment hub on the basis of such operations and expand to other types of goods later on. Even if Novatek and its partners should establish a permanent hub in Russia, let's say Murmansk, I think the enormous volumes of natural gas in the Arctic will enable Kirkenes or other Norwegian ports to take part of the operation with separate initiatives. However, the Russian attitude towards including other nations in these operations is unclear, and the lack of geopolitical analysis is also evident in the reports I have analyzed in the case study. Consequently, there are little emphasis on international relations in the next chapter with empirical findings. Because of this, I will discuss these issues myself in chapter 6, and explore how geopolitics will influence transshipment hub development in the Arctic.

5 Empirical findings

In this chapter, I will introduce the port development plans in Kirkenes and elaborate on the different components by categorizing the findings from the reports into the framework of Gritsenko & Efimova. First, the hard infrastructure and physical features will be presented. Then, another potential economic base for a transshipment hub in Kirkenes will be explored. This is done through assessing the potential mineral export from Finland and a discussion of the Arctic Railway. Third, the different intuitional bodies that shapes infrastructure development in the Norway's Arctic is presented, with focus on both domestic and multilateral frameworks. Lastly, the environmental dimension is presented with emphasis on shipping in Polar waters and environmental impact assessments.

5.1 Physical dimension

5.1.1 Connectivity and adjacent infrastructure

An important aspect of a success transshipment hub is the connectivity to other intermodal transportation modes, including road, rail and air connections for passengers and goods (Notteboom et al., 2020). In Kirkenes, the location for the new port is planned right next to Kirkenes Airport Høybuktmoen KKN and the main road E6 that stretches through Norway and connects Kirkenes to the rest of Northern Norway (Statens Vegvesen, 2015). This road connection can be used for hinterland access as well as bringing minerals and other export products from the region to the transshipment hub in Kirkenes. However, the distances in the Arctic are immensely vast. For example, driving from Kirkenes to Tromsø takes over 11 hours, with the shortest route passing through both Finland and Sweden.

Regarding the airport connectivity, there are no interregional flight connections within the Barents region and all flights must be operated through a hub airport. This is also the case for Kirkenes airport, which only offers domestic direct flights and connections to smaller towns in northern Norway as well as the capital Oslo (Barents Euro-Arctic Council, 2019).

At the moment, there are no railway connections to or from Kirkenes, but multiple actors on both sides of the border are looking at the possibilities for an Arctic railway from Kirkenes through Finland. This project and its market possibilities will be explored in the economic dimension of the analysis.

5.1.2 Maritime conditions

The Norwegian coastal administration (Kystverket) have in their work with the fairway investigation of Kirkenes established some physical requirements that needs to be met out of nautical considerations. A fairway is the navigable channel to a harbor, i.e. the usual course taken by vessels approaching the port (Kystverket, 2015). Both the existing port of Kirkenes and the surrounding fjords are defined by the municipality as an ice-free port. Within this definition, the port authority performs ice breaking services that keeps the fairways open when thin ice settles on the port waters. However, this only happens sporadically in Kirkenes, and is never to hindrance to the larger ships in the area. Hence, this is only a service to the local fishing fleet and other small boats.

According to Kystverkets analysis, the following elements must be considered when developing a new major port:

- Good entry and exit conditions for LNG and tankers
- Acceptable weather conditions (wind, visibility, sea)
- Satisfactory tranquility (low drag) and wind loads at quay
- Good anchorage places near terminal
- Defined waiting areas offshore for ships that have to wait for clearance
- Access to bunkers for transshipment storage
- Shielded unloading area

Further, based on the expected tonnage for the various products to be shipped from the port, the minimum water depth at the quay may be as follows:

LNG ships: 17m

VLCC: 28m

Condensate: 20m

LPG ships: 17m

Based on this, Kystverket assumes that the fairway requirements should satisfy vessels with a depth of up to 28 meters, and that the quays should be dimensioned for several types of vessels. Looking to other industry projects such as Polarbase in Hammerfest, Kystverket also finds that quays for equipment, maintenance and upgrading of large oil installations should range from a depth of 12 meters to 22 meters, if these kinds of industries would be relevant to include in a transshipment hub in Kirkenes (Kystverket, 2015).

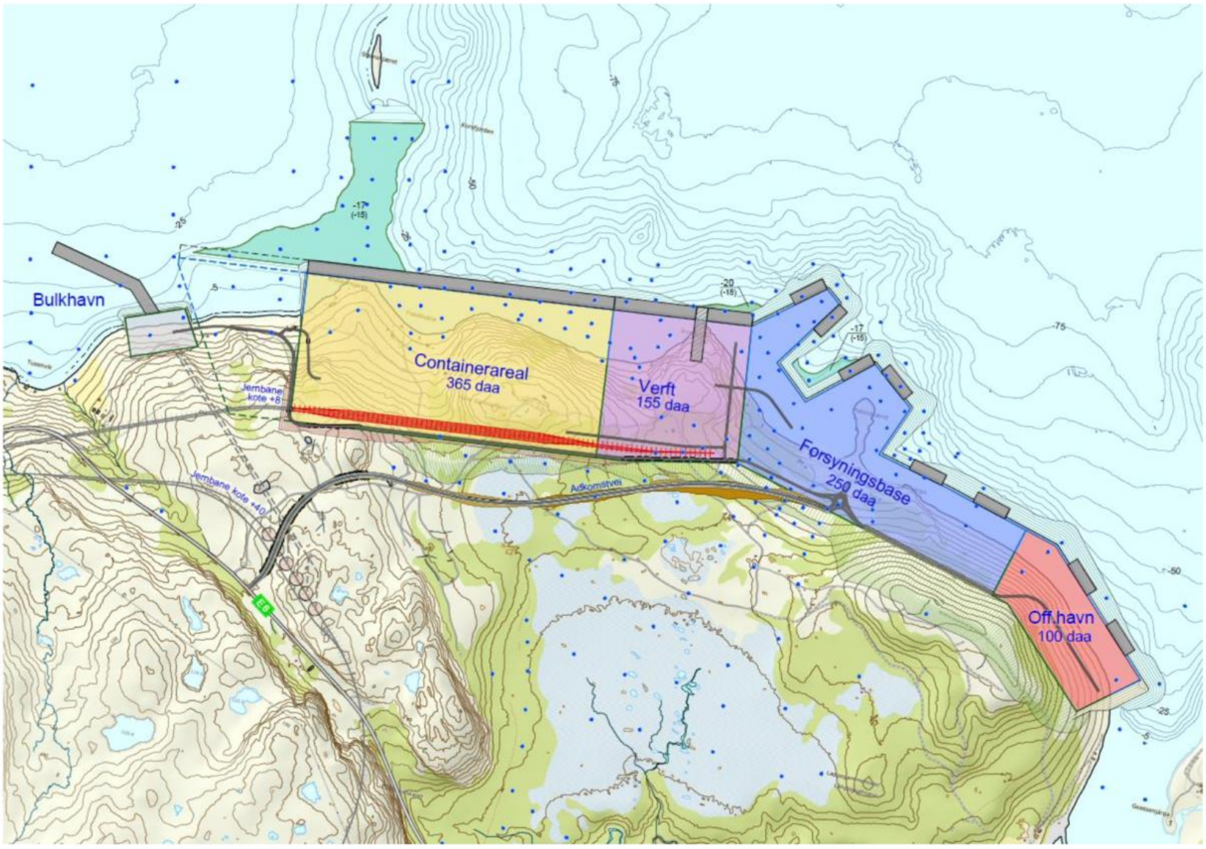
In its report, Kystverket concludes that all of these requirements can be achieved with ease at the proposed location of the new port in Kirkenes. These criteria will allow the port to be dimensioned for vessels up to 400 000 DWT, and position the port to handle the largest possible ships in the future. Based on the municipality's input, previous port investigations, proposals from the industry and its own assessments, Kystverket has reviewed 13 sites in Sør-Varanger municipality. The sites are considered to be able to function as a transshipment terminal and handle large quantities of goods in a multifunctional port. From documents that will be examined in the next section, we see that the authorities are working for realizing their plans at Høybukta Vest, which lies close to the airport outside of Kirkenes. Kystverket says that this area is large and is adjacent to existing road infrastructure. The area can be expanded step by step and provide the area needs for large industrial establishments. Looking at the maritime conditions, there are no restrictions for successful sea traffic. Another positive assessment is that Kystverket wants to accommodate the port for LNG carriers and LNG bunkering facilities, which can be a promising start of on-land transshipment operations in Kirkenes.

To summarize, Kystverket assumes that the fairway to a new transshipment hub in Kirkenes must be dimensioned based on the following nautical parameters:

- The fairway must have a width of 3 700 meters and not less than 1 850 meters
- Depth of the fairway should be 28 meters
- A true deep water port with depth at quays between 10 and 25 meters
- A grand transshipment hub must be able to receive vessels up to 300 meters
- The port should be ice-free all year around

5.1.3 Concept and port development plans

The plans for the new port in Kirkenes are divided into five different components and comprise of a public port, shipyards, supply base for the oil and gas industry, bulk port and a container terminal with connection to the proposed Arctic railway. The needs and requirements for the new port have been investigated by Multiconsult and Statens Vegvesen on behalf of the Norwegian government.



Map 5.1: Proposed port design (Multiconsult, 2019)

Public port

It is assumed that the public port for the Kirkenes area will have a large variety of freight types being loaded and unloaded. This cargo can be anything from break bulk cargo to larger units such as containers before the specialized container terminal becomes operative sometime in the future. The docks for the public port are considered to serve vessels up to 20 000 dead weight tons (DWT), which would be vessels up to 170 meters in length. This port will also feature quays with roll-on/roll-off (ro-ro) ramps, which makes for expedient loading operations and improve the functionality of the port. It is proposed that the public port will have two different quays each 100 meters long (Multiconsult, 2019).

Shipyards

There is already a fairly detailed plan and overview of the need for a new and efficient shipyard for eastern Finnmark. Since this infrastructure is currently in need of substantial renovations in the region, it is decided that a new shipyard serving all of eastern Finnmark will be relocated to the new port. These plans include around 350 meters of quays with depths up to 20 meters deep. Moreover, there are plans to include a floating / fixed dry dock of 150 x 30 meters. As shown in map 5.1, the front to the sea is around 350 meters, where quays with large water depths can be established over the entire seafront. The location of the shipyard next to a planned supply base means that there are opportunities for synergies between these two sites (Multiconsult, 2019).

Supply base

Previous analysis has shown that space should be allocated in the area for a supply base for the petroleum industry. This supply base is proposed 6 individual berths up to 24 meters deep, providing excellent maneuvering conditions even for the largest ships. The quays for the supply base are estimated to be around 100 m long. A large supply base for the whole Barents Sea oil industry must also have the capacity to serve oil drilling rigs and other huge installations, and the possible water depths for this area will enable these operations (Multiconsult, 2019).

Bulk terminal

The most specific needs for port facilities are the description of transport of bulk cargo to Kirkenes with the planned Arctic railway. The railway plans will be discussed in the next chapter, but some the port infrastructure is worth mentioning here. In this area of the fjord, there is large maneuvering room for even the biggest 50 000 DWT bulk carriers that will transport the cargo. The water depth in the area at the quay is more than 20 meters, which is more than enough for these kinds of operations. With the possible export of mining ore from Finland, this would mean one port call every week with these largest bulk carriers (Multiconsult, 2019). This component of the port may prove to be significant if the mineral export from Finland and Norway continues to increase. With a large bulk terminal in place, Kirkenes will have the capacity to uphold its position as an important transshipment hub in the area.

Container terminal

The final part of the port development plans is a major container terminal, justified by the expected increase in shipping traffic via NSR as discussed in the introduction. In the public plans for Kirkenes, it is proposed that the port facilities is able to serve vessels of size as the largest container vessels today; 400 meters long requiring water depths of 18 meters at quay (Multiconsult, 2019). A fundamental component of the construction of such a container terminal is the completion of an “Arctic Railway” linking Kirkenes to Rovaniemi and beyond, connecting to existing rail infrastructure in southern Finland. This gives Kirkenes a central position in NSR shipping with potential TEU transshipment in the long term.

A cluster of local industry actors in Kirkenes already have some initial estimates and long-term visions. They claim that if 10% of China’s exports to the Nordic countries is shipped via the NSR through the new port of Kirkenes for transshipment to rail transportation, this would constitute 1 018 TEU per day or a ship with 4,800 TEU every fifth day. This would require eight south-bound trains per day to keep pace with the unloading. They also work on the basis that there will be roughly the same number of wagons going the other direction, transporting a combination of empty return containers and export cargo to China to fill up the container ships for the return voyage (Sør-Varanger Utvikling, 2018). Based on the projections in the Arctic Railway Vision, preliminary area requirements and design of container ports are adapted to a volume of around 500 000 TEU annually (Multiconsult, 2018).

To summarize, the reports from Multiconsult and Statens Vegvesen emphasize the importance of capacity on land to expand the port area. This is important in order to account for future growth of the transshipment hub, where the five different components are meant to be constructed incrementally as the demand and need grows. This is also in accordance with the existing literature, which also stress the importance of physical room to expand. This is not likely to raise any problems in Kirkenes, as a total port area of 100 000 m^2 is under planning (Statens Vegvesen, 2015).

5.1.4 Physical constraints

There are few, if any physical constraints to be found in the Kirkenes plans. As reports from both Kystverket and Statens Vegvesen states, the maritime and physical conditions are deemed more than sufficient, with greater water depths than many larger ports. Even more significant is the fact that the port is ice-free all year around, which guarantee continuous operations at lower costs without the need for ice-breaker support. As just discussed, physical room for expansion is also not a problem, with huge areas available for future growth.

Within the port infrastructure itself there are interesting features to be found. The proposed scheme calls for a massive intermodal port with five different components for drastically different areas of use that makes up a multifunctional port. Whereas other ports (such as Sabetta) are highly specialized and only focus on one type of freight, Kirkenes will act as a fully intermodal transport hub if the plans are executed. This fact, combined with the geographical position of Kirkenes in the Barents Sea is another statement that the port plans themselves are robust and without any major physical constraints.

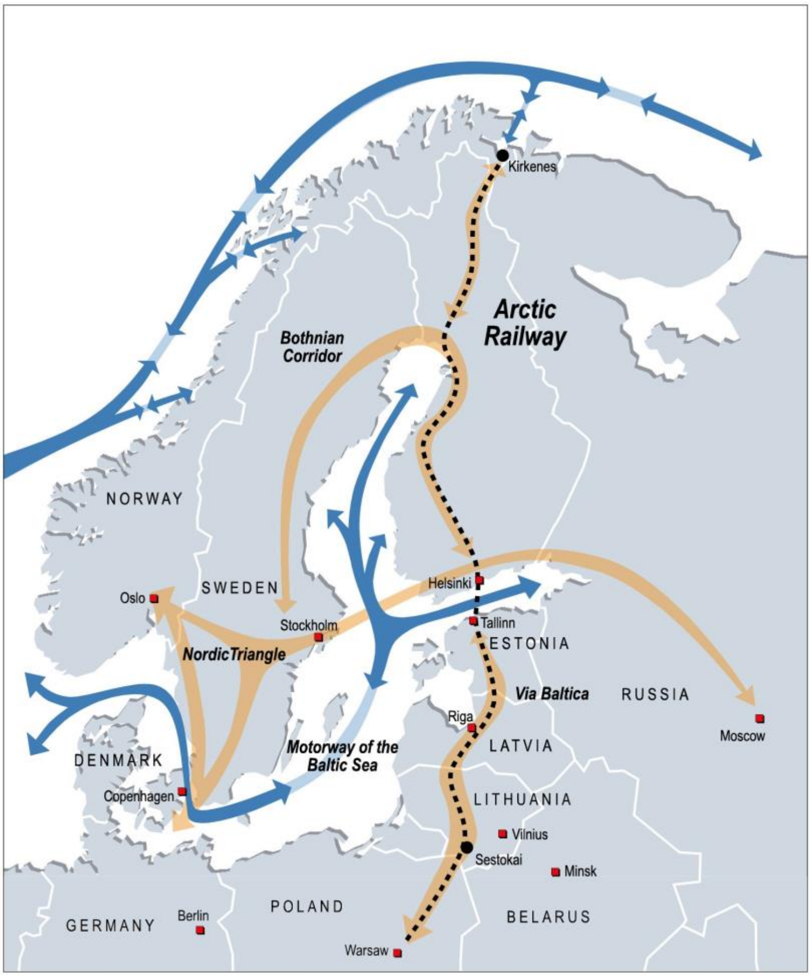
The only constraining factor to be found in this section is the somewhat weak connectivity to the domestic market. This is not unique to the case of Kirkenes, with vast hinterland distances being the norm all across the Arctic. Hinterland access could be important for a successful transshipment hub, but most of the port plans in Kirkenes focus more on moving goods forward in the global supply chain, with little emphasis on supplying the domestic market. Lastly, Kirkenes airport does not see any international flights throughout the year. This is a constraining factor, because larger competing hub cities might have better and faster airborne connections to the rest of the world through their international airports.

5.2 Economic dimension

The economic dimension of a transshipment hub revolves around the size and evolvement of markets, changes in trade patterns and the types of cargo moving through the port. In the case of Kirkenes this can be divided into two sections; the export of minerals and other goods on the Arctic Railway and the transshipment of TEU from China on the way to the European market. This section will investigate the market potential that arises from these two projects.

5.2.1 The Arctic Railway

The Arctic Railway is a proposed extension of existing Finnish rail infrastructure, connecting Rovaniemi to Kirkenes with a 465 km new railway link. The railway is also named under other working titles such as the Arctic Ocean Railway and the Arctic Corridor (FTIA, 2018). All of these schemes refer to roughly the same project, namely connecting Kirkenes and the new port there to Finland and the inner European market. It is worth noting that the following numbers are only estimations from secondary sources, and is not collected or processed by myself in any way.

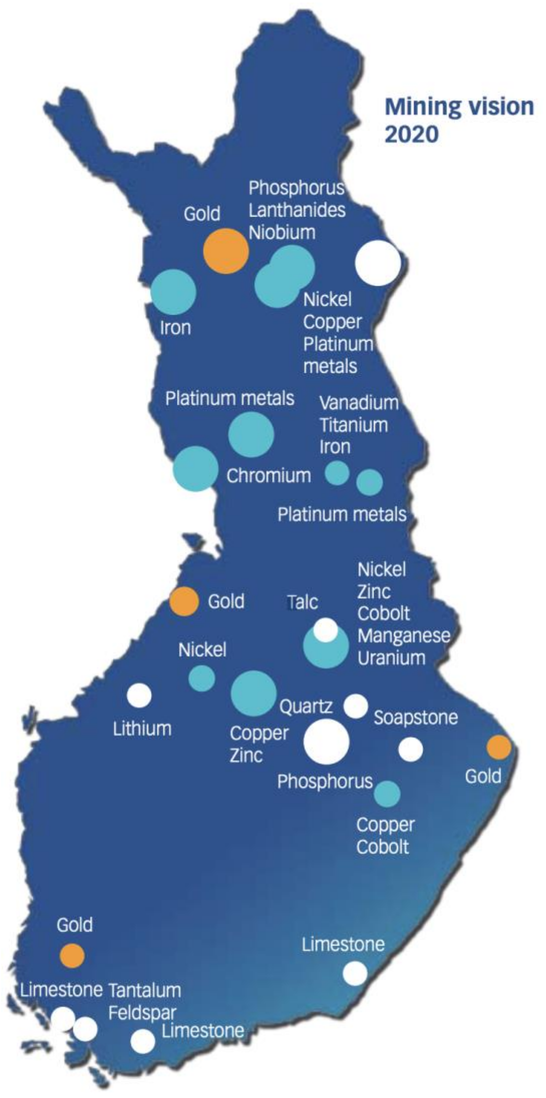


Map 5.2: The proposed Arctic Railway and its connection to other major transport corridors (Arctic Corridor, 2019)

The export potential for a railway connection with transshipment in Kirkenes is considerable. Different types of goods to be shipped either northbound or southbound include minerals, timber, LNG, disposable waste and containers, among other categories.

The forestry industry is a major contributor to the Finnish national economy, accounting for more than 20% of Finland's export earnings. According to some estimates, the railway transport potential for the forest industry in central Lapland is around 500 000 tons each year. Moreover, the Rovaniemi district heating plant will increase the transport of wood-based raw materials considerably (Arctic Corridor, 2019). The bioindustry in Finland is also growing rapidly, and several projects are under development. In Lapland, bio refineries are planned in Kemi and Kemijärvi, which by 2022 could have a production of around 500 000 tons per year. This would generate the need for significant transportation, especially of raw materials to the factories (Sør-Varanger Utvikling, 2018).

Another industry with massive transportation needs is the mineral industry in Finland. According to a report from the Finnish Transport Infrastructure Agency, mining projects under planning in northern and eastern Finland will generate a transport requirement of a total of 25 million tons of minerals by year 2050 (FTIA, 2018). In the port development plans for Kirkenes, they also mention mineral export and estimate a total of 1,5 million tons of phosphate from the nearest mine in northern Finland alone. If this is transported on rail and transshipped in Kirkenes, it would accumulate to 30 000 tons of phosphate out of Kirkenes each week (Multiconsult, 2019). As seen on map 5.3 this is just one of many mineral prospects that make use of an Arctic Railway and the export of minerals is a central part of fulfilling this massive railway project.



Map 5.3: Mineral deposits in Finland (Finland's Minerals Strategy, 2020)

Another great opportunity lies within the ambitions for utilizing the NSR as a viable alternative to the Suez Canal route as the Arctic waters continues to melt. As mentioned in the introduction, shipping to and from China is expected to grow further in the coming years. Several reports emphasize that it is the Chinese and their interests that will be decisive for container traffic along the NSR. "The Belt and Road Initiative" is China's major development strategy whose purpose is to invest in infrastructure to secure a logistics network that supplies its own economy, both export and import. As port of this initiative, the "Ice Silk Road" is the Chinese development plans for a marine trade route along the North Sea Route (Multiconsult, 2018). Thus, patrons of the Arctic Railway argues that parts of Chinese trade with the Nordic countries, and eventually the whole European market could be channeled through the NSR with the transshipment of TEUs in Kirkenes.

Country	Imports	TEU	Exports	TEU	Throughput	TEU
Germany	17 732 000	1 927 397	11 897 000	1 293 117	29 629 000	3 220 514
Finland	326 000	35 435	1 439 000	156 413	1 765 000	191 848
Sweden	877 000	95 326	619 000	67 282	1 496 000	162 608
Denmark	990 000	107 609	1 056 000	114 783	2 046 000	222 392
Norway	880 000	95 652	300 000	32 609	1 180 000	128 261
TOTAL	**20 805 000**	**2 261 419**	**15 311 000**	**1 664 204**	**36 116 000**	**3 925 623**

Table 5.1: Estimated Chinese container trade (tons and TEU) with Germany and the Nordic countries in 2016 (Sør-Varanger Utvikling, 2018)

Sør-Varanger Utvikling has calculated that around 2,26 million TEUs are imported from China to five of the northernmost coastal countries in Europe, and this equals to an import of 6,200 TEU per day. Moreover, they argue that some of these volumes could be transported from China via the NSR, and be transshipped in Kirkenes before being sent on rail through Finland. For example, if 10% (226,000 TEU) of imports in 2016 were moved from the Suez Canal to the NSR and sent on a 4 800 TEU vessel, one would receive a container ship with cargo from China to Europe on the NSR every fifth day (Sør-Varanger Utvikling, 2018). One could also assume that directional balance could be upheld by sending a combination of export products discussed earlier in this chapter and empty containers back to China. This would mean container traffic up to 500 000 TEU both directions combined.

5.2.2 Economic constraints

Even though the economic prospects are confident, there are a few constraints in these plans that needs to be addressed. An imperative factor for the mining and extracting industry is the commodity prices of their products. Today's volatile commodity prices has a huge impact on the industry, where shutting down and starting up operations frequently has become a rather normal situation. For example, the iron ore mine in Kirkenes was operational between 2009 and 2015 before the company became insolvent due to lower commodity prices. Now, new owners are reopening the mine with operations set to commence later this year (Trellevik, 2019). This is just one of many examples of how sensitive this industry is to the global prices of minerals, and should be considered before investing heavily in new port facilities.

Even though the plans call for a diversified port for various uses, the new port in Kirkenes might be constrained by the limitations of the current NSR traffic which today is centered around bulk export of natural resources, together with import of construction materials for the same projects. As previously discussed, LNG transshipment is a central part of the port activity in the Arctic. The literature also supports that this narrow focus, combined with sparse population in the Arctic and lack of non-extractive industries will limit the supply capacity of the NSR shipping system (Gritsenko & Efimova, 2017).

Although not the main focus of this thesis, some documents I have analyzed reports very high construction expenses for the combined project in Kirkenes. This might be a constraining factor, seeing that the revenues from the port's commercial activity will be insufficient to fully repay large capital investments in Arctic ports. This again limits the contribution of private investments and such projects are thus more dependent on governmental and international support (Hansen, Grønsedt, Graversen, & Hendriksen, 2016).

5.3 Institutional dimension

The institutional dimension of port development revolves around its different political and administrative actors. Both international relations and domestic organization are important for port development. This section will examine which policies and international agreements that shapes port development in Norwegian Arctic waters.

5.3.1 National policies

The current political climate in Norway displays great emphasis on the development of Norway's Arctic regions. To focus its efforts, the Norwegian government frequently develops an Arctic strategy, with the last edition being issued in 2017. The strategy highlight the Arctic as an important base for natural resources and is indicative of the government's commitment to develop the export industries in Northern Norway (Arctic Strategy, 2017). Another important policy at the national level is the decennial National Transport Plan (NTP). This document states that today's port in Kirkenes, located in the city center is not adequate for future expansion and development of a new port in Kirkenes is therefore considered necessary. However, the plan makes clear that it is the local authorities (at municipal and country level) in cooperation with private actors that will need to finance a new port in Kirkenes (NTP, 2017).

Moreover, the Ministry of Transport and Communications has developed a national port strategy from 2015. According to this document, one of the government's goals is to ensure the development of efficient, intermodal hubs along major trade routes. Through this work, the port in Kirkenes has been appointed status as a "main transport hub" which may receive financial governmental support for development. Contrary to the findings in the NTP, the national port strategy thus states that governmental funding will be granted if the local municipality and private investors supports the project with investments. The goal of this is to stimulate proactive ports and port owners, and prioritize state infrastructure funds where there is local involvement (National Port Strategy, 2015). Overall, the strategy seems to focus on efficient intermodal hubs, and so the port of Kirkenes and their plans should be applicable for added governmental support.

5.3.2 Multilateral cooperation

There are various frameworks and international agreements in place to promote infrastructure development in the Arctic. Most notably is the Joint Barents Transport Plan which serves as a framework for transport cooperation in the region. In the latest edition of this plan from 2019 Kirkenes titled a “comprehensive port” in the Trans-European Transport Network, which positions the port for potential financial support from the European Union. More importantly, the proposed railway through Finland has gained attention. The plan states that the main argument in favor of building the Arctic Railway is to provide access for the Finnish mining industry to an ice free port in the Barents as well as developing a Norwegian transshipment hub in Kirkenes. The working group of the plan suggest further research to identify the prospects of a new railway between Kirkenes and Rovaniemi (Barents Euro-Arctic Council, 2019). This is also supported by the Norwegian government who propose that more investigation between Finland and Norway is to be conducted and a joint working group has been established (NTP, 2017).

Looking beyond the Arctic nations, the development of the High North is evolving into a geopolitical matter that involves the entire world. One new stakeholder in the Arctic is China, who has massive plans for establishing new trade routes stretching westwards from China. As part of this initiative, China want to cooperate with other states to turn the NSR into an “Arctic Silk Road”. The main focus of the projects that form the backbone of this economic cooperation is shipping and energy (Chun, 2020). This scheme also coincides with the first ever Arctic strategy published by China in 2018, where China positions itself as a “near-Arctic state”. It is unclear what this exactly implies in the longer run, but in the strategy, it is clear that China wants to work with all parties fort the development of Arctic shipping routes. They also encourages their enterprises to participate in the infrastructure construction for these routes and calls for stronger international cooperation on the operation of the Arctic shipping routes (China’s Arctic Policy, 2018). In the longer run, this implies that we can see increased investment and commitment from China in the Arctic. For Kirkenes, with their intermodal focus and proposed container terminal, the Chinese interest could conceivably result in investments from the state-owned shipping company COSCO. Major shipping companies often operate their own terminals, and seeing that COSCO are increasing the number of Arctic transits with their container vessels every year (CHNL, 2019), a Chinese investment in the Kirkenes transshipment hub is not improbable, and rather quite plausible.

5.3.3 Institutional constraints

Even though there are many international frameworks and cooperation in the Arctic, all port development is essentially a domestic issue, confined to each country's government respectively. It is evident that international law and transnational organizations are of minor importance to Arctic port development because all ports fall under national jurisdiction. For example, in the UN Polar Code, there are no mentions of port state control in the Arctic. The code, which entered into force in 2017 does not allocate any special role to Arctic ports, nor does it define their role in maritime safety and environmental security (IMO, 2014).

Another concern is the cooperation over borders when it comes to railway development in Norway and Finland. There has been a Finnish-Norwegian working group to study prospects of the railway between Rovaniemi and Kirkenes, but the final report does not present any further measures for promoting the railway project (LVM, 2019). Moreover, the working group deducts that the legislation in both countries require certain legislative phases for the execution of the project. As mentioned, Norway has a long-term national transport plan (NTP) in place which has a twelve year span, from 2018-2029. A project of this size cannot be included in this plan unless the planning process is at an adequate level, and the same holds true for Finland's legislation. The precondition to start the planning process is a preliminary decision in both Norway and Finland to actually carry out the project. This means that in both countries the railway needs to be included in the respective National Transport Plans as a prerequisite to more detailed planning (NTP, 2017).

In the specific case of Kirkenes, another constraint is that the Kirkenes port development plans are not explicitly mentioned in Norway's Arctic strategy. Although the Norwegian government's ambitions in the Arctic region is indubitable, there is a lack of concrete financial support for Kirkenes in the plan. In the strategy document, Kirkenes is mentioned only 11 times, compared to Svalbard's 53 listings, the latter also with direct governmental financial support for various projects (Arctic Strategy, 2017).

Lastly, there are conflicting interpretations from the NTP and the national port strategy documents. Whereas the former states that Kirkenes will not get any governmental funding for the port expansion, the latter claims that Kirkenes can receive direct funding from the state through its status as a "main transport hub" (National Port Strategy, 2015).

5.4 Environmental dimension

The environmental dimension mainly covers the natural conditions and anthropogenic influence of port development. Of these factors, most are of negative nature, but some of them also comes with opportunities for Arctic communities that wants to develop their infrastructure and could bring future development potential.

5.4.1 Diverging impacts from climate change

Global climate change and its effects will have divergent impacts on the development of the Arctic. The Arctic Monitoring and Assessment Programme (AMAP) have assessed the impacts of climate change and have some interesting interpretations. From an environmental perspective, a warmer Arctic can create to more favorable conditions for shipping by keeping the entire NSR open for an extended season and the route may even be ice-free as early as 2030. However, rising temperatures in the Arctic may lead to unfavorable development such as more drift ice and more volatile and instable weather conditions, which in combination will make the route more challenging to navigate (AMAP, 2017).

For Kirkenes, or more precisely the Arctic Railway plans, the construction of the railway would affect the environment in two separate ways. On a global scale, the construction of a railway would have positive long-term effects. Railways are considered as an environmentally favorable way to travel and transport goods and the railway connection would drastically cut transport CO_2 emissions. As both goods and passengers would shift to using a train connection, more goods will be moved from the more polluting sectors of road and sea transport (LVM, 2019).

This view is also supported by the Finnish Transport Infrastructure Agency, which in their report argues that travelers and companies are getting more environmentally aware. As managers of supply chains consider both energy efficiency and the type of energy to be used, this will have an impact on how freight traffic is distributed between road and rail transport (FTIA, 2018). As traffic volumes increase, transport choices will have increasing significance for the environment, and a railway will contribute positively to this logistical quandary.

5.4.2 Environmental constraints

One clear limitation to the Kirkenes port development and the Arctic Railway plans are the lack of any comprehensive environmental impact assessments (EIA). In the analysis of all relevant documents and plans, I have not found any mentions of EIA or other environmental studies. I consider this to be a constraining factor and such initiatives needs to be undertaken before future development can commence.

However, some assessments have been made in the investigations of the Arctic Railway. FTIA reports that Lapland’s natural environment is extremely vulnerable, and the impact of construction may be longer-lasting than they would be elsewhere. The region has a lot of untouched wilderness and a great many areas of significant natural value and protected areas account for about half of the area of Northern Lapland (FTIA, 2018). It is evident that these areas need to be bypassed when detailed planning of the railway starts in order to ensure minimize the environmental impacts of the railway.

Moreover, the corridor between Rovaniemi and Kirkenes would also affect reindeer husbandry and the Sámi people. Consequently, I believe that when a comprehensive EIA is undertaken, emphasis should be put on determining the impacts on Sámi homeland, language, culture and livelihoods. This in order to minimize the impacts on traditional Sámi livelihoods and particularly to protect the reindeer industry on which the Sámi livelihoods relies on.
The Joint working group between Finland and Norway on the Arctic Railway also supports this, and concludes that the track would have an impact on both the scenery and environment in restricting the free roaming of wild animals through producing noise and vibration (LVM, 2019).

Lastly, as previously discussed in the literature review, the International Maritime Organization (IMO) have goals and legislation in place to reduce the amount of SOx, NOx and other particles from shipping activity. As a result, the IMO Polar Code has been created to drastically lower emissions and improve the Arctic shipping industry. From year 2029, a complete ban on heavy fuel oils will apply, forcing shipping companies to switch to greener fuels (IMO, 2014). I argue that the most likely solution to this is to switch to LNG propulsion, as LNG driven vessels operate with 90 % less of the said particles and pollutants (ICCT, 2017).

5.5 Summary of enabling and constraining factors

The goal of this chapter has been to investigate the port development plans in Kirkenes through a systematic analysis of numerous reports and documents derived from the project. A summary of the enabling and constraining factors can be found in table 5.2, and these findings diligently answer much of the first case study question in this research. In the summary, I have also included uncertainty factors in order to augment the analysis. This uncertainty originates on two different levels. Either from diverging findings in the analyzed documents or from factors beyond the ports and authorities' control, such as international encouragement and climate change impediments. As the outcome of these elements are uncertain, they should be assessed by the local authorities before continuing with the project. Finally, it is clear that the reports I have examined lack geopolitical and international considerations. Consequently, I will assess some of the most acute issues in the following chapter.

In my inquiry, the physical dimension is the strongest enabling factor for port development in Kirkenes. The position of Kirkenes along the NSR makes is far more attractive than its Norwegian competitors. Moreover, the port is ice-free all year around which is fundamental for NSR shipping. Combined with very few physical constraints, this positions Kirkenes as the most auspicious candidate for a transshipment hub in the western Barents region. The only constraining factor is the lack of international flights to and from Kirkenes, but this should not be imperative to enable successful transshipment operations. Regarding the railway plans, there is uncertain when, or if this will be operational to link Kirkenes to Finland and beyond.

The potential for transshipment of both minerals and LNG creates a feasible business model and make a reasonably solid economic base for Kirkenes. In my opinion, these two operations will be the most important enabling factors to ensure success for Kirkenes as a transshipment hub, with container traffic from China indubitably being a long-term vision with a more fragile financial and geopolitical foundation. Within this geopolitical sphere lies a lot of uncertainty, both for the whole NSR transportation chain along with the attitude of Russia and its politicians to include Norway in NSR activities. Another uncertainty factor is the volatile commodity prices of the very products that will be transshipped and exported from Kirkenes.

The institutional dimension is dominated by numerous supportive documents from all levels of government. Herein, the authorities reiterate their approval and endorsement of the project in Kirkenes. International initiatives are also positively invested in the plans. However, all of these reports lack one critical detail. There seems to be diverging judgement of the organization of financial matters within the project. Although not the focus of this research, the expenses for establishing this transshipment hub in Kirkenes will be formidable and will most likely need direct governmental investments. A plausible alternative would be public-private partnerships that includes international shipping and logistics enterprises. This however, could be controversial and be a source of conflict if these companies are controlled by contending nations, expatiating of the rising conflicts we see in the Arctic today.

In the environmental dimension, it is evident that climate change is the most important factor for port development with implications for all of Arctic development. On one side, climate change is the very trigger for increased shipping activity in the Arctic. The melting of sea ice will enable shipping with less ice-breaker support and eventually open Arctic waters for conventional ships. Patrons of the NSR and Arctic Railway also argue that this combination reduces CO_2 emissions compared to the competing Suez Canal route. However, any activity will impact the local ecosystems, which are among the most pristine and fragile in the world. Lastly, Sámi interests are also critically threatened by industrialization of the Arctic.

Dimension	Enabling factors	Constraining factors	Uncertainty factors
Physical	Fundamental position in NSR traffic, ice free port	No international airport, construction of port still not commenced	Inland connections, vast hinterland distance
Economic	Massive export and transshipment potential	Volatile commodity prices, high construction expenses	Geopolitical aspects of NSR shipping, sanctions
Institutional	Support from local and regional government	Unsure financial support from different governmental bodies	Funding and political support from foreign entities
Environmental	Melting sea ice, Lower CO_2 with rail transportation	Railway plans sensitive to Sámi interests, no full EIA undertaken	Effects from climate change, future regulations

Table 5.2: Enabling, constraining and uncertainty factors for development of Kirkenes

6 Discussion and analysis

In this chapter, I will discuss the findings from the case study and examine how these four dimensions will shape future port development in Kirkenes. By answering the two case study questions, I will also assess how to develop a transshipment hub in Kirkenes. Moving on to the main research question, I will then expand a theoretical model from the literature review to include transshipment hub characteristics. Thus, the overall goal is to add something new, because there seems to be a gap in the literature regarding the conditions for transshipment hubs in Arctic conditions.

6.1 Transshipment hub development in Kirkenes

The summary of the empirical chapter largely answers the first case study question: ***What are the enabling and constraining factors for the establishment of an Arctic transshipment hub in Kirkenes?*** Through classifying the findings into four dimensions, we clearly see which factors that influence transshipment hub development in Kirkenes. However, in order to truly understand the case, I will now discuss how and why these factors will shape the future development of Kirkenes as a transshipment hub.

The physical dimension is important for Kirkenes, because it's strongest advantages can be found within this dimension. Being mostly related to location and physical attributes, there are few changeable factors to consider for the decision makers in the project. Judging from the empirical findings, I think that the infrastructure proposals in Kirkenes are elaborate because they are planning for a fully intermodal hub with different types of activities. The alternative would be to design a highly specialized port for only one type of goods, which is often the case for Arctic ports. The literature also mention this specialization as a constraining factor to develop ports in the Arctic, and the competition between ports is low because of this exact reason (Tuomas Kiiski, Solakivi, Töyli, & Ojala, 2018). For example, this is the case in Sabetta, where the port is custom built to export LNG and lack other infrastructure for additional activities. Most other Arctic ports are also shallow and don't allow for the large vessels that are concomitant with transshipment hubs (Katysheva, 2019). This is a major advantage for Kirkenes, and so the authorities' aim for the new port should be to deliver as many services as possible. This is also the case, as my findings show that wharfs, ro-ro, container and bulk facilities and more are being included in the new Kirkenes hub.

As concluded earlier, the physical advantages for Kirkenes are superb and is probably also the reason that the central authorities have chosen this exact site for development over other locations. Both the concept and port design look promising for establishing a transshipment hub and the different components are designed to be added step by step as the port grows. The detailed planning process also suggest that some of the components probably will be conceived in the near future. Anyhow, the public port needs to be moved from its existing location and once the surrounding infrastructure for the public port is in place, other services for transshipment operations will be easier to establish in the area. Thus, the public port plans are important and will conceivably act as a catalyst for further port expansion in Kirkenes.

One constraining factor for an efficient transshipment hub in Kirkenes is the vast distances in the Arctic together with restricted hinterland access. It is uncertain how the infrastructure that surrounds Kirkenes will develop in the future and this makes is difficult to forecast any hinterland market size for a hub in Kirkenes. Anyhow, I will argue that the size of hinterland markets is not imperative for a transshipment hub in Kirkenes to thrive. Firstly, because the population in Northern Norway is small and insignificant in the global value chains, shipping companies have no interest in supplying the sparse populations in the region anyways. I think that from these companies' perspective the goal of a transshipment hub in Kirkenes is not to access rural hinterland markets, but rather opposite, to export valuable resources from the Arctic to the rest of the world.

Understanding this is important and brings the discussion to the economic dimension and the proposed Arctic Railway. As I have argued, the most promising prospects for a newly developed hub in Kirkenes will be to tranship and export Arctic resources, both oil and gas and mineral aggregates. As the empirical findings indicates, mineral export is already a cornerstone for Finland's Arctic industries and their Arctic strategy reflect this, with political determination to further develop this sector. As such, mineral export is occurring anyways and Kirkenes could certainly take a much more active role in this, even before any railway is constructed. For example, Kirkenes already has an iron ore mine close to the center and port facilities which is set to reopen later this year after an interim shutdown. When this operation resumes the amount of goods shipped from Kirkenes will be exceedingly higher, as this iron ore is transported a short distance on existing rail tracks before being shipped to the global market. This shows that mineral transshipment from Kirkenes is highly relevant and that this export will occur anyways, it is just a question of how to get the goods out of the region.

The Arctic Railway is unquestionably a long-term vision of local patrons and might never be fulfilled, but I think that mineral export will shape the future of Kirkenes if it takes a much more active role in this industry's value chain. For example, only sections of the railway could be built, starting closest to Kirkenes and expanding southwards with time to reach new mineral deposits in Northern Norway and Finland along the route. Even without any railway, there is still room for iron ore export in the new port. This is also supported by the findings in the physical dimension, where a bulk terminal for minerals is being planned. Thus, Kirkenes could make use of this bulk terminal without any railway connection and transport minerals from the surrounding mines by truck to this bulk terminal, before transshipment and export to the global markets. Lastly, geopolitical tension and influence by foreign nations will certainly play a major role in the development of the NSR. This will of course have consequences for Kirkenes, as conflict and disputes between the global superpowers could hinder economic development in the region. This is an impending issue, but evermore relevant and will be further discussed in the next section about LNG transshipment.

Moving on to the institutional dimension, it is rather unclear how the Norwegian government will combine its efforts to realize the port development plans in Kirkenes with all its components. Assuredly, the official support for development is in place, but all documents and studies from ministries and departments seems to lack concurrence over the progress and financing of the massive project. As I have discussed earlier, it seems that funding from federal government will be limited or completely absent. If this is the case, it is inevitable that the local authorities cannot sustain an investment of this size by themselves. Right now, the relocation of the public port seems to be most attainable, as the local municipality probably has sufficient funding for this small part of the entire project. However, I think that a public-private partnership is the only way to allocate the necessary funding for a full railway link between Rovaniemi and Kirkenes or the more substantial parts of the port project. The outcome of such an approach is very uncertain and I will advise the government to rather focus more on developing transshipment facilities in Kirkenes that generates money in the short term. This would be a much more sustainable approach from an economic perspective and could conceivably attract private investors in the long term. Similarly, as funding from foreign entities (nations, development funds etc.) is unsettled at this early stage, I rather suggest that all levels of government establish a common understanding of the way forward with attention to financing options and the necessary legislation.

Lastly, it is also uncertain exactly how the environmental dimension will shape the development of a transshipment hub in Kirkenes. The local effects of port development has not been assessed properly and is, in my opinion a major deficiency for continued planning and construction. For example, dredging at the construction site, pollution of the biosphere near the port and long-term effects on marine life are not yet assessed. Regarding the Arctic Railway, the empirical findings show a pattern where the governmental reports are way more cautious towards the environmental impact of the plans. This in contrast to the private initiatives with a more laissez-faire attitude, where they barely mention any negative impacts at all. From a planning perspective this is rather naïve, as I find it viable that Sámi interests, combined with environmental impacts and extreme investment costs could inevitably hold back the entire railway project. All of these factors need to be contemplated properly if the project should have any chance to attract investments from private actors.

Looking at the global perspective, climate change certainly enables increased shipping in this fragile area and development of new bustling ports. Understandably, critics and environmental devotees views new Arctic shipping lanes as a paradox and find it rather absurd that the worlds response to the melting of polar waters is to deploy even more tankers and industry activity in the Arctic, exacerbating the problem. However, most established environmental organizations also recognize the importance of Arctic shipping for the world trade and instead focus their efforts on how to mitigate the negative impacts of development in the Arctic. For example, the World Wildlife Fund (WWF) advocate for stronger regulations and prompt implementation of existing legislation such as the UN Polar Code. They also call for stronger initiatives building of the Polar Code, with further regulations on spill water, discharges invasive species, chemicals and more (WWF Arctic Programme, 2016).

What we do know, is that these regulations will certainly impact the Arctic shipping industry, with many companies being forced to undertake major investments in their shipping fleet with compliance to the new regulations as these are initiated. However, my own understanding is that both existing and future regulations only targets the shipping activities themselves and not port development. Thus, it is hard to interpret how Arctic port development will evolve in the future, but it seems likely that these ports will follow their respective country’s existing legislation and comply with any future amendments specific to the Arctic.

6.2 Geopolitical impediments for LNG transshipment in Norway

Moving on, I will now assess the second case study question in this research***: What are the geopolitical impediments for transshipment hub development in Kirkenes?*** As discussed in chapter 4, the port of Kirkenes is very much a minor port today with little significance for NSR shipping. However, because of its strategic location and physical attributes the port has potential to become a fully intermodal transshipment hub with time. As I implied in chapter 4.2, the transshipment of oil and gas, particulary LNG will be crucial for the growth of NSR traffic the coming years. As we know, transshipment of LNG from Yamal is already occurring in Norwegian waters. This is conceivably a big opportunity for Kirkenes, if they manage to establish a permanent LNG hub with storage facilities in the new port. As previously discussed, Novatek is doing transshipment by ship to ship as a temporary solution and is looking to establish a permanent transshipment hub on the western terminus of the NSR (Katysheva, 2019).

As I already proposed in chapter 4, Kirkenes is a very fitting location for an LNG hub that compliments the existing port plans there. This proposal is of course highly hypothetical and my personal suggestion. However, after working with the case for some time I will argue that this solution is attractive for all parties involved. The transshipment operations are already happening in Norway and is from the company's perspective a great success. The latest signals of continued an increased transshipment in Norway because of capacity issues on the Russian side also suggest that these operations will continue for a long time. If these operations were moved to a larger hub, such as Kirkenes, one could see synergy effects in congruence with the other port operations that will take place there. As we know from chapter 4, 44 % of the LNG from the Yamal LNG was transshipped in Norway last year and additional extraction projects are commencing rapidly in the area. It is pure speculation to estimate LNG transshipment potential the coming years, but some estimates show that that 80 million tons of LNG will be produced annually by 2030 in the region (Humpert, 2020a). There is of course a chance that the Russians will assert more control over the LNG transportation chain and this dependence on Russia is one of the geopolitical impediments for Kirkenes and Norway. However, I will argue that such enormous quantities will probably enable the establishment of an LNG hub in Kirkenes, even if other terminals are being established in Russia.

Although there lies huge potential in these operations for Norway and Kirkenes, a major weakness is that none of the documents analyzed in this research assess the geopolitical aspects of Arctic shipping. For Russia, the rate of economic development is conditioned by further developing of its Arctic resources. Thus, the perspectives of the growth of investment into development of new hydrocarbon fields in the Arctic are obvious, and will contribute hugely to traffic on the NSR for many years to come (Katysheva, 2019). I will argue that this gives Russia an incentive to cooperate with other nations and strive for stability in region. However, we also see exacerbating conflicts in the Arctic, especially embroiling the global superpowers China and the USA. For example, in its first ever Arctic strategy from 2018, China positions itself as a "near Arctic state" where the ultimate goal is to assert newfound dominance and undertake investments in the Arctic. Consequently. China is using investment and trade to gain economic leverage in the area, where they have invested in oil and gas projects such as the Yamal natural gas fields. The Chinese have also advanced an Arctic governance narrative that includes China, playing on the multilateralism prominent in many of the Arctic nations' regional strategies (China's Arctic Policy, 2018). The Arctic nations and conspicuously USA feel discontented with this development and I think that future development of the NSR relies on settling such disputes before they escalate with repercussions and economic downfall. Another geopolitical impediment for LNG transshipment in Norway is Russian authority over the NSR. Russia ascribes great importance to controlling the development of shipping in the area, and Russia invokes a historical right to administer the maritime area. Russia has also administrated the traffic through the straits without any major control activities and consequently, the Russian regime is widely recognized (Hansen et al., 2016). Still, a problem for other countries is the nuclear-powered icebreaker fleet, which must be considered as an integrated part of the NSR and enables Russia to navigate anywhere in the Arctic. Combined, this means that the power is in the hands of Russia and its different gas companies. I think it is inevitable that Norway must accept Russian control over NSR activities, but the two countries has cooperated well in the Arctic in the past.

To answer the second case study question, the main hindrance for development in Kirkenes is Russian control of both the NSR and the LNG resources being exported. On a global scale, geopolitical quandaries between the world's superpowers could also be detrimental to NSR development. Lastly, the Russian attitude towards utilization of the NSR remains unclear and is another uncertainty factor for successful transshipment operations in Kirkenes.

6.3 Summary and proposals for transshipment hub development in Kirkenes

The goal of this case study has been to establish the different enabling and constraining factors for transshipment hub development in Kirkenes. Through a profound analysis of documents emanating from the project I have assessed the potential Kirkenes has to transform its port from a small, local harbor to a fully intermodal transshipment hub with global potential. The findings show that Kirkenes possess multiple advantages within all four dimensions, but is also facing significant uncertainty and challenges as the planning and construction proceeds. Regarding the second research question about LNG transshipment, I have already addressed the geopolitical issues that these operations is facing both now and in the future. Irrefutably, the reality is that Russia and Novatek can cancel all transshipment in Norway at any moment, if they find their own interests threatened. It is also evident that a permanent transshipment hub could be located in Russia, closer to Murmansk instead of being established this in Kirkenes. This is a pressing issue that should have been assessed further, but I have unfortunately been unable to interview the local industry actors and politicians about the political aspects of the case study.

There is no need to reiterate the findings from this case study, as the two preceding chapters have discussed both the findings and assessed the case study questions, with a summary in chapter 5.5. Instead I will propose a transitory program of how the development of Kirkenes should advance, which denotes the most feasible solution based on my findings. As I have promoted earlier, the port plans in Kirkenes will be constructed in stages and grow jointly as demand increases. Thus, one should aim for the most viable projects in the beginning and I propose that the relocation of the public port and the establishment of an LNG terminal could act as a catalyst for further development as these projects will most likely generate profit within a short timeframe. Looking ahead, there are feasible opportunities to export minerals from both Norway and Finland through the new port and so this should be the authorities' goal in the medium to long term. Finally, if all of these projects are conceived, there could be enough interest in investments in the Arctic Railway to fulfill the long term vision of container transshipment in Kirkenes. This results in the following schedule for development:

Proposed chronology for port development in Kirkenes:

1. Short term: Establish LNG transshipment terminal
2. Medium term: Facilitate mineral export and other services
3. Long term: TEU transshipment with railway connection as ultimate goal

6.4 Distinctive characteristics of Arctic transshipment hubs

Moving on to the final goal of this research, I will examine which factors that is required to develop efficient transshipment hubs in the Arctic. These are by nature quite similar to the factors from the case study and the goal is to generalize some of the most important findings to a general framework for Arctic transshipment hubs. As previously conferred in the literature review, there is a gap in the literature regarding such models that includes specific factors or criteria for Arctic conditions. For example, the model from Gritsenko & Efimova applied in the analysis of Kirkenes encompass factors for Arctic port development in general, but present no specific transshipment criteria. Moreover, the model from Notteboom et al. (figure 2.2) presents some selection factors for transshipment hubs, but not in Arctic conditions. By answering the main research question: ***What are the distinctive characteristics of an Arctic transshipment hub?*** I will assess the significance of the overall design criteria and infrastructure components of an efficient Arctic transshipment hub, with particular emphasis on the logistical function these hubs serve in the value chain.

As already discussed, the model from Notteboom et al. presents some essential factors that needs to be in place for a transshipment hub needs to succeed. However, the model is quite general and does not address different types of transshipment operations. With the case study findings in mind, I now have some propositions for how Arctic transshipment hubs will operate in the future and the desired design of these. Accordingly, this chapter will introduce these specific factors and construct a new model for Arctic transshipment hubs (figure 6.1).

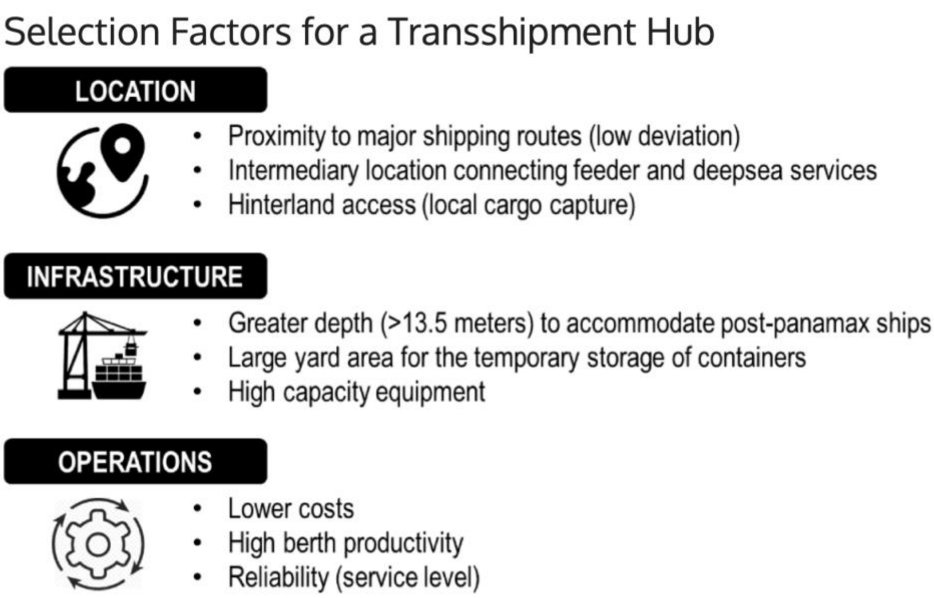


Figure 2.2: Selection factors for transshipment hubs (Notteboom et al., 2020)

Location

The first component of the said model is related to location and the physical attributes of the transshipment hub. With "normal" transshipment hubs located in southern waters, hinterland access and local cargo capture is both beneficial and imperative for the hub's operation. A good example is the two major transshipment hubs Shanghai and Rotterdam. In both cases, these hubs serve as their region's definitive transshipment hub because of their location and large contiguous population centers. Contrary, in the Arctic, my understanding is that hinterland access is not important at all because NSR shipping will be resource-based for long time to come. By this, I indicate that most of the goods being transshipped on the NSR will be originating from the Arctic, such as the many petroleum and mineral projects that are being commissioned in the coming years. In the Arctic, this also means that limited inland investments are required because most of the cargo is transshipped from ship to ship or with temporary warehousing at the port facilities. Thus, the footprint these terminals have on the local transport system will be limited. Instead, the key determining factor for Arctic transshipment hubs will be its location along the NSR, as the operational model is based on two hubs at the western and eastern ends of the shipping route (Milaković et al., 2018).

The reduced need for inland connections may at first seem like a paradox when one assess railway connections in the Arctic. Especially for Kirkenes, the Arctic Railway is the cornerstone and one of the main arguments for the project. However, railways are only fundamental in the supply chain when one is addressing intermodal hubs. As I have argued in the case study, these railway plans are a long-term vision and TEU transshipment on rail is highly unsure and contingent on Chinese attentiveness. Since the NSR will be mainly resource based for a long time, with ship to ship transshipment and export, a railway connection might be redundant for an Arctic transshipment hub. Even in Murmansk, with an already existing railway, this could be the case due to higher costs of TEU transshipment. Some studies also supports this, and concludes that the overall costs of the NSR shipping system needs to be lower in order to commercially rival the Suez canal route (Xu, Yang, & Weng, 2018)

Infrastructure

The infrastructure needed for transshipment hubs in the Arctic is mostly the same as for other places in the world. Like elsewhere, the physical attributes for the port and fairway must be dimensioned in order to receive vessels of any size. It is hard to predict the exact size of the ships that will navigate the NSR, but a successful transshipment hub will need to accommodate both large oil/gas tankers and possible container vessels in the future.

Another important finding from the case study is that Arctic transshipment hubs should not be specialized to just one specific type of transshipment operations. As mentioned earlier, too narrow focus for Arctic transshipment hubs will limit the supply capacity of the NSR shipping system and make Arctic transshipment hub less competitive to ports outside of the Arctic (Gritsenko & Efimova, 2017). Thus, the ideal Arctic transshipment hub will offer a range of different transshipment services with pertinent infrastructure. Examples of this encompass bulk terminals, storage facilities, supply logistics for oil companies and eventually TEU terminals.

Finally, Arctic transshipment hubs need to facilitate ship to ship transshipment. Today, such operations are not common in the major hubs in southern waters and hence, this is a feature that will be specific to the Arctic hubs. The main reason for this trait is due to the fact that the NSR shipping is highly focused on extractive industries such as petroleum and mineral export. As I have explored in chapter 4.2, these industries often make use of ship to ship transshipment. Consequently, any Arctic port that wants to establish a transshipment hub would need to attract these activities to its waters and supply the necessary infrastructure and technical equipment for such operations. These technical features have deliberately not been a focus of this research, but is nevertheless important for future development.

Operations

The final component of the model is related to the operations and the function transshipment hubs serve in the logistics chain. As I have settled several times, a key prerequisite for successful Arctic transshipment hubs is an ice-free port all year around. This is essential, because constant ice breaker service and management of the port itself would results in high expenses and lower productivity. This would also affect the ice breaker capacity of the whole NSR, since ice breakers would be occupied with maintaining open port waters, instead of being utilized out on the polar waterways where the capacity is needed.

On an institutional level, the IMO Polar Code will have the greatest impact on future NSR shipping. Both the literature review and the case study show that this legislation will determine how shipping companies operate in the Arctic. However, there is hard to predict how the Polar Code will shape port development itself. My studies show that this legal framework will have direct consequences for the shipping activities, but only indirectly affect the actual ports. Although not a topic of this research, it is clear that increased search and rescue capacity and environmental response will be the main requirements that originates from this new legislation.

Finally, the most important aspect of Arctic transshipment hubs is the fact that these operations will be intersection transshipment instead of the typical hub and spoke model that is found elsewhere. On the Suez Canal route smaller feeder ships supply a major hub with goods before it is transshipped to very large vessels and sent across the route. A significant finding of this research is that in the Arctic, we will instead se an intersection model, where the goods are transshipped directly between larger vessels. Thus, the transshipment hubs will serve more as an intersection on the NSR and not as the typical hub in a hub and spoke model.

Figure 6.1 is a summary of this discussion and the ultimate contribution of this research. Adding to a gap in the literature, I am confident that this contribution will prove helpful to further studies on this evermore relevant research topic.

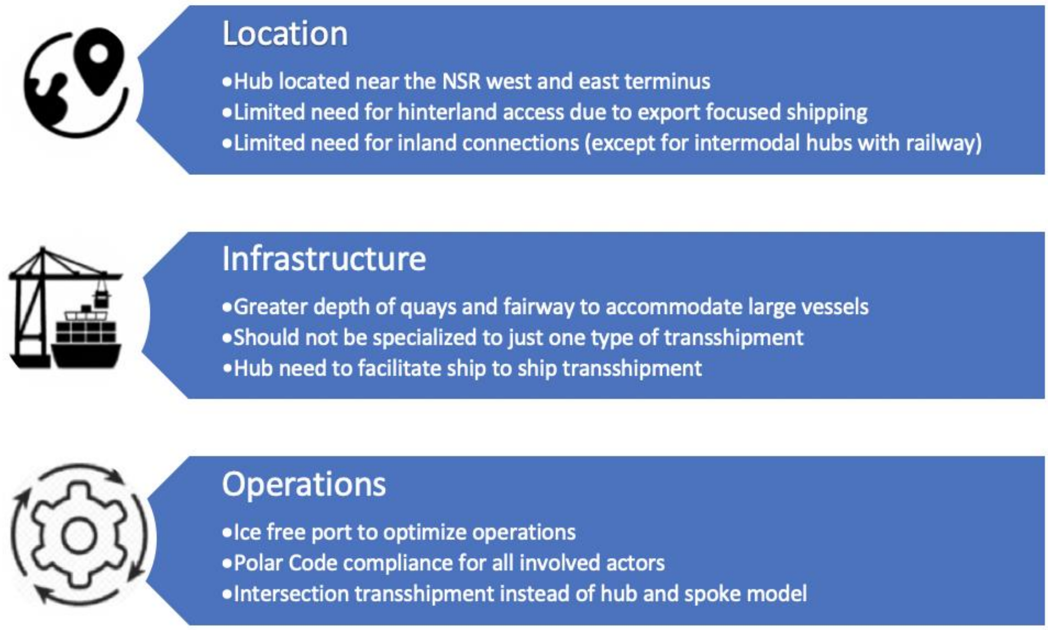


Figure 6.1: Distinctive characteristics of Arctic Transshipment hubs

7 Conclusion

In this master thesis I set out to answer the question:

What are the distinctive characteristics of an Arctic transshipment hub?

Compared to transshipment hubs in other places of the world, there certainly are some distinctive characteristics for doing such operations in this cold and remote area of the world. These characteristics can be traced to the ports themselves, as well as the overall functioning of the NSR shipping system. My findings and answer to the main research question have been categorized into three different factors, summarized in figure 6.1. Regarding location, the most important feature is that the hub is located near the end of an NSR terminus. For obvious reasons, a hub located too far into the NSR will struggle with extreme ice conditions in order to maintain year around operations. Likewise, a hub located too far outside of the NSR will not be a viable option for shipping companies. The most important infrastructure factor is that the transshipment hub should not be specialized to just one type of operations. This drastically limits the competitiveness of the hub and diminishes the advantage that the NSR have on competing sea routes. Finally, the most significant finding within operations is that Arctic transshipment hubs will function as intersections along the shipping route as compared to the more common hub and spoke model. This has implications for the entire NSR value chain, and is a research area where further analysis is needed in order to fully comprehend NSR shipping.

The main contribution of this master thesis has been to investigate the characteristics of Arctic transshipment hubs. Figure 6.1 can be interpreted as either a list of the said features or as a model for distinctive selection factors that authorities and companies need to adhere to in the planning of a successful Arctic transshipment hub. The other contribution has been to thoroughly assess the enabling and constraining factors for establishing a hub in Kirkenes and my hope is that these findings will prove useful to the actors working on realizing these particular plans. Regarding the two case study questions, they have already been assessed in the discussion and does not need any further remarks.

As described in chapter 3, there are some limitations to be found in this research. The most conspicuous issue is the lack of interviews due to the aberrant situation globally during my work on this project. My intention was to include interviews in the case study to properly investigate the industry needs and explore both Norwegian and Russian perspectives on the NSR. However, this proved difficult to accomplish and is something that future research on the topic should include. Although this master thesis has made a noteworthy contribution to NSR research, there are still many topics to be explored in this research area. For instance, future research should certainly include multiple cases and then compare the new results to the findings from Kirkenes in this thesis. The port of Murmansk is an obvious study object, being the largest port in the Arctic. Further research could also assess the dynamics between Murmansk and Kirkenes, or which support functions Kirkenes could maintain in future NSR shipping.

Regarding the NSR logistics system as a whole more research is needed on the eastern terminus of the route, and a location study using the new framework from this master thesis could be undertaken to explore the most feasible location of another transshipment hub. Finally, I reckon that the most interesting topic for further research is the difference between hub and spoke and intersection transshipment. The exact operations of these Arctic hubs have not been assessed in this master thesis and is a topic where research could construe the function of Arctic transshipment hubs in the logistical system on a deeper level.

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9 Appendix

9.1 Coding scheme for document analysis

Dimension	Category
Physical	
	Offshore conditions
	Onshore conditions
	Operations
Economic	
	Container transshipment
	Mineral export
	External interest
Institutional	
	Local policies
	National policies
	International policies
Environmental	
	Global consequences
	Local consequences
	Arctic shipping

Table 9.1: Coding scheme for document analysis