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Containerized Shipping via the Northern Sea Route

Master's thesis in Master's Programme Maritime Management

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DEPARTMENT OF MECHANICS AND MARITIME SCIENCES
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Abstract

Climate change has enabled Arctic shipping, specifically with the Northern Sea Route (NSR) that connects the Eastern part of Asia with Northern Europe. Providing a shorter distance from Northeast Asia to Northern Europe compared to the Suez Canal Route (SCR), the NSR could potentially become an alternative route to the SCR. The shorter distance additionally brings savings in time, fuel consumption and possibly other areas of costs. The study results showed that with the container vessel voyage via the NSR, there is a reduction of 25.1% in total distance, 25.8% or around 7.4 days in journey time and significant reduction can be seen in fuel consumption (44.2%) when comparing the same port pairs against the voyage via the SCR. However, the potential usage of the NSR for container liner shipping does not come without its own set of disadvantages and challenges. According to the interviews conducted for this study, difficult weather conditions were the most prominent disadvantage that caused doubts for the professionals from the shipping industry. That followed by the concern about the infrastructure along the coast of the NSR, administrative and political issues and extra demands or costs related to the vessel operations. Additionally, the commercial usage of the NSR could be stunted as many major shipping companies and customer goods owners have signed an environmental pledge, i.e., the Arctic Shipping Corporate Pledge. According to the pledge, the signatory parties commit to not use the NSR in their commercial activities because of the sensitivity of the Arctic region, the fragility of its ecosystems and habitat.

Regarding different stakeholders, the port authority has expressed a positive attitude towards developing the NSR and making it feasible for commercial activity due to their potential future gains connected to their advantageous geographical location. However, other stakeholders have shown more doubt about the actual practicability and success of the NSR as an alternative route to the SCR.

Keywords: Northern Sea Route (the NSR), Arctic shipping, Polar Silk Road, containerized shipping, Suez Canal Route (the SCR), advantages of the NSR, disadvantages of the NSR

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Likewise, we would sincerely like to thank all of the respondents that voluntarily gave their time and attention to interviews with us despite their busy schedules. This is extremely appreciated because having your priceless experience, knowledge, opinions and perspectives on various questions about the container shipping feasibility and potential via the NSR helped us structure and complete this study. Also, we would like to hand our gratitude for offering your time and contribution for any follow up questions.

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Gothenburg, 2021
Mari-Liis Ait and Rika Citra

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List of Abbreviations

Abbreviation	Description
AB	Able Seaman
BRI	Belt and Road Initiative
CPG	Consumer Packaged Goods
EU	European Union
FMCG	Fast Moving Consumer Goods
GOT	Gothenburg
GUNiO	ГУНиО (English: Head Department of Navigation and Oceanography, or HDNO)
HVP	High Value Products
INSROP	International Northern Sea Route Programme
JANSROP	Japan Northern Sea Route Programme
LBG	Liquefied Biogas
LNG	Liquid Nitrogen Gas
NSR	Northern Sea Route
NSRA	Northern Sea Route Administration
PSR	Polar Silk Road
RTM	Rotterdam
SAR	Safety and Rescue
SCR	Suez Canal Route
SHA	Shanghai
TEU	Twenty-foot Equivalent Unit
VPT	Voyage Planning Tool

Chapter 1: Introduction

This chapter provides the reader with the background information on the Northern Sea Route (NSR) and the value it may bring in coming years to the many stakeholders of shipping of goods. In order to frame the current work in a more concise manner, the research purpose together with research questions and limitations are presented.

1.1 Background

In recent years, it has been evident to most scientists that global climate change is accelerating. Even though this phenomenon brings about devastation in many corners of the world, it is also contributing to positive developments. One of them can be identified as the NSR becoming increasingly feasible as a trade route for commercial cargo from Northeast Asia to North West Europe. In the twentieth century, the NSR was used by Russian ships only, and the route opened for international or non-Russian ships in 1991 after the collapse of the Soviet Union (Milaković et al., 2018). Now, between these regions the shipping through the NSR reduces the average shipping distances and days of transportation by around 30%-40% in comparison to the currently used Suez Canal Route (SCR) (Bekkers et al., 2015; Furuichi & Otsuka, 2018).

Considering a shortened distance in comparison to the SCR, the fuel consumption is also reduced although with changing and sometimes unforeseen weather circumstances such as wind and ice conditions, the exact savings in fuel expenditure could be difficult to predict (Li et al., 2020). Liu and Kronbak (2010), similarly agree that higher building costs for ice-classed ships, non-regularity and slower speeds, navigation difficulties and greater risks (e.g., weather conditions), as well as the need for extra ice breaker service means that the reduction in distance does not automatically deliver equally as great cost savings. It could be expected that widespread usage of the NSR in commercial shipping can shift the dynamic between countries in various areas such as economy, politics, and defence. Assuming that climate warming continues and ice in Northern hemispheres keeps melting, making the NSR feasible for shipping on reduced costs, creates an opportunity for goods' owners to transport cargo likely in a speedier manner and on lesser costs. This creates a win-win situation where stakeholders such as shipper, cargo owner and consumer of the goods are all gaining from the situation. Additionally, Hill et al. (2015) point out that trade efficiency could be created since distance and time savings can be made through using the NSR and that saved time can be allotted for activities such as faster delivery of critical goods and lower amount of required inventory levels. Using the Arctic route could also potentially imply less money spent on crew and its various needs and slow sailing in those waters would create less opportunity for any hazardous or otherwise damaging accidents (Hill et al., 2015).

In addition, the most traditional shipping route between Europe and Asia, the SCR, comes with its own set of issues. For example, the SCR has been plagued with congestion issues, piracy incidents, considerable toll fees, and blockage (Martínez-Zarzoso, 2013; Hong, 2012; Furuichi & Otsuka, 2013). The alternative route to the SCR, trade route over the Cape of Good Hope is longer and time consuming than using the NSR and as Martinez-Zarzoso (2013) argued, also holds a risk of piracy. Furthermore, complete blockage of Suez Canal for several years from 1967-1975 (Feyrer, 2009) and congestion that halted the ability to let vessels through for almost a week in March of 2021 (Burns, 2021) are indisputable events that should be accounted for when figuring out an alternative route. Due to the conflict between Arabs and Israelis, which ultimately caused Suez Canal closure from 1967-1975, Feyrer (2009) argued that the responsiveness of trade to changes in trade costs suggests that increased trade volumes are caused by lowering the barriers of the same. Feyrer concluded that for many country pairs where the shipping distance increase was over 50%, due to the conflict, a significant drop in trading could be noticed. Another incident that caused a notable drop in trade revenues, took place in March 2021 and according to Lloyd's List Intelligence estimation caused 9.6 billion dollars of losses daily (Ghosh, 2021). Although damages of Ever Given being stuck diagonally in Suez Canal for almost a week are hard to estimate accurately, one can sense the ripple effect it is able to generate by throwing the global supply chain off the balance for months (Burns, 2021).

Moreover, Suez Canal is under immense pressure due to the yearly rise in international trading and the risk of piracy and length of the route over Cape of Good Hope, the NSR gaining a part of the commercial trading could possibly lead to higher efficiency in global commerce. However, the Arctic region is considered environmentally fragile and therefore should be protected. This is supported by the fact that in 2018, a non-profit organization Ocean Conservancy created the Arctic Shipping Corporate Pledge which promotes precautionary practices for the Arctic and avoiding it as a shipping route. Yet, if these obstacles can be overcome and are actively considered then NSR could have a more critical role to fulfil in the years to come. Until recently, the number of container ships that have taken the NSR from Asia to Europe or vice versa is limited to general cargo ships or tankers but with improved conditions this is expected to change. Furthermore, consumption of goods in Europe through e-commerce channels have risen rapidly. For example, online shopping has increased several folds from 2014 to 2020 according to the data released in PostNord Sverige's (2020) annual report with multiple countries reporting a significant increase in the frequency of online shopping.

In addition, 2020 saw Europe being hit by the COVID-19 pandemic which impacted the e-commerce market undoubtedly with citizens' movements being restricted. Consumers reported buying either a somewhat larger or much larger percentage of the products online with Spain, Belgium and Italy being on the forefront (PostNord Sverige, 2020). As the pandemic is still ongoing, thus it could be expected that online shopping will maintain its position as customers' choice for purchasing goods. Consequently, it could be expected that the need for strong contenders next to the SCR is only going to grow in coming years. The NSR, with its notably shorter distance, could prove beneficial for the transportation of the fast-moving consumer

goods which are identified as goods which have a high turnover and low cost ("Fast-moving consumer goods", 2021). From the consumer perspective, fast moving consumer products are frequently purchased, with low shelf life, low engagement, low price products for rapid consumption. While, from the marketer perspective, they have high volumes, low contribution margins, extensive distribution, and high inventory turnover ("Fast-moving consumer goods", 2021). All these described characteristics make it an ideal type of product to be transported over the NSR due to lower lead time. Some of the examples of fast-moving consumer goods could be named as toiletries, cosmetics, men's and women's inner garments, packaged foods, and beverages ("Fast-moving consumer goods", 2021).

At present time, the SCR is the main shipping trade route between Asia and Europe with 8% of world trade transported via the Suez Canal. However, Bekkers et al. (2015) estimate that in the future, two thirds of that same cargo volume will be rerouted over the shorter NSR. Given that Russia and China have both made commitments to developing the Arctic shipping route, it is likely that there will be major steps taken to attract business (Russian Government, 2019; The State Council Information Office of the People's Republic of China, 2018; Professor & Revenko, 2019).

1.2 Research purpose and research questions

The purpose of the thesis is to explore opportunities and efficiency for shipping companies and port authorities, regarding transporting containerized fast moving consumer goods (FMCG) via the NSR.

RQ1: What efficiency savings in containerized shipping can be made using the NSR during the summer?
RQ2: Which opportunities do stakeholders involved in international container shipping see in a future use of the NSR?
RQ3: Which FMCG products can be shipped via the NSR?

1.3 Limitations

This thesis will focus on calculating the efficiency of the NSR- finding the lead time and economical savings of inbound shipping of containerized goods via the NSR. Simulation of the optimized routes and calculation of the fuel consumption are key items for evaluation of the economic benefits and lead-time, which will be carried out using in-house numerical tool (MATLAB). The data will be collected from previous studies related to the NSR and interviews with different stakeholders with focus on fast moving consumer goods distribution. However, the interviews for the current research are from four different parties within the shipping sector which proves to be a limitation since for a broader view the data from more stakeholders would be required. Additionally, for better understanding on the benefits and challenges of the NSR usage, the input from companies from different countries and continents such as Asia would

present an added value to the reader. The study is focused on the data that is mainly connected to the fast-moving consumer goods in the Swedish market; it could provide a wider perspective when the goods were more diversified. Finally, since the authors are working on the deadline, it was decided that focusing on inbound cargo provides a more in-depth view to the reader on the matter; however, for balance, the study on the outbound traffic of goods could provide larger breadth to the thesis. Those limitations could be addressed in future studies.

Chapter 2: Frame of Reference

Chapter 2 of the thesis introduces the NSR and compares its potential and challenges to the already existing sea transportation route, the SCR. In addition, the authors present the consumer trends that likely might have an impact on further encouraging the usage of the NSR. Moreover, China's executive plan to tackle the shortcomings and demands of the Polar Silk Road (PSR), China's name for the Arctic route, is presented.

2.1 The NSR as an alternative route option to the SCR

The NSR is the shipping corridor connecting Northern Europe to Asia through Arctic waters mainly along the coast of Russia. The NSR is defined in Russian law as the set of Arctic marine routes between Kara Gate in the west and the Bering Strait (Arctic Council, 2009) which means that it runs through the Barents Sea, the Kara Sea, the Laptev Sea, the East Siberian Sea, the Chukchi Sea (Figure 1) following into the Bering Sea (Gunnarson, 2021).

Figure 1. The seas of the NSR (Liu & Kronbak, 2010, p. 436)

Global climate change has been increasing Earth's temperature and reducing ice in the Arctic (Hill et al., 2015). These developments have opened a new transportation route over the northern polar region called the Northern Sea Route (Hill et al., 2015). The NSR is believed to bring reductions in fuel consumption, emissions and transit time compared to the traditional Suez Canal Route (SCR) (Chou et al., 2017). However, the exact distance and cost reductions achieved by using the NSR differ. A study from Bekkers et al. (2015) found that the NSR can reduce around one third of the distance and time between Northern Europe and Northern Asia and lessen the cost of transportation around 20%-30%. The exact reductions in distance, transit

time and cost depend on different factors for example the speed of the vessel, the type of vessel, weather conditions, origin-destination combination and more. Raza and Schoyen (2014) pointed out that NSR as an alternative route to SCR provides a 50% shorter sailing distance between Northwest Europe (Hammerfest, Norway) and Northeast Asia (Tobata, Japan). Furthermore, the shorter distance of the NSR comparatively accelerated the route's cost efficiency by 42% and cut the carbon dioxide emissions by 52% (Raza & Schoyen, 2014).

Recessing ice and longer navigation seasons enhance the attractiveness of the NSR (Schach & Madlener, 2018). However, there are some disadvantages to anticipate for shipping in the Arctic waters such as political factors, shallow waters, infrastructure, or lack thereof, especially search and rescue capabilities, and climatic conditions (weather, ice, wind etc.) (Schach & Madlener, 2018; Hill et al., 2015). Additionally, there have been doubts about the reduction in time when taking the NSR instead of the SCR in the case of container vessels (Li et al., 2020). Li et al. (2020) found in their case study that due to the voluntary speed reductions caused by difficult weather circumstances, the journey time for container ships was not reduced. Sibul and Jin (2020) argued that container shipping is not profitable due to low eastbound load rates because of the underdevelopment and the low turnover of Russian Arctic ports. Hence, using the NSR does not come without its own set of challenges. The NSR is completely ice-free for approximately five months during the summer, from the beginning of July until the end of November (Sibul & Jin, 2020). During the rest of the year's seven months, the NSR is covered by fractured or consolidated ice, which requires ice-breaker's assistance (Schach & Madlener, 2018). Consequently, the lead time for ocean transport as well as the transport cost per container increases during the winter.

The Suez Canal Route (SCR) has been utilized for a longer period due to its feasibility and less challenging climate conditions compared to the NSR. Once the Suez Canal was deployed as a gateway from Europe to Asia and vice versa, the journey time between these two continents as compared to taking the journey over the Cape of Good Hope around Africa was significantly reduced (Martínez-Zarzoso, 2013). However, SCR comes with its own plethora of faults such as toll fees, a threat of pirate attacks, congestion issues and more (Blumen, 2012; Martínez-Zarzoso, 2013). Martínez-Zarzoso (2013) explored in her study the possible adoption of the NSR and Cape of Good Hope Trade route as an alternative even though the latter may deem also unsafe for commercial cargo ships sailing nearby Africa as Somali pirates and their *modus operandi* has reached the waters close by Madagascar and Mauritius. Piracy has been eradicated many times and tends to reappear when the fight for livelihood in areas close to maritime trade routes takes drastic turns (Fu et al., 2010; Martínez-Zarzoso, 2013). As piracy risk is substantial via SCR then it should be considered in shipping cost comparisons (Raza & Schøyen, 2014) specifically against the NSR which struggles under other types of costs such as ice-breaker fee. Furthermore, Hong (2012) pointed out one other obvious fault of the SCR which is the incapability of accommodating mega ships that then need to use the route around the Cape of Good Hope.

2.2 Feasibility of goods shipping via the NSR

During the past two decades, researchers have been conducting a feasibility study regarding the NSR (Kiiski, 2017). The topic has gotten more popular with the melting ice around the North Pole. Global climate change is opening up new possibilities for foreign shipping networks (Rahman et al., 2014). Particularly on the Russian Arctic or the Northern Sea Route, it will have an impact in European and Asian countries trading as through this route, they can save lead time and costs (Button et al., 2007), especially the ports in China, Japan and Korea (Zhu et al., 2018). Studies have been published regarding the feasibility of NSR since the 1980s, where the main conclusion is that sailing through the NSR can save up to 40% compared with the SCR (Cariou et al., 2019). Even though the NSR provides shorter distance between Asian and Europe, it does not mean that it will save time and costs (Zhu et al., 2018).

Published studies vary in their arguments when weighing the advantages and disadvantages of the NSR against the SCR. For example, Benefyk and Peeta (2018) showed that companies which transport more than 1000 TEU's would not likely use the NSR, as it will be difficult to adjust the transportation procedures. In addition, there are geographical factors such as navigable season, weather conditions, and sea ice that must be considered to sail through the NSR. Benefyk and Peeta (2018) addressed aspects that are able to persuade transportation companies to consider using the NSR, such as lower freight rates, shorter transit time, and sufficient reliability. Lasserre (2014) emphasized that by comparing his findings to previous studies, the NSR appeared profitable, but results vary depending on the factors and assumptions of any given example (Table 1). The study found that load factor and transit time are the most critical factors that determine the profitability of NSR (Lasserre, 2014) and departure and arrival port costs also affect the total cost (Sur & Kim, 2020).

Table 1. Results of comparison study between the SCR and the NSR (Sur & Kim, 2020, p. 182)

Studies comparing the NSR and the Suez route profitability, and cost criteria used.

Criteria	Route	Origin – destination	Time of navigation for the NSR	Profitability of the NSR
Transportation costs	NSR Suez	Hamburg – Yokohama	Year-round	X (higher income cost)
Transportation costs (2015–2025)	NSR Suez Trans Siberian	Hamburg – Shanghai	Year-round	X (higher cost per TEU)
Cost per TEU	NSR Suez	Rotterdam – Yokohama	July–December	X (higher cost per TEU)
Profit margins	NWP NSR Polar Suez	Shanghai – Rotterdam	Year-round 6 months 4 months	O
Transportation costs for a year	NSR Suez	Rotterdam – Tokyo, Hong Kong, Singapore	S1: year-round S2: seasonal	X for S1 O for S2
Operation costs	NSR Suez	Rotterdam – Yokohama	3, 6 or 9 months	O
Fuel costs	NSR Suez	Atlantic Europe – Northern Asia	Summer transit	O
Fuel consumption efficiency and fuel costs	NSR Suez	LNG: Porsgrunn – Shekou Bulk: Narvik – Qingdao	Summer transit	O
Advantages and risks of the NSR	NSR Suez	Murmansk or Kirkenes – Pusan	Summer transit	O
Costs for a single destination trip	NSR Suez	Kirkenes – Yokohama Melkøya – Yokohama	Summer transit	O
Cost differences	NSR NWP Transpolar Suez	Yokohama – Hamburg Shanghai – Hamburg	Year-round	O

One of the most significant disadvantages of the NSR is its economic feasibility, which depends on unknown factors and other variables such as longevity of the season, availability

and fees of ice-breakers and more (Liu & Kronbak, 2010). Additionally, Lin and Chang (2018) concluded that certain determinants can make carriers deem the NSR an attractive choice, "including improved navigation skill, higher bunker price, higher delay penalty, tighter service commitment and increased cargo volume". Zhao et al. (2016) pointed out that while for some port-pairs between China and Europe, the distance over the NSR would be shortened then for others it would be lengthened (Zhao et al., 2016). Bekkers et al. (2015) argued that between Japan and Northern Europe countries, the distance is reduced by around 37%, while for South Korea the savings were 31%, for China 23% and for Taiwan 17%.

To determine the feasibility of goods shipping through NSR, the following factors need to be considered by a shipping company (Figure 2). As seen on Figure 2, the process of determining the feasibility itself is a complex and time-consuming process (Kiiski, 2017).

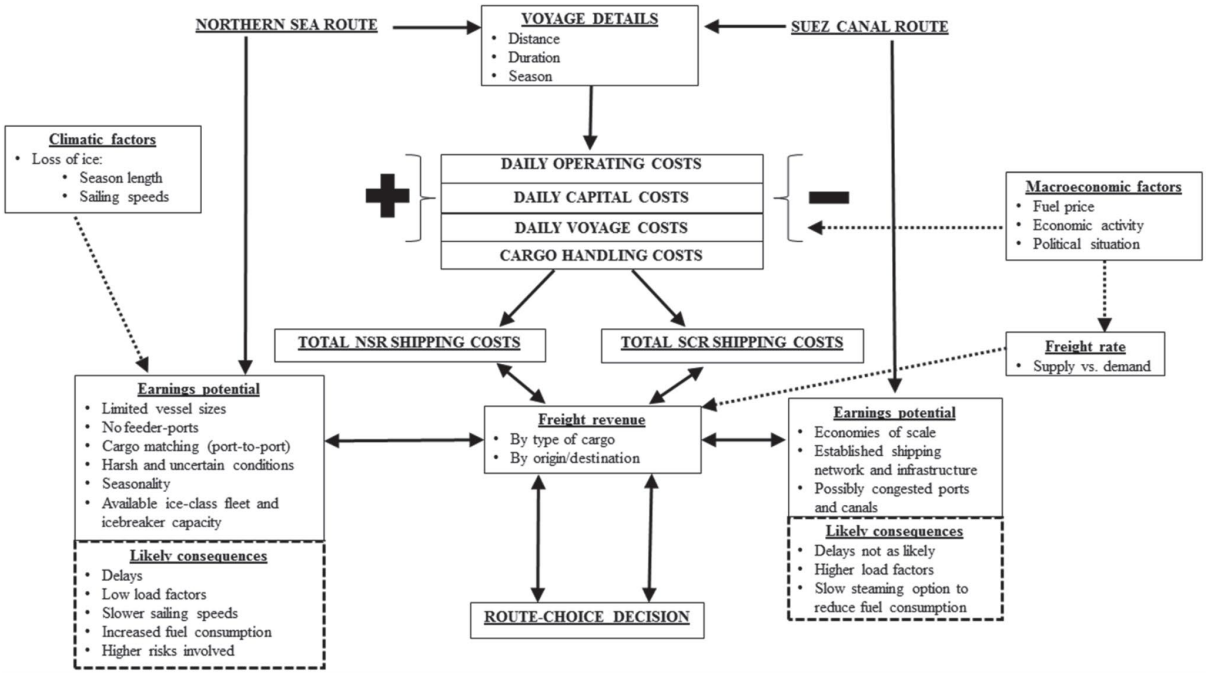

Figure 2. The main factors affecting the decision-making process of a ship owner (Kiiski, 2017, p. 149)

The potential of the NSR has been highly discussed since its opening for international shipping for commercial ships (Solvang et al., 2018). In the twentieth century, the NSR was used by Russian ships only, and the route opened for international or non-Russian ships in 1991 after the collapse of the Soviet Union (Milaković et al., 2018). First non-Russian ship that sailed in the NSR was a Finnish tanker ship in 1997 (Kujala et al., 2018). Since then, the NSR has been used by bulker, general cargo, container, cruise ships (PAME, n.d.). Rajagopal and Zhang (2021) analysed ship transits from 2011 to 2018, finding that NSR is mostly used by tankers and LNG carriers which translates into 41%-61% of the total activities. While container ships fall into category 2 (Figure 3), but container ships mostly used the SCR compared to the NSR (10%), this low number is affected by port infrastructure and development in the Arctic area

(Rajagopal & Zhang, 2021). Furthermore, the lower number of transits is affected by the low population in the Russian Arctic and non-industrial conditions, which resulted in a small number of container ship activities in the NSR (Kiiski, 2017).

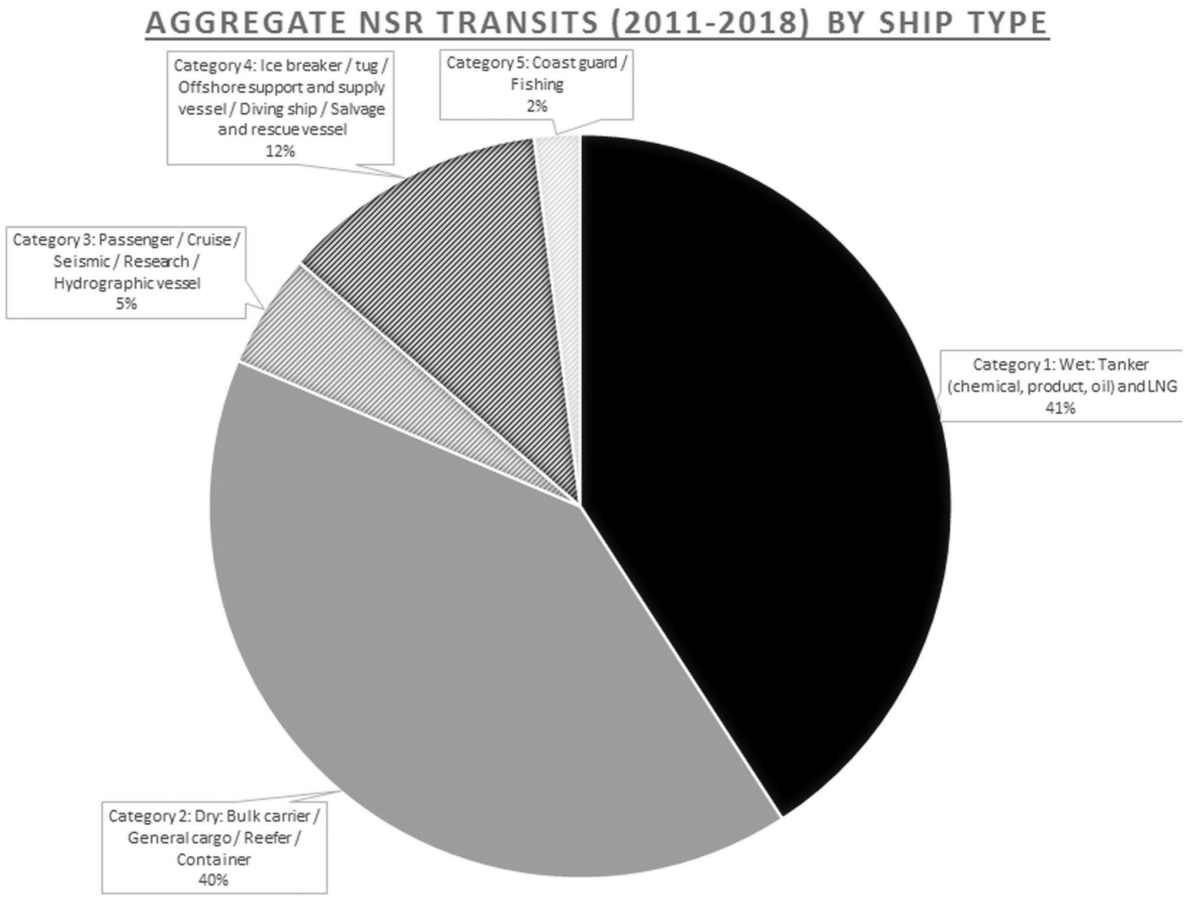

Figure 3. The NSR usage based on vessel type (2011-2018) (Rajagopal & Zhang, 2021, p. 6)

Figure 3 shows that the largest users of the NSR were tankers and LNG carriers with 41% or 123 transits of the total transits (Rajagopal & Zhang, 2021). It can be seen in Figure 4 that the number of transits in the NSR is unstable in general. However, when it comes to wet tankers (chemical, product, oil) and LNG, these tend to be stable in number of transits (Rajagopal & Zhang, 2021). Nonetheless, this number is not affecting the demand and the research of the shipping possibility through the NSR. The literature reveals possible factors which can result in the low number of the NSR transits:

1. Fewer options of loading and discharging port along the NSR (Rajagopal & Zhang, 2021)
2. Navigation hazards (e.g., ice) (Rajagopal & Zhang, 2021)
3. The NSR is not open all year around (Hayata & Huang, 2021)
4. (Might) need ice-breaker vessels (Hayata & Huang, 2021)

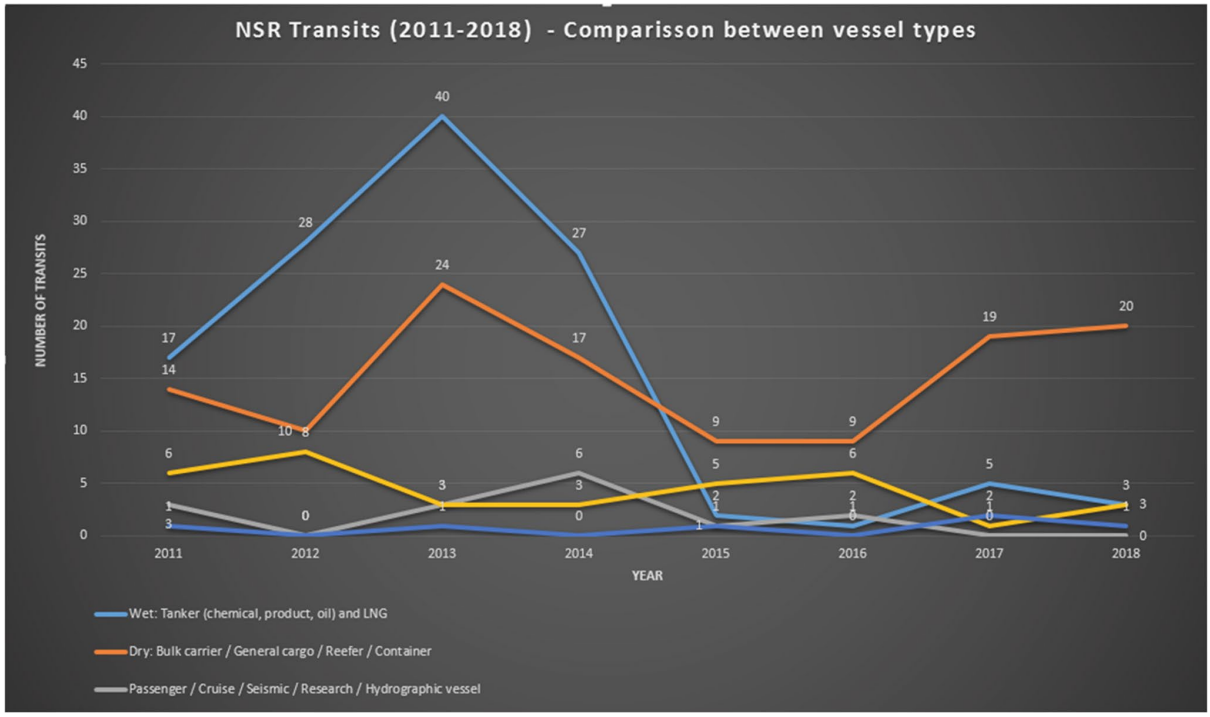

Figure 4. The NSR transits 2011-2018 (Rajagopal & Zhang, 2021, p. 7)

There are a lot of countries that put high interest in the potential and investment of shipping activities in the NSR (Balić et al., 2019). The demand for the shipping through the NSR is not depending on the type of the product but on the maritime transport demand, where the transport demands are dependent on the market demands (Balić et al., 2019). The NSR is seen as an alternative for the SCR and its specific limitations (Martínez-Zarzoso, 2013).

2.3 Environmental factors affecting shipping along the NSR

The Arctic Sea has received international attention because of global warming. Over the past 40 years, Arctic Sea ice has decreased significantly. Compared with the year 1993-2006 Arctic has 6.13 million square kilometres to 4.44 million square kilometres in 2007-2020 (Lindsey & Scott, 2020). The weather in the Arctic is becoming increasingly milder and tolerable for various industrial and business activities hence from a strategic and an economic perspective it is wise to capitalize on this opportunity.

The Arctic Ocean is the smallest ocean in the world and covered by sea ice and the NSR is one of the parts of the Arctic Ocean (Britanica, 2021). Astronomical factors have been one of the main reasons for shaping climate in the Arctic as well as atmospheric, ocean circulation, orography, and sea ice cover (Dobrovolsky & Zalogin, 1982). Other factors such as winds, waves, temperature, and currents are some of the climate conditions that form the Arctic water conditions.

2.3.1 Winds

According to Przybylak (2003), winds in the Arctic are depending on the season's atmospheric pressure. The characteristic of the Arctic winds is usually light but in other scenarios it has a wide variety of strength, for example the wind in the Russian Arctic tends to be stronger compared to Canadian Arctic. Between September and April (Autumn - Winter), the winds direction came from southerly and south-westerly and from May to August (Spring - Summer) the winds came from the northern direction. Those winds can push away the ice and create an ice-free zone (coastal polynyas) around 15-20 NM wide. According to Przybylak (2003), the wind speed on the summer ranges from 5-7 m/s or 18-25 km/h or 11-16 mph and in the winter is 7-12 m/s or 25-43 km/h or 16-27 mph, while the maximum wind speed in Arctic can reach up to 50-60 m/s (Przybylak, 2003).

2.3.2 Waves

The wave movement is dependent on the wind speed. According to Myslenkov et al. (2020), between the end of summer and the beginning of autumn, the heavy wave is likely to occur when the ice cover disappears. In the Kara Sea, the average wave height is 3-4 m and can reach more than 8 m during the storm period (Myslenkov et al., 2020). However, in the Laptev Sea, the wave height is around 1-7 m high; when the ice disappears, it can reach 6-7m height (Pastusiak, 2016). Pastusiak (2016) also mentions that in the East Siberian Sea, during storms, the wave can reach 4-5 m and in the shallow water, the wave height is around 2.5-3 m high. In the Chukchi Sea, the maximum height of waves is 9 m high, and between July - October the wave height ranges from 5-7 m high where in July and August the maximum height is only up to 5m (Pastusiak, 2016).

2.3.3 Currents

The Russian Arctic has an anticlockwise direction of surface water circulation (Pastusiak, 2016). Based on Pastusiak (2016), taken reference and data from Dobrovolsky and Zalogin (1982), Pavlov et al. (1996) and GUNiO (2009), the variation of water circulation is affected by atmospheric circulation, water from the region and the river water. In the Kara Sea involves the Barents Sea water, the beginning circulation flows at the rate of 0.1-0.3 kn then the flow rate increases to ~2kn when the water joins in Kara Gate Strait. The Laptev Sea has a slow and permanent current at 0.2-0.3 nm sometimes with the wind it can reach 0.8 nm as the Laptev Sea has one circle of cyclonal circulation. In the East Siberian Sea, the surface water cycle is characterized by cyclones. On the open seas, the current flow velocity is about 0.2-0.3 kn. In the narrow passages (Dmitry Laptev Strait, Sannikov Strait and Delang Strait), the current flow may increase to 0.6–1.0 kn, and sometimes even to 2.0 kn. Where the surface water cycle of the Chukchi Sea is most affected by the Pacific waters flowing into the Bering Strait. The water flow in the Dron Strait varies greatly, from 0.5 to 2.0 kn. The water flowing through the southern part of the Delon Strait and extending southeast along the Chukchi coast comes from the East Siberian Sea and may reach the Bering Strait (Pastusiak, 2016).

2.3.4 Air and sea water temperature

Temperature conditions in the Arctic are usually cold but it can be surprisingly warm in the summer. In the winter, the Arctic tends to have stable high-pressure that creates the cold and dry conditions in the Arctic where the temperature can reach or lower than -45 to -50 °C, while in the summer, it forms a low-pressure zone in the Eurasian continent (Pastusiak, 2016).

Every year, the NSR is covered by ice between November and May. Where the temperature of the sea water is close to freezing point range from -1 to -1.9 °C. The annual temperature for the NSR ranges between 1.32 ± 1.5 °C, where Chukchi Sea water temperature has an average of 0.86 °C (Carvalho & Wang, 2020). The sea water temperature also depends on ice concentrations. When the ice concentration is up to 6/10 the temperature ranges from −1 and +2 °C and When the ice concentration is 7-10/10 the sea water temperature is between −1.7 and −1.0 °C (Pastusiak, 2016). The sea water temperature will increase after the ice melts and the temperature will reach the maximum at the end of August. In the beginning of autumn in September, the sea water temperature will start to decrease and it will reach the freezing point in October. When the layer of sea water temperature reaches 0°C, usually the thickness of the layer is between 10-20 m but in other cases sometimes it can have thickness between 60-70 m (Pastusiak, 2016).

2.4 The Arctic Shipping Corporate Pledge

The Arctic Shipping Corporate Pledge is created to protect the Arctic environment and launched by Ocean Conservancy. Arctic Shipping Corporate Pledge is a voluntary pledge signed by consumer goods owners and shipping companies to encourage them to not use Arctic shipping, including the NSR, internationally due to global warming and to save the unique and one-of-a-kind ecosystem in the Arctic (Ocean Conservancy, 2018). The pledge focuses on two points, avoiding Arctic trans-shipment routes and promoting precautionary Arctic shipping practices. According to the pledge, product owners have to refrain from the shipping of products via the Arctic and using any services from carriers and freight forwarders that intentionally sell them and that intend to sail in Arctic trans-shipment routes. As for the shipping companies, they need to agree not to sell and allow any services that sail through the Arctic route (Ocean Conservancy, 2018). The full pledge is attached on Appendix-A.

The Arctic Shipping Corporate Pledge has been signed by several known container shipping companies, forwarders and consumer goods owners such as H&M Group, Hapag-Llyod, CMA CGM, MSC, Nike, Puma, Columbia, Gap, Ralph Lauren, Bestseller, Evergreen Line and Kuehne+Nagel. By signing the pledge, the company will assure not to sail or use the services of shipping companies that use the Arctic for transportation (Bennett et al., 2020) in respect of protecting the Arctic environment. With this pledge, more corporations that have impact on international levels decline to use the Arctic as a shipping route. According to Bennett et al. (2020), this might affect the commercial viability of Arctic shipping especially for the corporations that have sustainability agendas.

2.5 Initiatives in Arctic shipping

2.5.1 Russian initiatives in Arctic shipping

Over the years, Russia has become progressively invested in making the NSR an attractive choice for the shipping companies to use. Russia has therefore launched its plan for infrastructure development of the Northern Sea Route for the period 2020-2035 (Russian Government, 2019). Whilst the climatic conditions are changing rapidly in the Arctic region, Russia as one of the more impactful Arctic countries with a large land area is aiming to take advantage of it. Russia's administration has as a result-initiated projects to lay out a foundation for the maximized usage and profit from the Arctic and the NSR in coming years. In 2018, President Putin signed a decree with a goal that by 2024 the traffic along the NSR should reach 80 million tonnes which would be a significant rise from current cargo flows along the same route (Russian Government, 2019). However, the plan that Russia has in store for the period 2020-2035, approved and signed in 2019 December by the prime minister of Russia, carries more importance due to its wide coverage over various strategic and developmental goals. As introduced in the plan for the development of the infrastructure of the Northern Sea Route for the period up to 2035, there are 11 main areas that the plan focuses on (Russian Government, 2019):

1. Improvement of the infrastructure of ports and terminals
2. Development of the rescue and auxiliary fleet (SAR)
3. Development of navigation and hydrographic support in the Northern Sea Route
4. Activities aimed at improving the ice-breaker fleet
5. Measures to stimulate freight traffic and international transit shipping, including the construction of marine logistics centres
6. Aviation and railway infrastructure development
7. Measures to ensure the safety of navigation and communications
8. Development of energy capacities to ensure the functioning of the infrastructure
9. Training the staff for infrastructure projects and for providing medical assistance
10. Domestic shipbuilding for the purposes of Arctic shipping
11. Measures aimed at ensuring environmental safety

The 2019 initiative "*The plan for the development of the infrastructure of the Northern Sea Route for the period until 2035"* includes 84 activities and their timelines and executors within the mentioned 11 areas (Russian Government, 2019).

The responsibility of those developmental goals is on The Ministry of Finance of Russia, the Ministry of Transport of the Russian Federation, the Ministry of Industry and Trade of Russia, Ministry of Economic Development of Russia and the State Corporation for Atomic Energy Rosatom (Russian Government, 2019). Through collaboration and responsibility shared by these multiple ministries, the Russian government hopes to achieve the results that justify large investments planned for the development of the area in the future.

During recent years, the potential of using the NSR more widely as an alternative has received some negative backlash from international media. Russia's plan to be undertaken for the Arctic is aiming to mitigate the unfavourable response. As NSRA (Northern Sea Route Administration) determines whether ice-breaker escort is required or if the ship can navigate independently, based on the navigational season, ice conditions, and the vessel's ice class, it is essential that Russia's own fleet of ice-breakers to provide assistance is strong (Gunnarson, 2021). Russia already has dozens of more conventional and nine nuclear ice-breakers. According to the Russia's development plan 2020-2035 (2019), State Corporation Rosatom is responsible for modernization of the ice-breakers Yamal, Taimyr, Vaygach built previously and Project 22220 which entails the construction of four new nuclear ice-breakers by the end of 2026. Additionally, another batch of ice-breakers under the Project Leader is aimed to be finalized by the end of 2035.

In order to stimulate freight traffic, Russia's development plan (2019) foresees the development of a long-term cargo traffic forecast to be able to provide sufficient support in the form of logistic centres and port hubs such as Murmansk and Petropavlovsk-Kamchatsky. To secure the interest in container transportation, the plan (2019) foresees the creation of a Russian container operator, including using ice-class container ships operating on nuclear fuel or liquefied natural gas ensuring the implementation of international shipping and cargo transportation.

Several published studies have pointed out the vulnerability of the Arctic area, hence particularly high consideration should be taken in coming years to safeguard the environment (Hill et al., 2015; Zhu et al., 2018; Jing et al., 2021). Taking into account that the environmental fragility of the Arctic region is especially important since commercial shipping and other industrial activity is set to grow in the region. This can be done by employing numerous tools and applying specific actions. The Russian development plan 2020-2035 (2019) proposes mandatory usage of best available technology aimed at reduction of pollution; monitoring of the lithosphere, cryosphere, hydrosphere and atmosphere; monitoring the state of the environment and its pollution in the implementation of industrial environmental control in the areas of loading and unloading operations in seaports. Russia's development plan also reiterates the need to update the legal regulation in order to fulfil the requirements of the International Convention for the Prevention of Pollution from Ships, 1973 (MARPOL 73/78) and the International Code for Ships operating in polar waters.

2.5.2 Chinese initiatives in Arctic shipping, the *Polar Silk Road*

China is one of the world's leading economies who has its own set of intricate interests when it comes to the Arctic region. During the years, China has taken several steps to become more familiar and gain influence in the area. The country has solidified its relations and collaboration with Arctic countries such as Iceland, Norway, Finland, Sweden and Russia (Tillman et al., 2018). Since 2013, China has been acting as an observing country in the Arctic Council and since then, various Chinese stakeholders, including the state-owned shipping company

COSCO, have participated in activities aiming to yield presence, collect data and develop Arctic region (Tillman et al., 2018; Wu et al., 2021). According to Bekkers et al. (2015) if China decides to use 15% of their trading over the NSR, there will be a huge transformation on the shipping route from SCR to NSR.

The Polar Silk Road (PSR) was introduced by Sergey Shoygu, Russian Minister of Emergency Management (Wu et al., 2021). In January 2018, China released the white paper, China's Arctic Policy about state's plans in the region, outlining Arctic agenda including the exploration and understanding of the Arctic, the uniqueness of the environment and the impact of climate change, the use of Arctic resources, governance and international cooperation for the region, and the significance of maintaining peace and stability in the area (Tillman et al., 2018). The white paper elaborates on the importance of the PSR which is part of a more elaborate Belt and Road Initiative (BRI) and reiterates how all parties concerned can gain from and facilitate connectivity and sustainable economic and social development of the Arctic (Tillman et al., 2021). Furthermore, in the policy (The State Council Information Office of the People's Republic of China, 2018), China has declared itself a „Near-Arctic State", claiming that "the natural conditions of the Arctic and their changes have a direct impact on China's climate system and ecological environment, and, in turn, on its economic interests in agriculture, forestry, fishery, marine industry and other sectors." To conclude, China sees itself as an important stakeholder in the region and leadership of the state has determined that developing the ability to access and exploit the Arctic is a diplomatic, economic, and security imperative (Havnes, 2021).

Since the white paper was published, China's interests in the Arctic and with the NSR have received a lot of attention from the international media. The further exploitation plans of the Arctic are not always seen positively, especially by the environmental activists. A recent study by Wu et al. (2021), found that the PSR could be considered a fruitful endeavour when using a data-driven and multi-criteria decision-making method from an economic perspective. However, the results show negative effects of the PSR in terms of balance between the economic and environmental aspects and the economic and social aspects (Wu et al., 2021). The study presented by Wu et al. (2021) concluded that economic performance should be regulated by relevant policies to slow economic growth and prevent harmful environmental impacts once it reaches a certain level in a country or a region. Additionally, the method used by Wu et al. (2021), found insignificant interrelationships between the social and environmental facets but a negative relationship between the social and economic aspects could be distinguished (Wu et al.2021). Woon (2020) argued that several researchers within the Chinese scholarly community have accentuated the environmental hazards like oil spills from cargo vessels and land-based constructions as threats when using the PSR. According to Woon (2020), "these human-induced incidents will cause irreversible damages to the Arctic in the first instance, threatening the survival of the region's wildlife and biodiversity before 'moving on' as negative externalities to impact 'elsewhere' in an interconnected world "(Woon, 2020, p. 7). Havnes (2021) pointed out that in a recent study about the BRI, conducted by the World Bank, it was noted that without "deep policy reforms that increase transparency, improve debt

sustainability, and mitigate environmental, social, and corruption risks, the BRI projects could lead to worsening debt sustainability levels and exacerbate environmental damage for participating countries. "(Havnes, 2021, p. 126).

To set off above mentioned concerns, the China's Arctic Policy states that some of the principles for the Arctic region is to "protect its unique natural environment and ecological system, promote its own climatic, environmental and ecological resilience, and respect its diverse social culture and the historical traditions of the indigenous peoples (The State Council Information Office of the People's Republic of China, 2018)." In the policies´ section „Protecting the eco-environment of the Arctic and addressing climate change" it is reiterated that China will protect the environment through enhancing the control on ship discharge, offshore dumping, and air pollution, protect the ecosystem that is home to several endangered species and is committed to addressing climate change policies (The State Council Information Office of the People's Republic of China, 2018).

Further, Russia and China have become close allies, stemming from common interests and ambitions within the Arctic region, thus solidifying Sino-Russian relationships (Malle, 2017; Gao & Arokhin, 2020). Top leaders of both countries have taken steps to further the partnership, collaborating in energy, infrastructure and transportation (rail and shipping) projects (Gao & Arokhin, 2020). As Havnes (2021) argues, shipping and energy access are closely intertwined as Arctic oil and gas are likely to be shipped from Russia and other Arctic states, hence making shipping and transport infrastructure necessary to enable energy industry. In recent Sino-Russian energy agreements, one of the examples illustrating this interlinkage and mutually beneficial relationship could be named China's commitment to buy three million tonnes of liquefied natural gas (LNG) annually from the Russian Yamal gas fields as by the agreement signed in 2017; at the same time China and its state companies own 30% of Yamal LNG (Havnes, 2021; Sustainable Development Working Group, 2017). Malle (2017), addressing Russia's and China's collaboration, alludes that two countries are moving towards symbiotic relations from interstate deals to joint ventures, such as from coordination on infrastructural projects to mutual participation in financing new transport routes in less developed areas.

2.5.3 Japanese initiatives in Arctic shipping

Due to its location, Japan has implemented initiatives linked to the NSR since the 1900s to shorten the distance between the Atlantic and Pacific (Moe & Stokke, 2019). Japan was involved in the International Northern Sea Route Programme (INSROP) in the 1900s but ended in 1999 because of the negative comments regarding the commercial prospect (Ocean Policy Research Foundation, 2012). Leah Beveridge et al. (2016) research shows that it appears that Japan has no strong interest in NSR. This argument is strengthened by the conclusion of INSROP (The International Northern Sea Route Programme) as they note mostly unfavourable feedback on commercial prospects (Moe & Stokke, 2019).

In 2010, Japan became involved in JANSROP (Japan Northern Sea Route Programme) a follow up program of INSROP as Japan was pushed by a research organization to put more attention to the Arctic region. From The Arctic Conference Japan organized by Ocean Policy Research Foundation there are eight recommendations for Japan Arctic Policy in order to ensure the Arctic Ocean's long-term viability, the Conference calls on the government to take action (Ocean Policy Research Foundation, 2012):

1. Establish the Nation's Arctic policy and a joint chief of staff,
2. Bolster every research activity in the Arctic,
3. Actively take part in protection and preservation of the environment,
4. Participate much more directly in Arctic natural resources development,
5. Promptly respond to logistical changes in the seaborne trade by the opening of Arctic seaways,
6. Design a new national security program via the Arctic seaways and shipping,
7. Contribute largely to the establishment of an order of the Arctic Ocean, and
8. Make haste to strengthen Japan-Arctic states dialogues, in particular Japan-Russia one.

Japanese initiatives are related to market exploitation for natural resources such as oil and natural gas and direct destination in the NSR rather than trans-Arctic option. Compared to the whole of Japan, Northern Hokkaido have shown their interest in the NSR because of their location (Tonami, 2016). In 2015, The Japan Association of Marine Safety published a Northern Sea Route Handbook supported by The Nippon Foundation. The handbook provides a fundamental knowledge required for navigation safety, environmental protection, and day-to-day life when traveling along the NSR both as introduction for seafarers' students or for work on board who are exploring the knowledge about the NSR for the first time (Yamaguchi, 2016).

2.6 Development of e-commerce

E-commerce is a term used for selling services or goods online through the computer network and is gaining more and more popularity (Knight & Mann, 2010). According to Kim et al. (2018), rapidly improving IT and e-commerce solutions have been useful for international, cross-border markets due to cultural and geographic separation between the same. In their review, Jean et al. (2008) examined the role of advanced IT, how it changes the way companies manage cross-border supply chains and how it contributes to supply chain performance. The paper concludes that because of greater geographic dispersion and time gap, language and cultural differences, the benefits of IT solutions in international business activities are even more valuable allowing seamless information exchange (Jean et al., 2008).

Evaluating the amount of goods transported daily (Statista, 2021), there is a strong product demand and e-commerce businesses are becoming more popular which justifies looking into more reasonable options for transporting the goods from origin to destination. According to OECD, 90% of volume and 80% in value of world trade is executed through maritime transportation (Bekkers et al., 2015; Jiang et al., 2018). The most popular sectors that were shaping Sweden e-commerce revenue in 2019 were the fashion industry (31%) followed by electronics and media (23%), toys and hobby (20%), and furniture (16%) (Edwards, 2021). Currently, most online ordered goods are produced in Asian countries and shipped traditionally through the SCR by container ships.

COVID-19 affected e-commerce sales. On one hand, due to the movement restrictions, consumers needed to buy much of their goods online. On the other hand, the lockdown measures forced businesses to innovate, digitalize and adapt to be able to stay afloat in a competitive e-commerce market. 2020 saw e-commerce's share of global retail trade rising from 14% in 2019 to about 17% in 2020 (UNCTAD, 2021). According to UNCTAD (2021), the pandemic affected countries in Europe and North America particularly hard, strengthening the demand for online shopping. There is a shift in the customer and goods segment whereby older people and people further down the income scale are adopting online shopping and essentials being bought online as opposed to more occasional purchases or luxuries (UNCTAD, 2021). It has been reported that 46% of the consumers have their first grocery purchase online since the start of the pandemic and most of them planned to continue to do so (Naeem, 2021). According to Hao et al. (2020), COVID-19 also affected the hoarding behaviour whereby extreme situations (e.g., pandemic) led to stockpiling goods and noted that the supply chain should be prepared for such occasions to cope with heightened demand.

2.7 Fast Moving Consumer Goods (FMCG)

Fast Moving Consumer Goods (FMCG) or known as Consumer-Packaged Goods (CPG) are products that are known to be sold relatively quickly, low cost and sold in large quantities (Malhotra, 2014). FMCG companies tend to change the products in the short period of time as this phenomenon is connected to high demand from the customers or the short product lifetime i.e., fresh food (meat, vegetables, fruits, dairy products and baked goods). Due to large quantities of products and also high demand from customers, the competition inside the FMCG sector is very high (Reddy, Reddy, & Kumar, 2019). There are factors that determine the characteristics of FMCG (Kumar & Gogoi, 2013):

- The industry is involved in every part of human life.
- Products, Pricing, Place and Promotion (four P's) are the strong focus that characterized the FMCG sector.
- In most categories, FMCG has high volume and is low value oriented.
- FMCG is brand driven not product driven.
- The sector has low capital investment in plant and machinery.
- Brand building and promotion are the marketing area for the sector

- The sector is really dependent on the distribution network and this determines the success of the company.

There has been a steady growth in retail, owing mostly to e-commerce, which impacts not just businesses but also customers and society as a whole (Olsson & Samaan, 2018). The growth can be explained not only because of the consumer and business maturity but also the technology advancement in Sweden (Kalkan, 2015).

It can be noted that Swedish retail and consumption has increased significantly due to e-commerce activities (Olsson & Samaan, 2018). With digitalization, game retail also became a trend and has made the trade possible for computers, mobile phones and tablets. This increasing number is also influenced by the e-commerce imports activities. China, Germany, the USA and the United Kingdom are the four major markets that exported their product to the Swedish market (Svensk Digital Handel, 2018).

All four countries showed a larger trade on clothing, media products and home electronics. China is known as one of the biggest world exporters with low cost. Germany is famous for their spare parts and clothing as well as Zalando, one of the more known online shopping platforms in Sweden based in Germany. While the USA and the United Kingdom are the major trading venues for media products (Svensson et al., 2016).

Chapter 3: Methodology

A mixed method approach was used to conduct this research. Thus, both qualitative and quantitative data were applied for this study and gathered in parallel. According to Johnson and Onwuegbuzie (2004), mixed method research employs methodological pluralism or eclecticism which frequently results in superior research compared to monomethod research. That is because more investigators study and help advance it as they routinely practice it (Johnson and Onwuegbuzie, 2004).

3.1 Data collection

According to Wilson (2014), a deductive research approach is a research method that begins with existing theory as a general level of focus to develop a hypothesis as a specific level of focus and to test the hypothesis, research strategy is used. Deductive approach may include the qualitative data such as interview for the data collection (Wilson, 2014).

A literature review was used as secondary data for this research to explore an existing theory as a general level of focus to develop a hypothesis. Secondary data was collected from the data that has been published before, such as books, records, data archives, internet articles, research articles, databases, etc. (Kabir, 2016). The literature review is based on evidence and an important assessment that used to have an in-depth analysis of the subject (Winchester & Salji, 2016)

Thereafter, a case study involved interviews with experienced professionals within the shipping industry to collect primary data. The primary data is also supported by running the simulation of a study case on MATLAB. According to Kabir (2016), primary data is the data that has not been published and is collected from first-hand experience. The primary data source can be collected from experiments, surveys, questionnaires, interviews, observations, etc. (Yin, 2014). The SCR data is taken from the previous research by Pham and Miltiadis (2019) for comparison with the NSR data gathered from the MATLAB results.

3.1.1 Literature review

Qualitative method was applied in conducting the literature review. A semi-systematic approach can be applied to literature review and then be analysed and synthesized using a variety of approaches (Snyder, 2019). These procedures are frequently comparable to those employed in qualitative research in general. A thematic or content analysis defined as a method for discovering, analysing, and reporting patterns in the sense of topics within a text (Braun & Clarke, 2006) was applied. There are exceptions to the rule that this sort of evaluation is supported by a qualitative approach. Borman and Dowling (2008), for example, coupled a

semi-structured technique of gathering information with a statistical meta-analysis methodology.

The empirical data for the literature review was searched and found in databases at ScienceDirect, ResearchGate, Elsevier, Emerald, Springer Link, and Chalmers Library. The literature review focused on the main topic of the Northern Sea Route and the keywords included next options in combination with "Northern Sea Route" or in some cases the search was conducted by the keyword: Arctic route, Suez Canal alternative, containerized shipping in the Arctic, feasibility of the shipping in Arctic; Polar Silk Road, China ambitions in Arctic, China and Russia cooperation in Arctic, Sino-Russian relationships, Russia China developing Arctic; Consumption trends, ecommerce leaders, consumption changes in Sweden, disruption in consumer industries, rapid digital adoption, fast moving consumer goods.

In addition to previously mentioned main scientific databases, the data was also collected from books and websites of governmental organizations such as Russian Government websites, Arctic Council, and Ocean Policy Research Foundation to support the frame of reference. These were identified by using the relevant keywords in the searches conducted by the use of Google scholar.

3.1.2 Case study

A case study is a study that investigates one or multiple cases within the real-life context without manipulating the object's environment, and the result gathered and analysed based on quantitative methods (Dul & Hak, 2007) but also in this research qualitative methods were used to analyse the case study. For multiple units of analysis, a case study was utilized (Yin, 2014), specifically for creating new knowledge and sharing information.

According to Johansson (2007), a case study should represent the complexity of a single case, which should be a functional unit that is studied in its natural setting using a variety of methodologies and is relevant. The use of case studies also helps to bridge the gap between quantitative and qualitative approaches (Johansson, 2007).

The case study presented in this thesis is about shipping containerized goods from Shanghai to Gothenburg via the NSR and consists of a mixed-methods approach that combines quantitative simulations and qualitative data collection processes in the form of interviews.

Simulations: Simulations were used to explore cost savings and lead time savings for a company by comparing two different sizes of vessels in different ice conditions in the Arctic. For the simulation, 3600 TEU and ice class 1A Venta Maersk was chosen for the NSR. This vessel sailed the NSR in 2018. In addition to Venta Maersk another reference vessel (Vessel X) for the SCR was selected from a previously published literature (Pham & Miltiadis, 2019). This vessel has similar characteristics to the vessel owned by Ottawa Express operated by Hapag Lloyd (Thorsen, 2012), see Table 2.

Table 2. Vessels' characteristics (the authors, 2021)

Factors	Unit	Venta Maersk	Vessel X
Vessel type	-	Container-ship	Container-ship
TEU	-	3600	2808
Ice class	-	1A	1A
Deadweight (DWT)	tons	39 964	40 882
Gross Tonnage (GT)	tons	34 882	17 669
Length Overall (LOA)	m	200	232
Length between Perpendiculars (LPP)	m	196	230
Breadth (B)	m	35.320	32.2
Draft (T)	m	11.081	10.8
Displacement volume	m3	54 474	52 030
Design Speed	knots	21	24
Main engine power	kW	17 279	25 426

For evaluation of the NSR and the SCR, the route was planned from Shanghai – China to Gothenburg – Sweden. The vessel stopped at Rotterdam but made no other intermediate stops in the NSR.

The simulations only focused on the summer period where the ice conditions are relatively ice free but there is a possibility of dense ice concentration in the East Siberian Sea (Li et al., 2020). It was assumed though that ice would not affect the voyage. It was also assumed that the temperature in the NSR would not affect the product storage during the voyage as the products which are sensitive to temperature changes need a stable temperature.

The MATLAB code was used to calculate the fuel consumption during the summer period (July-October) from Asia (Shanghai) to Europe (Gothenburg) and also the return trip from Europe (Gothenburg) to Asia (Shanghai). The MATLAB code ran the data provided on a monthly basis. The data provided only covers the route details from Shanghai to Rotterdam. The Marine Traffic website was used to obtain the route details between Rotterdam to Gothenburg. The simulation process is presented on Figure 5.

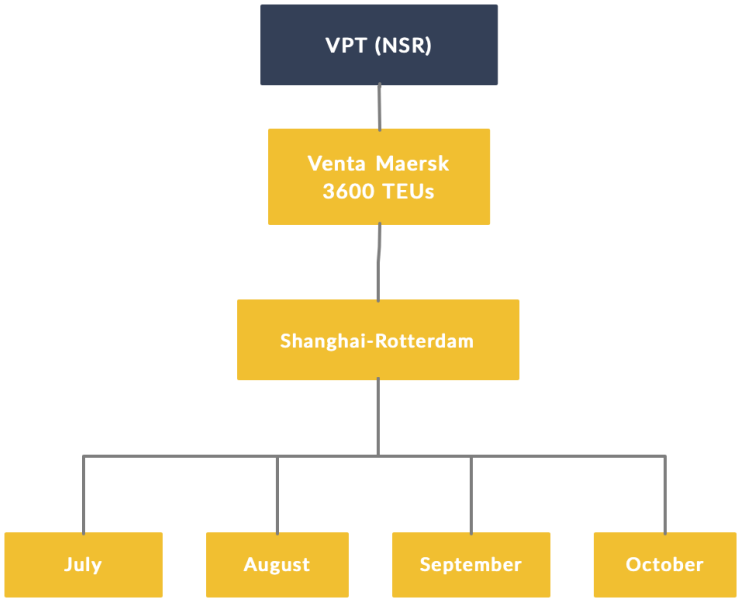

Figure 5. Fuel consumption simulation process (the authors, 2021)

The Suez Canal Route: In this research, the SCR was used to compare the voyage time and fuel consumption with the NSR based on a previously published model (Pham & Miltiadis, 2019). According to this model, in the open waters, the vessel speed can keep the constant speed at 20 knots while in the SCR, based on Suez Canal Authority regulation (2015), the vessels are allowed to transit with speed not exceeding 16 km/hour or 8.64 knots.

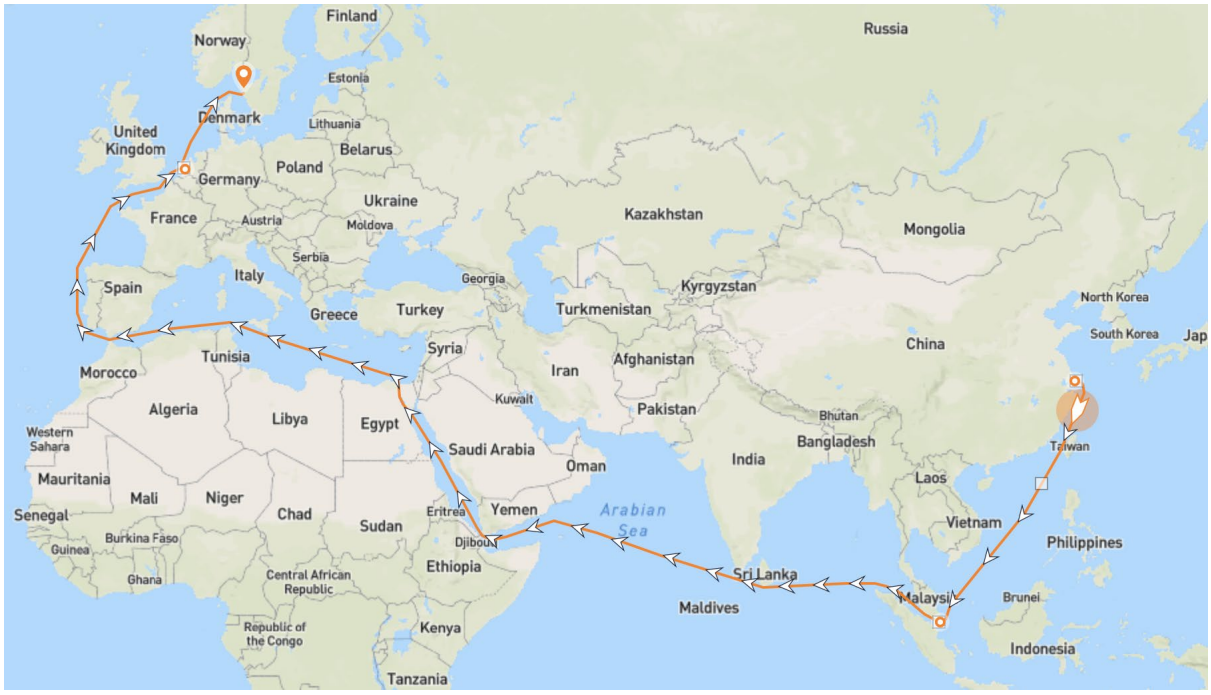

Figure 6. The voyage map via the SCR (Retrieved from Marine Traffic, 2021)

The route taken by the vessel from Shanghai to Gothenburg via the SCR included three port calls in Singapore, Rotterdam and Hamburg. The Suez Canal itself consists of three parts, Port of Tewfik, Suez Canal and Port of Said with a total distance of 193.3 km (Suez Canal Authority, 2018) (Figure 6).

Table 3. Average speed and time of the voyage via the SCR (Pham & Miltiadis, 2019)

	Route	Distance (nm)	Speed (knots)	Time (days)
I	Shanghai – Port of Tewfik	7512	20	15.7
II	Suez Canal	104	7.5	0.6
III	Port Said – Port of Gothenburg	3721	20	7.8
	Canal waiting time			0.8
	Port time			4
	Total	11 337		28.8

The total distance of the voyage through the Suez Canal was estimated to be 11 337 nm. It took 28.8 days with a constant speed of 20 knots as the SCR route is all open water (Table 3).

Interviews: Interviews were used to gather data on perspectives within the shipping industry about the NSR. For data collection, a modified semi-structured interview was used to explore a certain entity and their viewpoint on the topic depending on their position. According to Adams (2015), a semi-structured interview is suitable for open-ended question interviews that need follow up questions for better clarity.

For the interviews, various professionals (Table 4) within the shipping industry contributed. All the required communication was done in English through emails and online meeting platforms. The respondents were chosen due to their senior role within the entity and their experience, knowledge, involvement and/or interest in the NSR shipping activities.

Table 4. Interview respondents (the authors, 2021)

Respondent 1	Head of business cargo in the Port
Respondent 2	Commercial manager in a container shipping company
Respondent 3	Marine standards officer in marine services company
Respondent 4	Vice president of sales and marketing in the Port

Two of the respondents were working for the port authority in senior positions- the head of business cargo and the vice president of sales and marketing. One of the respondents was a marine standards officer, also described as superintendent, main responsibilities being health, safety and environment and lastly, one interview was with a commercial manager in a local branch of one of the biggest container shipping companies in the world.

The semi-structured interviews comprised 11-13 open ended questions for the interview (Appendix-A). The number of the questions in the interview differs because the interview questions were structured exclusively based on the role of respondents within the industry. There were four questions requiring the evaluation of the respondents on a scale from 1-5, 1 being the score with the least significance and 5 being the score with the most significance. Each interview took around 40-60 minutes, with a response rate of 89.6%. All the interviews were recorded, transcribed and double checked to ensure the accuracy of the information gathered. Once the interviewing process was finished, the authors went through the answers by comparing and analysing the same question and the response to get a clear overview on respondents' opinions and views on different matters presented via interview questions. That process was applied several times to present the reader with a full overview of the interview results.

The interview questions were designed to be kept as open as possible with the request to elaborate in order to receive accurate and intended information from a respondent. Interviews included questions on the respondents' experience and involvement with the topic and their viewpoints on the potential of container liner shipping via the NSR. It also covered questions on the advantages and disadvantages of considering the NSR and estimations on what changes the usage of the NSR could bring to the shipping community, customers, environment and more. Additionally, the viewpoints of the interview respondents regarding the preferable cargos and their interest in the NSR for containerized shipping were collected. The unit of analysis for the interviews were people in the appropriate position with relevant knowledge, experience and/or interest on the analysed topic.

3.2 Data analysis

In compliance with the mixed method approach, quantitative (simulations) and qualitative data (interviews) were collected in parallel. For the research, to obtain quantitative data, Voyage Planning Tool (VPT) was used to read real-time data related to the NSR coordinates. The voyage planning tool is an in-house MATLAB code (Li et al., 2021). VPT was used to estimate the cargo vessel's fuel consumption and improve fuel efficiency for open water operations. The unit of analysis is lead time, voyage time and fuel consumption. VPT is not only limited to voyage planning but also a 'berth to berth' solution between ports in Europe and Asia. Vessel specifications including engine and propeller specification to run the VPT. By this tool the ship performance will be automatically calculated by the ship performance model where response surface is the output from the model that reflects on the environment and operational conditions. The ship performance model is based on naval architecture perspective (Li et al.,

2020). With this perspective, it supports the model prediction when the design process and ship operation (Tillig et al., 2016).

The routing module in the VPT is used to determine the most cost-effective route and this module, based on the Dijkstra algorithm that focused on finding the best cost-efficient path options (Dijkstra, 1959), POLARIS RIO is used in the VPT for constraint criteria. The routing module works by taking the response surfaces from the ship performance module, the user-specified ship target speeds, and the weather service agent's ice and metocean data. The weather forecast data consist of wind speed and direction, wave height and direction, ocean current speed and direction, sea water surface height and temperature and ice thickness and concentration are provided by the UK Met Office and automatically transferred to the voyage planning tool (Li et al., 2020).

Analysis of qualitative data comes from the interviews with personnel in the entities related to the shipping industry and the literature review. The results from MATLAB simulations and literature reviews as quantitative analysis and the interviews as qualitative analysis in this research are based on methodological triangulation. Triangulation method is used in qualitative research to achieve a thorough understanding of the subject by using various methods or data sources (Denzin, 1978; Patton, 1999). This means that each method is connected with one aspect to obtain a different perspective and understanding on the commercial decision regarding the usage of the NSR. Triangulation is frequently used in research methods by comparing qualitative and quantitative data to prove a reliability of the results by looking at the data from different angles (Munoz et al., 2009).

Chapter 4: Results and Analysis

In this chapter, the analysed results from MATLAB-simulations and conducted interviews are presented. Opportunities for shipping companies, and port authorities- regarding trading fast moving consumer goods (FMCG) via the NSR are presented linked to the route planning, container volume per year in Sweden, potential of the NSR, preferable products to be shipped through the NSR, and industries' interest with the NSR.

4.1 Route planning

In this section, the quantitative results on the NSR and the SCR are presented in addition to the results of the MATLAB simulation for the NSR. Parameters of Venta Maersk were used for the simulation for the NSR and Vessel X was deployed as an assumption model for the SCR.

4.1.1 The Northern Sea Route

For the route planning, it was decided to not have any intermediate stops along the NSR and only make a port call in Rotterdam. The chosen route also helps to reduce the fuel consumption as it is 116 NM shorter in total compared to routing around the Yuzhny compared to previous studies (Pham & Miltiadis, 2019) (Figure 7).

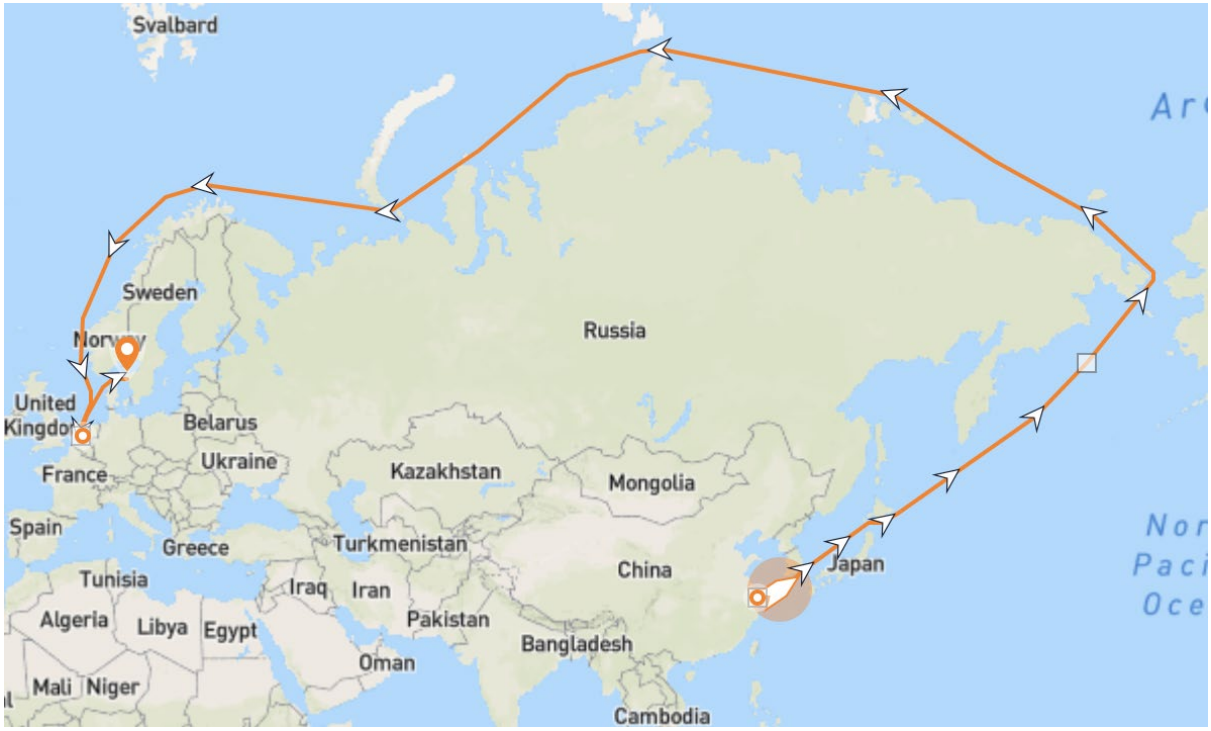

Figure 7. The voyage map via the NSR (Retrieved from Marine Traffic, 2021)

The estimated distance between Shanghai and Rotterdam along the planned route is an average of 7785.7 NM. The distance between Rotterdam and Gothenburg was taken from the Marine Traffic website and is 486.7 NM. Thus, the total distance between Shanghai and Gothenburg is 8494.7 NM (Table 5).

Table 5. The chosen Northern Sea Route distance (SHA-RTM-GOT) (the authors, 2021)

Route	Distance (NM)
Shanghai - Rotterdam	7785.7
Rotterdam - Gothenburg	486.7
Total distance between Shanghai - Gothenburg	8494.7

During summer months, i.e., between July and October, the shipping along NSR was assumed to be ice free even though Laptev Sea and East Siberian Sea at some points may have icy conditions or multiyear ice present (Li et al., 2020). Therefore, the speed of the vessel was reduced when going through the Arctic seas (Table 6). With the assumption speed in Table 6, the voyage time was calculated on MATLAB from Shanghai to Rotterdam (Table 7).

Table 6. The voyages' speed assumptions in knots (the authors, 2021)

Voyage speed (knots)	July	August	September	October
Open Sea	21	21	21	21
Arctic (NSR area)	10	10	10	11

Table 7. VPT simulations' results (the authors, 2021)

Month	Voyage time (hours)	Voyage time (days)	Fuel Consumption (tons/trip)
July	538.9	22.5	967.1
August	507.2	21.1	953.4
September	508.7	21.2	953.9
October	496.1	20.7	1050.1
Average	512.7	21.4	981.1

Above, Table 7 shows the results from the simulation. The average voyage time in the summer period (July – October) for one trip is 512.7 hours. The average days spent for one trip via the NSR is 21.4 days and it consumes 981.1 tons of fuel on average. From Table 7, October shows a slight reduction in voyage time while the fuel consumption has increased. This was affected by the speed that the vessel used in the NSR, one knot faster compared to the other months (Table 6) and the vessel running on higher speed tends to consume more fuel compared to the lower speed vessel (Gusti & Semin, 2018).

4.1.2 Comparison between the NSR and the SCR

Two different container vessels were used to compare the average time consumed and the total fuel consumption of the NSR compared to the SCR. From the result it shows that the NSR shortened the distance by 25.1% (in Nm) compared to the SCR from Shanghai to Gothenburg. The voyage through the NSR can save 25.8% or 7.4 days of the average time and 44.2% of the average of the fuel consumption tons/trip compared to the SCR when it is operated in the summer period with ice-free conditions (Table 8).

Table 8. The comparison of the results between the NSR and the SCR (Pham & Miltiadis, 2019)

	Northern Sea Route	**Suez Canal Route**	**Saving (%)**
Total Distance (SHA-GOT) (Nm)	8494.7	11 337	25.1
Service speed (knots)	21	20	-
Average Time (days)	21.4	28.8	25.8
Total Fuel Consumptions (tons/trip)	981.1	1759.1	44.2

The result will be different with the ice-conditions scenario as the speed will be decreased and there will be a potential need for ice-breaker assistance.

4.2 Interview results

4.2.1 Container volume per year in Sweden

Data suggests that there is a decent growth around 2% to 4% between 2017 to 2021 in the container volume and for 2021, the Port forecasts that there will be 810 000 TEUs handled (Figure 8). According to the results from an interview with the member of the port authority, there is a balanced traffic in the Port for import and export for laden containers. However, in 2017, compared to the previous year, the Port had a decrease in container volume because of the strike in the container port.

Retrieved data from the last four years and additionally the predicted data for 2021 (Figure 8), shows that on average, the port handles 750 600 TEUs annually.

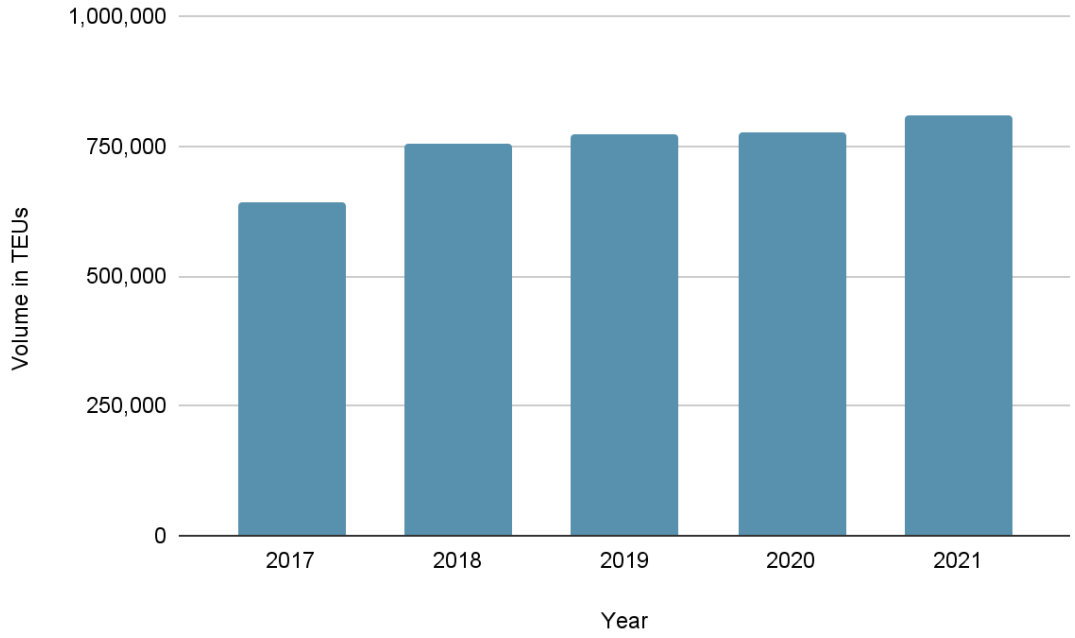

Figure 8. Container volume in Port of Gothenburg (Retrieved from the Port)

Considering the Port container volumes, if these containers were to be shipped with a vessel sized as Venta Maersk (3600 TEU), there would be a need for approximately 220.8 trips annually, which is roughly 18.4 trips per month or 4.2 trips per week (Table 9). If the volumes from Northeast Asia increase in the future, it could be beneficial that bigger container vessels are to be used to take fewer trips. However, in this case, the bathymetry of the various seas of the NSR needs to be taken into account. Aker Arctic, for example, has designed an 8000 TEUs container vessel with ice-class that is able to sail all year round in the Arctic Sea. This breakthrough could increase the volume of containers transported via the NSR in the summer and winter.

Table 9. Yearly container volume in TEUs and required vessels per period (calculated according to the size of Venta Maersk, 3600 TEUs) (the authors, 2021)

Year	TEUs	Nr of vessels /year	Nr of vessels/month	Nr of vessels/week
2017	643 000	189.1	15.8	3.6
2018	753 000	221.5	18.5	4.3
2019	772 000	227.1	18.9	4.4

2020	775 000	227.9	19.0	4.4
2021	810 000	238.2	19.9	4.6
Average	750 600	220.8	18.4	4.2

results from the interview with the container shipping company executive, the container volume being shipped, specifically to or from Sweden, is on average 100.000 TEUs per year. However, according to the interview, it is hard to quantify the number of vessels since they also use partner vessels. However, the size of the vessels ranges from 500 to 1500 TEUs and the company switches between 8-10 vessels. Since 2017, the volume of containers has grown significantly as the market has increased compared to 2016.

During the interview, Respondent 2 clarified that in Sweden, when it comes to export between Northern Europe and Asia, waste- plastic waste, metal waste, scraps- used to be a big part of the shipping market. This waste had become around 25%-30% of the total export until it was banned. When it comes to forest industry related products, steel products, chemicals, automotive from Sweden, there has been an increase every year. As for the import activity, home electronics, clothes, sporting equipment, spare parts for the industry, furniture and home decorations, and made in China products are showing an increase in volume. Almost all of the commodities show a rising number, except the waste, with a couple of percent. According to the interview with the commercial manager at the container shipping company, when the COVID-19 pandemic outbreak started, the commodity that showed a decrease in sales was clothing as people tended to stay at home more. However, according to the interview results, by mid 2020, the volume of cargo started to increase, derived chiefly from small electronics, e.g., home appliances such as toasters.

Unexpectedly, during the outbreak of COVID-19 in 2020, the number of laden containers handled increased slightly compared to 2019 and it is predicted to increase by a higher percentage in 2021 (Table 9). Furthermore, according to the interview with Respondent 2, a decrease in decrease in volume in export shipping activity could not be noticed due to the pandemic. In contrast to other European countries, Sweden was able to keep a steady volume in the number of containers as the government did not enforce a lockdown and the industry was not shut down unlike in Germany or France. As Respondent 2 stated during the interview, during the pandemic, not only home decoration goods have shown an increase but also outdoor products such as outdoor clothes, backpacks, and hiking boots. Respondent 2 also mentioned that this phenomenon is probably connected to people being at home and also wanting to go out to the forest. In import, there was a decrease in volume in fashion items, but this decrease in number was replaced with the increase in the furniture and other home decorations, or as Respondent 2 stated:

... It was maybe, import wise, 30% drop, 30% less volume being shipped. It was like that in Q2 2020 and as in Q3 2020 things were picking up again so it increased quite a lot, then it came back to normal. Now we are a little bit above normal. But it's just a few percent. (Respondent 2)

Analysed interview results reveal that the demand in Sweden has been slightly but not severely affected by the development of e-commerce and seasons. The rise in sales via e-commerce is mostly influenced by major online platforms like Wish, Amazon, and other online retail websites. It is in line with the literature review findings that e-commerce dominates retail growth in Sweden (Olsson & Samaan, 2018; Kalkan, 2015). As for the influence to the shipping volume due to the seasons, nowadays companies tend to combine spring/summer collections and fall/winter collections together to extend the shipping window. Companies are wary of time performance and rather increase their warehouse stock instead of having too close arrival dates as receiving the products on time can be problematic for a lot of them with everything that is going on right now. For some products the time performance is crucial for example Hight Value Products (HVP). If these goods are not delivered in a certain time frame, they might not sell, for example if you deliver outdoor furniture in July or in August, they might not sell as the season is almost over. The same outcome could be applied for crayfish- if the products connected to crayfish harvesting season arrive in October, nobody would buy them.

According to the interview with Respondent 1, when it comes to import and export volumes, these are relatively balanced throughout the year. It can be observed that the container volume shows some increase before the Christmas season in the late autumn, before the Chinese New Year, and before summer.

4.2.2 Potential of the NSR

During the interviews, the respondents were asked about the potential of the route in terms of possible advantages and disadvantages of using the NSR. The results of potential advantages of shipping in the NSR are shown in Figure 9.

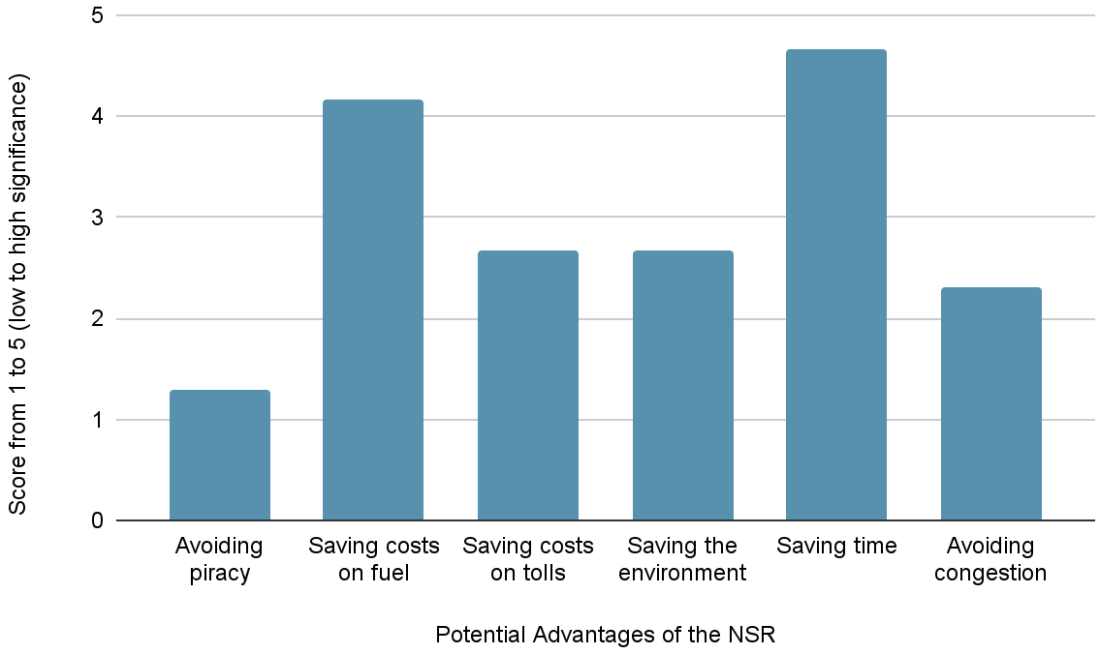

Figure 9. Potential advantages of shipping via the NSR (the authors, 2021)

According to the results (Figure 9), avoiding piracy was found to be the least important advantage when it comes to preferring the NSR over other routes between Asia and Europe. Most of the respondents expressed that this is currently not a major problem. Respondent 3 had an experience working in the piracy waters and even though he acknowledged that the lack of piracy is an advantage of the NSR, or as Respondent 3 mentioned:

I have been working in piracy waters for some time in the past and I can say that it's quite stressful for the crew. At the same time, as I see from the ship owner's perspective, if the money is there, they will go there anyway… (Respondent 3)

Saving cost on fuel and saving time has been mentioned several times in the literature and by the respondents, and shown in the route comparison results as advantages with significant potential when deploying the NSR. According to the interview results, these two advantages are related to the total cost of transportation. Also, this is in line with the literature review findings from Kiiski (2017), all extra relevant costs such as maintenance cost, operational cost and other costs related to the total cost cannot be separated, so therefore must be accounted for in the total cost. Moreover, interviews show mixed results in regard to evaluation and raise questions on saving costs on fuel. Respondents 1 and 3 said that saving on fuel is not important enough for using the NSR because there are additional factors that should be considered such as tolls, maintenance cost, and capital cost including the cost of building an ice classed vessel. However, Respondent 3 pointed out that because of the shorter distance, there are many cost saving opportunities. For example, lube oil is one of the most significant costs for the shipowner connected to the operational costs as the more running hours, the more lube oil is

consumed. According to the Respondent 3, particularly with a bigger container vessel engine, lube oil is a huge part of the cost of an engine operation. Additionally, Respondent 3 implied that due to the time saving factor, it is also possible to reduce the crew cost, cost of tolls due to fewer vessels being required to move the same amount of cargo and maintenance costs.

According to the literature, the ice-breaker fees are almost the same as the Suez Canal toll fees. The interview results reveal that the ice breaker fees might be slightly lower or the same as the SCR toll fees which increases the competitiveness of the NSR against the SCR. In addition, according to the literature, ice-breaker fees at the NSR could be negotiable. Thus, the cost of an ice-breaker can be an advantage if the fee is not high or the ice-breaker is not required or a disadvantage if the ice-breaker cost is the same as Suez Canal toll fee or more.

According to published literature, preservation of the environment has been a disadvantage and a challenge in the usage of NSR. However, Respondent 3 mentioned that there are two sides to this challenge as using less fuel and having less NOx, CO2 emissions in total are good for the environment but at the same time, the Arctic environment is fragile to disruptions and its ecosystems are sensitive. Respondent 3 also stated, in a matter of time, there would be an accident in a manner of oil spill or other type of pollution that would affect the Arctic environment. Interview results from Respondent 2 revealed that the company has signed the Arctic Shipping Corporate Pledge together with leading shipping companies and consumer goods owners due to ethical reasons and not commercial reasons. In addition, Respondent 2 also addressed that the availability of the NSR for commercial usage is because of the shipping and other industries' actions in the past that caused climate change.

We took the decision 2 years ago not to further explore or utilize the NSR. The reason why we took it is not based on the commercial opportunity, technically you can save on lead time, on fuel cost ... for us it is more about investing our time and money in alternative fuels or alternative shipping routes... - (Respondent 2)

According to interview results, saving time is the most significant advantage when using the NSR which is a shorter route compared to the SCR. The interview with Respondent 1 revealed that on long distance voyages, the ship operator tends to use slow steaming to save cost on fuel but it also increases the voyage time. At the same time, Respondent 2 from the container shipping company noted that due to the shorter route he understands how it could be interesting for shipping companies to look into that option as it is possible to avoid a lot of extra sailing time to reach Northern Europe ports such as Hamburg and Gothenburg from Asia. Time saved is perceived as the main advantage for using the NSR as the alternative to the SCR according to all four respondents.

Results from the literature review revealed that congestion can often occur in the port areas or shipping canals. In the recent past, it took more than one week to solve the congestion caused by the Ever Given vessel which was stuck diagonally in the Suez Canal in March 2021. According to Respondents 1, 3 and 4, avoiding similar congestion happening on the NSR due

to lack of bottlenecks is an advantage but would not be considered as significant as saving time and fuel.

Additionally, Respondents 3 and 4 addressed other advantages such as running the liner service between Europe and the Far East with fewer vessels. Since the transit time is shorter, there is a possibility to maintain the same traffic with fewer vessels, or as Respondent 4 acknowledged:

Since the transit time is shorter, you can maybe, instead of having 12 ships in a loop, you can use 8 or 9 ships and burn less fuel and so on. You can maintain the traffic with not so many ships, but on the other hand I don't think you can run the really big ships through the NSR, so that might equal out. I think the transit time and the fuel cost and not needing so many vessels might be the major positive in this. - (Respondent 4)

However, all respondents also evaluated the potential disadvantages of the NSR based on the low profitability, difficult weather conditions, administrative or political issues, extra demands/costs related to the vessel operations and underdeveloped infrastructure along the NSR (Figure 10).

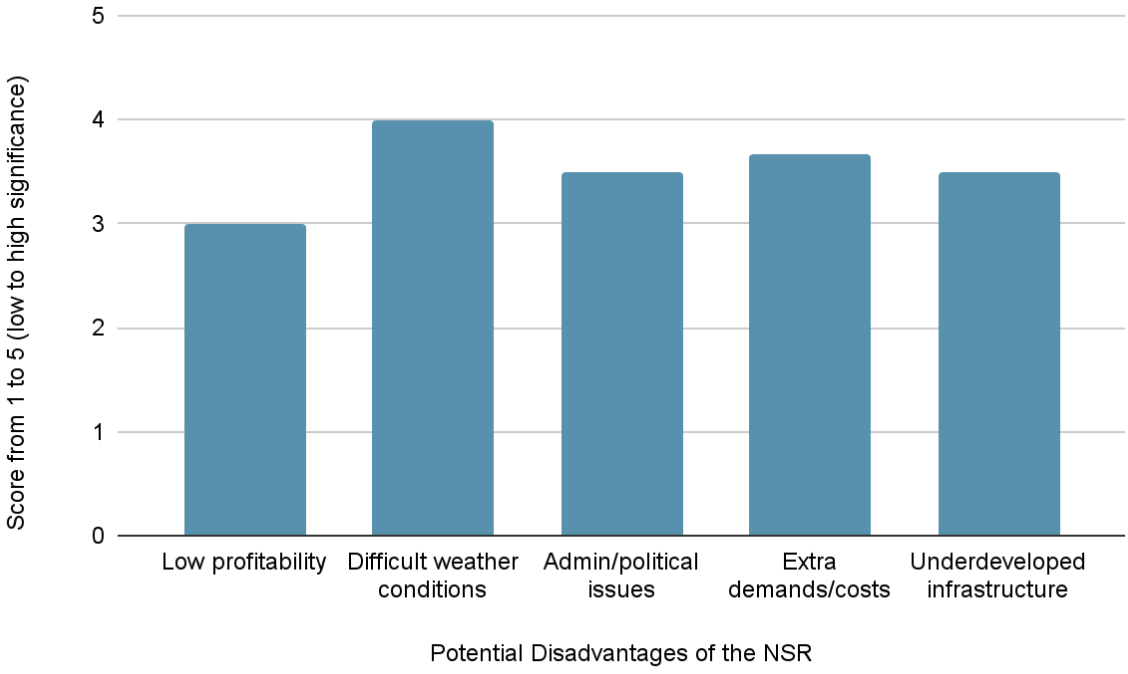

Figure 10. Potential disadvantages of shipping via the NSR (the authors, 2021)

Results from the evaluation reveal that the respondents felt uncertain about the low profitability disadvantage. This is because currently there are no clear cost details of using ice-breakers in the NSR. Additionally, all respondents addressed doubts regarding what size vessels are able to go through the NSR safely or the regulations regarding the usage of ice-classed ships. The

respondents also addressed a lack of clear information regarding the NSR tolls and this is important as it is one of the components of the total cost that should be taken into account.

Analysed interview results reveal that difficult weather conditions are one of the more significant factors that act as a shortcoming for the shipping industry for using the NSR. Combined results from the literature review and the interviews, showed that there are no tangible details or predictions about how long the NSR remains ice free and deployable by vessels as most of the water is covered in ice for most of the year. This was confirmed by Respondent 3 who mentioned that with the uncertain weather conditions, an advantage of saving time might become obsolete if the route is faced with the bad weather. From the literature it can be gathered that the NSR is best to use in the summer period as water is ice free then in most areas.

Another notable disadvantage addressed in the interviews is administration and political issues that shipping companies of the route might face. There is an uncertainty from year to year regarding what the costs would be for the shipping companies- what kind of demands are there for the carrier, what are the extra costs that need to be covered by the shipping company, what is the political climate in Russia, whose coastline most of the NSR covers, and between Russia and its main commercial partners. All of these factors might differ from carrier to carrier and impact how well they are able to benefit from the shipping in the NSR depending on the carrier company's size, prominence and the location of the customer goods owner. The marine standard officer from marine services company pointed out that there is the example of Crimea, which had a detrimental impact on the relationships between Russia and the EU. Other situations similar to that might arise and cause problems in commercial dealings between Russia and its potential business partners. Or as the officer for the marine services stated:

Russia is always uncertain. Now that we also have the political challenge with Crimea and the European Union has enforced different embargoes with Russia. That could be a big challenge because if you cannot move money in and out, just for payments, if you can't do payments then it would be very difficult to use the NSR… (Respondent 3)

All respondents addressed extra costs related to vessel operations mentioned in the interview as one of the disadvantages. There is a need to build ice-class vessels; hence, building an ice-class vessel is more expensive than a non-ice-class vessel. Additionally, Respondent 4 addressed that having and using the ice-class vessel will impact the ship building, operational and the maintenance cost. However, Respondents 4 agreed that the future opportunities for the NSR will increase with the advanced ship design and better, more environmentally friendly fuel options and advanced engine technology. Currently, there are not so many ice-class vessels available and there are no large vessels sailing through the NSR. Due to this, ice-breaker assistance is needed to navigate the NSR in certain conditions. Furthermore, Respondent 3 mentioned that the crew cost might be affected in the NSR as the daylight is only available for a few hours in certain time periods. At the same time, there is significantly more daylight in

the summer months compared to the SCR. During dark hours, AB (Able Seaman) is constantly needed on the bridge for a lookout, which can have a slight impact on the extra cost of maintenance in the NSR.

According to the results from conducted interviews and the literature review, safety and security has been one of the main focuses for the shipping industry. One of the disadvantages brought up in the interview questions, underdeveloped infrastructure in the NSR, has been a great concern for the industry. According to the interview with Respondent 4, questions remain- what if there is an accident or breakdown, where is the nearest tug or port? Does the administration of the NSR have the service that customers need? Can the vessel go through the same route every year due to ice conditions? What can be done when a seaman falls sick? These are some uncertainties regarding the NSR's safety, security and infrastructure.

4.2.3 Preferable products to be shipped via the NSR

This section presents the interview results on which FMCG goods are preferable to be shipped via the NSR (Figure 11).

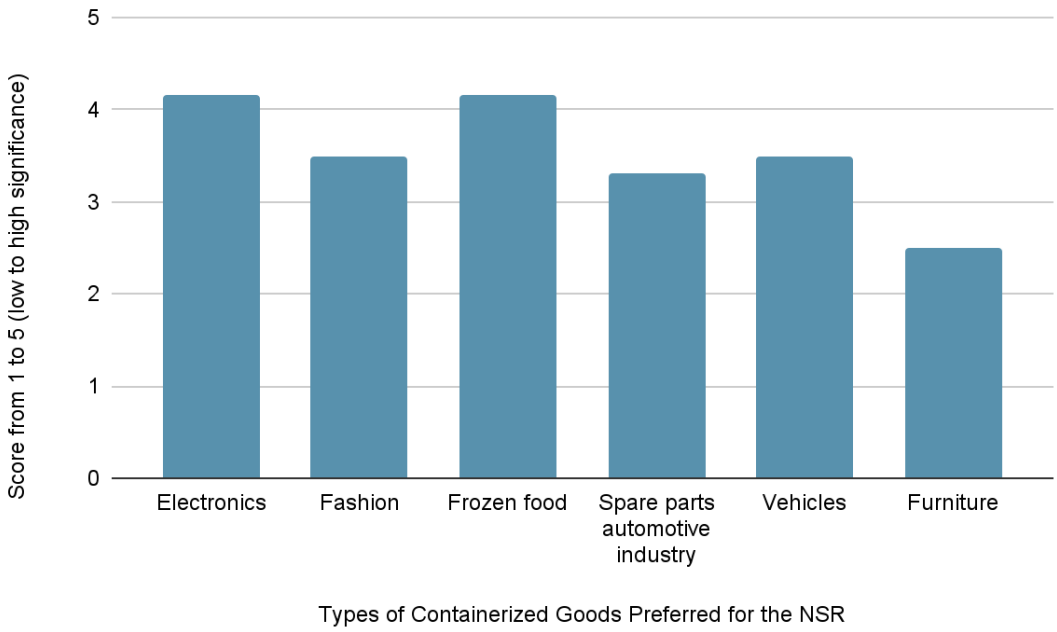

Figure 11. Types of containerized goods preferred for shipping via the NSR (the authors, 2021)

From the results presented in Figure 11, it can be seen that electronics and frozen food are the most preferable goods to be shipped through the NSR, these could be also categorized as High Value Products (HVP). According to the interview results, as for the actual scenario for a container ship, it usually carries mixed cargo rather than only one type of cargo so it is difficult to determine what is the complete list of products to be shipped via the NSR. However,

Respondents 1, 2 and 4 mentioned that HVPs would be the best to ship through the NSR as these types of goods are time sensitive and/or expensive and the goods owners will be willing to pay more for the timely shipping. Using the NSR for the transportation of HVPs is supported by the fact that there will not be any 25 000 TEUs ice-class vessels in the near future. Or as the vice president of the port addressed it:

Since most likely, there won't be any 25 000 TEU vessels using the NSR because they are never ice classed so you cannot use them in ice. Most likely, it will be somewhat smaller ships and with smaller ships, you have to go for a little bit more high value products so moving consumer goods like electronics and so on... High value products would use the NSR because that's where customers might be willing to pay a premium for faster transit time. - (Respondent 4)

From the interview results it could be gathered that there are some varying perspectives or opinions regarding the changes of product prices in case the goods are shipped through the NSR. Respondent 1 mentioned it is not going to affect the product price as the transport part of the total goods cost is relatively small. Respondents 2 and 3 anticipated that shipping goods through the NSR will affect the product price. As the distance of the NSR is shorter than the SCR, the product might have a lower price compared to the goods shipped through the SCR. Respondent 4 stated that the price will depend on the premium that the goods owner is willing to pay and also the type of commodities shipped. Respondent 4 estimated that the cost of the shipping via the NSR might have a marginal effect on the consumer price.

4.2.4 Industries viewpoints with the NSR

The interview results vary depending on which companies the respondents are working at. For example, Respondent 1 expressed their neutral interest in the NSR as he acknowledged that the NSR was feasible for containerized shipping. The respondent mentioned that the final decision depends on the calculation, if the outcome is positive and ends up being profitable for the shipping companies and consumer goods owners, they might use it;

If it's economically viable they want to use it, if it's not they won't. So, I don't think the answer itself is something they look at and say "oh we really want to use that". It is rather, just see if it's a possible route, do the calculation and if it's a positive one then they can consider it, if it's a negative one they won't. (Respondent 1)

This differs from the answer provided by Respondent 2, whose company has decided not to use the NSR for their shipping activities. They do not see any future in the NSR as a shipping route because of environmental reasons. To substantiate their commitment, the respondent's company has signed The Arctic Shipping Corporate Pledge. Moreover, they recognize that the main promoter of the NSR is the country with the longest coastline along the NSR as it would bring considerable revenue for the country. Alternatively, as Respondent 2 clarified:

I don't see the future in it, to be honest. A lot of big European customers, who are aware of their sustainability goals (environmental footprint), will not be able to do this and I can totally understand why because it would just be a big hoax, that if you say you care about the environment and in the end, you just care about a little bit shorter transit time etc. instead of saving the environment … (Respondent 2)

Further, Respondent 3, provided a different interest, since Respondent 3 addressed the question from the customer goods owners' point of view. According to Respondent 3, the customer goods owners are assumed to have a low interest in the NSR as that would mean that the polar region will be full of vessels, and it will not impress the customer goods owners due to the environmental impact. However, Respondent 3 believed that customers are more likely to care about the cost in the long run than other factors, such as the environmental factors, of the shipping goods. Respondent 3 addressed that consumer goods owners usually do not pay attention to who is shipping the goods and also predicted that the shipping companies would be aware that there is an impact if they started to use the NSR as a shipping route, and one of the impacts is media attention, most likely negative. This will be one of the reasons for the shipping companies to think twice before using the NSR.

(on using NSR) …the fuel and lube etc use would be less but I don't think it's the right answer to reduce the emissions for vessels because there must be another way to reduce emissions... Maybe in combination if we can have cleaner vessels with clean emissions and use the NSR that could be a combination but as for now, I think there are other ways to solve the environmental crisis... with the impact to the marine environment, it's not positive using that route … - (Respondent 3)

Respondent 4 has an optimistic perspective regarding the NSR compared to other respondents. According to the interview results, using the NSR will be of great interest if it is able to reduce the transit time by 2-3 weeks. During the interview, he mentioned that the drawback is mostly the infrastructure along the NSR which needs to be fixed to make NSR a feasible shipping route. Considering the ice and the conditions around the NSR, it might be needed to build an ice-class container vessel. There are no details regarding the water depth of the NSR for the full trip. Where is the bunkering station in NSR? What if the ship used LNG or LBG or marine diesel? Insurance difficulties also become one of the major problems if there are any casualties in the NSR. These uncertainties make the industry still unsure and hesitant to use the NSR and these concerns need to be addressed before the NSR can be used for container liner shipping.

Figure 12. Industries interest with shipping via the NSR (the authors, 2021)

From the interviews, it can be gathered that the shipping via the NSR would pose a great opportunity for the Port compared to other stakeholders. This favourable circumstance comes from the geographical position of the Port that is one of the first port calls when entering Northern Europe from the North. This was also addressed by Respondent 4:

We consider this to be a great opportunity for (the Port) because today when the ship arrives through the Suez Canal, the Mediterranean and then arriving in Northern Europe through ports like Rotterdam, Southampton, Hamburg- Gothenburg is the last port where the ship turns around and starts its journey back to Asia. With the NSR, it would be the total opposite... (Respondent 4)

In terms of the company management, all respondents stated that there will be no change with their company's management. As for the Port, it has the capacity, the cranes, the yard area, the fairway and the water depth that gives the Port confidence that the Port can handle considerably more volume than it currently does. So, in terms of the Port management and operation, the active usage of the NSR route would make no difference, however it would strongly increase the competitiveness of the Port. The main opinions of the respondents about the NSR are summarized in Table 10.

Table 10. Viewpoints of the interview respondents (the authors, 2021)

Subject	Respondent 1	Respondent 2	Respondent 3	Respondent 4
Future of container liner shipping via the NSR	Unsure- if cost reductions, then more likely	No future	Open and safe- would use as cost savings	Optimistic-long term
Preferable Cargos	High Value Products and Frozen food	High Value Products	All types of goods	High value fast moving goods
Interest in the NSR for containerized shipping	Moderate- if economically viable, then yes.	Not interested	Personal perspective- not interested Shipping industry- strong interest but should be done "right"	Interested, but need to solve the obstacles
Advantages of the NSR	Saving time and saving costs on fuel	No comment	Saving time and saving cost on fuel	Saving time and saving cost on fuel
Disadvantages of the NSR	All suggested factors critical but underdeveloped infrastructure is the most significant	No comment	Difficult weather conditions	All suggested factors critical but low profitability is not evaluated as the exact costs are unclear

Chapter 5: Discussion

This chapter presents the discussion and comparison between the previous chapter, the result and analysis and the literature review to highlight the possibility of the future container liner shipping in the NSR. Furthermore, the validity and generalisation of the research are discussed.

The theoretical framework of this study has shaped the ideas and opinions of this thesis regarding the containerized liner shipping in the NSR. However, the results show that there are many stakeholders interested in the NSR but there are some disadvantages that have made some industry leaders reject the idea of the shipping via the NSR and other parties hesitant as the conditions are not ideal. Additionally, there are many uncertainties connected to the regular and fixed Arctic shipping.

Results from the literature review, interviews, and MATLAB simulation several conclusions can be drawn. Firstly, the NSR does save time and therefore costs. This is supported by several studies and the MATLAB simulation run by the authors. The NSR provides shorter routes and reduced fuel consumption compared to the SCR.

Secondly, even though many stakeholders in the shipping industry have expressed their interest in shipping via the NSR, there are some notable shipping companies and the consumer goods owners that have signed a pledge to not use the NSR in order to respect and protect a unique habitat and delicate ecosystem of the Arctic. Furthermore, the Arctic shipping needs to be proved more environmentally sustainable because otherwise the companies connected to the Arctic shipping might face public backlash. However, there is still an opportunity for the liner shipping in the NSR if and when current roadblocks can be resolved or at least reduced so that the potential customers are willing to use the NSR. According to the results from the interviews, it will likely not happen in the next few years, but it might be feasible after 10 to 20 years as it will require better ship design, CO2 free fuel options. It also requires better infrastructure along the NSR, clarifications on the costs connected to the shipping via the NSR and insurance, and the safety and security along the NSR.

Thirdly, industries are more interested in shipping high value and/or time sensitive products through the NSR as the NSR provides shorter distance which also means it shortens the shipping time. Cost savings by using the NSR can be potentially made in many areas. The fuel cost can be cut down as it is a shorter distance. From the interviews, authors also gathered that it is possible to save on operational costs as potentially one is able to use fewer vessels in order to have the same number of products shipped. This is because the container ship loop is shorter and the vessel can finish her voyage in less days. The maintenance cost can be also reduced as in this case, the vessel is running on less hours. Furthermore, that results in cost reduction for the lube oil as the more running hours the vessel has, the more lube oil the engine consumes.

Lube oil is a considerable cost to be able to operate the engine, especially for the larger container vessels.

On the other hand, the conditions on the NSR can be unpredictable as it is unsure if an ice-class vessel is needed, if additional pilots are needed. In the case of needing an ice-breaker, the cost of it is uncertain. Additionally, ice-class vessels have heavier engines which would mean that there is also a possibility for a higher fuel and maintenance cost.

The decision process for using the NSR is shown in Appendix-C. The model, inspired by the model of Kiiski (2017), is based on the results of the interviews conducted by the authors with four senior employees within the shipping industry. It clearly shows that the decision for the industry leaders on whether or not to use the NSR is affected by the time and cost savings, sustainability goals and operational safety.

The MATLAB simulation results show a significant reduction in time and fuel consumption compared to the SCR. It is in line with the beliefs and opinions of the respondents of the interviews who expressed that using the NSR could produce meaningful time savings which ultimately reduces the cost in most areas. The authors found that the time and fuel savings can be reduced by around 25%. Exact economical savings in cost could not be detected by using the MATLAB as the tool is built to measure the lead time and the fuel consumption and additional calculation would need to be made in order to find monetary savings via the NSR.

5.1 Validity of the result

The thesis is based on a deductive research approach starting with the literature review used to compare the information from the interviews with senior professionals from the shipping industry and the simulation run in MATLAB. Additionally, a triangulation method was used to connect the results from literature review with the simulation and conducted interviews to achieve a complete perspective of the potential of the shipping via the NSR. In total, there were four respondents from the maritime sector who participated in the interviews and contributed with their knowledge, experience, and opinions. These interviews do not provide the opinions of other sectors regarding the NSR shipping.

The professionals from the port authority were with years of experience from the business, marketing and sales background. One of the respondents was from a container shipping company that has rejected the idea of shipping via the NSR due to environmental reasoning and sustainability goals. One respondent interviewed had little connection with specifically containerized shipping, however, he gave another perspective on the NSR due to his slightly different background but still vast experience within the shipping industry.

5.2 Generalization

The results of this study can be a positive input for future research as this area of research has a promising future for commercial shipping, particularly for containerized shipping. The NSR could potentially create a time and cost saving option for the regular ocean transport of goods between Northeast Asia and Northern Europe.

The results of the interviews gave an overview on how the shipping industry regards the feasibility of the shipping via the NSR. The opinions on the matter at hand vary to some degree between the respondents especially when it comes to the feasibility and future potential usage of the NSR.

The MATLAB results can be considered as a benchmark for establishing how vast the time and fuel savings can be while using the NSR in the summer period in mostly ice-free conditions. The simulations were run on the principle that the vessel navigated via the NSR without the ice-breaker assistance. However, only one vessel was used as a model for a specific time frame, summer period, to run the simulations. For a wider timeframe and differently built and sized vessels, adaptations are needed to get accurate and applicable results.

Triangulation method used in this research helped the authors to obtain a wholesome perspective regarding the containerized shipping via the NSR. The results are however not unanimous. It shows that the NSR has a lot of potential once most of the major disadvantages and concerns are solved.

Chapter 6: Conclusion

Since climate change has become more prominent and has gathered a lot of public attention, the NSR as a shipping route has become increasingly more attractive for commercial shipping activities. Due to climate change, the Arctic waters, which used to be not available due to the ice covering the water all year around, have become mostly ice free during the summer months, i.e., July to October. That has resulted in the shipping industry's interest as open waters in the NSR are more accessible and easier to navigate.

The idea of shipping via the NSR also brings a lot of media attention especially regarding the environmental issues, nevertheless there is a potential in the NSR. The purpose of this thesis was to present the shipping industry's perspectives and opinions regarding the NSR as an alternative shipping route, especially the opportunities that the NSR provides for containerized shipping.

- **What efficiency savings in containerized shipping can be made using the NSR during the summer?**

The study, using the container vessels as models, concluded that the NSR can save 25.1% of the total distance between Shanghai and Gothenburg. With the shorter distance, the navigation time also decreased 25.8% or, alternatively, around 7.4 days compared to the SCR with the same origin and destination. It also showed a meaningful reduction in the fuel consumption of 44.2% when using the NSR. That is also supported by the interview results, as there are potential time and cost saving opportunities when using the NSR because of the shorter distance and reduced fuel consumption as opposed to the SCR. However, these advantages could be made obsolete, for example due to the weather conditions not being favourable, at the appearance of hidden costs (admin fees/political obstacles), when additional services and relevant support is not available, etc. Despite the promising results in this thesis about the potential of containerized shipping via the NSR, two out of four respondents disagree with the idea of the NSR for container liner shipping, because of the environmental fragility of the Arctic region and separately, sustainability goals of the various stakeholders.

- **Which opportunities do stakeholders involved in international container shipping see in a future use of the NSR?**

From the MATLAB simulations and the interviews conducted for this study, it can be concluded that there are opportunities in future usage of the NSR in containerized shipping. It is an undisputable fact that the NSR provides a shorter distance, so time savings should be expected when conditions are favourable. This is motivated both by the result of the simulations which were run using the container vessel characteristics as a data input and, opinions and perspectives of the respondents about the shipping via the NSR. Shorter distance

involves time saving and time saving in general brings savings in other areas such as fuel consumption, maintenance and operational costs, ice-breaker fees etc. There is a possibility of reduced cost for the observed timeframe for the ice breaker because it is mainly not needed as the route is expected to be ice free during the summer period. However, the complete cost reductions are still unclear because of the uncertainties surrounding the NSR. From the results of the interviews, the authors gathered that the future opportunities for the NSR will increase with the advanced ship design and better, more environmentally friendly fuel options and advanced engine technology. The advanced ship design can elevate the usage of the NSR as this can encourage potential customers of the NSR to use it without receiving a public backlash. Moreover, the advanced fuel options and engine technology would also encourage future customers to use it as it lessens the environmental impact to the fragile and sensitive ecosystems in the Arctic. Additionally, the opportunity of using the NSR will become more attractive to the customers once the Russian Government and its administrative units are able to improve infrastructure, safety and security along the coast of the NSR. That will help to gain the trust of the stakeholders in the performance, safety, security and longevity of the containerized shipping via the NSR.

- **Which products in the fast-moving consumer goods segment can be imported via the NSR?**

From the interviews with the senior professionals in the shipping industry, it can be concluded that the NSR is suitable for all kinds of fast-moving consumer goods. However, according to the respondents, High Value Products are the most favourable type of goods to be transported via the NSR. These High Value Products, suitable for the containerized shipping via the NSR, include frozen/refrigerated goods, electronics and spare parts or the goods that have time sensitivity, for example seasonal products. As the NSR provides a shorter route and reduced transport time compared to the SCR, goods owners are likely willing to pay a premium in order to ensure the faster delivery of the goods.

Moreover, it should be mentioned that these results are indicative and future studies are needed that include more stakeholders in the study process, such as goods owners. It could be very beneficial to gather their perspectives as they also have a noteworthy impact on whether container liner shipping via the NSR could be a successful venture in the future.

6.1 Managerial implications

The results of this study suggest that further investments should be made in order to have a better understanding of the feasibility of the NSR for the shipping as there are still many uncertainties that need to be clarified before the NSR could be fully deployed. Various stakeholders should be involved for the maximized exposure and for solving the matter in hand in the most economical and environmentally friendly way so that the sustainability goals could be also addressed. The stakeholders that should be especially involved are the Northern European Ports due to their geographic location and perceived increase in competitiveness if

and when the NSR becomes available for containerized liner shipping. In addition to that, for the best possible outcome, other experts on the field such as naval architects, marine engineers, their academic peers and educational institutions should be involved for the innovative input. The authors also suggest that further trial voyages, preferably with varying vessel sizes, should be planned and executed to see what are the practical implications and performance of running the vessel in difficult climate conditions such as ice, volatile weather, etc.

As research in general is expensive, time consuming and full of risks and uncertainties, patience needs to be practiced in order to achieve the future stable commercial activity in the NSR shipping with the best results. Furthermore, the governments, mostly responsible for making the Arctic shipping a commercial success, should invest in their infrastructure, public relations and marketing tactics. That would shape the profile of the NSR for the future customers and increase the trust in the product, product being the container liner shipping via the NSR.

6.2 Theoretical implications (contribution)

This thesis aimed to find out whether the NSR is feasible for containerized liner shipping. This research used three different methods to gather the data including literature review, interviews, and simulation with MATLAB. Literature review and previous study regarding the NSR was used to create a foundational basis for the thesis. The interviews were conducted with four experienced senior professionals within the shipping industry to accumulate opinions and perspectives regarding the feasibility of containerized liner shipping and suitable goods to ship via the NSR. The interview questions assisted with finding out the experts' opinions about the NSR- advantages and disadvantages of the NSR, experience with the NSR, suitable goods to ship via the NSR and the future interest and feasibility of the NSR. The MATLAB simulation was done with the VPT model built by Li et al. (2021). The simulation uses real vessel (Venta Maersk) parameters and real-time weather data from the Met Office.

6.3 Further research

The authors suggest that further research is needed to achieve a deeper understanding on the topic and more thorough results. Firstly, the MATLAB simulation of the fuel consumption only covers the summer period in the NSR, all year-round simulation will lead to a better overview on the NSR and whether it is feasible and beneficial to be used in this format. Secondly, the interviews were conducted with professionals within the shipping industry, further interviews with the consumer goods owners who ship their goods from Asia to Europe are needed to obtain their perspective regarding the shipping via the NSR. All the respondents mentioned to a degree, the infrastructure aspect of the NSR being problematic which poses an obstacle for the NSR becoming feasible. Preferably, the further research can obtain the data and expand the study on the NSR and compare it with the SCR in more detail regarding the future container liner shipping feasibility. Thirdly, the interviews were conducted in Sweden and professionals focusing mainly on the Swedish market. Interviews with the counterparts from other Northern European countries, that are involved in shipping activities between Asia

and Europe and are interested to find out more about the alternative container shipping options, would be beneficial. Fourthly, it would be interesting if the model that the authors created based on Kiiski (2017) could be tested in future research to find whether the model is reliable or not. Lastly, it would be useful to further study about the sustainable container shipping options once the advanced ship design and fuel options are more widely available in order to transport goods in a more environmentally friendly way. That is a significant factor as the Arctic ecosystem is fragile and the public is very critical of its usage.

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Appendix

Appendix-A: The Arctic Shipping Corporate Pledge

Attachment A
Arctic Corporate Shipping Pledge

The Arctic is warming two to three times faster than other parts of the planet –resulting in shrinking summer sea ice, restructuring of marine ecosystems in ways never seen by humans, and great uncertainty for people living in the Arctic. Increasing vessel traffic on Arctic shipping routes poses additional risk of greater impact. Local and regional shipping in the Arctic are important for northern economies and indigenous communities, but trans-shipment of global goods on container ships along new Arctic shipping routes ("**Arctic Trans-Shipment Routes**") are beginning to be considered as an alternative to traditional, non-Arctic shipping routes.

As companies who ship goods across the globe, we acknowledge that greenhouse gas emissions from global shipping are jeopardizing the Arctic and will continue to do so even if we avoid Arctic Trans-Shipment Routes. As such, we will continue to explore ways to reduce emissions from global shipping. As companies who care deeply about the climate risks already impacting or threatening Arctic peoples, sea life, and ecosystems – we refuse to add to the risk of greater impact and pledge to:

1. Avoid Arctic Trans-Shipment Routes –

    a. For Consumer Goods Companies: Recognizing the potential impacts, we voluntarily agree not to intentionally allow our product to be trans-shipped on vessels via Arctic Trans-Shipment Routes, as shown on the Arctic Trans-Shipment Route Map, set forth in Attachment B. Similarly, no ocean carrier or freight forwarder retained by us may have our product on a vessel sailing or intending to sail these Arctic Trans-Shipment routes.

    b. For Logistics Service Providers: Recognizing the potential impacts, we voluntarily agree not to intentionally sell services or allow our vessels to use Arctic Trans-Shipment Routes as shown on the Arctic Trans-Shipment Route Map, set forth in Attachment B.

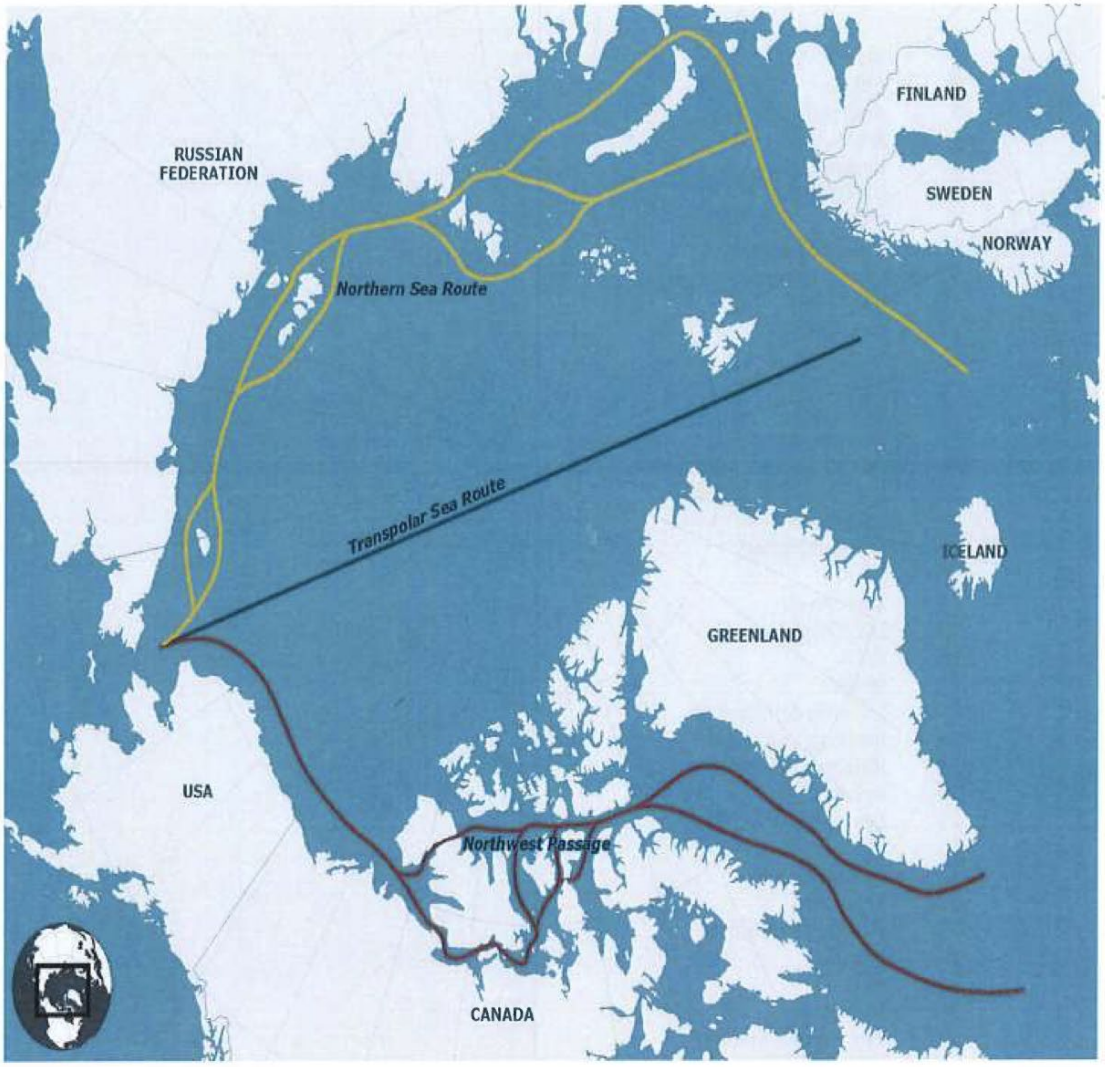
2. Promote Precautionary Arctic Shipping Practices – In addition to our pledge to avoid Arctic Trans-Shipment Routes, and recognizing that some companies may refuse to make that pledge, we support the development of precautionary Arctic shipping practices to enhance the environmental and human safety of current and future Arctic shipping.[1]

[1] These practices may include: a ban on heavy fuel oil use and carriage in Arctic waters (*see* Clean Arctic Alliance, The Arctic Commitment (January 25, 2017), https://www.hfofreearctic.org/en/arctic-commitment/), designation of the Central Arctic Ocean by the International Maritime Organization as a Particularly Sensitive Sea Area (*see* Stevenson, Todd C., Jeremy Davies, Henry P. Huntington, and Whit Sheard, "An Examination of Trans-Arctic Vessel Routing in the Central Arctic Ocean." Marine Policy 100 (February 1, 2019): 83–89. https://doi.org/10.1016/j.marpol.2018.11.031), evaluation of low impact shipping corridors that protect important ecological and indigenous cultural areas (*see* U.S.-Canada Joint Statement on Climate, Energy, and Arctic Leadership (March 10, 2016), https://pm.gc.ca/en/news/statements/2016/03/10/us-canada-joint-statement-climate-energy-and-arctic-leadership), and adoption of strict pollution controls. (*See* Ocean Conservancy (2017), "Navigating the North: An Assessment of the Environmental Risks of Arctic Vessel Traffic." Anchorage, AK. https://oceanconservancy.org/wp-content/uploads/2017/06/Arctic-Vessel-Traffic-Report-WEB-2.pdf).

6

Attachment B

Arctic Trans-Shipment Route Map



7

Appendix-B: Interview Questions

Interview 1:

1. How many containers have entered the Port annually since 2017 for shipping goods? Have you in general seen a rise in volume since then? In which type of goods have you noticed a rise in volume?

2. How and in what ways did the outbreak of COVID-19 affect the goods volume that entered the Port? What changes did you see in the product types and volumes ordered compared to before?

3. What are the most imported goods (high demand) in Sweden? Can you notice severe changes due to:
   a) development of e-commerce, if yes please elaborate on your answer
   b) season, if yes please elaborate on your answer

4. Evaluate potential benefits in using the Northern Sea Route (NSR) for shipping goods? If there is more than one, please name these reasons. Please evaluate your answer on a scale between 1-5 (5 being the most significant):

   Avoiding piracy 1 – 2 – 3 – 4 – 5
   Saving costs on fuel 1 – 2 – 3 – 4 – 5
   Saving costs on tolls 1 – 2 – 3 – 4 – 5
   Saving environment 1 – 2 – 3 – 4 – 5
   Saving time 1 – 2 – 3 – 4 – 5
   Avoiding congestion 1 – 2 – 3 – 4 – 5
   Other (not mentioned)

5. Evaluate potential disadvantages/barriers in using the Northern Sea Route (NSR) for shipping goods? Please evaluate your answer on a scale between 1-5 (5 being the most significant):

   Low profitability 1 – 2 – 3 – 4 – 5
   Difficult weather conditions 1 – 2 – 3 – 4 – 5
   Administrative/political difficulties 1 – 2 – 3 – 4 – 5
   Extra demands/costs related to vessel operations 1 – 2 – 3 – 4 – 5
   Underdeveloped infrastructure 1 – 2 – 3 – 4 – 5
   Other (not mentioned)

6. Do you know if any of your customers (shipping lines) have used the NSR?
   a. Yes, what is their experience with the NSR? (if known)

b. No, why have your customers not considered it as your option? (If known)

7. How do you see shipping companies deploying the NSR in their activities in the future when container shipping is available? Would NSR be used as a shipping route within import of goods all year around, or just during ice free months during the summer?

8. What type of containerised goods is suitable for shipping via NSR? Please evaluate your answer on a scale between 1-5 (5 being the most significant):

   Fast moving consumer goods, electronics due to high volumes: 1 – 2 – 3 – 4 – 5
   Fast moving consumer goods, clothes due to high volumes: 1 – 2 – 3 – 4 – 5
   Frozen food: 1 – 2 – 3 – 4 – 5
   Spare parts automotive industry: 1 – 2 – 3 – 4 – 5
   Vehicles (cars and buses): 1 – 2 – 3 – 4 – 5
   Furniture: 1 – 2 – 3 – 4 – 5
   Other

9. How would the Port be affected if NSR was used within import shipping of goods from Asia? What would change in the port management and port operations for the Port?

10. Do you see the usage of the NSR for transporting goods affecting product prices and if yes, how?

11. What interest do you see in the future use of NSR within containerized shipping? please evaluate your answer based on 1 to 5 (5 high interest)? 1 – 2 – 3 – 4 – 5

Interview 2:

1. How many containers (full) have you shipped annually since 2017 for shipping goods? Have you in general seen a rise in volume since then? In which type of goods have you noticed a rise in volume?

2. How and in what ways did the outbreak of COVID-19 affect the goods volume? What changes did you see in the product types and volumes ordered compared to before?

3. What are the most high demand imported goods in Sweden according to your company's data and your personal observations? Can you notice severe changes due to:
   a) development of e-commerce, if yes please elaborate on your answer

b) season, if yes please elaborate on your answer

4. Evaluate potential benefits in using the Northern Sea Route (NSR) for shipping goods? If there is more than one, please name these reasons. Please evaluate your answer on a scale between 1-5 (5 being the most significant):

   Avoiding piracy 1 – 2 – 3 – 4 – 5
   Saving costs on fuel 1 – 2 – 3 – 4 – 5
   Saving costs on tolls 1 – 2 – 3 – 4 – 5
   Saving environment 1 – 2 – 3 – 4 – 5
   Saving time 1 – 2 – 3 – 4 – 5
   Avoiding congestion 1 – 2 – 3 – 4 – 5
   Other (not mentioned)

5. Evaluate potential disadvantages/barriers in using the Northern Sea Route (NSR) for shipping goods? Please evaluate your answer on a scale between 1-5 (5 being the most significant):

   Low profitability 1 – 2 – 3 – 4 – 5
   Difficult weather conditions 1 – 2 – 3 – 4 – 5
   Administrative/political difficulties 1 – 2 – 3 – 4 – 5
   Extra demands/costs related to vessel operations 1 – 2 – 3 – 4 – 5
   Underdeveloped infrastructure 1 – 2 – 3 – 4 – 5
   Other (not mentioned)

6. Has the company that you work for used the NSR for shipping goods?
   a. Yes, what is their experience with the NSR? (if known)
   b. No, why have your customers not considered it as your option? (If known)

7. What do you think of NSR as the alternative route compared to SCR? Has your shipping company hesitated using NSR? If yes, why?

8. How do you see shipping companies deploying the NSR in their activities in the future when container shipping is available? Would NSR be used as a shipping route within import of goods all year around, or just during ice free months during the summer?

9. What type of containerised goods is suitable for shipping via NSR? Please evaluate your answer on a scale between 1-5 (5 being the most significant):

   Fast moving consumer goods, electronics due to high volumes: 1 – 2 – 3 – 4 – 5

Fast moving consumer goods, clothes due to high volumes: 1 – 2 – 3 – 4 – 5
Frozen food: 1 – 2 – 3 – 4 – 5
Spare parts automotive industry: 1 – 2 – 3 – 4 – 5
Vehicles (cars and buses): 1 – 2 – 3 – 4 – 5
Furniture: 1 – 2 – 3 – 4 – 5
Other

10. How would your company be affected if NSR was used within import shipping of goods from Asia?

11. Do you see the usage of the NSR for transporting goods affecting product prices and if yes, how?

12. What interest do you see in the future use of NSR within containerized shipping? please evaluate your answer based on 1 to 5 (5 high interest)? 1 – 2 – 3 – 4 – 5

Interview 3:

1. How many containers (full) have you shipped annually since 2017 for shipping goods? Have you in general seen a rise in volume since then? In which type of goods have you noticed a rise in volume?

2. How and in what ways did the outbreak of COVID-19 affect the goods volume? What changes did you see in the product types and volumes ordered compared to before?

3. What are the most high demand imported goods in Sweden according to your company's data and your personal observations? Can you notice severe changes due to:
   a) development of e-commerce, if yes please elaborate on your answer
   b) season, if yes please elaborate on your answer

4. Evaluate potential benefits in using the Northern Sea Route (NSR) for shipping goods? If there is more than one, please name these reasons. Please evaluate your answer on a scale between 1-5 (5 being the most significant):

   Avoiding piracy 1 – 2 – 3 – 4 – 5
   Saving costs on fuel 1 – 2 – 3 – 4 – 5
   Saving costs on tolls 1 – 2 – 3 – 4 – 5
   Saving environment 1 – 2 – 3 – 4 – 5
   Saving time 1 – 2 – 3 – 4 – 5
   Avoiding congestion 1 – 2 – 3 – 4 – 5

Other (not mentioned)

5. Evaluate potential disadvantages/barriers in using the Northern Sea Route (NSR) for shipping goods? Please evaluate your answer on a scale between 1-5 (5 being the most significant):

   Low profitability 1 – 2 – 3 – 4 – 5
   Difficult weather conditions 1 – 2 – 3 – 4 – 5
   Administrative/political difficulties 1 – 2 – 3 – 4 – 5
   Extra demands/costs related to vessel operations 1 – 2 – 3 – 4 – 5
   Underdeveloped infrastructure 1 – 2 – 3 – 4 – 5
   Other (not mentioned)

6. Has the company that you work for used the NSR for shipping goods?
   a. Yes, what is their experience with the NSR? (if known)
   b. No, why have your customers not considered it as your option? (If known)

7. What do you think of NSR as the alternative route compared to SCR?

8. How do you see shipping companies deploying the NSR in their activities in the future when container shipping is available? Would NSR be used as a shipping route within import of goods all year around, or just during ice free months during the summer?

9. What type of containerised goods is suitable for shipping via NSR? Please evaluate your answer on a scale between 1-5 (5 being the most significant):

   Fast moving consumer goods, electronics due to high volumes: 1 – 2 – 3 – 4 – 5
   Fast moving consumer goods, clothes due to high volumes: 1 – 2 – 3 – 4 – 5
   Frozen food: 1 – 2 – 3 – 4 – 5
   Spare parts automotive industry: 1 – 2 – 3 – 4 – 5
   Vehicles (cars and buses): 1 – 2 – 3 – 4 – 5
   Furniture: 1 – 2 – 3 – 4 – 5
   Other

10. How would your company be affected if NSR was used within import shipping of goods from Asia?

11. Do you see the usage of the NSR for transporting goods affecting product prices and if yes, how?

12. What interest do you see in the future use of NSR within containerized shipping? please evaluate your answer based on 1 to 5 (5 high interest)? 1 – 2 – 3 – 4 – 5

Interview 4:

1. How many containers have entered the Port annually since 2017 for shipping goods? Have you in general seen a rise in volume since then? In which type of goods have you noticed a rise in volume?

2. How and in what ways did the outbreak of COVID-19 affect the goods volume that entered the Port? What changes did you see in the product types and volumes ordered compared to before?

3. What are the most imported goods (high demand) in Sweden? Can you notice severe changes due to:
   a) development of e-commerce, if yes please elaborate on your answer
   b) season, if yes please elaborate on your answer

4. Evaluate potential benefits in using the Northern Sea Route (NSR) for shipping goods? If there is more than one, please name these reasons. Please evaluate your answer on a scale between 1-5 (5 being the most significant):

   Avoiding piracy 1 – 2 – 3 – 4 – 5
   Saving costs on fuel 1 – 2 – 3 – 4 – 5
   Saving costs on tolls 1 – 2 – 3 – 4 – 5
   Saving environment 1 – 2 – 3 – 4 – 5
   Saving time 1 – 2 – 3 – 4 – 5
   Avoiding congestion 1 – 2 – 3 – 4 – 5
   Other (not mentioned)

5. Evaluate potential disadvantages/barriers in using the Northern Sea Route (NSR) for shipping goods? Please evaluate your answer on a scale between 1-5 (5 being the most significant):

   Low profitability 1 – 2 – 3 – 4 – 5
   Difficult weather conditions 1 – 2 – 3 – 4 – 5
   Administrative/political difficulties 1 – 2 – 3 – 4 – 5
   Extra demands/costs related to vessel operations 1 – 2 – 3 – 4 – 5
   Underdeveloped infrastructure 1 – 2 – 3 – 4 – 5
   Other (not mentioned)

6. Do you know if any of your customers (shipping lines) have used the NSR?

a. Yes, what is their experience with the NSR? (if known)
b. No, why have your customers not considered it as your option? (If known)

7. How do you see shipping companies deploying the NSR in their activities in the future when container shipping is available? Would NSR be used as a shipping route within import of goods all year around, or just during ice free months during the summer?

8. What type of containerised goods is suitable for shipping via NSR? Please evaluate your answer on a scale between 1-5 (5 being the most significant):

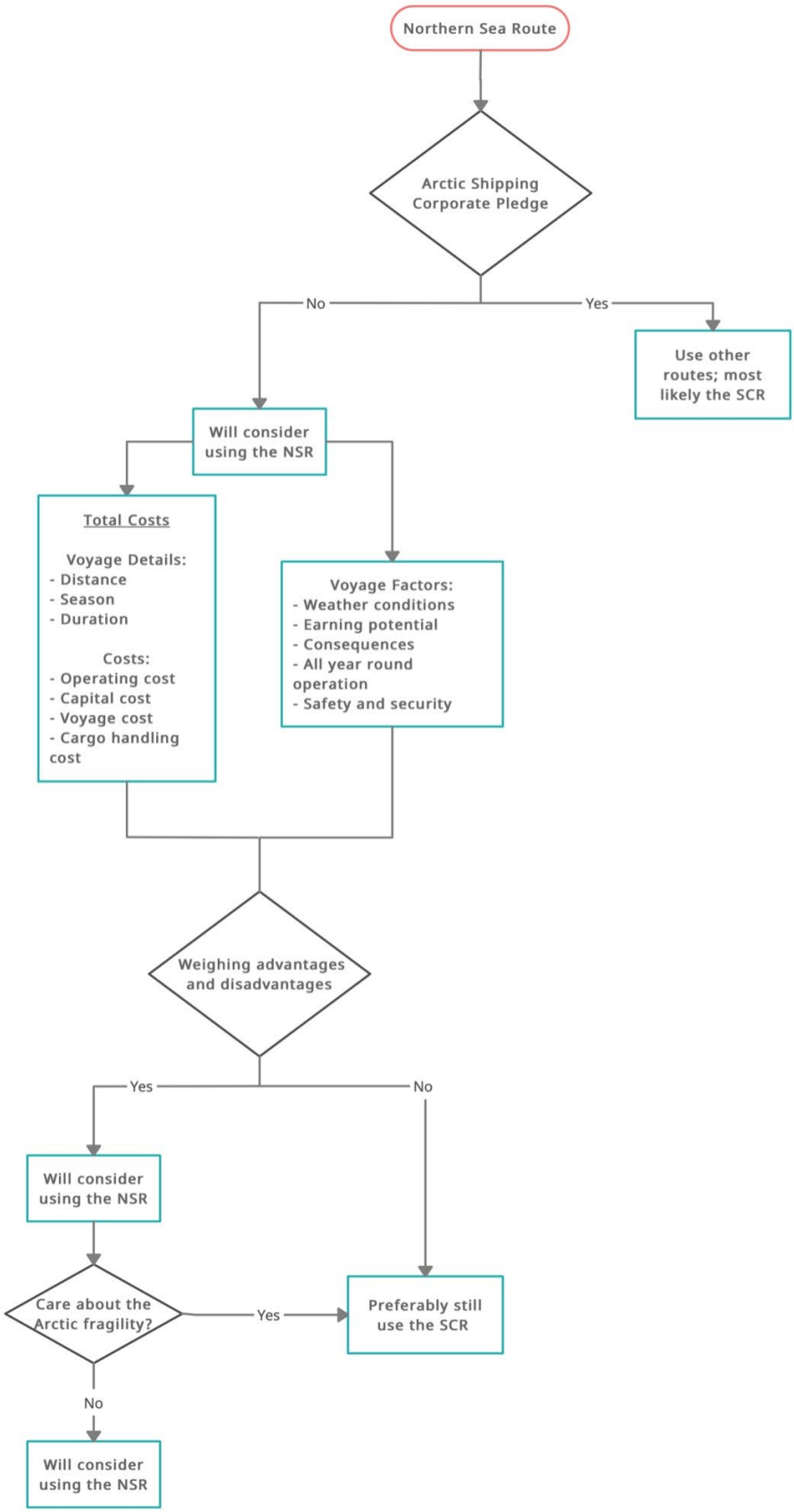
   Fast moving consumer goods, electronics due to high volumes: 1 – 2 – 3 – 4 – 5
   Fast moving consumer goods, clothes due to high volumes: 1 – 2 – 3 – 4 – 5
   Frozen food: 1 – 2 – 3 – 4 – 5
   Spare parts automotive industry: 1 – 2 – 3 – 4 – 5
   Vehicles (cars and buses): 1 – 2 – 3 – 4 – 5
   Furniture: 1 – 2 – 3 – 4 – 5
   Other

9. How would the Port be affected if NSR was used within import shipping of goods from Asia? What would change in the port management and port operations for the Port?

10. Do you see the usage of the NSR for transporting goods affecting product prices and if yes, how?

11. What interest do you see in the future use of NSR within containerized shipping? please evaluate your answer based on 1 to 5 (5 high interest)? 1 – 2 – 3 – 4 – 5

Appendix-C:


Northern Sea Route
Arctic Shipping Corporate Pledge
No
Yes
Use other routes; most likely the SCR
Will consider using the NSR
Total Costs
Voyage Details:
- Distance
- Season
- Duration
Costs:
- Operating cost
- Capital cost
- Voyage cost
- Cargo handling cost
Voyage Factors:
- Weather conditions
- Earning potential
- Consequences
- All year round operation
- Safety and security
Weighing advantages and disadvantages
Yes
No
Will consider using the NSR
Care about the Arctic fragility?
Yes
Preferably still use the SCR
No
Will consider using the NSR

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