Economic significance and potential of the Northeast Passage for Shipping and Energy Extraction

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Abstract:

In recent years, environmental changes have increased access to a series of maritime routes along the Arctic. Of these, the Northeast Passage, located on Russia's Northern coast spanning from the Novaya Zhelaniya Straits to Cape Dezhnev, has received the greatest interest as a sea route and a potential source of oil and gas extraction. Current projections regarding decreases in the extent of ice in the Arctic estimate that areas that normally would be frozen over are expected to be ice free for increasingly longer times of the year. These changes are exacerbated by the impacts of global warming and its associated effects on the environment that further increase access to the route for shipping and areas for the extraction of oil and gas. Given the passages ability to undercut the time and cost of shipping between Europe and Asia while providing an alternative source for oil and gas, the route is poised to become increasingly more significant and competitive into the future. Despite these potential benefits to the route's utilization, the route faces numerous challenges such as a lack of supporting infrastructure, limited seasonal operation, difficult environmental conditions, and many more that if not addressed, would greatly inhibit the competitiveness of the route.

Keywords: Arctic, Northeast Passage (NEP), Liquid Natural Gas (LNG), Shipping, Energy, Asia.

Introduction:

In the modern day, international trade in a globalized economy has been made possible through the utilization of the maritime domain in greatly reducing transportation cost and time of transit. The introduction of container shipping and other technologies allowing the mass transit of cargo has since further decreased logistics costs and increased shipping efficiency. Because 90% of all trade is carried through the maritime domain along trade routes as is seen in high traffic areas such as the Suez Canal, the need for these routes in easily accessing different markets for trade has never been greater. While routes through high traffic areas such as the Suez Canal, strait of Malacca, strait of Bab-el Mandab, and others have long been the primary zones from which most of the worlds trade has transited, a changing environment and increasing market for energy resources has the potential to make the Northeast Passage increasingly important for world trade.

In regions such as Asia which has experienced rapid economic and population growth, the need for energy resources has been increasing drastically. Because the passage exists between the markets of Asia and Europe while sitting atop of a vast unexplored energy resources In places such as the Barents sea, there is great potential in allowing the passage to sate these demands through providing a shorter route with direct access to these valuable energy resources. This thesis will compare the economic viability of the route in its current state with the barriers that are reducing its competitiveness and how these variables are expected to change over time. By analyzing the underlying Arctic institutions, current events, and market factors that are affecting the route, the potential prospects and practical application of the route for trade and energy extraction can assist in determining whether the route can increase its economic significance in the future.

Arctic Organizations

In the Northeast Passage, most guidelines, laws, and recommendations exist under the United Nations Convention on the Law of the Sea (UNCLOS), Russian domestic law, the Arctic Council, or the International Maritime Organization (IMO). These organizations and treaties create the rules and laws concerning all aspects of the political, legal, environmental, and technical nature of Arctic policy of which apply to the Northeast Passage. While these organizations to varying degrees decide Arctic policy regarding the passage, UNCLOS stands out as the primary legal guideline that first codified and collectively listed existing customary laws regarding the sea. Having been created in 1982, increasing interest and necessity for a forum for members prompted the creation of the Arctic Council. Although primarily concerned with creating a forum for Arctic states to discuss inter-regional issues or concerns, the council released its first binding treaty, the Arctic Search and Rescue Agreement in 2011 (Buixadé, Stephenson, Chen, Czub, Dai, 2014). Since then, the Council has risen in significance in leading the discussion of Arctic Policy among the Arctic states and others who share similar interests in the Arctic.

As with most international organizations, differing political and economic aims among various competing parties create difficulty in maintaining their cohesiveness and cooperative functions. Unlike most organizations on an international scale, most rules and organizations involved in deciding the rules of governance in the Arctic are decided on by Arctic member states, of which there are but a few. Among them, Russia, U.S., Norway, Denmark, and Canada all retain the largest Arctic coastal zone entitling them to a larger extent of the Arctic as part of their EEZ. Having larger EEZ in the Arctic gives greater control and influence on Arctic organizations that in concert define the rules and structures that govern their own considerably

large Arctic spaces. The Arctic states of Finland, Iceland, and Sweden in being within the Arctic circle are among the few states that have a smaller Arctic EEZ while still retaining their position alongside their comparably larger Arctic neighbors.

Participation among non-Arctic states are dependent on their overall contribution to their organizations in terms of funding, activity, and other such actions that showcases their commitment being an active member of whichever organization they're party to. While these Arctic states have been acknowledged as being the most influential and important nations regarding the stewardship and governance of the Arctic, observer status is one such title granted to non-Arctic states who retain certain Arctic interests despite their lack of access to Arctic territory. Among Arctic organizations such as the Arctic Council for example, observer status has been granted to China, Japan, South Korea, India, Germany, and many others who see the Arctic and its governance to be within the common heritage of mankind and therefore, being within the purview of all states. As recently as of 2013, the number of observer status states have grown considerably with applications still pending for potential members such as the EU. Although many of these member states have different interests and priorities regarding their Arctic policy, all states who wish to retain their observer status are required to affirm the rights of the members of the Arctic regarding their sovereignty in the Arctic and supporting legal frameworks such as UNCLOS that constitute the most important aspects of Arctic governance (Buixadé et al, 2014). Despite these requirements on part of observer status states, Arctic states such as the U.S. for example despite failing to ratify UNCLOS, have retained their seat on the Arctic Council. This exception is overlooked oftentimes given the U.S.'s adherence to UNCLOS despite not being legally bound to it. Given that the U.S. is one of the five initial members of the

Arctic Council, the status of the U.S. on the Council remains unchanged despite its inability to legally adopt such frameworks as law.

First Usage

Despite its early discovery in 1497 and subsequent limited use for domestic trade, it wasn't until 2004 that any non-Russian shipping vessels had begun to use the passage as a means of transportation. Although the passage was officially opened for international use on January 1st, 1991 following the end of the USSR it would take over a decade before any foreign commercial interest would take place. Following this period of, increasing interest of utilizing the route enabled it to see 46 voyages traverse along it carrying an estimated total of 1.26 million tons of cargo by 2012 (Lei, Xie, Wang, Lepparanta, Jonsdottir, 2015). Although not nearly as much traffic as was seen during the route's peak during the reign of the USSR in 1987 with 6.6 million tons of cargo carried by 331 ships, should current trends regarding the growth and expansion of cargo and bulk vessels using the route continue, it can be expected that this of traffic can once again be achieved if certain barriers inhibiting the routes usage can be further reduced or nullified (Verny and Grigentin, 2009).

Meteorological Difficulties

For much of the its history, sea ice has covered most areas along the Northeast Passage rendering it unsuitable for transportation most of the year. However, as global warming has been causing a general increase in temperatures, the Arctic has been subject to some of the worst declines ever seen. Over the last century, the ice in the Arctic has been decreasing on average per decade by 3-5%. This percentage represents a change of 3-4 °C temperature increase in the Arctic during this period (Ho, 2010). These changes can be most visibly seen in the summer months where the melting of ice has reached unprecedented heights of ice melt and temperature

increase. This rate of change is many decades ahead of previous forecast models regarding the loss of ice in the Arctic. The reason for this vast underestimation of previous predictions regarding melting ice has yet to be fully understood given a range of different environmental, meteorological, and other variables all of which impact the Arctic environment to varying degrees. Modern estimates considering multiple, less obvious variables now show that an ice-free Arctic in the summer could potentially occur within the next few decades should current climate trends continue. It's thought that ice-free summers could occur as soon as 2026 rather than the previously estimated date of 2050. While these estimations have been known to alter slightly dependent on seasonal variations and other meteorological aspects, all data points to an increasingly ice-free Arctic. When comparing different periods when the Arctic has been ice free, average time the passage was ice free has increased from the 1979 limit of 84 days up to 129 days by 2012. This reduction in days the passage is frozen over is expected to continue along a similar trend of increasingly longer time where the sea is ice free and therefore, achieve a greater period in which commercial operations can continue unimpeded by barriers such as ice blockage (Schøyen and Bråthen, 2011).

Ice Thickness

Because ice concentration, type, thickness, and other such related criteria are among the most significant physical barriers that would inhibit the routes effective use for shipping, there is a need to create accurate and consistent data that can be made available and updated constantly to ensure the avoidance of these dangerous unforeseen barriers. Due to seasonal changes in the ice thickness, location, and concentration, the route will need to adapt to changing environmental conditions both to take advantage of receding ice and avoid possible extensions of sea ice that might inhibit traffic along certain parts of the route. This necessitates an expansion of weather

monitoring stations and satellites to gather, sort, and analyze this data to create more accurate climate estimates to be used to navigate along less dangerous areas where shipping along the NEP can continue without fear of these factors. Efforts are currently underway by both China and Russia of whom have taken strides in providing accurate mapping and monitoring of such environmental changes to be used to assist in its utilization as a sea route and potential source for oil and gas extraction (Lei et al, 2015). The mapping of such ice thickness in the Arctic would enable vessels the ability to determine their routes along the Northeast Passage based on their ice class in determining where they can operate safely. Often undertaken using satellite coverage to identify changes in Arctic ice cover, these records can be used to identify common trends and areas of greatest effect regarding the melting of ice in the Arctic.

Scientific Mapping

Other means of monitoring and mapping the geography and weather data along the Arctic has been to send scientific monitoring expeditions to identify more specific difficulties seen along the route. Often undertaken by government organization under research teams, these expeditions serve a vital purpose in providing accurate data that can be accessed by those that might seek to utilize the passage for their own purposes. Among these, expeditions such as the Chinese National Arctic Research Expedition (CHINARE) sent in 2012 were meant to identify the feasibility of using the Northeast Passage on part of China. First beginning near the Chuck chi sea in July 2012, the expedition ended near the Norwegian sea by September having identified a slightly altered transit route. Using the icebreaker Xuelong, the research team traveled closer to the inner Arctic than what is considered the more conventional Northeast Passage that’s nearer to coastal regions such as northern Siberia. Under this slight deviation in the route, the expedition avoided the lower bathymetry coastal zones such as the Dimitry Laptev

strait that otherwise would inhibit the routes use for larger container vessels. From this expedition, it was found that during this period, container vessels and other such ships that require greater ocean depth to function can continue along the route set by the Xuelong expedition (Lei et al, 2015). Because China among other nations in East Asia have taken greater interest in the future utilization of the Northeast Passage, the construction of ice breaker vessels for the express purpose of being used in these areas are currently underway in several nations in the region. The newly built successor to the Chinese icebreaker Xuelong, the Xuelong 2, is set to be deployed by 2019 under the command of the Polar Research Institute of China (PRIC). As one of only two civilian icebreakers owned by China, the Xuelong 2 will be sent to the Arctic to further analyze and record data on the Arctic environment in an improved capacity from its forebear, the Xuelong. With new tools for oceanographic surveil and monitoring, the Xuelong 2 represents an advancement of Arctic monitoring technology and continued interest in the Arctic regarding Chinas foreign policy (Gady, 2018).

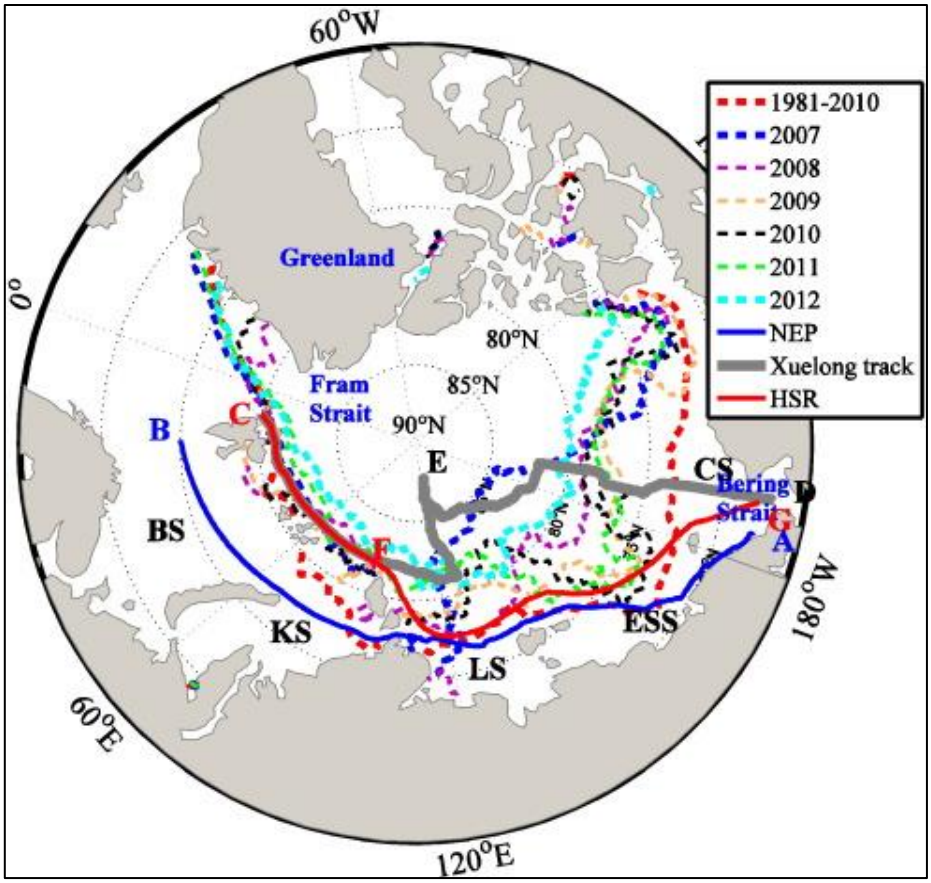

Fig. 1. Xuelong Track (gray) and the NEP (blue). (Lei et al, 2015)

Scientific organizations

One organization responsible for creating future projections regarding sea ice called the Arctic Marine Shipping Assessment (AMSA), has estimated that by 2025, continuous utilization of the passage for regional shipping in the Barents, Kara, and Pechora seas will create a more regular schedule for shipping companies to plan and organize around previously difficult to estimate environmental factors (Ho, 2010). However, studies conducted by other groups such as the Protection of the Arctic Marine Environment (PAME) under the Arctic Council have questioned whether their findings were more conservative estimates in what could potentially be a more quickly changing environment in the Arctic than was previously thought (Anderson, Baiborodova, Bailey-McCarthy, Ballestero, Balo, 2009). The combination of these competing divergent estimations, projections, and studies are one such factor that makes the practical utilization of the Arctic for resource extraction and shipping use less viable unless such organizations come to an agreement regarding the most accurate estimates to be used to determine its potential for regular commercial activities.

Effects of Methane release

Certain variables such as the release of methane from the melting of ice has been one such factor that makes it difficult to determine its impact on future projections of ice loss in the Arctic. Because methane is known to be capable of absorbing nearly 30 times as much heat as the more commonly feared phenomenon of carbon dioxide emissions, the current melting of ice in the Arctic has the potential to release vast amount of methane into the atmosphere that depending on the extent and rate of change could in turn cause a cycle that could sustain if not increase the current rate of ice melt regardless of any changes in the release of human caused CO2 release (Ho, 2010). Because scientists only recently discovered the extent of the

phenomenon of methane release in the Arctic, studies are currently in the process of finding answers and solutions to this problem. Although much of this release in methane has been found to be a result of trapped pockets being released through the melting of Arctic ice that had kept it contained, methane release has been found to be far more common in gas and oil facilities in the Arctic than what is seen in other non-Arctic environments. This discrepancy in the release of methane between these different climates can be partially attributed to the difficulty of effectively monitoring polar based facilities when faced with exceedingly cold, windy, and extended dark conditions that have the effect of hiding potential methane leaks (Shankman, 2018). Although the current trends of global warming and climate change bodes ill for environments around the globe, in respect to the use of the northeast passage, these trends will create greater periods between which the passage can be utilized for shipping and ease the difficulty in the extraction of Arctic resources that otherwise would be of greater cost and difficulty. While the international community has attempted to reduce the human impact of these trends through the creation of agreements such as the Paris climate accord, estimates show that the current rate of global warming will continue

Geographic Difficulties

The Northeast Passage is comprised of a myriad of different environmental attributes many of which hinder the passage's adoption. Much like other sea routes such as the Northwest Passage, the Northeast Passage has many islands and islets whose areas are only traversable for certain times of the year. Although it can be said that zones along the coast are less likely to retain significant amounts of sea ice than the Arctic interior, such zones retain other risks that are less obvious than as is seen along the interior. While many of these small bodies of land are left frozen and covered in ice, their thawing would necessitate greater effort put into mapping these

potential hazards that under normal circumstances are frozen over. With the thawing of sea ice, one other such factor that poses a great risk to shipping along the Northeast Passage is the relatively low bathymetry of the Arctic Ocean's depth along conventional routes of the NEP. This limited depth in certain spaces along the NEP will inhibit its use for the larger, newly created container vessels that are more commonly used in the Asian regions. This limits the adoption regarding container shipping among the increasingly large scale and sized vessels many of which would be incapable of traversing along certain areas of the route. Although it can be said that container shipping along the Arctic is of lesser potential and significance than the bulk shipping, these low depths pose risks for all forms of shipping dependent on the ships size. However, given that areas of low bathymetry are primarily concentrated along the coast, the continuation of receding sea ice will allow greater options in creating routes that are able to avoid areas of low bathymetry to account for larger vessels who otherwise would be incapable of using the regular route of the passage (Lei et al, 2015).

The primary ridges, straits, and other areas of concern regarding areas of low bathymetry are the straits of Dimitry Laptev and Sannikov as well as small portion of the Laptev sea. Among these areas of shallow draft, the 2 straits contained the shallowest area measuring at 6.7-meter depth at its smallest. The depth of these areas would effectively limit the size of vessels traversing through these limited portions along the passage to smaller vessels who would can operate at these lower depths at certain points. Given that the Northeast Passage isn't defined as a single defined route but rather can be interpreted and changed dependent on the extent of Arctic sea ice, such ridges and areas of concern can be effectively avoided with only slight deviations of what is normally thought of as the conventional route along the Northeast Passage (Buixadé et al, 2014).

Infrastructure difficulties

Given current trends regarding mass container transport, many ports located along the passage are unable to meet current necessary criteria regarding water bathymetry and mechanization. As container ships continue to increase in size and scale to better accommodate the larger markets of Asia, these vessels are expected to face difficulties in traversing along common standard straits and canals who are unable to adequately service the size of these vessels. Should larger vessels become more commonly seen along the Northeast Passage, modifications in port facilities regarding potential dredging, expansion of dock facilities, and other such services that are required to effectively service such vessels would need be upgraded and expanded to account for any potential increase in use by such vessels. Along other routes such as the Suez Canal, plans are currently underway to accommodate larger ships from its current maximum limit of 14,000 TEU to 16,000 TEU will as an aftereffect likely decrease the number of ships that can enter for each grouping of vessels, thereby reducing the maximum effective traffic the route can service (Schøyen & Bråthen, 2011). While these efforts are underway in the most heavily utilized shipping route along the Suez Canal, the lack of current use of the Northeast Passage makes similar possible endeavors unlikely to come anytime soon. However, this reduction in the number of vessels the Suez Canals can service along with current projections regarding an increase in vessel traffic creates an incentive for companies to seek alternative means of transportation of which the Northeast Passage can provide in excess for the movement of goods between Asia, Europe, and Russia.

Due to the long distance and lack of population centers between ports of call along the Siberian coast, the lack of supporting infrastructure represents a danger to vessels that many shipping companies are often unwilling to overlook as part of their regular operations, especially

regarding container shipping which relies heavily on accurate and reliable estimations for time of departure and arrival in creating efficient operations. As part of Russia's attempt to increase confidence and safety of the passage while downplaying potential risks these aspects can pose to shippers, improvements have been made by through the construction of ten new bases along the Northeast Passage that serve to assist search and rescue operations and improve the reliability of communication for vessels that might need help along the vest stretches of the sparsely inhabited coastal zones. Of these ten new bases, many are USSR Cold War era military bases and ports that have been retrofitted to serve in these new emergency capacities. With the reconstruction of these new facilities currently underway, the lack of infrastructure in areas such as the Siberian coast has been greatly improved regarding emergency services that can be rendered. However, these areas still suffer from a lack of potential ports of call that could otherwise provide ship repair and the prospect of transshipment between different ports. The ports of Tiksi, Pevek, and Dikson are well situated between the mostly uninhabited Siberian coast and should they become updated and operational for regular use, the area of greatest risk along the passage would be greatly reduced. While these ports have been designated as being in disrepair regarding their ability to provide regular port functions according to the Russian Federation, they retain search and rescue stations that are of greater importance to the passage regarding ship security and risk. Because these ports are located located along the sparsely populated Siberia coast, practical commercial services such as transshipment aren't entirely necessary given the lack of market access along these areas of limited habitation and use (Zhang, Meng, Zhang, 2016).

Of the limited ports of call providing marine services to vessels traversing the Northeast passage, many are designated as being in disrepair by the Russian government. As can be seen among port facilities primarily along the Siberian coast, only a handful of ports such as those in

Sabetta, Amderma, Murmansk, and a few others are thought to be operational for regular port operations. Of these functioning facilities, all are positioned on the western portion of the passage making the area spanning from Cape Dezhnev to the Yamal Peninsula without any functional regular port services available in between. Although attempts are underway to make these port facilities operational in concert with creating search and rescue (SAR) stations, the current limited utilization of the passage, lack of population centers, and difficult climate are but a few barriers that have inhibited these ports from functioning effectively and limited the practicality of updating them due to the routes current low traffic (Zhang et al, 2016).

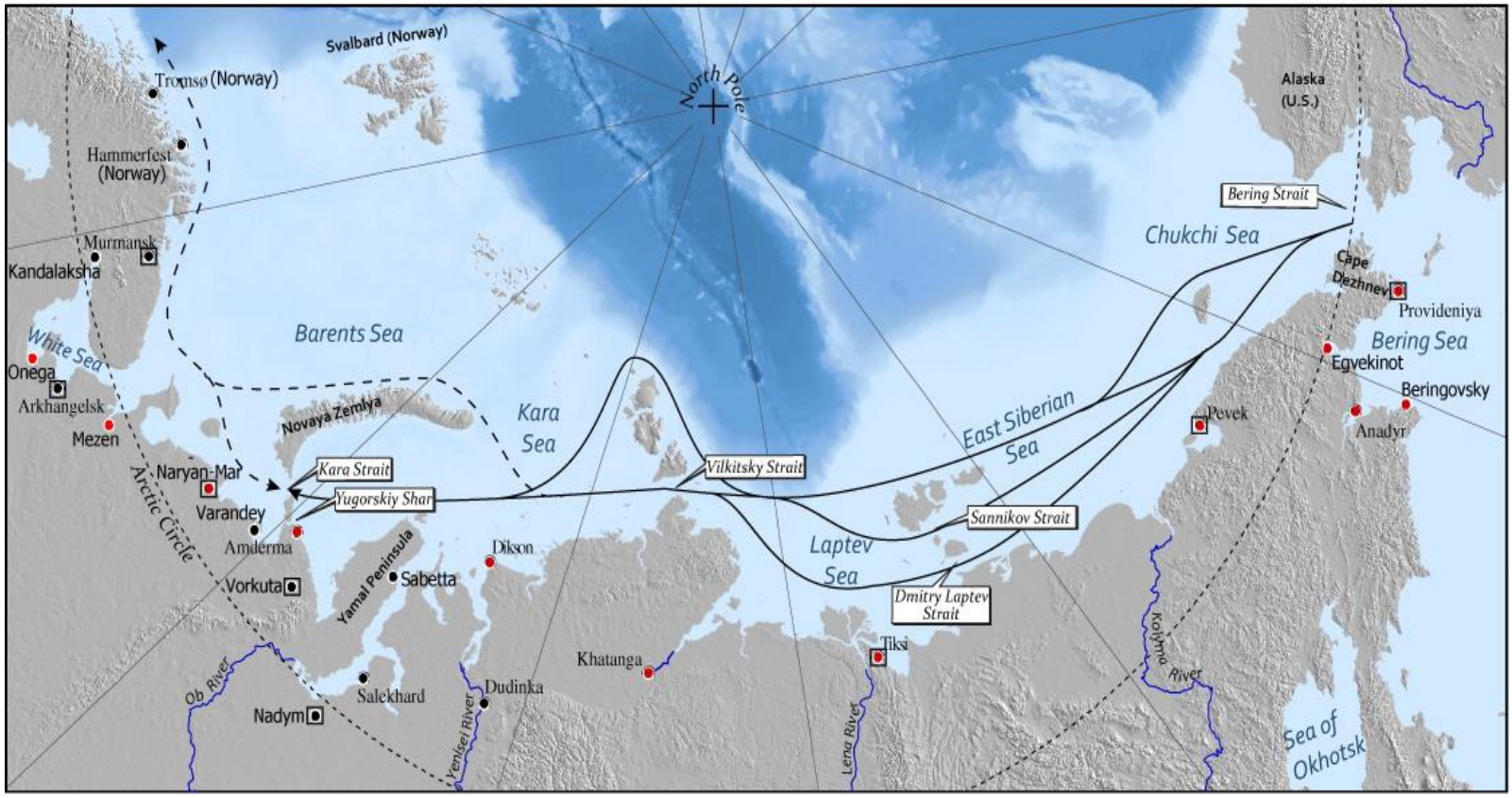

Fig. 2. Map of the Russian and Norwegian Arctic coasts, showing the Northern Sea Route (solid line) and its extension to the Northeast Passage (dotted line). Cities in red identified as having ports in disrepair. Cities with squares contain Search and Rescue stations (Buixadé Farré et al., 2014).

Communication difficulties

Operating closer to the Northern pole provides a host of difficult circumstances that aren't present in other non-Arctic transport routes. In areas such as the routes along the Suez Canal, communication connections are commonplace, reliable, and easily accessible for radio and satellite systems given its proximity to population centers and exceeding high degree of development. By comparison, traversing the northernmost areas of the Arctic along the Northeast Passage poses a problem for these forms of communication that limit its use and application. Despite current attempts by the Russian Federation to increase the effective range of available Arctic lines of communication to be made available for ships traversing along the passage, large investment is still needed before the range of these communications can adequately service the entire route (Østreng, Eger, Fløistad, Jørgensen-Dahl, Lothe, 2013). These types of communication are exceedingly important given the difficulty posed by traversing icy waters that at certain times require the aid of ice breakers to allow for a complete transit. Should these communications be incapable of reaching areas within the Northeast Passage, any ships that find themselves stuck in these areas would have difficulty in communicating their distress signals to emergency service stations and other vessels along the route. Improvements that have been made and are yet in progress have greatly reduced these risks associated with communication difficulties and are expected to continually improve the range and reliability of such connections for future ship travel.

Economic Difficulties

While certain physical, meteorological, and other such barriers pose some of the most obvious direct threats to the passage's adoption, certain market factors have the potential to greatly increase or decrease the relevance of the passage for world trade. Among industries such

as the extraction and exportation of energy resources such as LNG and oil, fluctuations in the energy market abroad have at different times led to greater demand of such resources prompting greater effort to being put into developing such industries. Market factors such as anticipated consumption for energy in Asia have had the effect of increasing investor interest in constructing such facilities to supply this predicted market. While this factor has had a positive effect in promoting the passages use, certain events such as the trade war between China and the U.S. or sanctions on Russia are but a few factors that can have the negative effect of further reducing ship traffic and investor interest in developing the Northeast Passage despite expected increase in consumption seen in places such as China (Schach & Madlener, 2018).

When determining the economic feasibility of using the Northeast passage, there comes a need to determine the base operating costs for vessels traversing the area. Variables involved in regular operations for shipping vessels such as transit fees, fuel costs, and port related costs are but a few that in combination, determine whether operations can generate profit for shipping. Along the Northeast passage, certain criteria such as transit fees associated with icebreaking assistance is an additional variable that is unique to Arctic operations. While some of these extra fees hinder the routes profitability for shipping operations, other criteria such as reduced distance between ports along certain areas have the benefit of decreasing total fuel consumption resulting in decreased shipping costs (Zhang, Meng, & Ng, 2016a).

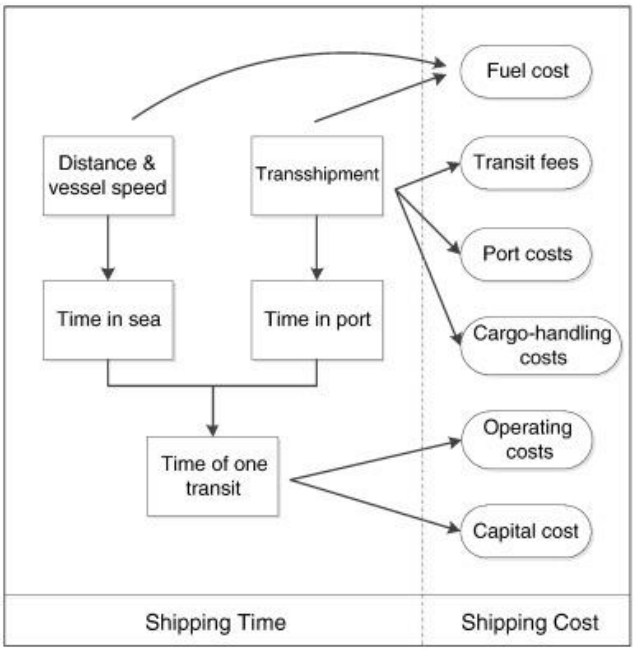

Fig. 3. Shipping cost Calculation (Zhang, Meng, & Ng, 2016a).

Perception among shippers

Among shipping companies that participated in a wide-ranging survey that identified their primary reservations regarding the potential of the Northeast Passage, the most common themes related to the costs associated with constructing ice-class vessels, increased insurance premiums, and extra crew training. Of these, ice-ship construction was the most often mentioned economic factor that many shippers avoid travelling through Arctic waters. Although these constituted the greatest market factors in determining the economic feasibility of the route, the greatest mentioned challenges and risks associated with travel along the Northeast passage centered on a lack of market access resulting from the routes remoteness. Because these results were sourced from different shipping firms specializing in different areas within the industry such as container, bulk, roro, multipurpose, etc in different regions, certain differences in criteria between these companies regarding their responses were made apparent. For example, European firms mentioned the cost of required equipment three times as much as did the equal number of Asian shipping firms. Similarly, Asian firms were twice as likely to point towards the relative cost benefit of using the route as being too low to warrant their interest when compared to their European counterparts. The results collected from Asian, European, and North American

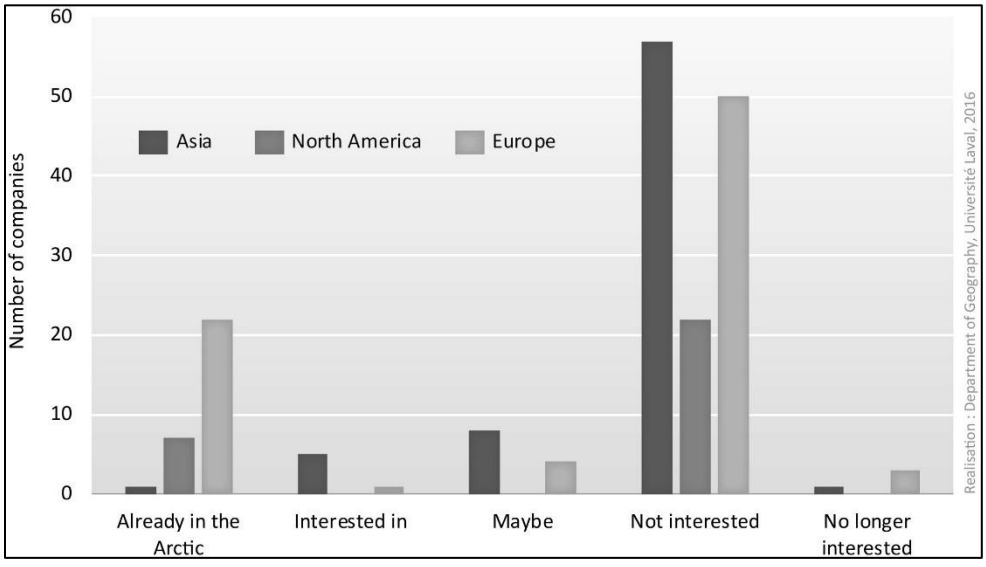

Fig. 3. Companies interest for Arctic shipping (Lasserre, Beveridge, Fournier, Têtu, & Huang, 2016)

shipping firms that were surveyed conveyed a general lack of interest among shippers (Lasserre, F., Beveridge, L., Fournier, M., Têtu, P.-L., & Huang, L, 2016).

Russian sanctions

Under the circumstances surrounding Russian sanctions, energy projects such as the Yamal LNG production facility faced difficulty in acquiring funding during 2014 during the height of the Ukrainian crisis. The fallout from this event caused by Russia's involvement caused governments such as the U.S. and the EU to heavily sanction Russia. These sanctions on individuals and organization operating in Russia caused a visible decrease in the number of investors for the projects such as the Yamal LNG production facility, delaying its construction for over a year. It wasn't until the introduction of Chinese financial assistance that the project was able to continue construction despite such sanctions imposed on Russia. Since this period of worsening of relations between Russia and the U.S., talks between China and Russia have since increased in terms of agreements for cooperation with an emphasis on the Arctic and its resources (Zhang et al, 2016).

When viewing ship traffic that took place after these Russian Sanctions in 2014, the end of 2014 and beginning of 2015 saw a significant decrease of in vessel traffic of all types traveling through the passage. Whether container, bulk, liquid, LNG, or general cargo, all saw measurably reduced transit during this period. Total ship traffic during 2014 constituted merely a quarter of traffic than was seen in the year previously. When comparing the traffic of vessels carrying liquids, total traffic in 2014 was 20% of the previous year's total transit (Zhang et al, 2016). For this reason, while numerous factors have influenced the decisions of businesses in deciding whether to utilize the passage since its opening to international use, in this instance, application of trade tariffs and sanctions from the U.S. has had the most visible and detrimental

impact to the route's utilization in the modern day. It can be said that Russia's domestic and international policies are one of the most determining factors in the success or failure of the route in achieving greater utilization and significance (Lee, 2015).

Icebreaker usage and cost

Under current conditions, the cost of maintaining and supplying icebreakers to assist in the safe transport of vessels necessitates additional fees per tonnage. Other variables such as the time of the year the good is shipped and the type of hull the accompanying ship has are determining factors in deciding the cost associated with hiring these icebreakers of which range from $4.36-$23.82 per ton as of 2007 (Stokke, 2007). This wide range of cost although intended to encompass the variables is left to the discretion of Russian authorities who make the process of determining costs associated with traversing the route. The secretive and ill-defined and secretive nature of these costs and its formula are often seen to change according to several unforeseen political and reputational variables. Companies originating from countries such as Korea for example are more likely to see reduced cost that can be attributed to Korean initiatives regarding the utilization of the Northeast Passage in prioritizing it as being in the top 20 most important government tasks between 2013 and 2017 during the administration of Park Geun-Hye (Lee, 2015).

Along the Northeast Passage, icebreaker assistance and its associated cost are assisted in a system that divides the area between the Bering Strait and the Kara Strait. This area is divided along seven evenly spaced zones that assist in determining the total cost of icebreaker assistance dependent on which given areas icebreaker assistance was required. The average cost of icebreaker assistance per zone for a bulk carrier of 40,000 dwt is roughly $200,000. Under conditions that icebreaker assistance is necessitated, the average sailing speed of vessels are

close to three nautical miles when trailing icebreakers breaking through thicker sea ice. Although the costs associated with fuel are lowered when operating at a lower speed, any decrease in the speed of vessels that follow icebreakers has the effect of increasing costs associated with extended operations along the Northeast passage (Pierre, Olivier, 2015). In the event that icebreaker assistance isn't required for vessels travelling along the Northeast Passage, the time and cost of transit for vessels utilizing the Northeast Passage is reduced.

Among icebreaking vessels assisting vessels traveling through the Northeast Passage, all are required to be operated by Russian companies or entities. These additional fees for icebreaker assistance and permissions for transit are paid to the Northern Sea Route Authority (NSRA) to cover the cost of maintaining icebreaking vessels, supplying weather forecasts for vessels operating in the Northeast Passage, providing satellite communication, and any pilotage that such vessels might need. When comparing these fees to those incurred when traveling through the Suez Canal, it costs roughly twice as much to travel through the NEP as it does through the Suez Canal should it necessitate the assistance of these icebreakers. Without such assistance, the cost although reduced considerably than it would be otherwise, still stands higher than what is seen along the Suez Canal route (Verny & Grigentin, 2009). While these costs continue to hinder the competitiveness of the route, decreases in potential dangers associated with receding sea ice, an increase in the routes use, and other market factors over time are expected to be reduced and will further increase the routes competitiveness. However, certain negative market factors such as increased shipping insurance premiums for vessels traveling along the NEP are yet another cost on part of shipping companies wishing to reduce potential risk on their vessels operating in the Northeast Passage. When compared to insurance premiums in places along the Suez Canal where access to emergency services and supporting infrastructure are far closer and developed, the cost

of insurance is increased to account for the shortcomings and the increased risk associated with vessels traveling along the Arctic through the Northeast Passage. The cost associated with such increases in vessel insurance is dependent on a host of variables such as time of transit, age of vessel, ice class of vessel, and many others that in total serve to determine the potential for risk associated with the vessels transit of the Northeast Passage.

Arctic Technology Adoption

Before the Northeast Passage can be adopted as a legitimate and competitive trade route to service the markets of Asia and Europe, there needs to be greater degree of investment and utilization of technologies such as ice hardened and doubled hulls to provide greater safety for vessels using the route. In the event of some unforeseen environmental event in the Arctic such as hitting a body of ice, the use of this technology can mitigate damage and allow actions to be taken beforehand to alter their potentially devastating outcome. Double hulled vessel technologies that assist in mitigating damage and risk associated with travelling in Arctic waters is one such technology that has seen widespread implementation among newly created liquid bulk vessels. The widespread implementation of this technology can be to some degree be attributed to the oil pollution and control act created in 1990 as a response to the Exxon Valdez oil spill in Alaska. Because of the damage that was caused from the spillage, the act was meant to ensure that such an event wouldn't occur again. This act made the prospect of transporting liquid fuels in older vessels less appealing by ensuring that ship owners were liable for the cost of cleaning up their spills and thereby increasing incentive to modernize and improve the safety of their vessels. However, in the short term of the act's implementation, many companies seeking to distance their assets from potential liability suits instead chartered vessels from independent contractors. Overall however, there have been considerably fewer major spills since

the act's implementation. Given the success of this act in increasing safety requirements among liquid bulk vessel across the industry, similar success can potentially be had in the future with other related technologies (Morgan, 2011). Among these, ice-hardened hulls are recommended for increasing the vessel safety when traversing through sea ice that normally would impede ship traffic. Vessels with such technology aren't common in the industry at large and given the current minimal interest in shipping through Arctic waters, the use of this tech will only apply to a very select number of vessels who operate in these icy waters, most if not all of whom have to varying degrees adopted Arctic technology on their vessels (Ho, 2010).

Limited Seasonal Operation

Given that trends in the extent of Arctic ice has been decreasing at a rate that is consistently underestimated among scientific projections, it begs the question as to whether adopting this technology for use of the passage today is as cost effective versus waiting until such a time as ships without this technology can ply the waters safely without it. Currently, there is commonly a five-month period when the threat of sea ice impeding ship traffic is minimal and doesn't necessitate the assistance of icebreakers. Under these conditions, the threat of sea ice causing harm to vessels is greatly reduced and although the adoption of technologies such as double hulled and ice hardened ships would decrease risk considerably, it's not entirely necessary for operation during these limited months of relative safety (Zhang et al, 2016). Due to seasonal changes in the melting and freezing of ice along the Northeast Passage, the months that the route can be made available can vary slightly. For example, during 2013, the time frame when the passage could be used without requiring ice breaker escort occurred between late June and late November. This period represents a commonly accepted five month sailing time when vessels can utilize the Northeast Passage. By 2015, this sailing period had been altered slightly

and occurred between July and December, nearly a month ahead of the sailing period as was seen during 2013. Of the vessels that had been recorded sailing through these waters between 2012 and 2015, all were of ice class A4 or above. The classification of ice classes represents a ships ability of traversing through ice infested water to varying degrees that range between A5 to A0 with lower designations constituting B0, C0, and D0. Ships that are classified as 5A-1A can operate in difficult ice conditions, 1B in moderate ice conditions, while ships classified as 1C can only operate under easy or minimal ice conditions. Among these vessels, very few had requested icebreakers to accompany them and among those that did, all shared a high ice classification (Liu & Kronback, 2010). The overwhelming number of high-level ice class ships traversing the route during this period is evidence that the market of Arctic shipping can continue to operate despite the high cost of the implementation and adoption of such technology on vessels operating in the Arctic.

Shipping Time Reduction

The NEP has the potential to drastically reduce shipping time and therefore cost to some of the world's largest and most prominent markets of Asia, North America, and Europe. Because these three regions comprise roughly 80% of all exports and imports, any reduction in shipping time and distance between these markets would reduce shipping cost for a majority of the world's international maritime trade. The time advantage of using the Northeast Passage compared to the Suez Canal can be exceeding high in certain cases such, as is seen between Hamburg, Germany and Tokyo, Japan. When utilizing current trade routes along the Suez Canal, this route under normal conditions is thought to take roughly 11,400 nautical miles to travel. By comparison, in the event the Northeast Passage is utilized as a means of shipping between these two locations, the total distance is reduced to 6,600 nautical miles. This distance represents a

42%-time reduction than what is now used along the Suez Canal route. One reason for this drastic reduction in shipping distance through the utilization of the Arctic is that among all the largest population and industrial centers in Europe, North America, Russia, and Japan, none are farther than 3,800 NM directly from the North Pole. This proximity to the world's largest markets and their industrial centers is one of the primary motivators behind the passages current and potential future use (Østreng et al, 2013).

Among the markets of greatest importance such as Rotterdam and Shanghai, similar numbers can be had concerning shipping time reduction between these two major port facilities. Because oil and gas production facilities in both the Arctic and the northern coast of Russia lie in between these two large markets, the time frame to ship these resources to either ports are greatly reduced when compared to what would normally have been had if the route thought the Suez Canal had been utilized. However, because the Northeast Passage is open for vessel traffic for only 5 months of the year, these resources would need be transported via pipeline likely through Russia or go through the longer Suez Canal route until the Northeast Passage's limited sailing period returns. Under these current climates, the Passage would likely see a supplemental role for oil and gas transportation to ports such as Shanghai (Verny & Grigentin, 2009).

Siberian Coast

As much of the Northeast Passage traverses along the exceedingly sparsely populated Siberian Northern coast, a lack of population centers along the route creates several issues that aren't seen in other non-Arctic maritime routes such as the more conventional route through the Suez Canal. With such a long stretch of uninhabited territory, the prospect of trans-shipment to offload goods along locations between the ending destination becomes unlikely given there lacks any significant markets leading up to Northern Europe along this area. The distance along the

Siberian coast and its lack of population centers also creates a greater risk in the large distance between potential ports and areas for repair. This area along the Siberian coast constitutes nearly 2,500 nautical miles of sparsely if not entirely uninhabited stretch of coastal territory (Verny & Grigentin, 2009). Given the dangers of traversing along waters with sizable ice flows while following an icebreaker, the degree of danger present in such a scenario is far greater than one would see through the Suez Canal and as such, the greater distance between ports would be of greater difficulty and an increase in risk when travelling along the vast swathes of the Siberian coast (Liu & Kronback, 2010).

Seasonal Changes

The seasonally changing extent of ice and its associated risks and delays are one of the many different reasons why shipping companies and the industry at large have been slow to entertain the routes possible utilization. While the case can be made that time reductions in certain circumstances between ports can potentially greatly reduce travel time and its associated expenses, logistics systems in the maritime domain prize reliability and despise unpredictable circumstances that might disrupt their established transport networks. The limited and alternating time frame of when the passage can be open increases the degree of uncertainty regarding how the passage can become a part of logistic company's accurate schedules. Companies that operate in sectors pertaining to bulk shipping of resources stand to become the most likely candidate to use the passage given that costs related to untimely shipments are greatly lessened than what is seen in other sectors such as container shipping. The potentially negative circumstances associated with sea ice, although rare, can have exceedingly dire consequences for shipping and the Arctic environment of which is thought to be exceedingly susceptible to such events. The susceptibility of the Arctic environment when faced with oil spills is often attributed to Arctic

currents and the generally low bathymetry of the Arctic ocean. The large impact that such an oil spill could have on the Arctic environment are exacerbated by exceedingly high costs in cleaning up the spills in an area of severe isolation with limited traffic under potentially dangerous environmental conditions (Schøyen & Bråthen, 2011). While such circumstances that would inhibit the shipping of goods can be political in nature such as labor strikes, environmental disasters such as typhoons, storms, and the damage they cause on either ports or the ships who dock on them are the most destructive and common.

Shipping Projections

Current projections regarding the expansion of the shipping industry estimate that by 2050, the industry will have risen between 20% and 60%. Although the estimation defines a rather large margin of error regarding how much it will grow dependent on various market factors. Overall trends in the industry point towards continued expansion into the future. Due to the ubiquitous nature and international use of the Suez Canal as the primary means of maritime transportation, any events that could disrupt the flow of goods traveling through the route would necessitate looking for alternative routes. Straits such as these represent security risks due to their limited size being easily closed off with relatively minimal effort and forces. Historically, when maritime travel through the Suez Canal was inhibited, the route along the Cape of Good Hope was one of the only available alternatives. When comparing the distance when using the route along the Cape of Good Hope as would be the case should the Suez Canal close, the routes connecting Europe to Asia would see a drastic increase in time spent at sea. If the Suez Canal should again be closed due to some unforeseen event, the continually improving conditions of transportation along the Northeast Passage will likely play a factor in improving the routes usage

and adoption by shipping companies who otherwise would be unable to function as effectively without access to the Suez Canal (Aksensov et al, 2017).

Speed Reductions

Despite the case being made for same speed movement reducing the time needed for transport across both the NEP and through other conventional routes, the prospect of instead reducing overall speed to save fuel while maintaining the same if not better time of transportation through the Northeast Passage has a certain number of useful applications. Under controlled speeds such as this, the cost of fuel for the whole trip would be reduced while maintaining similar if not better transport times than would be had using Suez Canal route. Although the time of transport would be longer than had they used normal speeds, certain industries pertaining to the transportation of natural resources in bulk often have fewer time constraints and limits thereby making it one of the industries that would stand to benefit the most from this speed reduction (Zhang, Meng & Hui-Ng, 2016a).

Shipping types

When comparing which shipping types stand to benefit most from the passage's adoption, several types of commercial vessels are better suited to take advantage of its geographic location. The Northeast Passage's proximity to oil and gas facilities such as Yamal and other facilities on Russia's northern coast would promote the export of gas and oil from these facilities to markets in Asia and Europe. These tankers are most likely to be seen working between the largest of Asia's population centers such as Tokyo, Seoul, and Shanghai. Given these Areas are located on the Northeast along the coast, they have the most prominent reduction in shipping time when connecting markets in Europe such as Rotterdam and their production facilities in northern Russia. Many of these vessels would likely be liquid bulk carriers carrying

LNG from Russian extraction facilities near the Arctic into larger European and Asian ports such as Rotterdam or Shanghai. When compared to the industry at large using container ships of which are often under severe time constraints and limits, the route has lower appeal for this form of transportation. A combination of the nature of oil and gas sources being strategically situated in between the ports of Northern Europe and the markets of East Asia necessitate the use of the Northeast Passage for the transport of this cargo during its seasons of operation (Østreng et al, 2013).

Oil and Gas

Projections by the International Energy Agency (IEA) under 2017's World Energy Outlook have estimated that by 2040, world gas consumption will be 45% higher than it is currently with LNG expected to constitute 90% of future growth in the exportation of gas. This rise in both consumption and production of LNG will make it the 2nd largest source of energy for the world with the 1st being oil. Because much of growth in the consumption of gas is expected to be from countries in East Asia such as China, Japan, and South Korea, the opening of the Northeast passage allows greater access to energy resources located in northern Russia that can assist in satisfying the demand for LNG in the region. Geographically, these production facilities would greatly benefit from the Northeast Passage with shipping time reduced by 40% and will increase the use of the Passage as a means of transportation for energy resources under such positive conditions (Schach & Madlener, 2017).

In the world of energy markets, Certain events such as the oil price increase that occurred between 2010 and 2014 and the Fukushima nuclear disaster are but two events that have previously been the cause for nations in Asia seek alternative sources of energy for short term consumption either due to economic factors or social anxiety as was seen in the fallout of the

Fukushima nuclear disaster. Among potential alternative energy resources, LNG is often seen as an easy supplement to other primary energy sources due to its varied liquefaction facilities and easy market access. Among nations such as China, the importation of natural gas via liquid bulk carriers is used to supplement their LNG demand of which is currently primarily supplied via pipeline from Turkmenistan. When comparing Chinas neighbors however, both South Korea and Japan lack access to pipelines to service their energy needs and rely on liquid bulk carriers serve as their one of their primary means of importing vital energy resources. When analyzing the short-term effect Japan's nuclear disaster and the subsequent negative perception of nuclear power, the market value and share of LNG in the region was greatly increased until 2014. Although much of Japan's energy market has since been re-acquired by nuclear power plants, the legacy of the disaster and its subsequent shift to LNG consumption has enabled the LNG market to maintain nearly a quarter of Japan's energy market (Vivoda, 2012). With increases in production facilities abroad in places such as the U.S., Australia, Qatar, and Russia there is little shortage to potential sources of natural gas. However, given that the Northeast Passage is strategically positioned near large quantities of mostly untapped and largely unknown gas reserves in the Arctic primarily within Russia EEZ, there is great potential for these reserves becoming available for extraction given current changes in the extent of ice caused by increased Arctic temperatures (Schach & Madlener, 2017). The Northeast Passages ability to greatly reduce shipping time when compared to the far slower Suez Canal Route (SCR) when shipping to regions in Eastern Asia who collectively contain the majority of all future expected energy consumption, the Northeast Passage can potentially serve as a primary route for accessing and transporting such Arctic resources to these areas who retain the largest expected increase in LNG consumption.

Growing Asian Market

Due to the largest growing market being in Asia, LNG imports in this region have constituted over half of all LNG transported worldwide. Currently, these markets are serviced by Russia, U.S., and Qatar whose production of LNG has burgeoned along with Asia's growing need for it. States such as Russia who are better geographically situated to take advantage of using the NEP have greatly reduced time for transportation of these products than other nations who use the Suez Canal. The NEP can service these growing Asian markets in South Korea, Japan, China, among others in the region by satisfying their energy demands (Schach & Madlener, 2018).

China

Under "Chinas Arctic Policy", a white paper published in 2018 detailing Chinas intents and interests in the Arctic, China described itself as a "near Arctic state" with Arctic interests pertaining to Scientific research, Arctic governance, and commercial development. This publishing of the official government strategy regarding the Arctic is a marked change from previous Chinese statements of which denied having any strategic intention for the Arctic. The document outlines several basic principles under which Chinas active participation can occur. These principles such as mutual respect, cooperation, win-win result and sustainability are but a few key concepts that stressed throughout the document (SCIO, 2018). Concepts such as mutual respect relating to the sovereignty of states within their coastal zone mirrors Chinas current actions in the South China sea in attempting to assert an extended zone of control through claiming territories included within as being indivisible and indisputably a part of China. Wishing to ensure that sovereignty is respected within coastal zones, these actions support the legitimacy of states in exerting control within their own waters. Of these concepts, one of the

most often seen in Chinese foreign policy is the concept of “win-win” as is identified in Chinas view of their participation in the Arctic. Through the application of their resources in funding Arctic projects included under the Belt and Road initiative such as Yamal LNG project, China benefits from gaining access to energy resources while those they invest in are provided money both in the forms of loans and direct investment that can be put toward the construction and development of the Arctic (Foy, 2017)

As part of Xi Jinping’s Belt and Road program, the Northeast Passage has been included as part of the “Polar Silk Road” as specified under China’s Arctic Policy. The inclusion of the Northeast Passage as part of Chinas largest global initiatives highlights the routes significance for easy access to markets both as a source for exports and a means of ensuring an available route for acquiring energy resources. Given China’s need for reliable sources of energy and routes to transport it, Chinese investment into LNG production primarily along the Arctic in areas such as Yamal has been considerable. Investments from various public and private Chinese entities into the new Yamal LNG facilities under construction in the Arctic constituted nearly 10% of the estimated 27-billion-dollar Yamal LNG production facility being owned by Chinas Silk Road Fund with the remaining split between the privately-owned company Novatek and the French owned company Total (Krabbendam, 2016).

Among Chinas commercial interests in the Arctic, the primary industries of shipping and resource extraction were of greatest prominence as is shown in Chinese investment in LNG production facilities in Yamal. While emphasizing Chinas right as stipulated under UNCLOS regarding freedom of navigation, laying of submarine cables, overflight, and other such legal activities within the Arctic, China stresses that such policies of governance must be mutually respected by all parties involved (Klimenko, 2018). However, certain stipulations on part of

Russia regarding who has the right to transport and extract such resources may prove to be an issue for China who seeks to operate without such rules and policies that serve to ensure Russian companies are the primary beneficiaries of such activities. Under current rules, the transport of oil and gas as well as ice breaking vessels all are required to be Russian in ownership. These rules and regulations would in theory make China beholden to Russia regarding the transport of oil and gas in the Arctic, a prospect that is unlikely to see widespread adoption on part of China. Russian adherence to an uncommonly used interpretation of maritime law regarding the power to regulate ice-covered waters outside of their territorial sea is yet another legal dispute that imposes on the international adoption of the passage. Because the interpretations of, ice-covered seas can be applied to most of the Arctic of which is covered in ice to varying degrees and concentrations, these claims can have far ranging effects and implementations (Lee, 2014). Under the rights of coastal states to regulate such ice-covered waters for shipping to ensure its environmental protection, these rules would effectively allow Russia to control their surrounding coastal zones to a greater degree than is seen elsewhere around the world.

The largest Asian market, China, is expected to continue to expand at least until 2040. During this period, its expected that Chinese demand will drastically outpace its own domestic production an continue to increase energy imports from neighboring countries. While domestic production is expected to continue to expand at a rapid pace, Chinas domestic consumption is thought to increase to nearly 600 billion Cubic meters by 2040 under current forecast models. This outpacing necessitates importation of energy resources via pipeline or LNG tankers of which could feasibly be sourced from the Northeast Passage. However, the import of gas can be sourced from several different suppliers such as Qatar, the U.S., Australia, and Russia. However, current U.S. sanctions against China have had the effect of de-incentivizing creating production

facilities in the U.S. and Australia as part of a general reluctancy on part of Chinese investors to commit to the construction of costly production facilities abroad at a time when trade tariffs between China and the U.S. have reached new heights. Among the retaliatory tariffs imposed on the U.S. included a 10% tariff on LNG imports. Because of these tariffs on LNG importation, companies such as LNG limited saw its shares reduced by nearly a quarter of its previous value. The planned construction of facilities such as the Magnolia LNG plant in Louisiana is one such facility that has seen delays up a year until such a time that more investors can be found (Weber, 2018). Because most of the investors of LNG facilities are based in China China, its expected that unless the trade war between China and the U.S. is solved, the construction of such facilities in the U.S. will continue to stagnate without foreign financial backing.

Russian interest and response

To increase investor interest and incentives to further expand into potential areas of extraction in the Arctic, taxes associated with the extraction and sale of natural gas were greatly reduced for a period of 12 years in Russia beginning in 2015. These tax reductions effectively eliminated the most substantial initial taxes associated with LNG extraction and export while retaining a 15% tax on the company's total earnings from its sale. This tax relief in support of LNG extraction and export in the Russian Federation will likely prompt greater interest from investors under these generous considerations. Although much of the LNG extracted within Russia is transported via pipeline circumventing the use of the Northeast Passage, the extraction of any oil or gas within Russia Arctic EEZ makes the routes application necessary in these areas. (Khartukov & Eugene, 2018).

To further increase investor interest and competition, LNG export permits were given to the private company Novatek, a change in practice from Russia previous policy regarding

licensing of foreign companies. This marks a change in the Russian Federation's stance on whether to grant private entities licenses to export oil and gas resources and a shift in power from when the Russian Federations state owned oil company Gazprom had been given the sole rights for the sale and export of oil and gas. The introduction of privately traded companies such as Novatek threatens the monopoly on the industry that Gazprom had previously enjoyed for many decades. In concert with these changes in practice and policy regarding LNG production, extraction, and export, the previously dominant use of transportation of LNG via pipeline on part of Russia will see a marked change as these new Arctic facilities will necessitate their transport via liquid bulk carriers operating in the maritime domain along the Northeast Passage. Of these Arctic facilities, one of the largest and most ambitious projects known as the Yamal LNG project finished construction of the first of four planned LNG liquefaction facilities and begun exporting by 2017. The success of companies such as Novatek in constructing such a facility in the Arctic despite Russian sanctions contrasts starkly with Gazprom's previous statements regarding the project's unfeasibility of the project due to its location. The entry of Novatek allowed the project to begin and finish construction despite serious difficulties resulting from Russian Sanctions and a harsh climate. It's estimated that of the three facilities in Yamal still under construction, two will be done by the end of 2018 and the last will be done 2019. Given the current construction of these facilities on the Yamal project as well as interest in the creation of newer facilities on the Gydan peninsula by Novatek, the use of the Northeast Passage will be necessary for the transportation of this LNG to Europe and Asia of which are the two primary markets that these facilities are expected to service (Schach & Madlener, 2018).

As part of Vladimir Putin's vision for Russia's future ambitions, the Yamal project took center stage as the president publicly stated his intention for Russia to become the world's

leading LNG producer during the first call from the port of Sabetta in 2017 (Putin, 2017). While far from being among the largest LNG producing nations such as the U.S., Australia, or Qatar dwarf Russia's current production considerably, growing interest in and construction of facilities near the Arctic have the potential to greatly increase Russia's market share of the production of LNG. It's thought that the Yamal and Gydan peninsula's retain large enough gas deposits support comparable production capacity to the current leading producer LNG, Qatar. With construction of facilities in Yamal nearing completion and plans for construction of facilities on the Gydan peninsula underway, it can be expected that LNG production will continue to expand as these projects achieve their completion and continue to expand to service the increasing future market demand (Paraskova, 2017).

LNG Market trends

Given the trend towards a growing market for LNG, decrease of negative conditions brought upon by the extent of ice in the Arctic, and increase in the use of the North East Passage, currently undiscovered LNG deposits primarily within the Barents Sea in Russia's EEZ along the Northeast Passage have the potential to meet this new expected energy demand. With current gas prices sitting at roughly $8.1 per MMBtu in regions such as Asia, there is a cost incentive to invest in new facilities in the Arctic despite their large estimated cost of construction (Gloystein, 2018). Difficulties to be had concerning U.S. sanctions on part of Russia further decreased investor confidence and willingness to take part in in LNG projects such as was seen for the Yamal project. However, because gas prices are estimated to continue to rise from the current threshold, the construction of such facilities in the Arctic are underway despite these negative factors. While the cost of extraction and transportation of gas from the Arctic is expected to be more expensive than in it is in other oil and gas producing nations such as Qatar of which

maintains some of the most cost effective extraction facilities, the Arctic's unique geographic location allow it to reduce shipping time to greatly to nations in Eastern Asia of that currently primarily relies on the longer Suez Canal route to supply its energy needs. The shorter distance, government support by means of reduced taxes, and a growing market in Asia are all factors that are continuing to enhance the competitiveness of the route for the extraction and export of gas to neighboring regions (Schach & Madlener, 2018).

Competing energy suppliers

Energy producing countries such as Qatar whose estimated production cost for LNG is thought to be less than $2 per MMBTU question the economic competitiveness of Arctic gas exploration and exploitation given their own considerably low and exceedingly cost-effective operating costs (Schach & Madlener, 2018). In comparison, recent estimates at an investment summit regarding the cost of gas from the Yamal facilities owned by Novatek in the Arctic are thought to be roughly $3 per MMBtu of gas when considering its extraction, liquefaction, and shipping (Krabbendam, 2016). Although Qatar retains an exceedingly competitive cost for natural gas, certain events such as Saudi Arabia's blockade of Qatar and threats by Iran to close the strait of Hormuz have shown that despite being one of the largest and most cost competitive LNG producing nations, the market will avoid complete reliance on any single region or nation and instead favor market diversification to supply energy resources. This diversification of markets and sources of energy allow the market to change according to political and environmental events that otherwise would create gaps that would be difficult to fill under these circumstances. Should the threat of Iranian closure of the strait of Hormuz come to fruition for example, the Persian Gulf would be made incapable of engaging in maritime activities including their all-encompassing oil and gas export (Schach & Madlener, 2017).

Currently, to further Qatar's goals of solidifying its hold on the LNG market limits on the production and extraction of LNG have been almost entirely removed by 2017. While before, such exportation and extraction had been maintained at an even and stable volume of 77 metric tons per annum (MTPA), these changes in rules and policies regarding LNG are a part of Qatar's long-term strategy in maintaining its hold on the LNG market. These changes in domestic policy will allow the continued expansion of LNG production facilities and will likely further increase their considerable market share of LNG production (Schach & Madlener, 2018). Despite this expected increase in market share on part of Qatar, Russian LNG facilities in the Arctic can provide further diversification of energy resources under competitive costs to Asia of whom currently almost entirely relies on the Suez Canal route to provide their energy needs. Because the area surrounding Qatar provides a host of security problems such as a potential Iranian closure of the strait of Hormuz, political turmoil spillover from the middle east, and the recent Saudi led attempts to blockade Qatar are but a few sever events that have questioned whether Qatar can manage to maintain control of a market under such questionable conditions. Should such situations continue to occur, alternative sources for LNG and other energy resources could continue to accrue part of Qatar's share of the LNG and energy resource market.

Such events create an incentive for LNG importers to develop alternative routes and sources in an increasingly interconnected and shifting global economy. Suppliers from countries within East Asia for example have several reasons to identify the Northeast Passage as an attractive supplement to their own energy supply networks. Unlike the route through the linking Qatar and East Asia of which passes through a host of different straits and territories such as the strait of Hormuz or the strait of Malacca, the Northeast Passage for the most part is almost entirely within Russia's EEZ and area of jurisdiction. This has the effect of reducing uncertainty

of navigating in areas of alternating political jurisdiction with questionable regional security as is seen along the Persian Gulf along the Strait of Hormuz. In the past, Iranian threats of closing the strait were met with stiff resistance internationally and never came to fruition. As recently as this year however, the U.S. administrations has engaged in a combative stance on Iran in demanding an end to all Iranian oil imports internationally by November 4th. As a response, Iranian president Hassan Rouhani publicly said that Iran could disrupt oil shipments travelling through the strait of Hormuz. These statements were corroborated by Iran's revolutionary guard in asserting their capability and willingness in doing so. The closure of such a route would

Conclusion

The primary threats that have the greatest potential in offsetting confidence and decrease the passage's use for future endeavors lies in changes to future Russian policy and the state of future energy markets and their supplies. The current Russian domestic policy of identifying key areas as territorial waters rather than as international straits brings into question Russia's adherence to UNCLOS and its rules regarding such classification. Under these rules, Russia would gain a greater degree of control over which entities would be allowed to traverse through its waters. The opening up of the Northeast Passage to greater amounts of traffic would necessitate a broadly accepted rules of conduct regarding the passage and regulations concerning its use.

Domestic policies such as the addition of fees for the transit and utilization of services along the passage continue to reduce the competitiveness of the route when other cheaper alternatives are more freely available along the Suez Canal route. Russian foreign policy can indirectly impact the routes usage dependent on other international parties. Sanctions such as were seen following the Russian annexation of the Crimea and its involvement in Ukraine

assisted in greatly reducing vessel traffic of all types. Given Russia continues to play a role in the conflict in Ukraine, the prospect of renewed international pressure in the form of sanctions or other measures could inflict a reduction in vessel traffic. Other events such as Russia's tampering in U.S. elections had a similar effect in causing an expansion upon previously established sanctions under the Obama administration. The subsequent trump administration has since further expanded upon sanctions on the Russian federation and continued to isolate Russian businesses. These sanctions negatively affect the routes possible utilization by entities who wish to avoid associating with businesses who have been targets of these sanctions.

Under current conditions, the Northeast Passage can serve to supplement the Suez Canal during its open periods for shipping goods between Northern Europe, Northern Russia, and East Asia. Current climates enable the shipment of goods during roughly 5 months within a small margin of error without fear of potential ice blockage. Although limited in time scale that the route can be used without icebreakers, these routes time of availability can be relied upon during this period with only slight deviations between seasons that can be measured to accommodate ship transport. Given current trends relating to the melting of ice and opening areas of potential need will manifest itself and continue to rise in terms of production depending on the cost of gas and availability of other alternative energy sources. Because the cost of oil and gas are expected to increase, continued development along the route by way LNG energy extraction facilities, and increasingly less severe environmental conditions will continue to increase its economic significance and competitiveness for the extraction of gas and shipping between the regions of Europe, Asia, and Northern Russia. Under these circumstances, although the route will likely see an increase in use primarily in areas related to LNG shipping and extraction, the cost benefit of

using the passage when compared to alternative routes provided along areas through the Suez Canal has yet to supersede fears concerning environmental dangers and lack of market access.

References

Aksenov, Y., Popova, E. E., Yool, A., Nurser, A. J. G., Williams, T. D., Bertino, L., & Bergh, J. (2017). On the future navigability of Arctic sea routes: High-resolution projections of the Arctic Ocean and sea ice. *Marine Policy, 75*, 300–317. https://doi.org/10.1016/j.marpol.2015.12.027

Anderson, S., Baiborodova, K., Bailey-McCarthy, K., Ballestero, H., Balo E. (2009). Arctic Marine Shipping Assessment 2009 Report. *Protection of the Arctic Martine Environment.* https://www.pmel.noaa.gov/arctic-zone/detect/documents/AMSA_2009_Report_2nd_print.pdf

Buixadé Farré, A., Stephenson, S. R., Chen, L., Czub, M., Dai, Y., Demchev, D., Wighting, J. (2014). Commercial Arctic shipping through the Northeast Passage: routes, resources, governance, technology, and infrastructure. *Polar Geography*, *37*(4), 298–324. https://doi.org/10.1080/1088937X.2014.965769

Foy, H. (2017, October 20). Russia's Yamal gas project navigates ice and sanctions https://www.ft.com/content/8412ba8c-6ace-11e7-b9c7-15af748b60d0

Gady, Franz. (2018, September 11) China Launches First Domestically Built Polar Icebreaker. The Diplomat. https://thediplomat.com/2018/09/china-launches-first-domestically-built-polar-icebreaker/

Gloystein, Henning (2018, May 3) Global LNG-Prices firm as fundamentals tighten amid support from oil, coal. *Reuters.* p. 1. https://www.reuters.com/article/global-lng/global-lng-prices-firm-as-fundamentals-tighten-amid-support-from-oil-coal-idUSL8N1SB08Z

Ho, J. (2010). The implications of Arctic sea ice decline on shipping. *Marine Policy*, *34*(3), 713–715. https://doi.org/10.1016/j.marpol.2009.10.009

Khartukov, Eugene M. (2018). Demystifying Russia's oil and gas taxes. *Oil and Gas Journal*, *116*(4). https://www.ogj.com/articles/print/volume-116/issue-6/general-interest/demystifying-russia-s-oil-and-gas-taxes.html

Klimenko, Ekatarina (2018, February 7) Shipping along the Arctic's Northern Sea Route will be determined by Russia–China cooperation in the region | SIPRI. https://www.sipri.org/commentary/expert-comment/2018/shipping-along-arctics-northern-sea-route-will-be-determined-russia-china-cooperation-region

Krabbendam, Richard (2016, September 20). Yamal LNG unaffected by low oil prices. *LNG world news.* p. 1. https://www.lngworldnews.com/report-yamal-lng-unaffected-by-low-oil-prices/

Lasserre, F., Beveridge, L., Fournier, M., Têtu, P.-L., & Huang, L. (2016). Polar seaways? Maritime transport in the Arctic: An analysis of shipowners' intentions II. *Journal of Transport Geography*, *57*, 105–114. https://doi.org/10.1016/j.jtrangeo.2016.10.004

Lee, T., & Kim, H. J. (2015). Barriers of voyaging on the Northern Sea Route: A perspective from shipping Companies. *Marine Policy*, *62*, 264–270. https://doi.org/10.1016/j.marpol.2015.09.006

Lei, R., Xie, H., Wang, J., Leppäranta, M., Jónsdóttir, I., & Zhang, Z. (2015). Changes in sea ice conditions along the Arctic Northeast Passage from 1979 to 2012. *Cold Regions Science and Technology*, 119, 132–144. https://doi.org/10.1016/j.coldregions.2015.08.004

Liu, M., & Kronbak, J. (2010). The potential economic viability of using the Northern Sea Route (NSR) as an alternative route between Asia and Europe. *Journal of Transport Geography*, 18(3), 434–444. https://doi.org/10.1016/j.jtrangeo.2009.08.004

Morgan, J. D. (2011). The Oil Pollution Act of 1990. *Fordham Environmental Law Review*, 29. https://ir.lawnet.fordham.edu/cgi/viewcontent.cgi?referer=https://en.wikipedia.org/&httpsredir=1&article=1376&context=elr

Østreng, W., Eger, K. M., Fløistad, B., Jørgensen-Dahl, A., Lothe, L., Mejlaender-Larsen, M., & Wergeland, T. (2013). *Shipping in Arctic Waters: A comparison of the Northeast, Northwest and Trans Polar Passages*. Chichester, UK: Praxis

Paraskova, Tsvetana (2017, April 2) Putin Says Russia Will Become World's Top LNG Producer. *Oilprice,* p. 1. https://oilprice.com/Energy/Natural-Gas/Putin-Says-Russia-Will-Become-Worlds-Top-LNG-Producer.html

Pierre, C., & Olivier, F. (2015). Relevance of the Northern Sea Route (NSR) for bulk shipping. *Transportation Research Part A: Policy and Practice*, *78*, 337–346. https://doi.org/10.1016/j.tra.2015.05.020

Putin, Vladimir (2017, March 30). Video conference on the occasion of the first call of a gas tanker at the port of Sabetta. *Kremlin.ru.* p. 1. http://kremlin.ru/events/president/news/54148

Schach, M., & Madlener, R. (2018). Impacts of an ice-free Northeast Passage on LNG markets and geopolitics. *Energy Policy*, 122, 438–448. https://doi.org/10.1016/j.enpol.2018.07.009

Schach, M., & Madlener, R. (2017). Impacts of an Ice-Free Northeast Passage on LNG Trading: Transport Routes and Optimal Capacity Planning. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3129990

Schøyen, H., & Bråthen, S. (2011). The Northern Sea Route versus the Suez Canal: cases from bulk shipping. *Journal of Transport Geography*, 19(4), 977–983. https://doi.org/10.1016/j.jtrangeo.2011.03.003

SCIO. (Jan 26, 2018) China's Arctic Policy, *Information Office of the State Council of the People's Republic of China (SCIO)*, http://english.gov.cn/archive/white_paper/2018/01/26/content_281476026660336.htm; and Marc Lanteigne and Mingming Shi, "China Stakes Its Claim to the Arctic," *Diplomat*, January 29, 2018, https://thediplomat.com/2018/01/china-stakes-its-claim-to-the-arctic.

Stokke, O. S. (2007). A legal regime for the Arctic? *Marine Policy*, 31(4), 402–408. https://doi.org/10.1016/j.marpol.2006.10.002

Verny, J., & Grigentin, C. (2009). Container shipping on the Northern Sea Route. *International Journal of Production Economics*, 122(1), 107–117. https://doi.org/10.1016/j.ijpe.2009.03.018

Vivoda, V. (2012). Japan's energy security predicament post-Fukushima. *Energy Policy, 46*, 135–143. https://doi.org/10.1016/j.enpol.2012.03.044

Weber, Harry. (2018, October 28) Magnolia LNG final investment decision delayed until 2019 amid China tariffs | S&P Global Platts. https://www.spglobal.com/platts/en/market-insights/latest-news/natural-gas/102918-magnolia-lng-final-investment-decision-delayed-until-2019-amid-china-tariffs

Zhang, Y., Meng, Q., & Zhang, L. (2016). Is the Northern Sea Route attractive to shipping companies? Some insights from recent ship traffic data. *Marine Policy, 73,* 53–60. https://doi.org/10.1016/j.marpol.2016.07.030

Zhang, Y., Meng, Q., & Ng, S. H. (2016a). Shipping efficiency comparison between Northern Sea Route and the conventional Asia-Europe shipping route via Suez Canal. *Journal of Transport Geography*, 57, 241–249. https://doi.org/10.1016/j.jtrangeo.2016.09.008