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Arctic shipping routes as alternative to the Suez Canal

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Abstract

The grounding of a 400-meter long container vessel, called Ever Given, in the Suez Canal blocked the busiest shipping lane, which is responsible for 12% of seaborne trade, for 6 days. Some shipping companies had to divert their vessels and they had to take a much longer route around Africa to reach European ports. The concerned shipping industry started to look for alternative sea route to the Suez Canal with lesser risk of blockage, without a need to go around Africa. Such routes, which connect the Pacific and Atlantic Oceans, exist in the Arctic and the warming of the global climate makes them more accessible over time but the assessment of their viability requires a multifaceted analysis based on available professional navigational publications, scientific papers, and knowledge of polar shipping realities. Several nautical aspects are taken into account with the purpose of choosing a polar route that is most suitable as an alternative to the Suez Canal. Three routes are under consideration. One of them is the Northern Sea Route in the eastern part of the Arctic Ocean, along the coast of the Russian Federation. The second route is the Northwest Passage through the western part of the Arctic, passing waters belonging to Greenland, Canada, and the United States. The third one passes near the North Pole, a prospective route that may become available for commercial shipping in the future due to Arctic ice shrinkage, and it is known as the Transpolar Route. Analysis of these routes unambiguously point to the Northern Sea Route as the only viable option. Most prospective alternatives to the Suez Canal are technically feasible with the new generation of cargo vessels and they are experiencing a growth in maritime traffic together with a steady development of associated infrastructure. The existing simplified analyses of the transit costs, assuming strait passage in polar waters without any course deviation and the additional fuel that is burnt to overcome increased friction during passage in ice, shows that under present conditions that the Suez Canal Route is still cheaper than any polar transit and, moreover, offers year-round availability. It cannot be ruled out that the upcoming warming of the Arctic climate, and a lowering of the transit tariffs by the Russian Federation may tip the balance in favor of the Northern Sea Route. Presented here is an analysis of the competitiveness of the Arctic Routes in comparison to the Suez Canal from the perspective of the mariner.

Introduction

On the 23rd of March 2021, a shockwave hit the shipping community as the ULCV class (ultra large container vessel) *Ever Given*, a 400-meter long vessel, ran aground in the Suez Canal. Figure 1 shows the vessel bow and the stern firmly aground at both sides of the Suez Canal.

After a few unsuccessful attempts, she was eventually refloated six days later and towed to the Great Bitter Lake for hull inspection. The blockage caused enormous financial losses. This canal is responsible for 12% of global trade (Hard) and the journal Lloyd's List estimated the value of the delayed traffic as $9.6 billion daily (LaRocco, 2021). Egyptian authorities claimed almost $1 billion in

Figure 1. *Ever Given* grounded in the Suez Canal, includes attempts to refloat the vessel (Werr & Saul, 2021)

compensation for the stalled traffic, salvage operations, and loss of transit fees revenues. Ripples of the canal blockage reached even the U.S. Navy as some shipping companies, which decided to detour their vessels around Africa, inquired about maritime security to the U.S. Navy 5th Fleet. Waters along the North-East coast of Africa region are well known for piracy and the accumulation of valuable cargo in this area could have made passage even riskier (Hart, 2021). To prevent such incident in future, Egypt is ordering new tugboats, dredgers, and offloaders as measures to increase its ability to salvage large vessels. The Egyptian President made some vague statement about planned studies regarding the building of a second waterway, parallel to southern part of the canal (Werr & Saul, 2021). Such a solution would prevent the complete blockage of the waterway, but costs would be astronomical.

The concerned shipping industry started to look at alternative sea routes with a smaller risk of interruption. Existing and prospective alternative maritime routes are in the Arctic, but it is not clear if they can compete with the Suez Canal at the present time. An assessment of their viability as replacement for the Suez Route requires a multifaceted comparative analysis based on professional navigational publications and available scientific papers, alongside instructor's experience of seafaring on ships operating in polar waters. The following analysis comprises three main threads: navigational conditions, technical requirements, and cost analysis. Each of these factors may decide the competitiveness of a particular route with respect to the Suez Canal. For the purpose of this analysis, three Arctic routes are considered. Two of them, the Northern Sea Route (NSR) and the Northwest Passage, are already in use but with some limitations for commercial shipping due to their harsh environments. Their infrastructure still needs further development and the vessels plying in the Arctic have to comply with heightened technical requirements. A third route, known as the Transpolar, will be available for maritime transport in future due to the warming of the Arctic climate and the multi-year recessing of the ice. The adverse navigational conditions eliminate the Transpolar Route and the Northwest Passage from further analysis. Cost analysis for the NSR and the Suez Canal is based on available scientific papers, despite their shortcomings like the omission of any deviation from the direct course and the extra fuel burnt when navigating through ice. In spite of this, the transit cost analyses clearly show that the Suez Canal is still the cheaper alternative for commercial shipping compared to the Northern Sea Route, at least for the time being.

Arctic Sea routes

The warming of the global climate has reduced the extent and the thickness of the Arctic ice. Figure 2 shows the changes in the extent of the Arctic Sea ice over a period of 30 years. The data was compiled from satellite observations by the NASA Earth Observatory (NASA, 2021). Graphics show the extent of ice for the months of March (the winter season and the peak of ice coverage) and September (the summertime, the end of the ice thaw and the minimum of ice coverage). Yellow line represents the median for the extent of ice for years 1981–2010. The ice coverage for March has not changed significantly for the last 30 years but the ice composition consists of less multi-year ice, which opens opportunity for commercial shipping. Due to the desalination process, old ice is much stronger than first-year ice and, thus, only purpose-built icebreakers are capable of operating in multi-year areas, but only within the limits set by their design. Most of the cargo vessels are expected to sail only through first-year ice, which may include old ice inclusions. The ice extent in the summertime shows considerable shrinkage and a lower ice concentration within lanes of open water, mainly along the eastern coast of the Arctic Ocean. The western part of the ocean also shows a reduction of ice due to the warming of the climate, but it is often clogged with ice during the summer with a possibility of some multi-year ice remaining in the channels between islands.

The Arctic Sea routes are known under their names, and acronyms, as the Northern Sea Route (NSR), the North-West Passage (NWP), the Transpolar Sea Route (TSR), and the Arctic Bridge Route

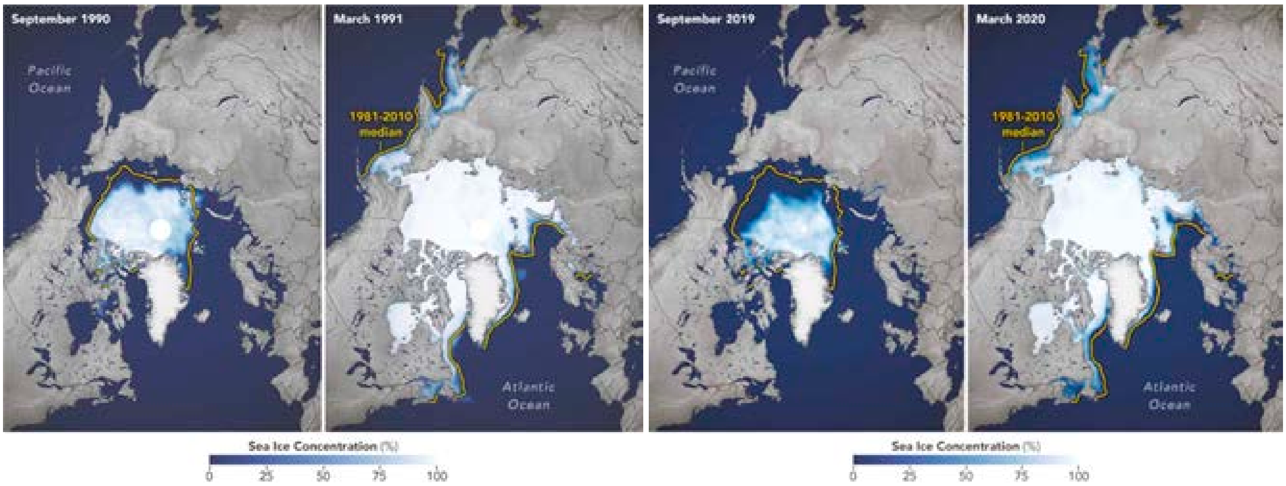

Figure 2. Arctic Sea ice coverage for the summer 1990–winter 1991 and summer 2019–winter 2020 (NASA, 2021)

(ABR) (Humpert & Raspotnik, 2012, p. 282). The map on Figure 3 shows the trajectory of each of these routes.

Figure 3. Paths of the Arctic shipping routes (Humpert & Raspotnik, 2012)

For the time being, the Transpolar Sea Route is not accessible for international cargo trade due to the presence of multi-year ice. Activity in this area is limited to scientific expeditions and tourist cruises on board powerful icebreakers. Simulations for sea ice decline in the 21st century are predicting the possibility of opening this route in mid-century for vessels with an ice class typical for the NSR and the NWP (Melia, Haines & Hawkins, 2016). Such vessels are designed to operate in at least medium first-year ice with some inclusions of old ice. Within a few decades, the TRS will become the shortest route from Far East ports to Europe, which is accessible for cargo vessels with Polar class when the ice cover abates. At present, this lane does not have any practical value for maritime transport between Europe and Asia.

The Arctic Bridge Route serves mainly as a seasonal link between the Russian Federation port of Murmansk and the Canadian Hudson Bay port of Churchill, Northern Canada's only deep-water port. Waters along Greenland, the Davis Strait, and the eastern part of Hudson Bay are Polar Waters as defined by the International Maritime Organization (IMO) in Polar Code (IMO, 2014). By choosing a route closer to Iceland, vessels may sail outside the mentioned waters for a greater part of their voyage.

The two remaining routes are of much greater importance for Arctic industrial activity and could act as international shipping lanes. The map on Figure 4 shows the areas of commercial activity in the Arctic, which includes the mining of minerals and oil and gas production. Local communities need to be supplied with basic goods, while minerals and

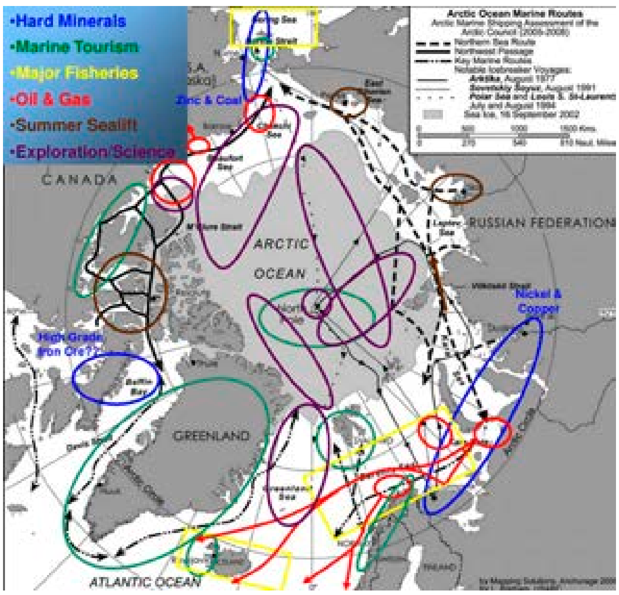

Figure 4. Industrial activity in the Arctic (Brigham, 2008)

fossil fuels are being exported abroad via these Arctic marine transport routes.

Both routes offer significantly shorter ways from the Far East to the largest European port of Rotterdam, if compared with passage through the Suez Canal. Namely, the NSR is 485 nautical miles shorter than the NWP. Table 1 provides the distances to Rotterdam, and the distances gained, from a few major Far East ports.

Table 1. Sailing distances between Far East ports and Rotterdam (in nautical miles) (based on NGA, 2017; Buxaide et al., 2014)

From	Suez Canal	NSR	NSR distance gain (%)	NWP	NWP distance gain (%)
Yokohama	11,333	7010	38	7495	34
Busan	10,744	7667	29	8152	24
Shanghai	10,557	8046	24	8531	19
Hong Kong	9701	8594	11	9079	6

Northwest Passage

A route called the Northwest Passage links the Atlantic Ocean with the Pacific Ocean passing (from East to West) through the Davis Strait, the Baffin Strait, the maze of numerous straits in the Canadian Arctic Archipelago, the Beaufort Sea, the Chukchi Sea, and the Bering Strait. The most critical parts of the route leads through Canadian internal waters, but the United States are contesting Canadian rights and they consider these passages to be an International Strait. The EU Commission supports US stance on this matter. Legal disputes still remain unresolved and both countries maintain the status quo of agreeing to disagree (Meritt, 2021). The further development of the Arctic will require a formal agreement, not only between Canada and the USA but also with the remaining Arctic states. Figure 5 shows the main routes of the NWP.

The Canadian Arctic Archipelago is divided into northern and southern parts by the Perry Channel. It starts (passing from East to West) with the Lancaster Sound, the Barrow Strait, the Viscount Melville Strait, and the McClure Strait. It is a deep-water route but in the summer season the McClure Strait may be jammed with multi-year ice, which is very challenging even for icebreakers. Melting first-year ice gives way to old ice drifting south from the Central Arctic Ocean and enters the narrow straits. The same problems may affect the other Canadian Arctic Archipelago straits. Vessels may by-pass the McClure Strait by using the Prince of Wales Strait, which opens into the Amundsen Gulf and the Beaufort Sea. This route has an average depth of 32 meters, which is sufficient for cargo vessels that are currently in use. Local communities are using the route through the Pell Sound, which passes along the continental shore and provides access to local harbors. This route is accessible only for vessels with a draft less than 10 meters, but the local ports are shallow and sometimes barges must be used to move cargo from vessel to shore. Navigational season typically starts in mid-June and closes at the end of October, when the Canadian Coastguard icebreakers are leaving the NWP. The start of the season is sometimes delayed

Figure 5. Routes of the Northwest Passage (Arctic Portal, 2021)

(even by 4 weeks) if temperatures are lower than usual. Even for ice-free conditions, the passage is infested with icebergs, bergy bits, and growlers that are also present at the peak of the summer season. Ice free conditions are encouraging masters to proceed with full speed, but the risk of collision with ice is very high and icebreaker assistance may still be required. The variability of the ice thickness and their changing locations from year to year, alongside the presence of multi-year ice, may delay development of the NWP as an international shipping lane (Østreng, 2010; Eger, 2010) for regular shipping. Certainly, this route cannot compete with the Suez Canal as an alternative shipping lane. Navigation in the Northwest Passage is difficult due to the prevailing ice conditions and the route is still in the early stage of its development in regard to its infrastructure. Since 1984, the steady growth of cruise tourism in the Canadian Arctic is attributed to the warming climate that has been observed. Passenger vessels are a common view in the Canadian fiords, where first year ice is thawing leaving open waters that are safe for navigation. But further changes in the climate may alter the character and the distribution of the ice, which is dangerous for navigation since multi-year ice is replaced by first-year ice. Increased risk to navigation may have a serious impact on the steadily developing cruise tourism industry in this area (Stewart et al., 2007). The NWP mainly serves the needs of the local population with very few transits between European ports and the Far East. A lack of infrastructure and the difficult navigational conditions make this lane much less competitive compared to the Suez Canal Route and also the NSR.

Northern Sea Route

The Northern Sea Route is defined as a maritime lane that passes through several Arctic seas (from East to West): Kara, Laptev, East Siberian, and Chukczi with entrance from the East via the Karskye Vorota Strait or North of the Novaya Ziemlya Island and the Bering Strait from the West. The eastern extension of the NSR, which is outside the limits set by the Russian administration is often called The Northeast Passage. Figure 6 shows a set of typical paths for the NSR, which includes the deep-water route.

The depth of the open waters vary from 20 m to 200 m, but the straits could impose restrictions for ocean-going vessels. Charted depths in the straits are as follows (ABS, 2014):

- Kara Strait (in the fairway part) – 50 m,
- Matisena and Lenina – not less than 20 to 25 m,

Figure 6. Paths of the Northern Sea Route (Arctic Portal, 2021)

- Vilkitskogo – 50 to 250 m,
- Shokalskogo – 200 to 250 m,
- Yugorskiy Shar – 13 m,
- Sannikova – 13 to 15 m,
- Dmitriya Lapteva – 8 to 9 m,
- Bering – 30 to 50 m.

Due to the limited depths in some parts of the NSR, the administration of this route imposes several draught restrictions for vessels (OCIMF, 2017):

- Dmitryi Laptev Strait – 7.7 m,
- General transit – 10 m,
- Sannikov Strait (with a speed reduction to minimize squat) – 12 m,
- North of the New Siberian islands – 12+, a deeper draught vessel may be accepted by the NSR Administration on individual basis.

Vessels may have to use routes that require permission from the NSR Administration, for which an application must be submitted. This administration may reject permission on the grounds that the vessel does not comply with Russian rules relating to construction, equipment, and the required supplies on board. Currently the route is divided into 27 zones, which replaced the 7 earlier ones in 2020. These zones are designed for specific ice conditions and are used to determine what kind of vessels are allowed to sail in any given condition. The total amount of icebreakers service fees depend on the number of zones in which icebreaker assistance is needed. The new system for the NSR zones allows the use of vessels with a lower ice class in more areas, which reflects the changes in the Arctic climate. Despite an introduction of the new zones, the official tariffs from 2014 still refer to the 7 old zones but the existing system will soon be updated with the purpose of making the Northern Sea Route

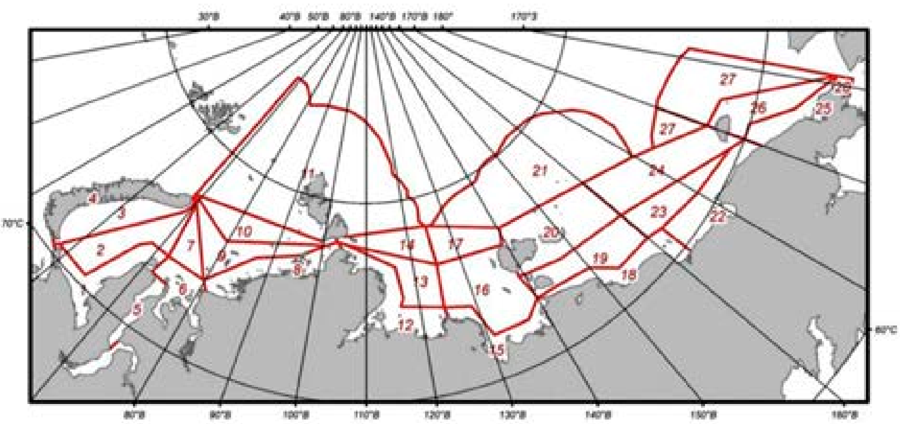

Figure 7. New navigational zones in the Russian Arctic (Arctic Today, 2021)

cheaper than the Suez Canal Route (Russia Today, 2021). Figure 7 shows the newly introduced zones, in which the markings represent the range of Northern Sea Routes.

The navigational season in the NRS is currently split into 5 months summer-autumn (typically July–November) and winter-spring (December–June) (Gunnarsson, 2021), known as extended seasons. The transit passages are carried out mostly during the summer and the autumn. Northern Sea Route navigation rules are published on the NSR Administration website in the Russian language with an unofficial English translation (NSRA, 2021). Ship operators or shipowners may apply for a passage permit four months in advance but no later than 15 days before the planned passage, by providing all the necessary documents. A faster track system is available for an extra fee. The NSR Administration is responsible for the planning of the voyage, icebreaker assistance, and the organization of Search and Rescue operations (SAR). Vessel sailing with icebreaker assistance is required to follow orders from the master of the icebreaker, who is in command and responsible for choosing the optimal path through the ice. Despite the requirement of certification in ice navigation for both the master and officers, it is still recommended that they carry on board a Russian ice pilot and sometimes even an ice helmsman. They are paid on a daily basis and stay onboard only within the NSR limits. Communication is generally in English, but local charts and some vital information are only available in Russian. It is also an advantage to have a Russian pilot on board, when closely cooperating with the icebreaker. A Global Positioning System (GPS) works satisfactory, but it is recommended to also have a navigational receiver for the Russian satellite positioning system GLONASS, which provides accurate position along the route. Some areas may not be covered with the electronic vector charts of the Electronic Chart Display and the Information System (ECDIS); Russian paper charts are then needed for navigation. The latter are mostly up-to-date and accurate, but all their information uses the Russian alphabet. Recent development of the NRS has brought improvements in Electronic Charts coverage, as shown in Figure 8.

The reception of information on navigation safety is essential and most of the world has access to

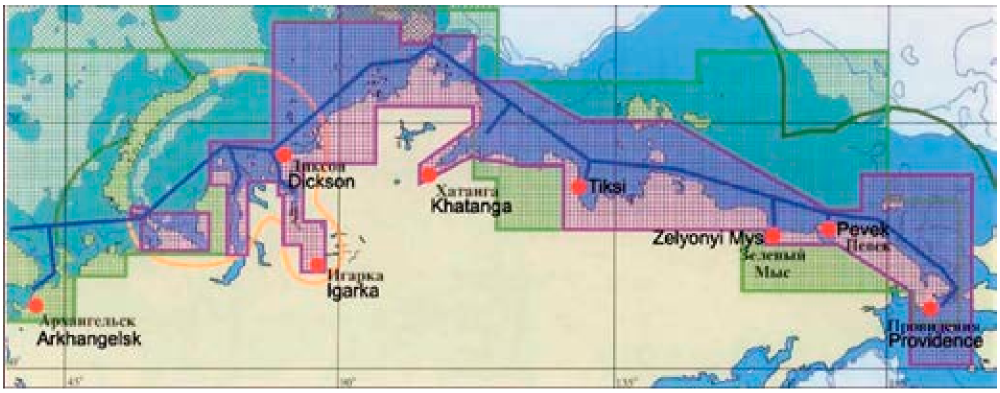

Figure 8. Source of the NRS Electronic Chart coverage (ABS, 2014)

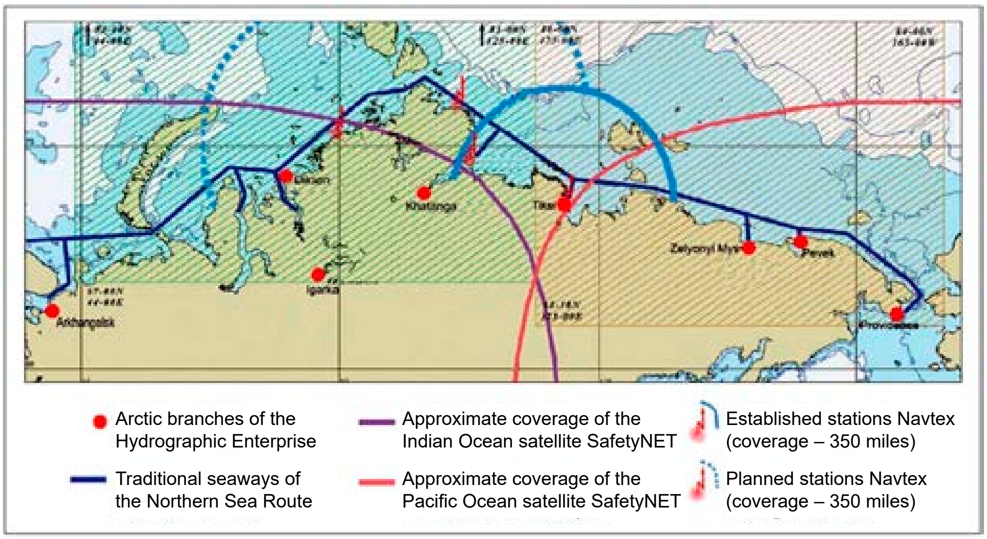

Figure 9. Navigation information system for NSR safety (ABS, 2014)

it via a radio communication system called NAVTEX and the satellite communication systems, SafetyNET and SafetyNET II, that are used for the automated reception of Maritime Safety Information and Search and Rescue related information. Due to the high latitudes, the satellite communication system called INMARSAT (International Maritime Satellite), which is based upon geostationary satellites, has a limited range and some NSR areas are not covered with SafetyNET. To alleviate this problem, satellite coverage gaps are filled with long range NAVTEX stations (with additional stations to be build), which extend the safety information available to the deep-water route. Figure 9 depicts the availability of the safety information along the NSR.

The Northern Sea Route is the most developed among all the Arctic transit routes, but this process has not been completely finished yet. It is a route that offers the assistance of nuclear icebreakers and Search and Rescue Services (SAR). The safety of navigation in the Northern Sea Route has increased in recent years, due to the increased availability of electronic charts and a network of long range NAVTEX stations. The satellite navigational system GLONASS is more reliable in high latitudes then its counterpart GPS NAVSTAR. Safer navigation makes the NSR a main competitor to the Suez Canal Route.

Arctic vessels

Although the NSR Administration accepts passage vessels without any ice class for summer transits, there is a large number of vessels specifically designed for sailing in various ice conditions. Ice class notation is determined for vessels by a classification society that supervises construction of the vessels. Each classification society has its own set of rules regarding ice class, but most of them are identical to the rules of other societies. Arctic vessel ice classes are called Polar classes as they are designed for polar waters. The International Association of Classification Sociates (IACS) coordinates the standards used for the rules of classification societies; they provide unified international standards for Polar classes, as shown in Table 2.

Table 2. International Polar classes for vessels (Yu, 2008)

Polar Class	Ice description (World Meteorological Organization nomenclature)
PC 1	Year-round operation in all Polar waters
PC 2	Year-round operation in moderate multi-year ice conditions
PC 3	Year-round operation in second-year ice, which may include multi-year ice inclusions
PC 4	Year-round operation in thick first-year ice, which may include old ice inclusions
PC 5	Year-round operation in medium first-year ice, which may include old ice inclusions
PC 6	Summer/autumn operation in medium first-year ice, which may include old ice inclusions
PC 7	Summer/autumn operation in thin first-year ice, which may include old ice inclusions

Most of the Arctic vessels have a Polar class within a range from PC 3 to PC 6. Class PC 6 is designed for NSR summer operations; it is equal to the highest Baltic ice class 1AS, which can operate in any ice conditions on the Baltic Sea without icebreaker assistance. Vessels with Polar class notation from foreign classification societies need to obtain, from the NSR Administration, the equivalent Russian Register class notation for the purpose of accessibility to particular zones. Russian and International Polar classes are related as follows (Daley, 2014):

- Arc 7 – PC 3
- Arc 6 – PC 4
- Arc 5 – PC 5,6

The typical design for an Arctic vessel is the so-called double-acting vessel. Its bow shape is typical for an icebreaker and the vessel is propelled by azipods (podded propulsors). In light ice conditions, the vessel breaks ice by using her bow but sails astern in severe ice conditions, which breaks the ice with a spoon-shaped stern and azipods pulling the vessel. Ice chunks are crushed by the propellers (designed for this purpose), which prevents ice flows from going under the hull and reduces the friction between the ice and the ship's hull. This kind of design has become very popular among new Polar class cargo vessels and recently built conventional icebreakers. Depending on the power requirements, the vessel is driven by one to three azipods. Icebreakers may also have azipods fitted at their bows. This type of propulsion provides much better maneuvering characteristics, which is very important for operations in ice. Azipod propellers are driven by electric motors that are powered by the vessel's diesel driven generators.

Hybrid propulsion is much better suited to ice navigation and offers a higher degree of reliability. The breakdown of one generator may lower a vessel's icebreaking capabilities, but it certainly will not immobilize her. Medium-speed engines with electric generators run on Marine Diesel Oil (MDO), a mixture of light gas oil and fuel oil. MDO is less harmful to the Arctic environment in case of spillage compared to much cheaper fuel oil that is used for the main engines of ocean-going vessels. Today many low- and medium-speed marine engines are built in a dual-fuel configuration with the purpose of limiting emissions and lower the running costs by using liquified natural gas (LNG) as a second type of fuel. Typical design of the Arctic vessel correspond to Polar class PC 3 (Arc 7), which is capable of breaking 2.1 m second-year ice and uses LNG as the primary fuel; this kind of vessel is depicted in Figure 10.

Figure 10. LNG carrier for the Yamal Project, which is powered by 3 azipods and a 45 MW total power (GlobalSecurity, 2021)

Discussion

It is difficult to properly analyze the transit costs for the NSR and the Suez Canal. Several attempts have been made but numerical analyses were always based on several assumptions, which can be disputed. Comparison of all three Arctic routes with the Suez Canal was carried out eleven years ago (Wergeland, 2010), which pointed to the Transpolar Sea Route as the optimal path in regard to cost savings, but today the route is not accessible to cargo vessels due to the permanent ice cover and the presence of multi-year ice, which is challenging even for large icebreakers. Today's purpose-built cargo vessels for Artic operations are designed for first year ice with some inclusion of old ice, conditions that are typical for the NSR, but their construction is more expensive compared to cargo vessels trading in mild climate. This analysis also lacks estimations of the icebreaker fees, which are difficult to estimate since the time length of any icebreaking services depends on current ice conditions. Present icebreakers tariffs are dated back to 2014 (NSRA, 2021) and could be changed at any time. Fuel cost estimations in this publication are based on the reduced speeds in ice conditions and, thus, a lower fuel consumption. However, such an assumption is not always correct. Vessels moving through ice need to overcome the resistance of ice friction against the hull at the expense of extra fuel being burnt. Cargo vessels specifically built for the Arctic partly alleviate this problem by using low friction hull coatings. Voyage planning for long straight passages is often heavily modified by wise ice navigation that require the avoidance of travel through ice, when longer ice-free tracks are available. Vessels moving within ice covered areas never move in straight lines as she needs to find ice weakest points, crack, and polynyas. The theoretical and real lengths of track can be quite different for ice navigation.

Very thorough comparative analysis of the passage costs through the NSR and the Suez Canal Route was presented at the International Association of Maritime Economist in Marseille in 2013 (Furuichi & Otsuka, 2013). Some assumptions that are made in this publication are too simplistic for real sailing conditions in the Arctic. The fuel costs analysis, based on a specific fuel consumption, may provide lowered results for a passage through heavy ice and the real cost and emission savings can be lower than expected due to the extra fuel usage. Maintenance costs for a vessel plying in Arctic waters cannot be solely based on a percentage of the shipbuilding value, due to frequent and serious damage sustained by vessels during ice navigation. The high costs of unplanned repairs are elevating insurance fees. An accurate analysis of the NSR transit costs is very difficult, since many parameters are unknown (lack of sources) or depend on unforeseen meteorological conditions. Despite these reservations, the final result of the abovementioned analysis is correct: the transit costs for the NSR are higher than for the Suez Canal. The Russian government currently estimates a 30% difference, although it is working to make the NSR cheaper than the Suez Canal with the help of state subsidies and the setting up of special economic zones on the Russian Arctic (Russia Today, 2021). Most vessels can sail on the NSR for approximately 5 months of the summer navigational season as opposed to the year-round availability of the Suez Canal, unless climate change extends the navigational season in the Arctic. There were some winter trips of Arc 7 ice class LNG carriers in January and February 2021, but one vessel sustained damage to one of her azipod propulsors (Kubny, 2021).

The shorter time of passage in the Arctic reduces the total fuel consumption and the emission of greenhouse gases and other harmful substances, but only if conditions allow for fuel savings when the ice presence is limited. New purpose-built Polar class vessels are using a cleaner diesel oil and LNG as fuels, but conventional ocean-going vessels are still running mainly on fuel oil in areas where emission to the atmosphere is not limited by regulations. The forthcoming IMO ban for use of heavy fuel in the Arctic is coming into force on 1st July 2024 and will eliminate at least one of the environmental contaminants, but this will also rise fuel costs for vessels that use diesel oil as a replacement for fuel oil (MEPC 76, 2021). Suez Canal transit fees are much lower than the cost of icebreaker services and only a decline in the Arctic ice may improve the situation without state intervention. The situation may change when the Egyptian government decides to widen and deepen critical parts of the Suez Canal without engaging public funds, which may imply plans to raise the transit fees (El-Tablawy & Karam, 2021).

When planning passage through the Arctic it is very difficult to calculate the transit time as the ice movement and conditions are often unpredictable from a navigational point of view. This could be a problem for vessels that run on a tight timetable, like container carriers but tankers and bulk carriers will not be affected as much. Vessels using this route can make more trips due to the shorter transit times and increase in their revenues. The Suez Canal route passes through two areas known to be infested with pirates that attack commercial shipping. These locations are the South China Sea at the Malacca Strait and the Gulf of Aden. Vessels passing areas with heightened risk of piracy pay additional insurance fees. The Northern Sea Route is free from acts of piracy, but ice navigation elevates the risk of damage to vessels and insurance providers are asking for extra fees in regard to insurance of the hull and machinery, i.e., the Protection and Indemnity (P&I). Shipowners of vessels plying in the Arctic should take under consideration the possibility of ice damage to the hull, rudder and propeller, a faster wear of the protective coatings, and a more frequent breakdown of the propulsion system due to sever ice conditions, which all result in non-planned costly shipyard repairs. At the present stage, it is difficult to say that the NSR is a viable alternative to the Suez Canal. Although it is certainly needed as a backup route if the Suez Canal again runs into trouble. The decline of the Arctic ice and the further investment in Polar class vessels (including new generations of icebreakers) will make the NSR more competitive compared to the Suez Canal Route.

Conclusions

The unexpected grounding of the M/V *Ever Given* in the Suez Canal brought to a complete standstill the busiest shipping lane for 6 days. The shipping industry immediately began to search for alternative route to the Suez Canal, but ones shorter than travelling around Africa. Attention has been focused on the Arctic passage called the Northern Sea Route, which is administered by the Russian Federation. The two remaining alternatives, the Transpolar Sea Route and the Northwest Passage, are currently inaccessible to cargo vessels due to the more severe ice conditions or underdevelopment. Availability of these routes will change in future, as the extent of multi-year Artic ice continues to shrink, replaced with weaker first-year ice. The NSR has been used for several decades, but it mainly served intra-Arctic transport with limited possibilities for international transit. The economic development of the Russian Arctic and the decline in Arctic Sea ice has increased the importance of the NSR for international maritime shipping. At the present time, the NSR seems to be uncompetitive with the Suez Canal Route due to the unpredictably harsh Arctic environment, the shorter navigational season, the technical difficulties, and the high tariffs for icebreakers services. The Russian Federation is planning to invest in the infrastructure of the NSR and the lower transit fees make the transit costs cheaper than those of the Suez Canal passage. Low transit costs, with shorter transit time, could soon make the NSR a viable alternative to the Suez Canal Route but traditional cargo vessels would need to be replaced with technically advanced, Polar class ships that are capable of sailing along the NSR for extended periods of time, which would ultimately provide all-year services due to the gradual warming of the global climate. The increased number of voyages, and the rising amount of cargo volume in recent years, shows the growing importance of the NSR as a cargo transit route (Gunnarsson, 2021). The situation may change in favor of the NSR, if the Suez Canal Authorities decides to finance perspective upgrade works with higher transit tariffs (El-Tablawy & Karam, 2021).

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