Analysis and Consideration of the Navigation Support Capability of Arctic Shipping Route in China

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Abstract: In order to have a more systematic understanding of China's navigation support capability of Arctic Shipping Route and to form a basic perception of the situation to inspire the subsequent work related to its development, this paper makes a targeted analysis and functional classification of China's navigation support in all aspects for Arctic Shipping Route at the present stage, and makes a comparison from the actual demand, so as to point out the shortcomings and explore the sustainable development.

1. Introduction

With global warming, the sea ice in Arctic has diminished and part of the Arctic Shipping Route is navigable seasonally. As a shortcut for trade among the economically active regions of Asia, Europe and the United States, as well as an important global energy source, the Arctic Shipping Route has the advantages of being short in distance and time and low cost, so this "golden route" is bound to change the pattern of world shipping. To ensure the safety of navigation on the Arctic route, the charts and publications, aids to navigation, maritime communications and other necessary navigation support services are indispensable.

The White Paper on *China's Arctic Policy* released by the State Council of People's Republic of China in January 2018 clearly states that "On the basis of the principles of 'respect, cooperation, win-win result and sustainability', China, as an important stakeholder in Arctic affairs, is ready to cooperate with all relevant parties to advance Arctic-related cooperation under the Belt and Road Initiative, so as to build a community with a shared future for mankind and contribute to peace, stability and sustainable development in the Arctic." (State Council Information Office, 2018) An accurate grasp of the basic needs for navigational support in the Arctic Shipping Route and practical strategies that China can adopt in related areas are of great significance in further promoting China's participation in the development of Arctic Shipping Route, Arctic affairs, connectivity in the Arctic and the construction of the Polar Silk Road.

2. Arctic Shipping Route and its Current Status

2.1 Arctic Shipping Route

The Arctic Shipping Route, also known as the Arctic Passage, refers to the oceanic route that crosses Arctic Ocean while bridging Pacific Ocean and Atlantic Ocean. The Arctic Shipping Route consists of three main routes:

Northeast Passage. The Northeast Passage, also known as the Northern Sea Route, begins

at Murmansk in Russia and passes through Barents Sea, Kara Sea, Laptev Sea, East Siberian Sea, and Chukchi Sea from west to east, bypassing the Bering Strait till the North-East Asia, with the total length of approximately 2,936 nautical miles (ARCTICC, 2013).

Northwest Passage. The Northwest Passage, a route linking the Atlantic Ocean and Pacific Ocean, starts in the north of Baffin Island in northern Canada, passing through Davis Strait and Baffin Bay and heading west through the waters of Canadian Arctic Archipelago to the Beaufort Sea in the north of Alaska of the United States (ARCTICC, 2013).

Central Passage. The Transpolar Passage, also known as the North Pole Route, which starts in the Bering Strait and crosses the central area of Arctic Ocean to Greenland Sea or Norwegian Sea (ARCTICC, 2013).

Compared with the traditional sea routes from Northern Europe to East Asia, the Arctic Shipping Route not only reduces the distance and time of the voyage, but also is significant in reducing the nontraditional security threats in passing through the Panama Canal or the Suez Canal.

2.2 Current Status of the Arctic Shipping Route

Due to the harsh weather conditions, the Arctic Shipping Route is covered under sea ice for most of the year and only from July to September can the Route be navigable with the assistance of icebreakers. In recent years, with the global warming, the melting of sea ice, the continuous improvement of ice-breaking technology and the increasing capacity of the Navigation Support for the Arctic Shipping Route, its environmental conditions for navigation have hence improved and the navigable period throughout the year has increased.

Opened in the 1930s, the Northeast Passage is a straight route with relatively good navigable conditions and has been used commercially on some scale. At this stage, the navigable period can last up to five months in a year (from July to December). According to data from the Russian Northern Sea Route (NSR) Information Centre, the freight volume of the Northeast Passage increased from 3 million tonnes to 30 million tonnes from 2011 to 2019, exceeding 33 million tonnes in 2020 and 35 million tonnes in 2021. In addition, 617 different vessels were recorded between 2016 and 2020, reaching a gross registered tonnage (GRT) of more than 8.7 million tonnes, with a total of 241 ship owners, 27 different flag states and 28 ship types.

The Northwest Passage has complex terrain along its route, with many straits and islands, and also reefs and shoals in the way. It opens for navigation for three months (from July to October each year). At this stage, the Northwest Passage has not been used commercially on a large scale and is only used for experimental freight transport.

And the last is the Central Passage, which is far from the mainland and is only used for scientific investigation, tourism and military activities now due to the high density of multi-year ice in the central area of Arctic Ocean.

Countries concerned and international organizations observed that sea ice in Arctic Ocean has been diminishing over the past five decades, and this trend has been intensifying over the past 20 years, with satellite data showing an average annual decrease of 3%. In

recent years, Arctic temperatures have continued to rise at a rate twice the average global warming, and sea ice area has been shrinking at a rate of 10% per decade, especially in summer when the total amount of multi-year ice has declined sharply. Some scientists predict that there may be no ice in the Arctic Ocean for part of the year by 2030 at the earliest (Feng, Li & Ma, 2016).

3. Navigation Support Capability of Arctic Shipping Route

3.1 Concept of Navigation Support Capability

Navigation Support Capability refers to the ability to provide a range of comprehensive services to ensure maximum safety of the ship during navigation.

Navigation Support Capability includes nautical charts and publications, marine hydro-meteorological services, aids to navigation, the broadcast of communication information and so on.

3.2 Requirements for Navigation Support Capability of Arctic Shipping Route

The Arctic Shipping Route is located in Arctic Ocean, with high latitude, remote waters, ultra-low temperature, strong storms, ice area and complex geomagnetic environment. Although there are no restrictions on ship size and draught, and the aids to navigation and radio facilities have been set in some waters, the Route still faces more difficulties than traditional routes due to both the geopolitical conditions and geographical and climatic conditions like high latitude and ultra-low temperature of the Arctic. In particular, there are greater challenges in terms of the accuracy of nautical charts and publications, the rationality of the aids to navigation, the accuracy of satellite communication positioning and the promptness of safety information broadcast.

4. Analysis to the Navigation Support Capability of Arctic Shipping Route and its Future Construction

4.1 Nautical Charts and Publications

China has now published two navigation guides, *Guidances on Arctic Navigation in the Northeast Route*, published in 2014, and *Guidances on Arctic Navigation in the Northwest Route*, published in 2015, as well as other materials concerned with Arctic navigation such as *Atlas of Arctic Navigation* (2015) and *Guidances on Arctic Communication in the Northeast Route* (2017), which provide data guarantee for ships flying Chinese flag and seafarers to navigate safely on Arctic Shipping Route (Ding, Liu & Wei, 2017). The two navigational guidances cover aspects of the awareness of the polar environment and climate change, and also provide information and services related to navigation support for ships that transit the Arctic Shipping Route.

Unavailability of related nautical charts is one of the concerns. There are currently no Chinese versions of charts in both printed and electronic copy for Northeast Passage and Northwest Passage. The charts for Northeast Passage, from Bering Strait to the waters of northern Norway, are mainly Russian versions on a scale of 1:100,000 to 1:3.5million. Soundings in those charts are sparsely marked, even around recommended routes; charts for

the Northwest Passage is mostly the US, Canadian and Danish versions. The chart sequence for northern Alaska, southwest Greenland, and the Canadian mainland coast are relatively complete, but smaller in scale than conventional waters, with a large number of areas that have not been mapped. Besides, the sounding data is age-old, and track or single point sounding is mostly used outside the main passage. The language barriers and the fact that the chart information involves a number of terms such as chart coordinates and magnetic variation have caused hindrances for relevant staff in the use of the charts (Wu, 2020). Furthermore, only about 9% of the Arctic Ocean has been mapped based on international standards, and most of the waters have not been explored. There are currently no charts available for navigation in areas north of 75°N.

There existing nautical charts and publications are not corrected and updated timely and the correction channels are poor, in addition, most of the data sources are age-old, with marine data of the year 1941 to 1989 and land data from 1953 to 1992 (Maritime Safety Administration, 2017). The difficulty of access to that information makes it difficult for China to grasp information on the natural environment and actual geographical conditions of the Arctic Shipping Route, thus harder in providing basic and necessary guarantees for safe navigation.

4.2 Applicability of Aids to Navigation

The IALA A maritime buoyage system is used for the Northeast Passage, which is deployed seasonally, and the location of those aids is not fixed. The number of aids to navigation varies greatly along the coast, with the Barents Sea and the White Sea having the largest number and the Kara Sea, Laptev Sea, East Siberian Sea and Chukchi Sea having only a few seasonal ones. As it is foggy along the Northeast Passage, its visibility is poor. Therefore, there are audible aids such as foghorns, radar transponders and radar ramarks or radar aids (Maritime Safety Administration, 2014).

The Northwest Passage is sparsely marked with aids to navigation, mainly in important channels and headlands, and not much of radar transponders. The coast north of Alaska is not marked with aids to navigation, and the range of those facilities only covers a short distance north of the Bering Strait. The navigational aids along the Bering Sea coast in the northern Aleutian Islands serve mainly trawlers and fishing vessels. There are also several areas of Aleutian Islands Chain where navigational aids are in place to serve local and trans-Pacific shipping. The majority of vessels navigating in the Northwest Passage pass through the central channel, away from the shoreline, and rely mainly on satellite positioning for real-time positions (Maritime Safety Administration, 2014).

The high latitude and complex geomagnetic environment of the Arctic waters make the automatic north finding moments of traditional navigational instruments low and traditional navigation systems such as the gyrocompass and magnetic compass deviate considerably. As no radio positioning system has been established in the Arctic, ships rely more on satellite navigation. There are four major satellite navigation systems in the world, which are, Global Positioning System (GPS) from the United States, GLOBAL NAVIGATION SATELLITE SYSTEM (GLONASS) from Russia, the EU Galileo Satellite Navigation System (GSNS) and China’s BeiDou Navigation Satellite System (BDS), can all achieve polar navigation and

positioning at this stage, among which GPS is the most mature one.

4.3 Maritime Communication and the Broadcast of Safety Information

Communication on Arctic Shipping Route has always been a difficult issue for the stakeholders due to the surface curvature and high latitudes. Distress alerts and ship-to-shore communications have been difficult to secure the Arctic navigation.

Shore-based Communication. The Arctic shore-based communication infrastructure is poorly developed, with little equipment in coast radio station, and is only distributed in some important waters. In 2007, IMO added five NAV/METAREA zones to Arctic Ocean. The coordinating country for the XX and XXI zones in the waters of the Northeast Passage is Russia, with ground communications facilities such as MF/HF SSB, DSC, and also the INMARSAT to communicate and acquire service along the coast. VHF, MF and HF coast radio stations were set up along the Northeast Passage (Northern Navigation Service Center, 2017); VHF coast radio stations were constructed in its important waterways, and southeast Alaska, northern Bering Sea, southwest Greenland and Svalbard. Due to the special geomagnetic environment in the Arctic, the shortwave communication is not stable, so the communication service is not good. Coastal states in the Arctic are trying to solve this problem, for example, by establishing ionospheric observation stations, so that ships can take appropriate measures based on ionospheric parameters.

Satellite Communication. The existence of blind sectors in satellite coverage at high latitudes makes it difficult to achieve real-time signal transmission between geostationary satellites over the equator and communication terminals in the Arctic. The International Maritime Satellite (INMARSAT) system is unable to cover areas above 75°North latitude. The US Iridium Satellite communication system was approved for Global Maritime Distress and Safety System (GMDSS) services in May 2018 as a GMDSS communication equipment is widely used in Arctic navigation. China's BeiDou Navigation Satellite System (BDS) is also accelerating its application in the global maritime sector. At the 99th session of Maritime Safety Committee of the International Maritime Organization, China submitted an application to endorse BeiDou Messaging Service as a GMDSS service provider, and at the NCSR7 of the IMO in January 2020, a proposal to join the pre-assessment of GMDSS was adopted, which will be carried out by IMSO for technical and operational assessment. At present, the Beidou's messaging service system will still face uncertainties brought by the on-site technical evaluation of IMSO and the revision of international recognition standards. Once successfully joined GMDSS, it can effectively drive the overall development of BDS.

4.4 Thoughts and Suggestions on the Future Construction of the Navigation Support Capability of Arctic Shipping Route

With the continuous warming of the climate, the conditions for large-scale and regular operation in the navigable period of Arctic Shipping Route in summer have been preliminarily met, and the shortcomings of the navigation support capability of Arctic Shipping Route in China are of vital importance for the enhancement of its navigation capability. But the navigation support is systematic and comprehensive, with high requirements for financial support, technical equipment, personnel training and other basic

needs. Meanwhile, the special geopolitics of the Arctic should also be taken into account. Therefore, in view of the particularity of the navigation support work of the Arctic Shipping Route, we must seek for the breakthrough and focus point in our research.

(1)Strengthening the construction of infrastructure. Through in-depth cooperation with “Polar Silk Road” countries, China will strengthen communication and cooperation with Arctic coastal states, provide financial, material and technical support for port infrastructure, and jointly build infrastructure for navigation support of Arctic Shipping Route. Also, the Loran/Chayka navigation system, Automatic Identification System (AIS), hydrography, coast radio station and other infrastructure in the Arctic will be promoted.

(2) Intensifying satellite communication. We will continue to strengthen the construction of the Beidou communication system. With the launch of China’s BeiDou-3 Navigation Satellite System, we will keep deepening the development of its function in accordance with the concept of “China’s Beidou, the world's Beidou, and also the first-class Beidou”. We will give full play to the application of Beidou short message communication technology to provide more timely and accurate information services such as marine meteorology and notices to mariners for Arctic navigation.

(3) Deepening international cooperation. We should make full use of various maritime organizations and related regional platforms to step up international cooperation on navigation support for Arctic Shipping Route. At the same time, we also should pay attention to the International Maritime Organization (IMO), International Hydrographic Organization (IHO), International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA), International Telecommunication Union (ITU) and other international organizations concerning Arctic navigation support, focus on the priorities of relevant organizations in the work of Arctic navigation support, and contribute better solutions based on our real conditions. We will work together with other users of the Arctic shipping routes to formulate the agenda and standards for navigation support in the Arctic, so as to reflect the demands of countries using the Arctic Shipping Route. Also, China will strengthen its participation in research and development and international cooperation in core technologies and equipment for polar navigation support, and also in scientific investigation of the navigation environment in the Arctic, so as to better offer China’s contribution to the Arctic waters, including nautical charts and publications, marine hydrometeorology, cultural environment and other fields.

(4) Establishing domestic Arctic navigation support system. China has integrated its domestic Arctic research institutes, enterprises and public institutions to jointly build a navigation support platform for the unified Arctic Shipping Route in terms of vessel navigation aiding, marine communication and navigation and weather forecast, which has achieved information sharing and could provide dynamic information services for ships in a timely manner. In building a national navigation support system for the Arctic, the focus should be on strengthening technical support and support capabilities for distant and remote voyage. In hydrographic survey, we should continue in the research of satellite remote sensing technology, and also carry out the survey of Arctic coast and waterway depth to encourage ships flying Chinese flag to participate in bathymetric survey and establish bathymetric data sharing. Nautical charts and publications should enrich the types of Arctic

nautical book products and promote the data update. In terms of maritime communication, shortwave communications in the eastern and western Arctic waterways would be promoted through on-board tests. In addition, special vessels conducting scientific investigation and rescue service will be constructed, with the ability to carry out Arctic survey, traffic environment investigation and emergency preparedness and rescue.

5. Conclusion

This paper systematically introduces the characteristics of the Arctic Shipping Route and situation about navigation support. As the navigable conditions of the Arctic Shipping Route improve year by year and the number of navigable vessels increases, the backward navigation support infrastructure and inadequate capacity have become the bottleneck restricting the improvement of its navigable capacity. The construction of navigation support for the Arctic Shipping Route is also an important part of China's participation in Arctic affairs, and a concrete step of China's policy goal of "understand, protect, develop and participate in the governance of the Arctic".

As a responsible major maritime country and an observer of the Arctic Council, China should plan and build a navigation support system for Arctic Shipping Route as early as possible to provide more timely, accurate and refined services of navigation for Chinese ships and ensure the safety of vessels passing through the Arctic.

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