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Article

Current Status of Shipping Development in China and Russia: Prioritized Routes for Tanker Operations

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Abstract: This study investigates the current state of tanker transportation in China, with a particular focus on identifying key operational routes for inland tankers. Additionally, it analyzes shipping activities along Russia's Northern Arctic and Far East maritime routes. By comparing the operational practices of both countries, the research highlights the potential for mutual benefit through the exchange of technological and engineering expertise. The findings emphasize that the development of weapons and military equipment is intrinsically linked to the efficiency of inland transportation systems, which hold a pivotal role in national infrastructure across most countries.

Keywords: Shipping and tanker ship; Northern Arctic; Russia

1. Introduction

Chinese Inland Waterway Transport (CIWT) system has undergone extraordinary growth, evolving from handling less than 150 million tons of cargo in 1978 to a remarkable 3.74 billion tons in 2018. This sixfold increase over the combined volumes of the European Union and the United States establishes China as the operator of the busiest IWT system globally [1]. The transformation has been driven by sustained investments in infrastructure, which upgraded underutilized waterways into high-caliber channels. These improvements facilitated the movement of larger vessels, enhanced operational efficiency, and reduced transportation costs. In addition to physical infrastructure upgrades, China has invested

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heavily in advancing technical expertise and cultivating skilled professionals [2]. Today, China boasts 127,000 kilometers of premium navigable inland waterways, recognized for their high efficiency and impressive safety records. The majority of China's IWT projects were completed within stringent timelines during a period of rapid development. This phase also saw the adoption and development of internationally recognized innovations, including river classification standards, vessel modernization, advanced navigational technologies, and robust environmental protection measures [3].

Forty years ago, CIWT was largely overshadowed by the development of road and rail networks, with waterways perceived as secondary to modern transportation needs. This scenario mirrors the current state in many countries, where inland waterways remain underutilized despite their potential for freight and passenger transport [4]. China's reform and development efforts revitalized its dormant CIWT sector, transforming it into a dynamic mode of transportation. This rejuvenation has contributed significantly to economic development along riverbanks, turning waterways and adjacent regions into thriving economic corridors. The success in CIWT development offers valuable lessons for other nations. Understanding the mechanisms and strategies behind this transformation is crucial for policymakers worldwide. Beyond past achievements, CIWT system continues to evolve, with innovations focused on enhancing efficiency, resilience, and safety. Additionally, international collaborations are refining and advancing this already sophisticated system. By leveraging its expertise and ongoing advancements, CIWT system provides a compelling case study for countries seeking to unlock the potential of their inland waterways and integrate them into modern, sustainable transportation systems.

The CIWT system has undergone an extraordinary transformation, growing from handling less than 150 million tons of cargo in 1978 to an impressive 3.74 billion tons in 2018. This exponential growth has positioned the CIWT system as the most active globally, with a throughput six times greater than that of the European Union or the United States. This success can be attributed to China’s unwavering commitment to infrastructure investment, which has transformed underutilized waterways into high-quality channels capable of accommodating larger vessels, enhancing transport efficiency, and reducing operational costs. In addition to these physical upgrades, significant resources have been allocated to developing technical expertise and operational know-how [5].

Today, China’s inland waterway network spans 127,000 kilometers of superior navigable waterways, distinguished by high safety standards and operational efficiency. Most IWT projects have been completed within ambitious timelines, aligning with a period of rapid infrastructural advancement. During this time, China has adopted and developed internationally acclaimed innovations across various domains, including river classification systems, vessel modernization, advanced navigational technologies, and environmental management.

Just four decades ago, the CIWT system was nearing obsolescence, overshadowed by the rapid expansion of road and rail networks. Inland waterways were not viewed as a vital component of a modern transport framework. This scenario is not unique to China—many countries today underutilize their inland waterway networks despite their potential for efficient cargo and passenger transport. In contrast to this global trend, the CIWT sector has experienced a renaissance, evolving from a neglected mode of transportation into a dynamic driver of trade and economic activity [6]. This revival has catalyzed significant socio-economic development along riverine regions, transforming waterways and adjacent corridors into thriving economic hubs.

China's achievements in this field are both instructive and inspiring. The methodologies and strategies driving the CIWT sector's transformation offer valuable lessons for countries seeking to realize the untapped potential of their inland waterway systems. Furthermore, the CIWT system continues to evolve, with ongoing initiatives aimed at improving efficiency, resilience, and security. Collaboration with international partners is poised to elevate this already advanced network to new heights, establishing CIWT as a benchmark for excellence in inland waterway transport—a model that other nations may seek to emulate [7].

2. Priority routes of tanker operation

The Chinese shipbuilding industry has made a significant breakthrough with the domestic fleet of oil tankers catching the eastern wind. Shanghai has witnessed the launch of a new generation of green and environmentally friendly oil tankers. The International Maritime Organization (IMO) has decided to expedite the phasing out of single-hull oil tankers by five years. The ban on single-hull oil tankers is set to impact fuel oil prices in China significantly [8].

In an era characterized by the burgeoning shipbuilding industry, major shipping giants from the world's largest nations are vying for the development of supertankers due to their advantageous cost-quality ratio. Presently, China has a total of 15 supertankers with a combined carrying capacity of less than 4.5 million tons. Reviewing the current routing structure, Chinese shipowners transported 1.3 million tons of imported oil from the Middle East along the eastern route in 2020, all of which were carried by the Chinese merchant fleet, accounting for only 3.78% of the oil imports via this route. There's virtually no cargo being transported by Chinese shipowners along the eastern route from West Africa.

Some experts emphasize that constructing a fleet of supertankers is no easy feat, facing long cycles, substantial investments, and high risks. Despite the significant capacity shortfall demonstrated by Chinese shipowners compared to China's demand for oil imports, the global tanker shipping supply-demand ratio still exhibits an oversupply [9]. Mismanagement could lead to immense pressure, which must be mitigated by significant financial backing. Therefore, building a supertanker fleet is a complex and considerable undertaking. It cannot be swiftly achieved solely through company efforts but requires the backing of competent governmental agencies. It also demands coherent cooperation between sectors such as shipping, petrochemicals, and shipbuilding, all playing a strategic and crucial role.

The construction of a Chinese supertanker fleet is an urgent and critical matter. Primarily, having its own supertanker fleet would allow China to reduce costs associated with importing overseas resources. Notably, the economies of scale of 200,000-ton and 300,000-ton tankers can bring the cost of transporting a unit of product close to zero. Secondly, by drawing on Japan's experience, it could capitalize on the comprehensive development trend of China's steel, trade, and financial industries. Thirdly, possessing an independent supertanker fleet could break the monopoly of international shipping giants like Japan.

Once China has its own supertanker fleet, it will not only gain the above-mentioned advantages but also acquire special significance for Chinese oil import security. Given that the vast majority of Chinese oil imports come from the Middle East and Africa, oil transportation must navigate through lengthy sea routes and several fragile passages, including the war-torn Strait of Hormuz and the pirate-infested Strait of Malacca.

Given the US military deployment and control in these regions, it's highly probable that oil transportation routes could be blocked due to wars, terrorist attacks, and political factors, posing a threat to Chinese oil security.

With its own supertanker fleet, the Chinese government can confidently provide armed escorts during crises, quickly and decisively handle post-crisis situations, circumvent various certification and accountability issues arising from tanker leasing, and better protect the interests of Chinese companies—even the safety of the entire national economy.

Since ancient times, inland water transport (IWT) has played a pivotal role in moving goods from production sources to consumption destinations. While railways and highways are becoming increasingly vital to modern China's transport network, they cannot entirely supplant waterways. The high cost of construction restricts widespread railway expansion, and railway conditions are often congested. The capacity for hauling freight on highways is limited, and these roads are unsuitable for the movement of bulk goods. Chinese potential in water transport is vast yet far from fully actualized. Nevertheless, China possesses over 75,000 miles (about 125,000 km) of navigable inland waterways, the most extensive system of any nation in the world. The distribution of waterways is primarily within Central and Southern China, with a few navigable streams in the Northeast [10].

One of the earliest aims of the Communist government upon assuming power in 1949 was to establish a national network of waterways. It also initiated a program of construction and reconstruction of port facilities and dredging of river channels. By 1961, approximately 15 major waterways were operational, focused on the Yangtze, Pearl (Zhujiang), Huai, Han, Yellow (Huang He) rivers, and the Grand Canal. Subsequently, the development of water transport received considerable attention. Dredging and other improvements to the inland waterways were vital to economic recovery, while the capital and operational expenditures on water transport were much lower than for railway transport.

China's 8,700-mile (14,000 km) coastline is indented by some 100 large and small bays and has about 20 deepwater harbors, most of which are ice-free year-round. Coastal shipping is divided into two main navigational zones: the Northern and Southern maritime districts. The Northern district extends northward from Amoy to the North Korean border, with Shanghai serving as its administrative center. The Southern district extends from

Amoy south to the Vietnamese border, with Guangzhou as its administrative center. Most ocean routes begin from ports such as Dalian, Qinhuangdao, Tianjin, Qingdao, Shanghai, Huangpu, Zhanjiang, or Hong Kong. Shanghai has been a leading port of China since the early 19th century but was eclipsed by Hong Kong when the latter was reincorporated into the country in 1997 [11-14].

The leading river ports are integrated transport hubs focused predominantly on the transfer of containers, coal, and ore. Over 40 years, China has established a national network of inland waterways with quality navigable routes and major ports in the country's leading regions along these routes and in river deltas. The scale of hydraulic engineering and dredging is considered among the best globally. By the end of 2019, the total length of Chinese inland waterways reached 127,000 kilometers, ranking first in the world. Of the planned 19,000 kilometers of high-level inland waterways, nearly 13,400 kilometers have achieved the desired standard, connecting the eastern, central, and western parts of China. The network of tributaries and canals is linked with roads and the sea.

There are three primary maritime routes for the transportation of products made in China to the world via the Pacific, Atlantic, and Indian Oceans. Choosing the Pacific route, ships will pass through the South East China Sea, proceeding north through the Sea of Japan and the Okhotsk to enter the Northern part of the Pacific Ocean. This route enables vessels to reach Western Latin America, the Western US, New Zealand, Australia, and Western Canada.

Additionally, numerous vessels follow the Atlantic route. In this case, ships head southward from China, navigating through the Indian Ocean and around the Cape of Good Hope, thereby setting a course for Western Europe, the Eastern US Coast, the Suez Canal, the Persian Gulf, and the Mediterranean.

The third route frequently plied is the Indian Ocean, often used to transport oil. This corridor allows Chinese goods to reach the Persian Gulf, Eastern Africa, Western Europe, and North America, proceeding towards the Cape of Good Hope.

The study has identified priority operational routes for tankers, which are presented on the map (see Fig. 1 and Fig.2).

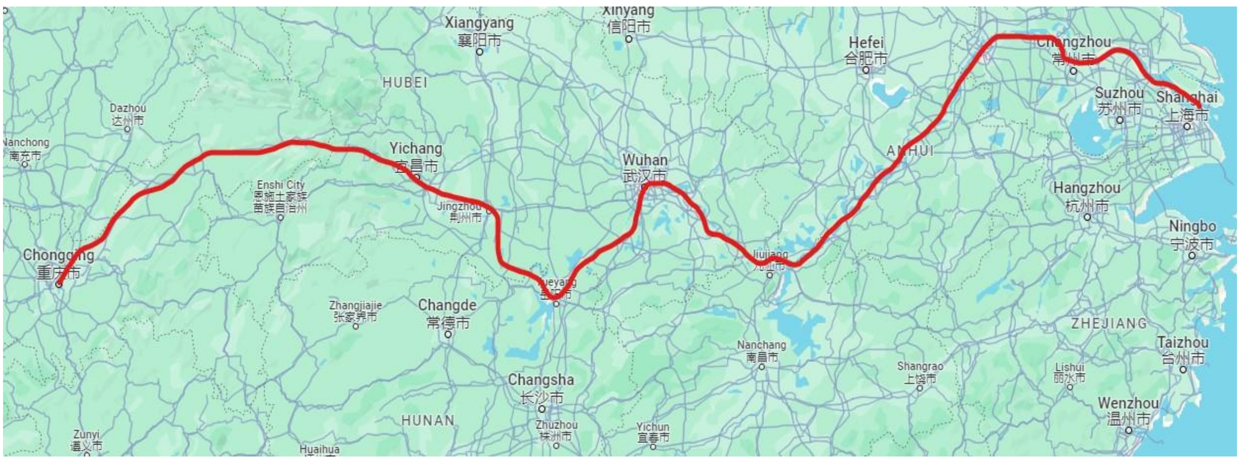

Fig.1 priority route of tanker operation along the Yangtze River

Fig.2 GIS-based shipping annotation maps Conditions on the tanker's route

Over the past 40 years of development in inland waterways, China has created a national network consisting of high-quality navigable routes and large ports, strategically placed along these pathways and in river deltas. The scale of hydraulic engineering and dredging is among the finest internationally. As of the end of 2019, the total length of Chinese inland waterways reached 127,000 kilometers, securing the world's leading position. Out of the planned 19,000 kilometers of high-level inland waterways, nearly 13,400 kilometers have met the desired standard, linking Eastern, Central, and Western China. This network of tributaries and canals integrates seamlessly with highways and seaways.

The volume of waterway transportation on Chinese inland waterways is the largest globally, and their efficiency and profitability continue to grow [15].

The number of river vessels in China reached 124,345 in 2018, with a total carrying capacity of 129.2 million tons. Annual navigation on these inland waterways in 2019 hit 3.913 billion tons, with the Yangtze River alone seeing an annual traffic flow of 2.39 billion tons, making it the busiest in the world.

The country has seen continuous development in the emergency and rescue readiness system for water transportation. A monitoring system for the safety of navigation and rescue operations has been established, and resources for search, rescue, and emergency response to oil spills in riverine emergencies are regularly improved. The response time to emergencies on major inland waterways does not exceed 45 minutes. The average success rate of search and rescue operations on water is at least 96% [16].

Significant strides have been made in key areas of ecological sustainability. Active construction of shore-based treatment facilities for liquid and chemical cargo, coastal LNG bunkering terminals, shore power supply for vessels, and the building of liquefied gas and electric ships are underway.

Specialized docks with equipped and substantial port areas have been established in leading river ports across the country. Accelerated development of multimodal transportations, modern logistics, and provided business services is evident.

The internal water network of China includes the following components of the national IWT network:

- Two horizontal routes: the Yangtze River and the main waterways of the Pearl River
- One vertical route: the Grand Canal
- Two networks: the Yangtze River Delta and the Pearl River Delta
- Eighteen high-quality waterways and their tributaries: 10 tributaries of the Yangtze River Basin; three tributaries of the Pearl River Basin; and the Huang He, Liao River, Songhua River, Amur River, and Min River.

The Yangtze, China's most important waterway, is also one of the most economically significant rivers in the world. Along with its tributaries, it accounts for nearly half of the country's waterborne mileage, while the volume of goods it carries amounts to about a third of all cargo transported by river. Work undertaken in the mid-1950s to improve the middle reaches of the Yangtze made it navigable throughout the year from its mouth to Yibin in Sichuan Province. In summer, the Yangtze River is navigable from its mouth to Chongqing for ships up to 5000 tons [17]. Many cable stations have been created at the rapids in the upper reaches of the Yangtze and its major tributaries, such as the Wu River. Boats going upstream are towed through the rapids by robust steel cables attached to stationary winches, boosting their load capacity, speed, and saving time. These improvements have enabled regular passenger and cargo transportation on the Yangtze.

The Xi River ranks second in importance after the Yangtze and is the main water transport artery of Southern China. Ships of 1000-ton displacement can navigate upstream to Wuzhou, while smaller vessels can travel further up its mid and upper reaches, as well as up the Bei and Dong rivers and tributaries of all these streams. Both the Yangtze and Xi are free from ice in winter. The Songhua River, flowing through the Manchurian Plain, is navigable for half its course; it is ice-bound from November through March and is bustling with movement the rest of the year. The Amur (Heilong) and Ussuri (Wusuli) rivers and their tributaries form a network of waterways stretching about 12,500 miles (20,100 km).

In the past, the Yellow River (Huang He) was scarcely navigable, especially along its middle and lower stretches, but mechanized junks now operate along its middle course in Henan.

The Grand Canal, China's only major north-south waterway, traverses the river basins of the Hai, Huang, Huai, Yangtze, and Qiantang rivers, extending 1,100 miles (1,800 km) from Beijing to Hangzhou. As one of China's most remarkable engineering feats, rivaling the splendor of the Great Wall, it is the world's longest artificial waterway. Some sections of the canal follow the natural course of rivers, while others are hand-dug. The construction of the canal began in the 4th century BC and was completed by the end of the 13th century. It forms a crucial north-south link and transport connection between China's most densely populated areas. However, from the second half of the 19th century, due to political corruption, mismanagement, and flooding from the Yellow River, the canal gradually silted up, and the higher section in Shandong was blocked. Efforts to reopen the Grand Canal for navigation, this time to accommodate larger modern vessels as well, began in 1958. The canal plays a pivotal role in transporting bulk cargo from north to south, facilitating the nationwide distribution of coal and food.

3. Experience of Russian tankers

The global demand for oil and petroleum products is at an all-time high today. The United States remains the world's largest consumer of petroleum products (with an annual consumption of 3.5 tons of oil per capita in the US and Canada, and 2.5 tons in China), with Russia accounting for more than 20% of the world's oil product output.

In the context of Russian oil fleet geography, Aframax tankers predominantly represent the Baltic contingent. However, their share has been decreasing due to an increase in Suezmax tankers. This change is attributed to active fleet renewal by the shipowners in the region, primarily on the orders of the Sovcomflot group. According to Nikolay Kolesnikov, the vice president of OAO "Modern Commercial Fleet," the company is indeed developing quite dynamically and plans to reach a total deadweight of 5.8 million tons in the next three years (currently at 4.24 million tons). The eventual merger with OAO "Novorossiysk Shipping Company" will allow the group to rank first in the world in terms of the number of product tankers, second in Aframax vessels, and fifth in Suezmax ships.

A significant portion of oil is transported from Baltic ports to Rotterdam; other volumes are directed toward Finland and Great Britain [18].

An inverse dynamic is observed in the Black Sea. Here, Aframax vessels are also primarily employed in oil transportation, but their number is consistently increasing, while Suezmax vessels are on the decline. This trend is caused by pressure from the Turkish side, insisting on the use of smaller ships for passage through the Bosporus. The percentage of Panamax-type vessels, MR product tankers, and Handysize tankers in the Black Sea basin remains virtually unchanged [19].

The composition of the Far Eastern tanker fleet lacks stability. While Aframax ship share was steadily increasing last year, it declined again in 2007. The percentage of MR type tankers decreased in 2006 but has risen again this year [20].

From the Russian Arctic, oil is exported mainly to North America by Aframax and Suezmax vessels and to Europe by MR and Handysize tankers.

The primary operational route for tankers in Russia is the Northern Sea Route (NSR). The NSR is legally defined by Russian legislation as lying east of Novaya Zemlya and specifically running along the Russian Arctic coast from the Kara Sea, along Siberia, to the Bering Strait [21]. The entire route lies in Arctic waters within Russia's Exclusive Economic Zone (EEZ). Parts are ice-free for only two months a year. The NSR, passing the Russian side of the Arctic from Cape Severny to the Bering Strait, is named the Northeast Passage, analogous to Canada's Northwest Passage [22].

While the Northeast Passage includes all the East Arctic seas and connects the Atlantic and Pacific Oceans, the NSR does not include the Barents Sea and thus does not reach the Atlantic.

The melting of Arctic ice is likely to increase traffic and commercial viability of the NSR. For instance, one study points to noticeable shifts in trade flows between Asia and

Europe, a diversion of intra-Europe trade, intensive Arctic navigation, and a significant drop in Suez traffic [23]. Projected trade changes also suggest significant pressure on the already threatened Arctic ecosystem.

The Russian sector of the Arctic Ocean requires significant investment in the development of freight transit infrastructure, icebreaker assistance, safer navigation and rescue services, and the creation of new materials and technologies for ships capable of operating in polar waters [24]. For China, accelerating cooperation with Russia in Arctic shipbuilding and marine engineering to address the current gap in icebreaker assistance as well as navigation and support services is undoubtedly a priority. Both countries need each other to overcome existing economic, technological, and even climate thresholds on the path of potential convergence of the NSR and the "Polar Silk Road" initiative and the establishment of secure maritime routes in the North [25].

Meanwhile, Chinese NSR activities need to be well-balanced with Russia's regional interests, current and future technological needs, and special regulatory rights in accordance with international legal regimes recognizing the particular conditions of navigational risks [26].

Unpredictable ice, wave, and wind conditions, changing routes, high environmental risks, and a lack of qualified and experienced personnel for safe navigation in polar waters are just some security-related issues for intensifying commercial shipping on the NSR [27]. In light of creating safer and more stable navigation on the NSR, identifying areas suitable for the development of deep-sea navigation and the use of large-scale tankers and icebreakers must be complemented by studying the main technological, engineering, and economic factors affecting Sino-Russian cooperation. China has both the experience and the funds it can offer to Russia, which is currently almost cut off from previously used Western technologies due to sanctions.

However, implementing Chinese technologies and engineering solutions first requires Russia's openness to accept them, thereby reconciling with the growing Chinese presence in Russia's Arctic sector, and secondly, significant changes to Russia's far from perfect policy of import substitution, as well as customs, tax, and financial legislations. Ultimately, intensifying shipping and securing the NSR for international transit largely depend on Russia's willingness to modernize national legislation and create favorable conditions for cooperation with China and other partners in the fields of marine engineering, shipbuilding, ice and weather monitoring, and navigation services .

4. Conclusions

Thus, priority tanker operation routes in China have been determined, as well as an analysis of conditions on these routes. In addition, Russian experience in tanker operations was analyzed.

1.The experience of developing IWT for tanker operations in China shows that obstacles in the path of IWT development, after a lengthy period of insufficient investments and neglect, can be overcome. However, the development or rejuvenation of IWT requires a long-term horizon. China's economy and society currently depend significantly on the proper functioning of the IWT system.

2. China's experience is not a template; it has a unique management mechanism and faced an unusual convergence of circumstances that may be atypical. Political, social, and economic conditions vary in each country. Nonetheless, many countries aspire to understand how to replicate China's achievements in the resurgence of IWT and what lessons can be learned from its experience.

3. For new IWT projects, the impact assessment process should consider broader benefits in terms of economic, social, and environmental indicators. The lessons learned in China are valuable for other countries that are developing or restructuring their IWT systems. A strong and sustainable policy is required in combination with coordinated centralized planning.

4. Improvement of infrastructure and fairways, standardization of ships, and classification of waterways must be synchronized. A specialized educational system is needed in all aspects of IWT to revive the sector.

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