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The impact of Northern Sea Route on China's shipping industry

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The Impact of Northern Sea Route on China's Shipping Industry

By

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Declaration

I certify that all the material in this research paper that is not my own work has been identified, and that no materials are included for which a degree has previously been conferred on me.

The contents of this research paper reflect my own personal views, and are not necessarily endorsed by the University.

Tang Minyu
2012-06-09

Supervised by
Professor Shi Xin
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Abstract

Title of Research paper:	**The Impact of Northern Sea Route on China's Shipping Industry**
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As one of the results of global warming, the ice in the Arctic region is quickly retreating back. It is estimated that in 10 or 20 years, the Arctic region will not have any ice in summer. That definitely is a catastrophe to polar bears and seals. However, the melted ice makes way for merchant vessels to sail safely across the Arctic Ocean. It provides new options for the shipping industry in sailing routes and they have many advantages over traditional ones in many aspects. Researchers have managed to conceive of two major NSRs and China stands in the middle of them. Meanwhile, nowadays China has become an essential player and has dramatical influences on world economy. In next 5 or 10 years, the exploration of NSR will for sure become a serious issue for the whole world and because the Arctic region contains massive amount of rare nature resources, the situation could become tremendously complex. It is definitely important for China's shipping people to have an integrated knowledge about this new issue so that they can seize the opportunity of the future development. This thesis focuses on China's situation in NSR issue and the impacts that NSR will bring about on China's shipping industry when the world uses NSR as routine sea routes like traditional ones people have today. SWOT analysis and AHP model is used in the paper to comprehensively analyze the NSRs' impacts on China's shipping industry.

KEYWORDS: Global warming**,** Climate Change, Northern Sea Route, Impacts on Shipping Industry, Shift of the main traffic volume, SWOT Analysis, AHP model

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List of Abbreviations

AHP	Analytic Hierarchy Process
BDI	Baltic Dry Bulk Index
GT	Gross Tonnage
IMO	International Maritime Organization
ISBA	International Sea-bed Authority
NSR	Northern Sea Route
NWR	Northwest Route
NER	Northeast Route
NSIDC	National Snow and Ice Data Center
SST	Sea Surface Temperature
UNCLOS	United Nations Conference on the Law of the Sea
WTO	World Trade Organization
WMO	World Meteorology Organization

Chapter 1 Introduction

1.1 General Background

As global industrialization goes on, more and more greenhouse gases are being released into the atmosphere. The earth is becoming warmer and bringing various kinds of problems to the whole world. One of the many, the warmer climate is melting the ice in the Arctic Ocean which is unfortunately a catastrophe to polar bears but is a good news to the shipping industry. The retreating ice will gradually make enough room in which merchant vessels can safely sail, and that is known to the world now the Northern Sea Route or the Arctic Sea Route. NSR is considered as new gold sea route for shipping.

Nowadays, the traditional sea routes between China and Europe, or China and the east coast of the U.S. are relatively too long and inefficient for operation, especially the China-Europe route. Compared to NSR, the traditional ones are much longer which would cost shipping people more time and money. As we all know, the farther the distance is, the more fuel and sail time will be needed, which means more costs. Moreover, passing through those canals and political sensitive areas will cost carriers extra fees and other costs as well as with higher risks. NSR provides a new shortcut to the shipping industry, especially for China. Obviously, the new routes start from north China to both Europe and east coast of the U.S. are much shorter than the traditional ones. It may have remarkable impacts on China's economic because using new routes carriers' costs could be dramatically cut down, thus transport costs for trade will also be much lower. This will act as an accelerator to China's economic and trade development.

In addition, China nowadays gradually becomes a critical factor which could dramatically influence the international economy. The market itself is proving it all

the time, especially during the Spring Festival this year. During the festival period, China's market almost completely stopped, which made the original fragile shipping market collapse again. The BDI index dropped to 647 point, which was the lowest since 1986, even lower than 663 reached in 2008 caused by the crisis. And soon after China was back to the market, the situation became much better. With such a gigantic influence China could have on the shipping industry, it is quite important to be aware of the impacts that NSR could bring about to China's economic and its shipping industry. One of the many, with the shift of major freight volume, there will be a new shipping center in the north area of Asia, followed by the changed demand of off-shore services such as bunker service, etc. On the other hand, according to the former researches, the North Pole contains massive amount of nature resources which are becoming rarer elsewhere these days. With the exploration of NSR, those precious resources will be no longer unaccessible.

1.2 Literature Review

The temperature of Arctic Area has been climbing for years, which has aroused shipping people's attention both in China and abroad long time ago. Both academic scholars and shipping people have already been researching the NSR for decades, and many exploration and experiences were done to prove the true value of those new sea routes.

According to Professor Zhang Xia and his colleagues, they believed that the sea ice would be thawed totally in summer within 10 years, which would enable a new sea route to connect the Europe, east of North America and East Asia in their paper, *The Economic Estimate of Arctic Sea Routes and Its Strategic Significance for the Development of Chinese Economy,* (2010). Meanwhile they analyzed those new routes from distance, operating cost and possible impacts it might cause to China's economy, trade and the development of coastal regions. By scrupulously calculating the distance between world's important ports and the length of both new and old sea routes, the authors managed to make a contrastive analysis of the NSRs. Bai Chunjiang, (2009)

and his colleagues summarized the features and current situations of Northwest Passage and NSR in the Arctic Ocean. They believed the establishment of those new sea routes would be benefit for the countries along them and their shipping companies, also for transportation of massive natural resources in the Arctic Ocean.

Li Zhenfu, professor of Dalian Maritime University, wrote several papers about the NSR. In *Analysis of China's Strategy on Arctic Route*, (2009), he believed that the focus of Arctic issues is the competition of NSRs' passing rights and interests. Furthermore, in his later study Professor Li analyzed China's opportunities and threats while opening up NSRs, based on the analysis of the importance of those sea routes. The opportunities mainly are cost saving, tourism value, new chances for ports in northern China, etc. While the threats could be more intense competition and different influence on economy between the north and the south of China, etc. Moreover, Professor Li proposed that China should establish relevant national policies and take counter measures from the aspect of China's shipping companies.

The new sea routes will also have some impacts on China's logistic industry. Professor Wan Zheng and Deng Zhibing, (2005) proposed to open up new routes as well as an idea to build a logistics platform in Arctic Area at the background of global warming and more and more melting sea ice in that region. They also analyzed such changes of logistics pattern in a strategic level. In addition, they discussed the fourth party logistics business opportunities brought about by the navigable Arctic Ocean and other radiation effects.

Margaret Blunden, (2012) revealed his idea in his paper that the major trading powers of Europe and Asia, particularly Germany and China, are preparing their strategies and capabilities in anticipation of the possible opening of one the NSR, to regular commercial transit. He made further analysis from international political aspect which is one of the most critical problems of developing NSR. Additionally, Petros Kelaiditis, (2011), one former student of ITL, introduced the current severe problems

of piracy and their remarkable damage to shipping industry and international trade. Therefore, he believed the open-up of the Arctic sea routes would be an excellent solution to the piracy issue. He used voyage estimate to calculate voyage costs when take traditional routes and new ones to find out to what extend the new routes could help carriers save their costs.

Foreign experts have already done quite a lot about the research of NSR, while Chinese researchers did not pay adequate attention. Many Chinese researchers shared the same opinion that China was not doing enough in the research of NSRs. Professor Li Zhengfu states in his study, that:

> *So far, most researches on the Arctic concentrated in the natural sciences, mainly related to meteorological, geological and biological research and there were few researches for the Arctic sea route issue. The problems mainly include:*
> *1) Former researches were not deep enough and there has been no systematic research, most of which were only limited analysis of the possibility of opening the Arctic sea route. 2) More articles of introduction and translation than forward-looking and predictive ones. 3) Researches on key issues were not enough. The focus of the Arctic route issue is how to solve disputes. However little research appears not many introductory article, obviously does not meet the actual needs.*

Not only Professor Li had this point of view, other researchers like Professor Zhang Xia and his colleagues, (2009) also appealed that more and further researches for NSR should be done, especially in statistical methods. Most domestic researchers still dwell on the dispute of whether NSR is valuable for exploring, negotiable for merchant vessels, or if it is meaningful to do such researches. According to those experts, NSR issue includes problems in various aspects and polity is one of them. A news report on the internet said that Russia has turned down China's propose to share the resources in the Arctic Area, with the belief that they belong to Russia only. The

dispute has lasted for years yet no agreement has been reached.

To sum up, as the Arctic sea ice is retreating, there comes the brand-new and pure virgin waters to which the whole world would pay more attention. Being one of the biggest international traders, China would be remarkably influenced by the effects brought by those new sea routes. The severe competition of this new resource would come along in no time. China should be prepared for it. To gain some advantages and protect its reasonable rights, China shall do further studies to acquire more comprehensive knowledge about the Arctic area and the NSR.

1.3 Methodology

The main purpose of this dissertation is to look into the future and to find out what possible impacts those new sea routes would bring about to China's shipping industry. The author uses recent and former researches and records to analyze the current status of the Arctic area and its developing trend. Then SWAT analysis and AHP model are used to comprehensively analyze the merits and demerits of China's shipping industry in the NSR issue. And based on such analysis, the author tries to conclude proper strategies. Meanwhile, with the help of optimization models, the author attempts to illustrate the impacts on China's shipping industry and logistics system, brought by the fully open of NSR.

1.4 The Framework and Contents

Chapter one is the introduction of the whole dissertation, including the background information of the topic, literature review, the methodologies used in the thesis and its structure. Chapter two introduces NSR in more details and the author also analyzes current status of the Arctic region and predicts its development tendency in the future based on both recent and former researches and records. Chapter three uses SWOT model to find out the possible effects that NSR could bring about to China's shipping industry and use AHP model as a complement for SWOT analysis of NSR. In Chapter four the impacts on China's shipping industry are analyzed and propose strategies

based on the former SWOT analysis. The author believes that with the influences of NSR, more freight volume will shift to North China and additionally there will be new opportunities for China's sea ports. Finally chapter five concludes the whole thesis.

Chapter 2 Overview of NSR

2.1 The Formation of NSR

2.1.1 Global Warming

According to recent studies about the ice cores taken back from the South Pole, much like the shipping industry, the global climate also has its cycles which means in relatively certain period of time the global average temperature goes up and down with a regular pattern. Now the climate is at its warming up pattern and human activities are remarkably and continuously accelerating the process, which is known to people the global warming effects. The global temperature is influenced by the heat which is hold by the atmosphere both from the direct sunshine and ground-reflected infrared. The more gases such as carbon dioxide, sulfur dioxide, methane, etc. the earth is like covered by an increasingly thicker blanket which keeps more heat from the sun. That's why those gases are called green-house gases.

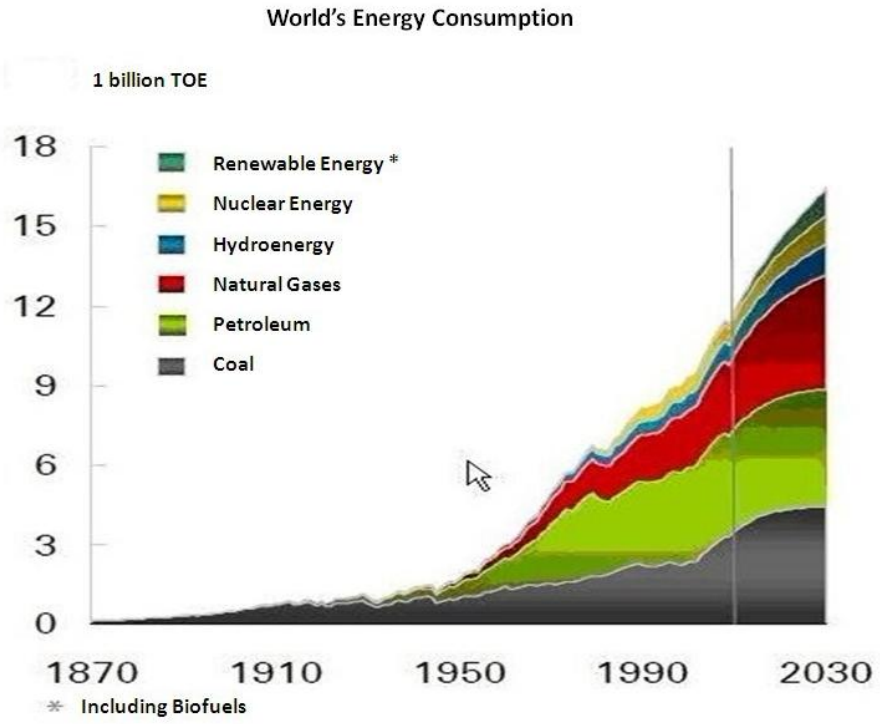

Figure 1- World's Energy Consumption
Sources: http://image.baidu.com/

Since the world's industrialization, human activities have discharged so many green-house gases which severely damaged the balance of the atmosphere. The industrialization process and the boom of the world's population directly caused people burning more and more fossil fuels.

As shown in Figure 1, from 1870 to today, world's energy consumption has increased remarkably. And among all the energy sources, fossil fuels like coal, petroleum and natural gases remain the main energy sources which in recent years are gradually decreasing in proportion yet still hold 90% of the total nowadays consumption. As a consequence, human now are discharging hundreds even thousands times of green-house gases than they did before, which traps huge amount of heat causing serious climate changes. Due to the gradually changed global climate with more frequent and severer disastrous weathers, people now begin to realize the importance to slow down global warming process through cutting down the emission of green-house gases. The decreasing proportion of the fossil fuels in the world's total energy consumption is one proof of people's efforts, indicating that more new environment-friendly energy sources are being explored and put into usage. However unfortunately, despite whatever efforts people do, this natural process is unstoppable and irreversible. That is to say, even if people from now on make every effort to reduce the emission and take all measures to protect the environment, the global average temperature will still continue to grow up.

2.1.2 The Developing Trend

On 10th April, 1912, the fully boarded brand new cruise vessel, the Titanic hit an iceberg and sank in the North Atlantic Ocean not far away from the Bermuda area. Year 2012 is the 100th anniversary of the Titanic Event. In memory of those people lost in the accident, the movie "The Titanic" was revised to 3D version and was put on the show this April. According to the introduction on the webpage of IMO, it was because this disaster that spawned SOLAS Convention, the first and still the most important treaty today, which stands for the convention on the safety of life at sea.

Even IMO its own foundation was facilitated by the event, because people then realized that they need an international institution to help making sea transportation safer[1].

On the other hand, the accident indicates that 100 years ago icebergs could float down all the way to that latitude area. It is due to the lower temperature in winter so that the Arctic icecap could reach out far away from the pole area and when huge pieces of the icecap broke up and flew away, they became icebergs and some of those icebergs would not be completely melted even until summer. At that time, since there flew countless icebergs in various sizes, for merchant vessels even sailing in North Atlantic Ocean was quite dangerous not to say sailing in Arctic Ocean. However, nowadays since the global climate continues to warm up, icecap all around world is retreating faster and farther, especially in the Arctic region.

Some reports suggest that the covering area of the Arctic sea ice is reducing 3% every 10 years. In 1980, that number went up to 10% (Wan Zheng, 2005). According to the data from NSIDC, Professor Wan and Deng Zhibin made a diagram showing the changing trend of the Arctic sea ice area.

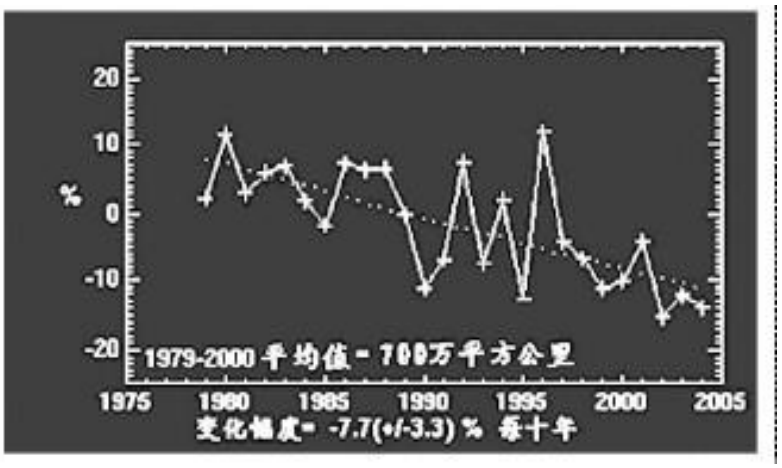

Figure 2- The diagram of the ice area
Sources: A New Logistics Pattern in the Future

[1] The content is on the front page of IMO website.

The diagram shows that the ice cover has reduced nearly by 20% from 1980 to today. At the same time, thickness of the Arctic sea ice in 1993 ~ 1997 was much thinner than it was in 1958-1976. The thickness of the ice has been reduced by about 40%. (Rothrock, D.A & Y, Yu, 1999)

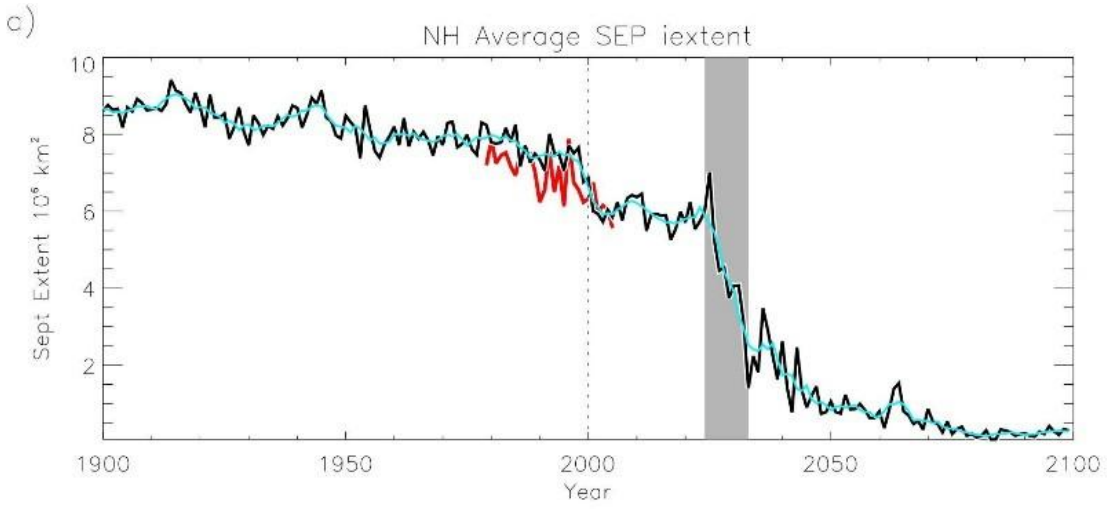

Figure 3- Average ice extent in September
Source: http://www.realclimate.org

Figure 3 shows the extent of Arctic icecap in September. From 1900 to 2000 is based on real state collected from satellites and after 2000 is the prediction of a meteorology model. It is obviously that icecap extent is retreating at an increasing speed.

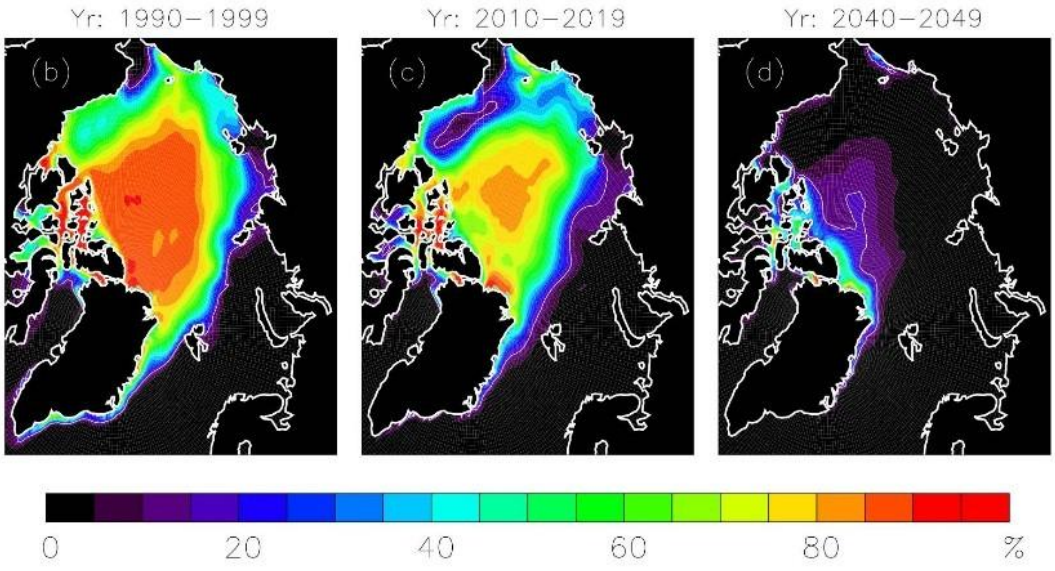

Figure 4- Satellite image of ice extent
Source: http://www.realclimate.org

Figure 4 also contains two parts that one is based on actual data and the other is a prediction from the model. It shows the actual location of the Arctic icecap extent and how the situation would change with a map. The color means the level of covering ice. Black means no ice at all and red means the water is 100% covered by ice. Nowadays, in September, little ice could be seen along North Russian coast and also little ice in north Canada. This tremendous retreat of icecap caused quite a lot of problems such as less icecap let the sea absorb more heat from the sun because white ice can reflect sunshine, which makes the green-house effects even stronger and may starts a vicious circle. Additionally, the extent of icecap becomes farther away from the land which is a fatal change for polar bears who would like to move to the polar area and use icecap to hunt seals in winter, as well as Arctic Seals. They would probably die out soon, if without human's protection.

Based on a report from WMO, global warming has caused a phenomenon called the south-cold-north-warm weather, which means the weather of the Arctic area keeps being warmer while lower latitude areas suffer the attacks of extreme cold air mass, causing extreme low temperature and deadly blizzards there. (WMO weather report, 2010) According to this research, this phenomenon has occurred several times in last decades and it will continue to take place even become more severe in years later since the global temperature keeps climbing up. The trend is that less icecap will be left in the Arctic area as well as floating icebergs, and the warming climate would eventually clear out the waters. NSR will be definitely useable in the near future. The prediction part of Figure 1 and Figure 2 also reveals the possible future that the icecap would eventually completely disappear. Another report from WMO says that if the situation continues to develop in today's pattern, there will be absolutely no ice left in the entire North Pole area in summer and only a little and thin icecap in winter in 2020~2050. Once that becomes the truth, NSR will no longer be limited along north Russian and Canadian coasts, merchant vessels can easily pass through the North Pole area just like if they were sailing on open sea, without any fear of hit by a floating iceberg.

2.2 The Reasons to Choose NSR

2.2.1 The Characteristic of Shipping Industry

Shipping industry is a capital intensive and derivative industry from international trade, which is remarkably influenced by international economic development. From a long term point of view, the shipping industry develops with circulative patterns. Professor Shuo Ma once stated in his lesson that a full circle usually takes 7 years. However, the latest one lasted for 11 years because of China's economy boom. (Shuo Ma, 2012) In recent several years, the shipping industry has experienced rapid ascent and sharp fall. We know that in 2003 the shipping market began to shoot up and reached its peak in late 2008. After the outbreak of the Subprime Crisis started in the U.S., the global economy collapsed and so was the shipping industry. Baltic Dry Bulk Index, shorted as BDI, is one of important indicators people used to assess, analyze and predict the market. The index from a certain aspect reflects the actual market situation.

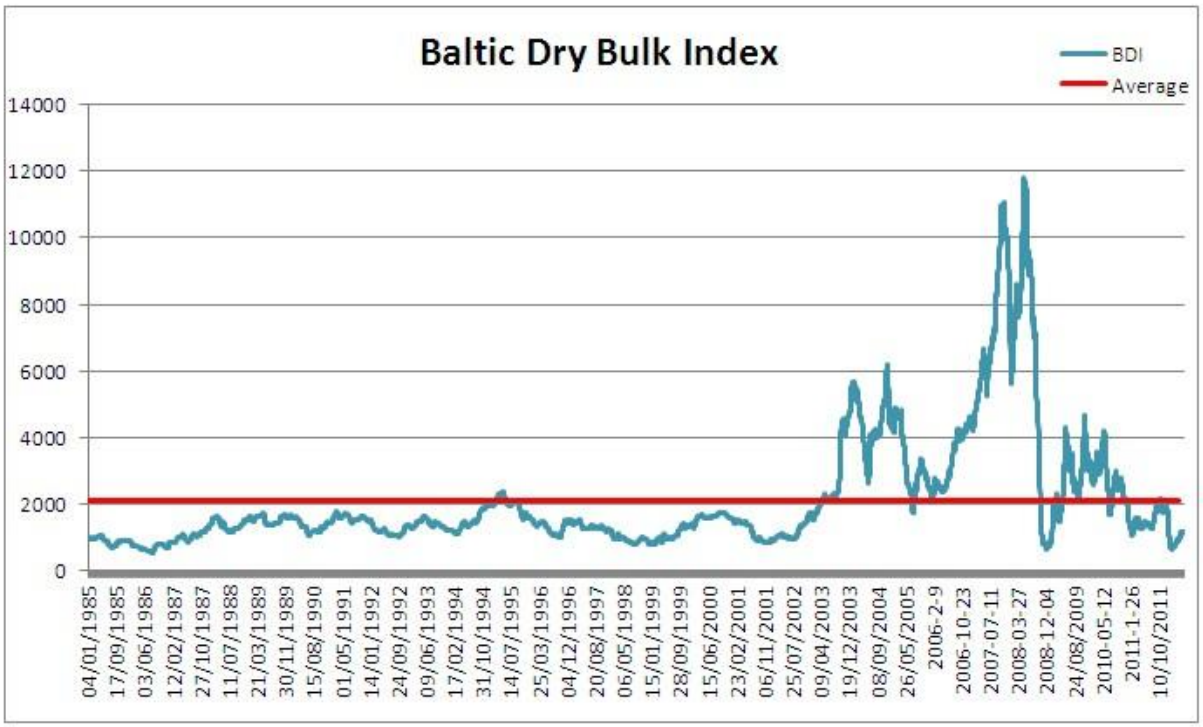

Figure 5- BDI from 1985 to 2012
Source: Data from Baltic Exchange

The diagram shows BDI from its very beginning from 1985 to today and the average line. The diagram reveals three characteristic of the industry. First the circulative

pattern can be observed. The index went up and down with regularity. Second it shows the huge fluctuation with the boom of the industry from 2003 to 2008 and then there was a vertical drop. The third characteristic is that despite the huge fluctuation, in most time the industry runs at a relative low level, which means in most time shipping people do not have a good market.

Compared with the fluctuating revenue, the costs of shipping have been however constantly increasing, which includes crew's salary, insurance, bunker price, etc. In recent decades, crew's salary and bunker price climbed up most dramatically among other costs. Nowadays, bunker costs have been a heavy burden of shipping people, accounting for over 60% of their total costs. (Shuo Ma, 2012) And with the gradually exhausting global oil resources, the bunker price will continue to grow from a long term of view, which will further squeeze away profit margins of the industry. With these concerns, the industry is desperate to find new methods to cut down their costs, such as new shorter routes so that they can save more time and fuels. Consequently, NSR aroused their interest.

2.2.2 Restriction of Canals

Canals are rivers digged or modified from natural rivers by people for water transportation purposes or to connect important waters to create shortcuts such as the very famous Panama Canal and the Suez Canal. To take the Panama Canal as an example, it works as a bridge between the Pacific Ocean and the Atlantic Ocean so that ships need not to go around the Cape Horn at the bottom of South America which tremendously decreases the voyage distance. However, the canal has its limits. The land is above sea level so ships crossing the canal need ship locks to lift them as an elevator. As a result, the locks have their fixed length, width and draft. Ships crossing the canal cannot be longer or wider or have deeper draft than the locks. That's the reason today there is a vessel type named Panamax which means the biggest size of vessel that could across the Panama Canal, same reason for Suezmax. Any ships with bigger sizes than that have to go around the Cape Horn or Cape of Good Hope. So

there comes the Capesize. Although Panama authorities have widened the canal several times, it still is not enough for the process of the scale economy which induces people to build larger vessels. Eventually, canals will no longer be shortcuts but restrictions for shipping industry.

2.2.3 Pirates and Politics

There are many risks when sailing on the sea. Some of them are natural risks like heavy wind, huge waves, reefs, etc.; and some are artificial ones like pirates, wars, etc. In recent years, pirate activities are becoming increasingly rampant, especially in Somali, West Africa and West India waters. Nowadays, pirates are not just robbing passing vessels, but they attack vessels with heavy weapons and kidnap both the vessel and the crew on it, even would kill them if they resist. Then they hold their victims and vessels as hostage to extort the owner or the shipper. Some extremely vicious pirates would even kill those innocent sailors with brutal methods. New forms of piracy are estimated to be costing between 0.01% and 0.2% of maritime commerce, amounting to about $8 trillion every year. (Blunden, Margaret, 2012) Petros Kelaiditis analyzed current pirate situation and took it as his dissertation topic. According to his study, approximately 60,000 vessels per year pass through the Malacca Straights carrying 30% of global trade between European and Asian markets. In 2007, 20,384 vessels have passed through the Gulf of Aden and Suez Canal carrying 700 million tones cargo to Europe, Asia and Africa. (Petros Kelaiditis, 2011) That is to say, the majority of merchant vessels and the cargo transported by sea would pass the above waters. Consequently, they would be of great risks to be attacked or even be hijacked by those criminals. Petros also revealed that damages caused by armed piracy attacks have been estimated between $10,000 and $50,000 per attack. In 2008, 183 actual and attempted piracy attacks have taken place along the MSR. Damages of $30,000 per attack could cause financial loss of $5,490 million per year. (Petros Kelaiditis, 2011) Despite these direct losses, vessels passing pirates waters may require extra insurance and moreover ship owners or shippers may not accept passing through these areas

which could generate additional costs of deviation. As a result, shipping people tend to find safer sea routes to avoid such risks.

Another reason could be the politic problems. Every vessels sailing on the sea has its nationality and the relationship between different countries could also bring about problems. Moreover, as mentioned above, today's most busy sea route passes through the waters of the Middle East, where there are so many destabilizing factors and unpredictable events. For instance, Iran used to threat to close the Strait of Hormuz, which could severely endanger oil export from Saudi Arabia and Iraq. Additionally, the political unrest could also cause great troubles. Started from November, 2011, the political turmoil in Egypt even led to the closure of the Suez Canal for some time, forcing ships to take longer voyage via the Strait of Good Hope. On the other hand, regional political instability might aggravate pirate activities, such as Somalia which has been in anarchy since 1991.

2.3 The Exploration of NSR

NSR is not a new topic for researchers and the shipping industry, and countless studies have been done to find out its true value for the industry. European countries began to search for alternative sea routes from the very beginning of 1970s. (Ola M. Johannessen, 2007) Nowadays, two routes are widely accepted that one is across the Bering Strait and along North Canadian coast called the Northwest route and the other is along North Russian coast called the Northeast route to enter Atlantic Ocean.

Based on the report of Professor Bai Chunjiang and his colleagues, the current status of NSR is as described followed:

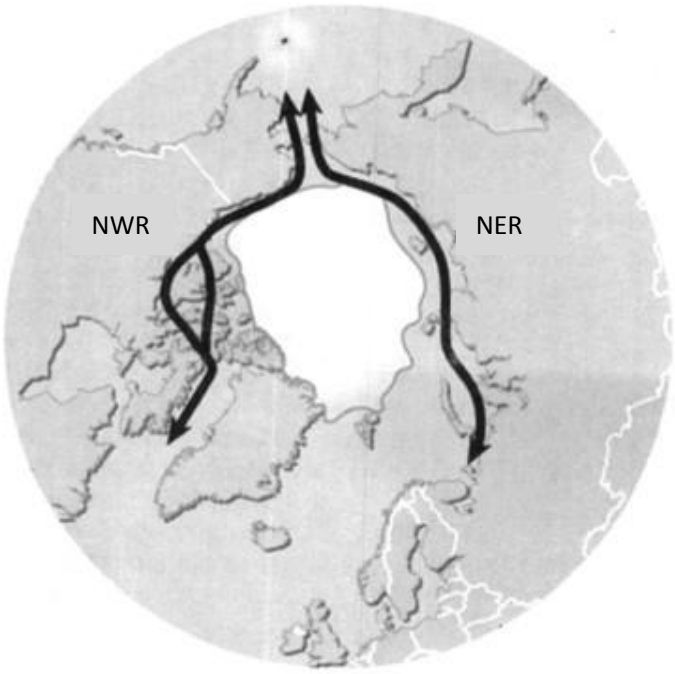

Figure 6- The NSR Schematic Map
Source: The Economic Estimate of NSR and Its Strategic Significance for the Development of Chinese Economy

The NER is the shortcut between the Atlantic and the Pacific, and also is the shortest sea route between Europe and Asia. In west it starts from Murmansk, crossing the Barents Sea, the Kara Sea, the Laptev Sea, East Siberia Sea and the Chukchi Sea in south of the Arctic, and to the Bering Sea of the Pacific to Vladivostok. Its total length is about 5620 nautical miles. This route was formally open in 1930s and the navigation phase of whole line was 2 ~ 3 months. It was difficult to go through the part of the route between the Kara Strait and the Bering Strait and pilot support of icebreakers was needed. Main ports along the route are Dixon, Dudinka, Igarka, Tiksi, Pevek, Provideniy, etc.

On the other hand, the NWR is made up by a series of straits of American Arctic area. In east it starts from Baffin Island and ends in west at the Beaufort Sea. Its total length is about 800 nautical miles, the depth of the main channels is 305 meters and the channel extends in all directions with starstudded islands. Usually the sea was covered by massive ice nine months a year and half of the channels were ice jammed throughout the year. American Arctic area has tough weathers and the channels are

complex. Normally, if not supported by advanced navigation equipment and ground-based guidance, it is difficult to find a correct passage. Even in the summer there are still floating ice and icebergs in the sea in the NWR. The Arctic icecap constantly provides petrous ice pieces from the west through the McClure Strait, which gravely threatens the safety of merchant vessels. In winter, the NWR is overall frozen and none ordinary merchant vessels can navigate through it.

With such situation, NSR would not be quite attractive to shipping industry because they are too dangerous and cannot be used all year round. NER can only be used for 2~3 months and the NWR is almost useless all year round if without appropriate support. However, with the warming climate situation is gradually changing. Mentioned above, the Arctic icecap is retreating, nowadays the NSR's navigable period has already been wider and soon enough they will become new routine routes which are navigable all year round.

2.3.1 Advantages of NSR

First of all, the Arctic area is rich in oil, gas, minerals and fishery resources. About a quarter of the petroleum and natural gas resources which people has not yet discovered are in the Arctic, with an huge amount of 10 billion tons at least. With the exploration of NSR, people then can establish routine transport routes so that to have access to those precious natural resources. This huge amount of new reserves of petroleum and natural gas could ease energy crisis nowadays in a certain extent.

Secondly, in next 50 years, NSRs are well likely to challenge current sea routes going through the Panama Canal or the Suez Canal. It is well known by shipping people that the current Asia-Europe sea route is about 13,000 miles, and if NSRs are fully open, they may shorten the Asia-Europe sea voyage at least to 7,900 miles, which is 5,100 miles less.

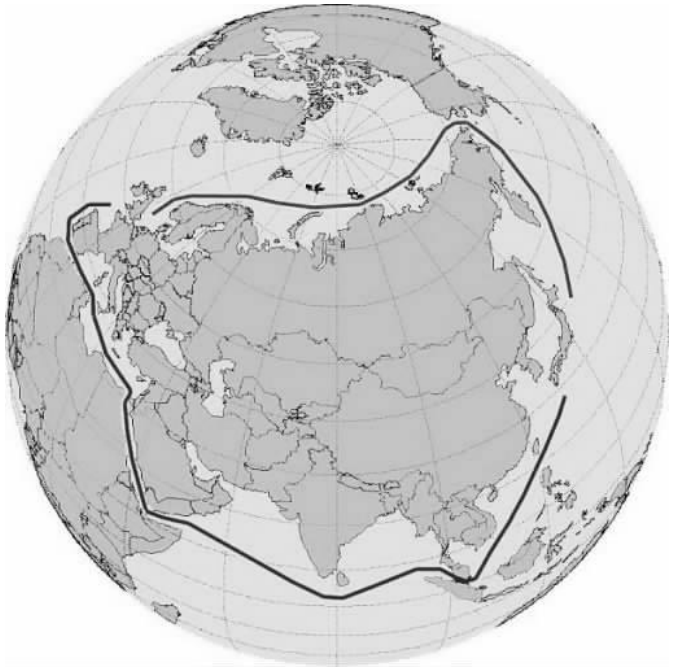

Figure 7- Northwest Sea Route
Sources: Analysis of China's opportunities and threats on Arctic route

Now NSR is still not fully open, but the Asia-Europe route is gradually warming up. At present, there are 54 circle lines around the Asia-Europe route providing weekly container liner service and other three routes started from Europe, via Australia then back to Asia. This means that the weekly freight volume of the route could be up to 321,500 TEU and annual freight volume could be 16.718 million TEU. Among the 57 routes, 15 routes have enough ships standing by with a capacity of more than 7,500 TEU each. A quarter of the new container vessels delivered in 2007 were put into the Asia-Europe route, its rising speed was faster than the predominant Trans-Atlantic route. If takes a container carrier with a speed of 21 knot, traveling from north China to Port of Rotterdam, Dutch. If it goes around the Cape of Good Hope, it may need 29 days' time; If it goes via Singapore, the Strait of Malacca and through the Suez Canal, it may need 22 days; But if it takes NER, it may only need 15 days, with a time reduction of 30% less than the current traditional sea route through the Suez Canal. For ocean going transportation, vessels can save much time and travel distance and at the same time, they can save the canal expenses, fuel costs and ship dissipation, which will bring significant economic benefits, and much lower operation costs for ship companies.

Furthermore, establishing NSR may release the industry from heavy dependence on the Suez and Panama canals, which could lead to another ship upsizing process. Taking the Panama Canal as an example, it has 6 ship locks working as elevators to lift and avale ships. Each of them is 304.8 meters long and 33.53 meters wide and 12.55 meters deep. The extension project started in September, 2007, which would provide the canal the third generation of ship locks and they will be 427 meters long, 55 meters wide and 18.3 meters deep. (Wikipedia) With these new locks, even some relatively smaller Capsize vessels can pass through the Panama Canal. However, with the development of technology, several years later even Capsize vessels might only be called small boats. That is to say that fixed ship locks still will be a restriction for upsizing process even being expended. With NSR, such limitation will no longer exist. Vessels taking NSR are sailing on open sea so that the industry can continue the upsizing process to pursue better economy of scale.

2.3.2 Problems of NSR

On the other hand, NSR also has some weakness that may currently bring some problems and troubles to the shipping industry. First, although the temperature of the Arctic area has remarkably increased which accelerates the melting speed of the ice there, the temperature there is still very low. The contemporary situation of NSRs could let merchant vessels pass only in a very short period of time in a year. Because the temperature there now is not warm enough and there are still many areas covered by thick ice and many icebergs scattered. The low usable rate of NSRs may decrease most shipping people's interest to explore them. And for now, vessels which take NSR still need icebreaker support as mentioned above according to Professor Bai's report. (Bai Chunjiang, 2009)

As the ice situation there would gradually become better, merchant vessels could sail there as safely as they do in other waters today yet the vessels still need to prepare for the low temperature. That is another weakness for NSR, because it requires not only the insulation measures to provide the crew with a warm working condition but also

some special steal-making technologies to ensure the steal can endure the low temperature. As people all know, when steal is kept in a low temperature environment, it tends to become more fragile which might endanger the safety of the entire vessel. And some scholars believe that it could be one of the many reasons that made the Titanic sink so fast.

Thirdly, the bad weather may sometimes cause some troubles for merchant vessels. The Arctic area often has strong wind, which could bring along tough wave and surge and makes the voyage more difficult and risky. So it would be quite necessary for the industry to have access to this information. However at present, there are still many problems because of lack of reliable data of the relevant waters, such as weather and sea condition materials (storm, wind, sea fog, SST, sea ice, current, wave, tidal etc.); Waterway status (water gauge, navigation marks, lighthouse etc.); Port state (draft, icing extent, ice thickness etc.); Ground-based support (communication, supplies along the route, icebreaker and emergency rescue, shelter etc.); Environment protection (oil spill response, liquid or solid waste collection). (Bai Chunjiang, 2009)

Moreover, NER goes along the Russian coast line and NWR goes across Canadian territorial sea. Consequently, the exploration of NSR would include international political problems as well as the abundant natural resources in that region. Unfortunately, the international convention, UNCLOS, does not have detailed or specified clauses about the Arctic Sea. (Blunden, Margaret, 2012) As a result, arguments about that issue have been continued for decades. Canada for years has been claiming that NWR is in its continental sea. However, other countries disagree with that and believe that it should be shared by the whole world. On the other hand, Russia has been claiming its rights in the exploration of waters along its north coast all the time. Russian expert, Guru Leah J, from Russian Law of the Sea Center believes that Russian control on NSR is indisputable. He also insisted that NSR is an artery of the country and Russia has been exploring it long time ago and it shall be under Russian control. (http://www.ship.sh/news_detail.php?nid=3331) Other

countries around the Arctic area, such as the U.S., Canada, Denmark, Norway, Sweden, Iceland, and Finland also have their own point of view about this issue.

To sum up, all those criteria together let shipping people desperate to find a way to reduce their costs and risks and improve their income. As the growing temperature in the Arctic area, NSR becomes to be more and more valuable for the shipping industry. Although there still be many problems to be solved, since the exploration of NSR could bring not only the shipping industry but also the global economy countless amount of benefits, the international society will make every effort trying and eventually come to an agreement to explore it together.

Chapter 3 A SWOT analysis of the NSR issue

In this chapter, the paper analyzes the impacts that the NSR can bring about to China's shipping industry. With the exploration of NSR, China's shipping industry will enjoy several benefits. However everything on the world has duel characters. The exploration of NSR could also bring about problems. The author uses the SWOT model to analysis China's situation in NSR issue from both sides.

3.1 SWOT Model

SWOT is a strategic analysis method to find out the advantages and disadvantages of the core competitiveness, which draws the conclusion through comprehensive evaluation and analysis of the object by strengths, weaknesses, opportunities and threats. Through combining the internal resources and the external environment to precisely spot advantages and defects of the object; and understand the opportunity and challenge the object faced with, so as to adjust methods or resources in both strategic and tactical aspects to ensure the implementation of the object and to achieve the planned goals. Among the four capital letters, the "S" represents strength; "W" represents weakness; "O" represents opportunity; and "T" represents threat. Furthermore "S" and "W" are internal factors; "O" and "T" are external factors. It is also known as trend analysis and it was proposed by a professor of management at the University of San Francisco in the early 1980s. It is a relatively objective and accurate analysis method which studies the real situation of a unit. SWOT analysis has gradually been used by many enterprises in their management, human resources, product research and development and other aspects.

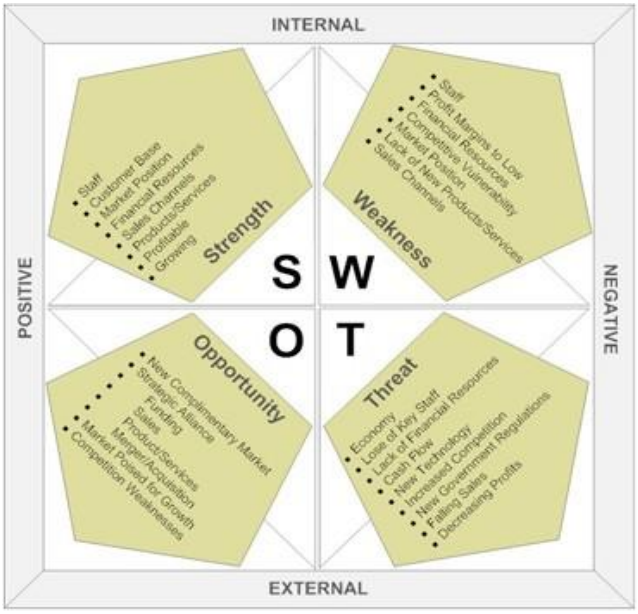

Figure 8- SWOT Model
Source: http://baike.baidu.com/view/95520.htm

SWOT analysis is one of enterprises' internal analysis methods at a certain point, which means to analyze things based on its existed internal conditions. This method has its forming foundation. According to the complete concept of competition strategy, a proper strategy should organically combine "can do" (the strengths and weaknesses) and "possible" (opportunities and threats).The Theory of Competition, put forward by the famous competition strategy expert Michael, gives a thorough analysis and instruction about enterprises' "possible" from the aspect of industrial structure. On the other hand, managerialists of the Capacity School use the value chain to analyze enterprises' value creation process, focusing on the companies' capacity and resources. SWOT analysis integrates the two theories above and is represented by the scholars of the Resource School, combining the internal analysis (the research direction of the authoritative management scholars in the middle of 1980s and is represented by the Capacity School) and the external analysis of industrial competition environment (the central theme of the earlier strategy research, represented by Andrews and Michael. Potter) together, forming its own structured and balanced systematic analysis pattern. Compared to other methods of analysis, SWOT analysis has remarkable structured and systematic characteristics. From the structure aspect, first in the term of form, SWOT analysis method tends to form SWOT matrix structure, and defines different

analysis meaning for different area of the matrix; second from the term of content, the main theoretical foundation of the method is also analyzing the external environment and internal resources from the structural analysis. In addition, before the 1960s when SWOT analysis was founded, someone had already proposed those variables of the method such as internal strength, weakness and external opportunity and threat, but they just analyzed them separately. The important contribution of the method is to use systematic thought to match up those factors which seems to be independent of each other and to analyze them comprehensively. It makes the enterprise strategic plan more scientific and comprehensive.

Since its formation, SWOT method has been widely used in enterprise strategic research and competitive analysis, and it has become an important analysis tool for strategic management and competitive intelligence. Direct in analysis and simple to use are its important advantages. Even without the support of accurate data and more specialized analysis tools, also can convictive conclusions be drawn. But, it is because this direct and simple, makes the method inevitably have the defect of insufficient precision. For example, SWOT analysis uses the qualitative method, forming a fuzzy enterprise competitive position description through listing its various performances of “S”, “W”, “O” and “T”. Judges based on such description would inevitably be with subjective assumes. As a result, in the use of SWOT method, attention should be paid to the limitation of this method, and when listing the facts as the reasons of judgment, people should try to ensure their reasons to be real, objective and accurate, and provide certain amount of quantitative data to make up for the deficiency of the qualitative analysis of SWOT, constructing the basis of high-level qualitative analysis.

3.2 Strength and Weakness

3.2.1 Strength

Nowadays China has become the second largest economy body of the world, which has an increasing influence on the developing trend of the global economy. And as a major trader, China will continue to export and import massive amount of raw

materials and products using sea transportation. China will inevitably have more and more interest in the exploration of NSR, since it can remarkably reduce transportation costs. Russia experts also believe that with China's increasingly consolidated position in international events, China may have growing interest on NSR and the Arctic natural resources. And Russia's global status is also closely related to the value of the Arctic area. Considering the nature of the strategic partner relationship between China and Russia, the NSR issue would possibly be a new platform of the cooperation between the two countries. (http://www.ship.sh/news_detail.php?nid=3331)

China also enjoys an exceptional advantage in its geologic position. It stands in the very middle of the two major route of NSR, which tremendously cut down the voyage distance to its two major trade partners, the east coast of the U.S. and North Europe. The unique position will magnify the benefits China could obtain from NSR. Moreover, according to the latest estimate of USGS in 2008, the Arctic region has a reserve of undiscovered petroleum of about 90 billion barrels, natural gas of 47 trillion cubic meters and flammable ice of 44 billion barrels. (Zhang Xia, Tu Jingfang, etc., 2009) As a result, the Arctic area would be a better choice for China's manufacture industry because they are much closer than current options, which also mean lower costs.

Recently, China becomes more vigorous in scientific investigation and research to the Arctic region. Not only the academic people but also the shipping industry pays more attention on this issue. More researches are done to discuss the true value of NSR and its influences and some practical experiments have been done to prove those theories. Also in law inspect, China is studying further about current international sea to consolidate its rights in NSR issue and actively participating the international discussion about the issue to prompt a fair agreement for every country involved.

3.2.2 Weakness

China suffers several disadvantages in NSR issue in different aspects. As mentioned

above, although the temperature in the Arctic region continues to climb up, it will be quite cold in a long time. In near future, ships taking NSR still need specially made hull steel and enhanced insulation equipments. In 2011, China is the second biggest ship builder of the world with a new building GT of 123.961 million tonnes, accounting for 33.7% of the total new GT every year, just 3.7% lower than South Korea. (Wikipedia) Unfortunately, although China enjoys a great propulsion in market share, most China's shipyards still lack advanced vessel designs and building technologies. When NSR are accepted as routine routes, new requirement of seaworthiness will also be put on the table. At that time China's shipyards will suffer the lack of this advantage and will be forced to transform its industrial structure to adapt themselves to the new market.

Speaking of technologies, the exploration of natural resources in such high latitude area with relatively cold weather would also require advanced technologies and huge amount of initial investments. And in that aspect, China currently also does not have much experience and enough technologies to handle those challenges. Moreover, although China's international position is rising up, it still lacks discourse power in such important and multilateral events as the exploration of the Arctic natural resources and NSR. Additionally, China is not a coastal country around the Arctic Ocean like the U.S, Russia, Canada, Norway, etc. Although the exploration of NSR will remarkably influence China's economy and shipping industry, it cannot hold the dominant position of the issue.

And more, China's north ports system is relatively weaker than its south one. According to the Table 1, the freight volume of China's north ports only counts for 12.29% of the total freight volume, yet the one of south ports counts for 71.73%.

Table 1- The freight volume in water transportation of China in 2011

Total	North ports	South ports
39,714,390	4,879,440	28,485,180

Unit: 1000 ton
Source: www.transchina.com

There is still a lot of preparation for China to do, when NSR is fully open and the global sea traffic volume begins to shift towards north.

3.3 Opportunities and Threats

3.3.1 Opportunities

As the second biggest economy body on the world, China has magnificent influence on the whole world's economic development. And China is and still will be a developing country for many years, which means it will still need massive amount of natural resources and raw materials to build up its economy. (Li Zhenfu, 2009) For years, China import iron ore most from Brazil, Argentina, Australia and India; coal most from Canada, the U.S., Indonesia and Russia; petroleum most from Russia and Middle East Countries and other general products from Europe and the U.S. China's domestic resources are far from enough for its normal consumption, and importing from other countries are costing huge amount of money to transport those cargos to China. China definitely wants new sources of raw materials and Chinese shipping industry wants a new market to increase their market.

Table 2-China's trade volume with countries around the Arctic Region in 2007

	Russia	Canada	U.S	Norway	Denmark	Iceland	Sweden	Finland	Total
Import	196.77	109.90	693.79	16.15	18.23	0.36	41.47	37.96	1114.63
Export	284.88	193.97	2327.04	22.01	45.90	0.92	45.49	65.64	2985.85

Unit: U.S dollar
Sources: The Economic Estimate of Arctic Sea Routes and Its Strategic Significance for the Development of Chinese Economy, Zhang Xia, 2010

So the reserves in the Arctic area provide China's shipping industry with a good opportunity. With such resources much closer to China, a huge amount of logistic costs can be saved.

Table 3-The comparison of the mileage of current routes and NSR

	St. John's	Boston	New York	Houston	Murmansk	Reykjavik	Hamburg	Lisbon
Tumen	14742C 12070D 10650M 7047A	15238C 12893D 10091M 7746A	15317C 13061D 9927M 7958A	15982C 14596D 9440M 9728A	16225C 12756D 5754A	15133C 11762D 7140A	14948C 11479D 7198A	13634C 10143D 8246A
Tianjin	14560C 11888D 11500M 7966A	15056C 12699D 10941M 8665A	15135C 12876D 10777M 8876A	15800C 14414D 10290M 10647A	16043C 12574D 6728A	14951C 11607D 8114A	14771C 11302D 8172A	13479C 9988D 9220A
Shanghai	13973C 11301D 11290M 7722A	14469C 12112D 10731M 8421A	12548C 12289D 10567M 8632A	15213C 13827D 10080M 10403A	15456C 11987D 6508A	14364C 11020D 7894A	14184C 10715D 7952A	12892C 9401D 9000A
Xiamen	13451C 10779D 11682M 8115A	13947C 11590D 11123M 8985A	14026C 11767D 10959M 9197A	14691C 13305D 10472M 11127A	14934C 11465D 6915A	13842C 10498D 8301A	13662C 10193D 8359A	12370C 8879D 9407A
Hong Kong	13239C 10567D 11935M 8379A	13735C 11378D 11376M 9078A	13814C 11555D 11212M 9289A	14479C 13093D 10725M 11060A	14722C 11253D 7167A	13630C 10286D 8553A	13450C 9981D 8611A	12158C 8667D 9659A

Note: "C" means via the Malacca Strait and Cape of Good Hope Unit: Nautical mile
"D" means via the Suez Canal and the Strait of Gibraltar
"M" means via the Panama Canal
"A" means taking NSRs
Source: http: / /www. dataloy.com

From Table 3, it is easy to find out that in most cases, taking NSR could dramatically decrease the mileage between those important ports. The voyage difference between China's sea ports and European ports are quite big. Starting from China's ports to Russian ice-free port, Murmansk, in Arctic Ocean, the traditional route could save the voyage of an average of 4000 ~ 7000 nautical miles, about 36% ~ 55% of the traditional one. And it can save about 1370 to 4600 nautical miles if go to Reykjavik in Iceland, Hamburg in Germany and the ports around the Baltic Sea. To Lisbon, Portugal, using NSR and depart from the ports in the north of Shanghai can save 400 ~ 1900 nautical miles, yet ports in the south would be 500 ~ 900 nautical miles more. General speaking, using NSR voyages from China to northern Europe, west Europe

and ports around the Baltic Sea would be much more convenient and efficient than to south Europe. And the extent of such convenience depends on the distribution of China's sea ports, the farther in north the more advantages the port has. (Zhang Xia, 2009)

Table 4-The cost reduction percentage of NSR

Sea Route	Fuel	Insurance	Salary and operation costs	Port charges	depreciation
NSR	10%-25%	0%	1.6%-2.7%	0%	-2.1%

Sources: The Economic Estimate of Arctic Sea Routes and Its Strategic Significance for the Development of Chinese Economy, Zhang Xia, 2010

Despite the reduction of China's logistics costs, China stands at a great position when NSRs are widely accepted. Many researchers believe that when the weather of the Arctic area becomes warm enough, people can establish a new global logistics center there, so that to transform the entire global logistic system from the ribbon pattern to the net pattern. (Wan Zhen, 2005) Based on this theory, China's sea ports are in the middle region connecting current international shipping center, Singapore and the future one, the Arctic area and will experience the whole shifting process. With the north shifting of the traffic volume, China's north ports would embrace perfect opportunities to develop their land-based services. Moreover, such a change of logistic pattern will benefit China's other segments of its shipping industry, like bunkering, ship services, insurance, etc.

3.3.2 Threats

Along with the new opportunities, there would also be some threats. Professor Li Zhenfu gives the idea that, once NSRs are fully open, it will attract more freight volume up to China's ports in north so that ports in south might suffer a remarkable loss in their freight volume. Since the open-up policy started, China's economy has been developing rapidly, especially in its coastal areas. In 2007, the Gross Domestic Production was 24.95299 trillion RMB, and the 12 provinces of the coastal area, which accounts for 43% of the total national population, have the GDP of 16.932552

trillion RMB, accounting for 68% of the total national GDP[2]. (Zhang Xia, 2009) And among the whole coastal area, the focus nowadays has been in southern area like the Yangtze Delta area, including Shanghai, Ningbo, Zhoushan, Nanjing, etc.; and the Pearl River Delta area, including Shenzhen, Guangzhou, Hong Kong, etc. Although north ports like Dalian, Tianjin, etc. also has been developing quite well and there are new multifunctional and specialized ports built these years, Shanghai is going to be China's new international shipping center according to its plan. However, with the fully open of NSR and the northward shift of traffic volume, this plan might be in problems.

Another problem of China's shipping people would be the International Law which is a barrier for China to gain its benefit from NSR. The new born market will be a virgin land for all the competitors around the world, who would also make every effort to obtain some benefits from it. According to the UNCLOS, the ice covered waters around the North Pole of the Arctic Sea are international waters, which shall be of the ISBA's supervision and management. Countries around the Arctic Sea like Russia, the U.S, Canada, Norway and Denmark only have the EEZ of 200nautical miles away from their coastline[3]. But the convention still leaves some leeway. If there are evidences to prove that the continental shelf of the country extends to the Arctic Sea, the sovereign ownership still needs further discussion[4]. (Gu Yue, 2009) Gu also reveals that countries like Russia and Canada have claimed their sovereignty to the Arctic Sea for years. And more countries which do not claim for the sovereignty but they also insist that they have rights to enjoy the priority of exploration of the resources there.

Consequently, while NSR could bring opportunities to China's shipping people, it could also leads to even more severe competition. How to beat those tough players would be the ultimate task for China's shipping people.

[2]Data from China's Statistical Yearbook from the National Bureau of Statistics
[3]UNCLOS(1982): Article 3, 4, 57
[4]UNCLOS(1982): Article 76, 77

3.4 Quantization of the Analysis

As mentioned above, SWOT analysis is qualitative analysis and its demerit is week in quantitative analysis, which would influence its accuracy. Professor Li Zhenfu once combined the fishbone diagram with AHP model so as to compensate his analysis. In the much alike method, the author combines the AHP model with SWOT analysis to achieve a comprehensive analysis of NSR.

3.4.1 AHP Model

AHP model was proposed by Professor T. L. Saaty in the early 70s.The model is a simple, flexible and practical multi-criteria decision method for quantitative analysis of identified problems. Its characteristic is to methodize various complex factors through the classifying them into interconnected orderly hierarchies. And then according to the subjective judgment structure of some certain objective realities (pairwise comparison), the model directly and effectively combines the experts' advice and the analyst's objective judgment, quantitatively describing the importance of the piarwise comparison of single hierarchy factors. After that, mathematical methods are used to calculate the weight values which reflect the sequence of relative importance of factors in each hierarchy, and rank all the factors with their weight value through figuring out the total order of all the hierarchies. Due to its combination of qualitative and quantitative and the system is flexible and concise, AHP model is quickly and widely used in every field of the society, such as energy system analysis, city planning, economic management, scientific research evaluation, etc.

3.4.2 Factors Set

Based on the former analysis and taking some reference from Professor Li Zhenfu's work, under the basic structure of SWOT model, the author set factors into four groups as follows: STG={STG_1, STG_2, STG_3…STG_n}, which stands for the strength of NSR; WEK={WEK_1, WEK_2, WEK_3…WEK_n}, which stands for the weakness of NSR; and it is the same to the opportunities and threats: OPP={OPP_1, OPP_2, OPP_3…OPP_n}, THR={THR_1, THR_2,THR_3…THR_n}.

Table 5-Factor details

Strength	STG_1- China's major trader status
	STG_2- China's enhancement in the investigation and research to the Arctic area
	STG_3- The rising up of China's shipping industry
	STG_4- The growth of China's international status
Weakness	WEK_1- China has not much discourse power in international events
	WEK_2- China is not a coastal country of the Arctic Ocean
	WEK_3- The conflicts of the culture
	WEK_4- China's shipbuilding and logistics planning technologies are not advanced enough
Opportunities	OPP_1-Cost reduction of shipping companies and logistics
	OPP_2- Asia ports at high latitudes will become the new international shipping center
	OPP_3- The great tourism value of the Arctic area
	OPP_4- The pattern of international trade and shipping will be changed in the beneficial direction for China
Threats	THR_1- China has no advantage in the exploration of NSR from the International Law of the Sea
	THR_2- the Pressure from the U.S, Russia, Canada and other Arctic coastal countries
	THR_3- China's low latitudes ports will be adversely influenced
	THR_4- Even much severer competition

3.4.3 Evaluation Set

The evaluation value is to give each factor a quantitive value to show the extent of its importance. The grade is divided into 9 grades, which are v=-4, -3, -2, -1, 0, 1, 2, 3, 4, among which the positive factors like strength and opportunities are of positive value and weakness and threats are of negative values. The bigger the absolute value the great the extent is.

Table 6-The strategic value of each factor

Strength				Weakness			
STR_1	STR_2	STR_3	STR_4	WEK_1	WEK_2	WEK_3	WEK_3
4	1	4	3	-3	-4	-2	-3
Opportunities				Threats			

OPP_1	OPP_2	OPP_3	OPP_4	THR_1	THR_2	THR_3	THR_4
4	4	1	3	-3	-3	-2	-3

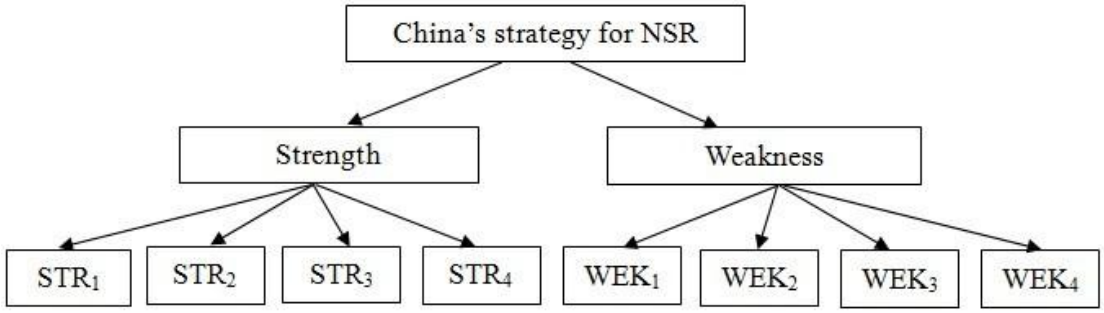

Figure 9- Analysis model of STR and WEK

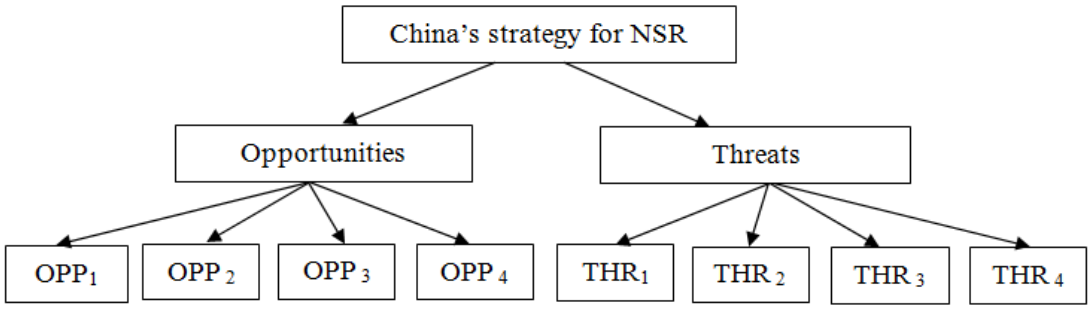

Figure 10- Analysis model of OPP and THR

3.4.4 Calculation of the Matrix

(1) Based on the above analysis models, the next step is to form the comparison matrix, making pairwise comparison of the two groups, STR/WEK and OPP/THR. Each of the factors is given value from 0~9 and then the comparison values are calculated. The matrix calculation as follows:

Table 7-Comparison value

Value of C_{ij}	Interpretation
1	Factor i and j are equally important
3	Factor i is slightly more important than j
5	Factor i is strongly more important than j
7	Factor i is very slightly more important than j
9	Factor i is absolutely more important than j

M_1=Strength matrix; M_2=Weakness matrix; M_3=Opportunities matrix; M_4=Threats matrix[5]

$$M_1=\begin{bmatrix} 1 & 5 & 3 & 2 \\ 1/5 & 1 & 1/4 & 1/3 \\ 1/3 & 4 & 1 & 1/2 \\ 1/2 & 3 & 2 & 1 \end{bmatrix} \qquad M_2=\begin{bmatrix} 1 & 1/3 & 2 & 3 \\ 3 & 1 & 4 & 5 \\ 1/2 & 1/4 & 1 & 1/2 \\ 1/3 & 1/5 & 2 & 1 \end{bmatrix}$$

$$M_3=\begin{bmatrix} 1 & 1/2 & 6 & 2 \\ 2 & 1 & 7 & 3 \\ 1/6 & 1/7 & 1 & 1/5 \\ 1/2 & 1/3 & 5 & 1 \end{bmatrix} \qquad M_4=\begin{bmatrix} 1 & 2 & 4 & 3 \\ 1/2 & 1 & 3 & 2 \\ 1/4 & 1/3 & 1 & 1/2 \\ 1/3 & 1/2 & 2 & 1 \end{bmatrix}$$

(2) Then to calculate the normalized matrix M^{*}[6]:

$$C_{ij}^{*}=\frac{Cij}{\sum_{i=1}^{n} Cij}$$

$$C_{11}^{*}=\frac{1}{1+1/5+1/3+1/2}=0.4918 \qquad C_{12}^{*}=\frac{5}{5+1+4+3}=0.3846$$

…….

Then here is the normalized matrix M_1^{*}

$$M_1^{*}=\begin{bmatrix} 0.4918 & 0.3846 & 0.48 & 0.5217 \\ 0.0984 & 0.0769 & 0.04 & 0.0869 \\ 0.1639 & 0.3077 & 0.16 & 0.1304 \\ 0.2459 & 0.2308 & 0.32 & 0.2609 \end{bmatrix}$$

(3) Calculate the weight (W_i) of each row of M_1^{*}

$$W_i=\frac{\sum_{j=1}^{n} cij*}{n}$$

$$W_1=\frac{0.4918+0.3846+0.48+0.5217}{4}=0.4695;$$

W_2=0.0756; W_3=0.1905; W_4=0.2644

And the average weight (AW):

$$AW=\begin{bmatrix} 1 & 5 & 3 & 2 \\ 1/5 & 1 & 1/4 & 1/3 \\ 1/3 & 4 & 1 & 1/2 \\ 1/2 & 3 & 2 & 1 \end{bmatrix} * \begin{bmatrix} 0.4695 \\ 0.0765 \\ 0.1905 \\ 0.2644 \end{bmatrix} = \begin{bmatrix} 1.9477 \\ 0.3052 \\ 0.7815 \\ 1.1069 \end{bmatrix}$$

(4) Calculate the λ_{max}

[5] The values are given with reference of other similar studies.

[6] Here just use M_1 as a detail example, and other three matrixes are calculated in the same way.

$$\lambda_{max}= \sum_{i=1}^{n} \frac{(AW)i}{nWi} = 4.1190$$

(5) Calculate the constancy index (CI) and constancy ratio (CR)

$$CI= \frac{\lambda max-n}{n-1} = 0.0396 \qquad CR= \frac{CI}{RI} = 0.0440<0.10$$

So the matrix dos not suffer any serious inconsistencies. And the CR of M_2=0.0618; M_3=0.0286; M_4=0.0115, which means they all have satisfactory consistency.

(6) The final value of each factor:

Multiply each factor's strategic value and weight.

Table 8-The final values of the factors

Strength				Weakness			
STR_1	STR_2	STR_3	STR_4	WEK_1	WEK_2	WEK_3	WEK_3
1.8782	0.0756	0.7621	0.7932	-0.6989	-2.1522	-0.2037	-0.3815
Opportunities				Threats			
OPP_1	OPP_2	OPP_3	OPP_4	THR_1	THR_2	THR_3	THR_4
1.1641	1.9038	0.0507	0.5471	-1.3975	-0.8314	-0.1919	-0.4832

And the final scores of S, W, O, T are as follows:

S=3.5089; W=-3.4362; O=3.6657; T=-2.9040.

3.5 Summary

In order to show the result of the model, enlightened by the method used by Professor Li Zhenfu in his work, the author also makes a pane diagram:

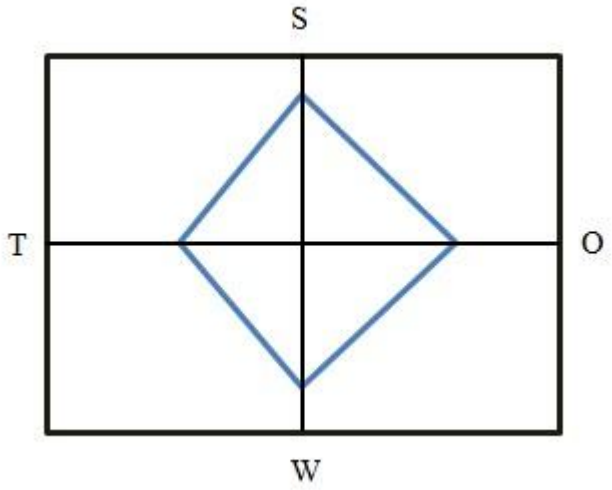

Figure 11-The pane diagram of SWOT analysis of NSR

Figure 11 shows clearly that China has almost off-set strength and weakness in NSR issue and of course strength is slightly bigger than weakness. But it has much more opportunities than threats. As a result, China and its shipping industry should take a vigorous strategy in NSR issue, taking advantage of its strength, overcoming its shortcomings and seize all the decent opportunities that NSR brings about.

Chapter 4 Impacts on China's shipping and logistic industry

4.1 North Shift of the Shipping Center

4.1.1 Shipping Center

It is known by all that nowadays the world's shipping industry is running around Singapore as its true traffic center. Almost all the freight volume goes along lower latitude areas of the earth. The world's busiest sea route is the Far East to Europe route which starts from North China, via South China, Southeast Asia to Indian Ocean and then enters the Mediterranean Sea through the Suez Cannel and ends at Europe. Another sea route with heavy traffic is the Far East to America route which connects Asia and America across the entire Pacific Ocean. Standing in middle of the two busy sea routes is Singapore. That's why Singapore truly becomes the center of world's shipping industry, which enjoys a tremendous traffic volume though its own freight volume is very small.

For instance, Singapore once was the biggest container port in the world for many years and kept this position until China's new ports rose up in recent years. Yet it still is among top 5 despite it is a small country with a size even smaller than Shanghai and a population of only more than 5 million. According to the logistic theory, the development of a container port is dominated by the hint-land stands behind it. And that is the reason that Shanghai, the later comer surpassed the former stronger, Kaohsiung, and became the biggest container port in that region. The main reason is the shifts of major hint-land from Taiwan to the mainland of China. However, Singapore works as a transshipment port and it also takes advantage of its unique position in the world's shipping industry, providing other extended services such bunkering, shipping insurance, finance services, etc. and with decades' of excellent performances, Singapore has become an indispensable point of world's shipping industry.

4.1.2 North Shift of the Traffic Volume

With the formal open of NSR, the situation would be thoroughly changed. Much freight volume would shift to higher latitude areas, using NSRs as shortcuts to go back and forth between Far East and Europe or Far East and America. Based on the characteristics of different segments of the shipping industry, most tanker and container transport would still go along lower latitude areas because the majority of petroleum is produced in Middle East and because main consumers are Europe countries, China, Japan, the U.S., etc. and current layout of hint-land of container ports, instead of NSRs, traditional routes are more appropriate to take. Of course, for North Sea Oil Field and the undiscovered reserves in the Arctic region, things are quite different.

In addition, when NSR is widely accepted by the shipping industry and routine routes are well established, which will takes place in about 15~20 years, the traffic volume will inevitably shift towards north. Based on the basic logistics theory, if other criteria are more or less the same, transportation will always tend to use the shortest way so as the costs can be kept at minimum. Along with the exploration of the Arctic natural resources, current international trades will also go along NSR as their shortcut connecting their major markets.

Along with the shifting traffic volume, the shipping center will also move with it. As mentioned above, nowadays Singapore is out of question the very center of the global shipping industry. When major traffic volume is moved toward north, Singapore will lose its central position of the global traffic. At the time NSR is fully open, with the huge amount of freight volume going north, North Asian ports will become new shipping center. (Wan Zhen, 2009) As the gradually development of NSR, the center may shift further to north, even to the North Pole.

4.2 A Logistics Center in the North Pole

With the theory of shifting shipping center, an innovative assumption of new hemispherical logistic center was proposed. According to the former report about future development of the weather of the Arctic area, it is predicted that in less than 50 years, maybe in 35~40 years, the Arctic ice cover will completely vanish in hot seasons. When that happens, the top of the earth will become an open waters where ships can sail back and forth freely. Based on that prediction, Professor Wan Zheng and his colleagues came up a conception of the North Pole logistics center.

> *Because the Arctic Ocean is the top point of Europe, Asia and North America and is the shortcut those three continents. Due the particularity of its geographical position, after the sea ice melted and the NSR fully opened, the voyage distance among the three continents will be greatly shortened and the current geographic pattern of shipping will be broken.*

The conception is to establish a huge logistics platform in the North Pole, which has various of services, including sea transport, air transport, transshipment, storage and information service as a whole, and the islands around could provide warehousing, supplies, and have offload function. They believed that the platform will be the first real international shipping hub in the sense of geography, at least in the northern hemisphere. The existed ribbon trade pattern will be broken and instead a net pattern in the middle of the North Pore will be formed.

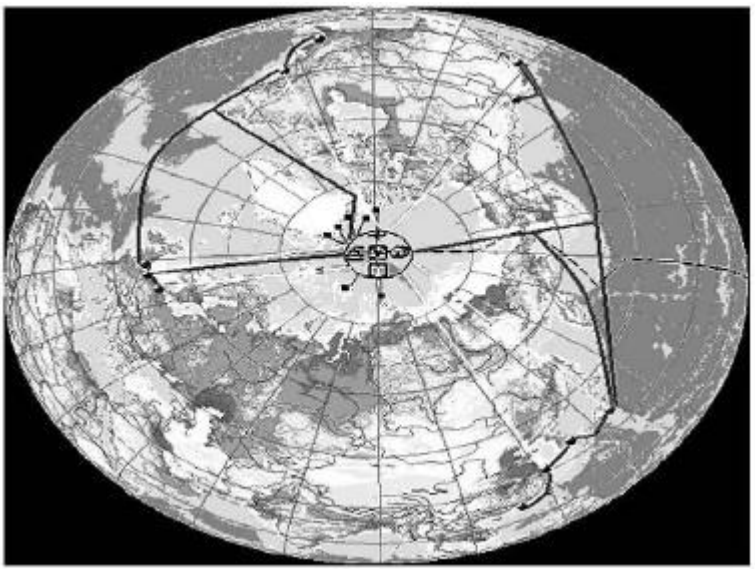

Figure 12- The conception of the North Pole logistics center

Source: A New Logistics Pattern in the Future – An Idea of Opening up New Arctic Routes and the establishment of Arctic Platform

This logistic center will act as a global warehouse and distribution center of the entire North hemisphere. As Figure 12 reveals, the center sets right in the middle of Asia, North America and Europe, from where it is always the shortest distance to each continent. Using such logistics system in radial pattern, massive transportation costs can be saved.

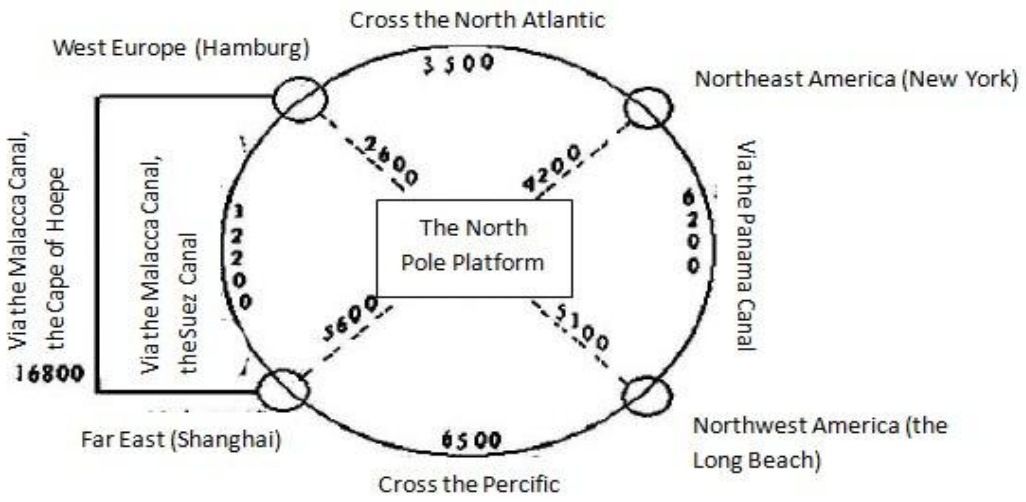

Figure 13- Distance between the new center and important ports
Source: A New Logistics Pattern in the Future – An Idea of Opening up New Arctic Routes and the establishment of Arctic Platform

Figure 13 shows the comparison of the voyage distances between the net pattern system and the ribbon one. Using the platform system, from Shanghai to Hamburg, the distance can be cut down by almost 50% if via the Cape of Good Hope and 30% via the Suez Canal. And it also provides shortcuts for continent-crossing transportation which is showed in the figure as the cross, i.e. Far East to Northeast America or West Europe to Northwest America.

4.3 China's Strategy

According to the weather studies and former researches of NSR, the exploration of NSR should gradually proceed since the environment condition will change in several decades. Although the exploration of NSR is still at its starting phase, China and its shipping people must act quickly to catch up with other countries which now have been far away ahead in this issue.

Combining the result of SWOT analysis and AHP model, the author finds that China has more strength and opportunities in NSR issue, so it should take relatively more vigorous strategy to participate NSR exploration.

4.2.1 Scientific Field

The Arctic area is still one of the few places where people do not fully comprehend. There are many researches and investigation to do for China to comprehensively understand the situation of that region. As mentioned above, if NSR is to be fully used, massive amount of supporting data will be required, and China has to do enough preparation so as to gain some advantages in this information market. And recently, China did enhance its scientific research of the polar areas. Routing trips to both the North and the South Pole are done by the expedition ship, MV Xue Long, every year. Professors and teachers of SMU also take part in those voyages.

On the other hand, China's shipping industry, especially ship building engineers should do more researches of new ship designs to provide shipyards outstanding technologies and new structures or methods which makes new vessels more seaworthy for NSR and further environment friendly and with better fuel consumption efficiency. Meanwhile, shipping companies need to start their study to form applicable actual sea routes and ports of call along NSR based on current and constantly updated data about the Arctic region. Only with those criteria combined can China and its shipping industry enjoy a favorable situation in the initial stage of the NSR issue.

4.2.2 Legal Aspect

According to current international law and China's international status and relatively weak discourse power in international events, it is not favourable for China to ensure its benefit in NSR issue. Since China is not a coastal country of the Arctic Ocean, it has no sovereignty problems but other coastal countries like Russia, Canada, etc. tend to claim their sovereignty of as more area as possible so as to obtain extra right to occupy those valuable resources.

It is a weakness China needs to overcome. China's government shall take a more vigorous attitude to participate the international discussion about the NSR issue, and China's maritime lawyers and scholars should do further research and acquire more comprehensive information so as to assist the government. (Li Zhenfu, 2008) Since China is not a coastal country around the Arctic Ocean, as a spectator China should help those involved countries come to a relatively fair agreement about the issue and procure the international cooperation to explore the Arctic and NSR.

Chapter 5 Conclusion

The thesis makes a comprehensive analysis of the NSR and its impact on China's shipping industry. Although this issue has been discussed for decades, most people still are holding questioning view about it. However, based on the study in this thesis, the author believes that since the global warming process is unstoppable and irreversible, the increasing temperature of the Arctic area will eventually make NSR be of great value to the shipping industry. And NSR would bring about great change to international shipping and logistics system. The issue should never be whether NSR is valuable or useful but when it is ready for a full scale of exploration.

China has been a major international trader for decades and it will continue to play that role, which would rely heavily on its transportation and logistics operation. To well confront the revolution that NSR is about to bring along, China must act quickly and efficiently, as other countries have already started, especially those are around the Arctic area. The author believes the entire development process could be divided into three stages.

First stage can also be called the primary stage. This stage could last for another five or ten years, during which the Arctic temperature gradually increases with more ice melting and the navigable time of NER will be increased and NWR begins to have certain amount of ice-free time. However, in this stage, NSR is still not quite suitable for most ships to pass because passing through that area still needs reliable and accurate land-based support which is currently not mature enough. And ports along the route still suffer heavy icing problem in cold seasons which means land services will be poor. Consequently, in this stage NSR is not ready for business operation. Instead, the melting ice opens the door for scientific research and investigation, and shipping industry could also cast some actual experiments to get ready for fully operation in several years. As mentioned in Chapter four of this thesis, China's

shipping people must make use of this stage to prepare themselves for the new coming competition. Moreover, the government also needs to cooperate with shipping people, and take part in the discussion in the U.N. to promote the international society to come to an agreement of the cooperation in the Arctic and NSR exploration.

The second stage is the growing stage. It will begin in 10~20 years when the temperature is high enough that NSR will be ice free in most time of a year. The author believe, at that time, the international society will have accepted the importance of NSR and enough prepare work will have been done. The weather and temperature will no longer be barriers for merchant vessels to pass through. Through years of development, supporting services like the investigation of waters condition along the route, port services, real time sea condition and weather report data, etc. will be completed and accessible for vessels and shipping people. And some land-based services which would generate extra costs such as icebreaker support will be no longer required. In that stage, China's shipping people must improve their services and make their vessels suitable for constant operation along NSR. In addition, after the fully open of NSR, global sea traffic volume begins to be divided into two main lines and north Asian ports are going to be new shipping center. To take advantage of this chance, China's north ports need to transform themselves from ports that merely serve its hint land to comprehensive and advanced transshipment ports.

The final one is called the matured stage. This stage will take place in 25 or 30 years, when the Arctic ice cover will completely vanish in hot seasons and vessels then can directly cross the polar area. With the establishment of the polar logistics center, the global logistic system will be changed from a ribbon pattern to a net one. At that stage, since its beneficial position, China should pay more attention on the development of the 4PL services than actual transport services. Along with the north shift of traffic volume, China needs to seize the opportunities to develop the two types of shipping center. North ports would gradually embrace more traffic volume and supporting logistics transportation which will be suitable for shipping center of actual shipping

services. While Shanghai now is rising up as a new shipping center will lose quite a lot of traffic volume and much demand of transshipment services, so it can be transformed to a financial shipping center, providing the industry broking, banking, and derivate products exchange services as London is doing.

The full exploration of NSR is just around the corner. Its change to the global shipping can be said as revolutionary. China's rising shipping industry must seize this opportunity to consolidate its position in the global market to pursue a further and long term development. Of course, there are still many uncertainties of NSR. More and deeper researches need to do for China's shipping industry to be well prepared for the NSR issue.

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