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Economic approach of piracy along the Maritime Silk Road and cost analysis of the Northern Sea route

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Economic Approach of Piracy along the Maritime Silk Road and Cost Analysis of the Northern Sea Route

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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.

Petros Kelaiditis

Supervised by

Professor Shi Xin

World Maritime University

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Abstract

Title of Research paper:	**Economic approach of piracy along the Maritime Silk Road and cost analysis of the Northern Sea Route**
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Traditional piracy or the simple robbery of ships' equipment and stores has been replaced by modern piracy operating with the aid of international criminal organizations now terrorize the international shipping industry by hijacking ships, incarcerating crew and cargo and detaining both for ransom. The unwillingness of ship owners to report such incidents due to fears of rising insurance premiums as well as lengthy and expensive investigations have allowed for the rampant growth of piracy. Thus, this paper is focused on the Northern Sea Route as a solution to piracy which occurs along the main trade route between Europe and Asia, through the Suez Channel and Malacca Straights. This paper provides a radically different solution to the global phenomenon of piracy with the substitution of the main trade route by the Northern Sea Route. An economic analysis of piracy will estimate and evaluate the total expenses of piracy on the shipping industry. This paper will also give a brief introduction of the NSR and the environmental changes due to which the ice is melting and will also conduct a cost analysis of the operational, voyage and capital costs of a container ship sailing along the Northern Sea Route. Finally, the costs of piracy and cost of sailing along the NSR will be compared while a fuzzy comprehension evaluation analyses will evaluate the importance of all the fuzzy or uncertain factors in terms of environmental, policy and technological issues that may influence the development of the NSR.

KEYWORDS: Piracy, Economic Impact, Northern Sea Route, Maritime Silk Road, Substitution, Feasibility Analysis, Cost Analysis, Fuzzy Comprehensive Evaluation Model.

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LIST OF ABBREVIATIONS

ARCOP	Arctic Platform Program
CMRDI	Central Marine Research & Design Institute
DAV	Double Acting Vessel
DWT	Dead Weight
EU	European Union
FCEM	Fuzzy Comprehensive Evaluation Model
FNI	Fridtjof Nansen Institute
GATS	General Agreement on Trade in Services
H&M	Hull and Machinery
ICC	International Champer of Commerce
ISPS	International Ship and Port facility Security Code
IMB	International Maritime Bureau
IMO	International Maritime Organization
INSROP	International Northern Sea Route Operational Program
IT	Information Technology
MARPOL	Maritime Pollution
MSR	Maritime Silk Road
NSRA	Northern Sea Route Administration
NSR	Northern Sea Route
P&I	Protection and Indemnity
TEU	Twenty-foot Equivalent Unit
SOF	Ship and Ocean Foundation
SOLAS	Safety of Life at Sea
VLCC	Very large Crude Carrier
UNCLOS	United Nations Convention on the Law of the Sea
USSR	Union of Soviet Socialist Republic
USA	United States of America
WTO	World Trade Organization

Chapter 1 Introduction

1.1 Background

Since 1956, when Malcolm McLean loaded 58 containers on the 20-year-old modified tanker, “Ideal X”, international transportation and global trade have experienced tremendous growth (Muller,1999). The further maturation of information technologies and integrated logistics services in correlation with outsourcing of production processes, to countries with low cost labour, have been some of the factors that contributed to the development of sea transportation; resulting in more than 80% of the world's merchandised goods being carried by sea (United Nations Conference on Trade and Development, 2008). The most important shipping corridor is the maritime route passing through the Malacca Straights and Gulf of Aden linking Asian and European markets known as the Maritime Silk Route (MSR)[1].

Despite the development of maritime transportation and global trade due to globalization there is still an imbalance among the countries that have actually benefited from the globalized economic era. According to the United Nations, forty countries face food crisis due to the increased price of food commodities and oil. On the other hand and due to the slow responsiveness of the developed countries to solve the problem of poverty in developing countries, individuals are easily tempted to resort to and exercise the most ancient criminal act of violence at sea, piracy (Petretto, 2008). Piracy has a great economic impact on shipping industry that some experts have estimated to be around $16 billion per year. Piracy was never successfully eliminated while due to the development of more integrated logistic services piracy attacks have a great impact on the international trade. Financial loss caused by piracy in terms of ransoms paid, damages to the ship and cargo, increasing insurance premiums and operational cost impose great pressure on the shipping industry.

On the other hand, the rapid environmental changes that have been taking place over the last three decades turned the eyes of the international maritime community

1 cf paragraph 2.4

towards the Arctic Ocean. The rapid decrease of the sea ice extent along the Eurasian continental shelf creates a new maritime route that could link the areas of the North Pacific and North Atlantic Ocean, known as The Northern Sea Route (NSR)[2]. NSR could save more than 50%, in terms of distance and eventually partly substitute the traditional MSR providing thus a solution to piracy. The exploration of the Arctic Ocean in terms of natural resources will further develop the NSR by using tanker vessels and bulk carriers to transport oil, hydrocarbons, coal, timber and woods products from the region of the Russian Arctic continental self; however, Twenty-foot Equivalent Unit (TEU) containers are the most appropriate cargo for transit transportation. Environmental, administration, legal, insurance and technical issues need to be considered and further discussed. The possibility of piracy or even maritime terrorist attacks along the NSR will be eliminated due to the extreme environmental conditions and inaccessibility of the Arctic region, providing a safer passage through the Arctic Ocean. Studies regarding the Arctic sea ice extent predict 40% decrease of ice along the NSR for the next twenty years[3] making even more attractive the idea of using the NSR for seaborne transportation.

1.2 Literature Review

The amazingly well organized pirating against the Saudi Arabian Very Large Crude Carrier (VLCC) “Sirius Star” in 2008 is evidence that piracy has developed at an alarming pace (Menkhaus, 2009). Shipping companies in order to prevent piracy will install expensive equipment on board the vessels, hire armed security contractors and substitute traditional trade routes adding thousands of dollars to the daily operating cost. An effect of the increased levels of piracy along the Maritime Silk Road and more specific along the coastal nations in the Gulf of Aden is the fact that many shipping companies prefer to sail around the Cape of Good Hope which eventually reduces the risk of piracy, however; at the same time increases the daily

2 C.f paragraph 4.3
3 Whitney, Bradley, & Brown. (2001). Naval Operations in an Ice Free Arctic. *Naval Operations in an Ice-free Arctic Symposium 17-18 April 2001 Final Report*, from http://www.natice.noaa.gov/icefree/FinalArcticReport.pdf

operational cost of the merchant vessels (Khalid, 2008a). In another article '*Some Reflections on Combating Piracy in the Gulf of Aden'* Khalid (2008b) mentioned that maritime supply chains and international trade which are both closely related to speed and efficiency might suffer due to the prolongation of steaming time.

In addition, Costello (2008) in the article, "Shipping Insurance Cost Soars with Piracy Surge off Somalia", states that insurance companies might increase the insurance premium which is a significant factor that determines a percentage of the freight rate. Costello (2008) also mentions that in the year 2008 insurance premiums for sending a cargo through the Gulf of Aden have increased to $9000 from $900 last year. Despite the fact that shipping companies, with the above mentioned means of prevention, might reduce the risk of piracy, the dilemma of piracy and cost of piracy prevention still remain. According to Glen, Dragonette, and Young (2007) threats and acts of piracy can not be prevented or eliminated in isolation from the shore, especially if we take into consideration the 199 piracy attacks, 581 hostages, 7 missing crew members and 9 deaths that have taken place along the MSR the first nine months of 2008 (International Chamber of Commerce, 2008). The economic impact of piracy on the shipping industry is approximately $16 billions due to the loss of ships, cargoes, paid ransoms and increased insurance premium (Luft & Korin, 2004). The need for alternative maritime trade routes that will eliminate the risk of piracy but at the same time optimize vessels' operational costs and distance is imperative.

The idea of a short passage between Asia and Europe via the Arctic was developed in the 15th century due to European maritime nations' curiosity about and scientific studies on the arctic's natural resources (Borodachev, 2007). "The Northern Sea Route (NSR) is a national transportation route under full Russian control and jurisdiction, stretching from the archipelago of Novaya Zemlya in the west to the Bering Strait in the east connecting the European and Asian continents, and passing through the seas of Chukchi, Barent, Kara, Laptev and East Siberian" (Ostreng,

2000). As professor Valsson (2007) states, the distance from Rotterdam to Shanghai through the Suez Canal is approximately 9.600 miles, while the distance from Iceland to the Pacific Ocean through the NSR is only 3.500 miles; an enormously redundant distance and fuel consumption, which actually accounts up to 50% of the operational costs of a vessel (Stopford, 1997).

Taking also into consideration canal fees, insurance premium for critical piracy zone, fuel consumption, operational costs and all the expenses that determine the freight rate, the above mentioned shortcut could save 20% of the operational cost of container vessel for a single trip, from $17 million to $14 million per year (Borgerson, 2008). The Northern Sea Route is not only appealing because of the enormous, up to 40% mile redundancy, compared to the main trade route between Europe and Asia but also due to the low risk of piracy and maritime terrorism and due to huge Russian Arctic reserves of natural resources such as gas, oil and minerals which are in high demand in both Europe and the United States (Offerdal, 2008). Russia will then be able to export its natural resources to both Western and Eastern markets using the NSR. On the other hand, the increased effects of global warming make the idea of using the North East Route to avoid piracy even more attractive. The obvious decrease in the thickness of Arctic Sea ice, Parkinson and Cavaliery (1999), and the thickness of the ice covering the Arctic Ocean Rothrock, Yu and Maykut (1999) reveals the alarming environmental situation, but on the other hand it introduces opportunities for the shipping industry. Between 2004 and 2005, the Arctic lost 14% of its permanent ice - the main obstacle to maritime transportation. In the last 23 years, 41% of this ice has melted away (Borgerson, 2008). The most optimistic models predict that an ice free NSR will be a reality in the summer of 2013 (Alexandrov et al, 2007). However, the extreme environmental conditions of the Arctic low temperatures, ice thickness and high winds followed by snowfalls hinder the ability to perform adequate scientific research (Holland, 2002). The NSR is seasonably available and even its availability between two seasons is unpredictable, (Tirschewell, 2007), causing uncertainty for the navigation along the route in terms

of specified time periods. In addition, not much academic research, focused on the suitability of the NSR for commercial purposes, has been conducted while most of the available information is based on private research institutions, making these sources not completely reliable.

According to International Maritime Bureau, *Annual report of Piracy and armed robbery against ships,* (2008), 48 Bulk Carriers, 49 Containers Ships, 38 General Cargo and 30 Tankers have been attacked by pirates. Considering the average speed of these ships, it is clear that vessels with lower speeds are more appealing to pirates. As a matter of fact, the North Sea Route could be a good alternative route for Tankers, Bulk Carriers, General Cargoes and Chemical/Product Tankers. However for transit transportation between Europe and the East container vessels seems to be the most appropriate. Despite the enormous reduction of sailing days and fuel consumption, in the long run, the development of a network to support the maritime transportation of goods in the Arctic region demands a huge amount of investments in related infrastructure. Design and construction of ships for ice, land based infrastructure for pollution prevention, information technology, establishment of search and rescue centres, crew training, real time information on weather and ice conditions are some of the factors that need to be taken into consideration by the shipping industry for the implementation of the NSR project, Bobylev et al. (1994), as well as safety equipment on the vessels and real time communications for immediate response in case of emergency (Ranger, 2000).

However, the melting of ice is not good news for everyone especially for animals that depend on the permanent ice cover for procreation (Holland, 2002). As a matter of fact environmental issues should be taken seriously into consideration due to the increasing shipping activity that would lead to industrial development and growth of population (Lathrop, 2008). Experts of the maritime industry are skeptical regarding the implementation of the NSR. Oil spills like the one caused by the Exxon Valdez in 1989 in Prince William Sound, Alaska, could cause a significant environmental

disaster. Although there are many projects that have been developed for the use of the NSR for commercial purposes, a concrete conclusion as to when the NSR will be totally free from ice can not be determined.

Currently the passage is ice free only for four months during the summer months and sometimes navigation along the NSR is restricted by severe sea ice conditions. The resulting unpredictability of ice conditions demands the use of icebreakers along the Northern Sea Route (Johannessen et al. 1997). The use of Icebreakers could add a significant cost for the navigation of the NSR and even overcome its advantages in terns of miles and fuel consumption redundancy (Dibenedetto, 2006). The developing of “Double Acting Vessels” with both ice-strengthened and Ice breaking capabilities will be the solution to the expensive Russian fleet of icebreakers (Arpiainen & Kiili, 2006). Nevertheless several other factors such as legal and marine insurance can impose great limitations on the development of the NSR. Although Russia national legislation that governs the NSR is based on the United Nations Convention on the Law of the Sea, a rather discriminatory policy in terms of NSR fees and regulations has been imposed towards foreign vessels (Brubaker & Ostreng, 1999). The lack of adequate marine insurance and infrastructure for navigation along the NSR impose restrictions, however the increasing demand for transportation will definitely provide the means to balance any such limitations.

1.3 Methodology

The purpose of this paper is to estimate the annual economic impact of piracy on the shipping industry and then to suggest the development of the NSR, for transit transportation between Europe and Asia, as a solution to the increasing piracy incidents along the MSR. To achieve the above mentioned goal, this dissertation will first analyse the main factors that fuel piracy and then will estimate the financial loss of the direct and indirect impacts of piracy attacks. On the shipping industry, in terms

of cargo and vessels losses, ransoms for kidnaps, increasing operational cost of the vessels, environmental threats, investment on anti-piracy equipment, insurance premiums, investigations and off-hire.

The next step will be a cost analysis of a container vessel sailing along the Eurasian continent in order to identify the annual cost of a TEU for transit transportation. All the components that form the expenses, of a 5,000 TEU container vessel such as capital, operational and voyage expenses will be identified and estimated based mostly on studies conducted by international private institutions such as the Aker Technology Inc[4]. As soon as the cost for transporting one TEU container has been identified the next step will be a comparative analysis of the annual economic impact of piracy and the annual total cost of the container vessel sailing along the NSR. Furthermore, fuzzy comprehensive evaluation analysis of the NSR will follow to highlight the importance of environmental, policy and technical issues that need to be considered for the further development of the NSR. The statistical data based on which the evaluation will take place derive from questionnaire that the author developed and sent to evaluators. Finally, this thesis will provide author's conclusions and suggestions.

1.4 Structure

Chapter one gives an introduction of the thesis followed by the literature review of studies focused on piracy and the NSR. The thesis's objectives and methodology used as well as structure and finally the difficulties the author faced during the research process can also be found in chapter one. Chapter two introduces and defines the phenomenon of piracy as well as highlights the trends of piracy along the MSR. Further analysis regarding the factors that fuel piracy can also be found in chapter two. In chapter three the author will conduct an analysis with which the annual financial loss of the shipping industry due to piracy incidents will be estimated. Chapter four will introduce the Northern Sea Route and the

4 Arpiainen, M & Kiili, R. (2006). Arctic shuttle container link from Alaska US to Europe. Aker Arctic Technology Inc project, report K-63.

environmental changes that are responsible for the melting of ice and present a case study conducted in order to identify the total expenses of a 5,000 TEU container vessel sailing along the NSR. Based on the annual expenses of the vessel in terms of operational, voyage and capital cost in relation to the annual amount of cargo transferred between Europe and Asia the transportation cost of a single TEU transit will be indentified. In chapter five the author will make a comparison analysis between the annual cost of piracy and cost of sailing along the NSR while a further fuzzy comprehensive evaluation analysis will evaluate factors that according to experts opinion have an increased level of uncertainty that may influence the development of NSR in terms of environmental, technical and policy aspects. Finally, chapter six will provide the author's conclusion and recommendations.

1.5 Restrictions

Lack of resources regarding the economic potential of the Northern Sea Route was definitely one of the main restrictions of this thesis. Although many e-mails were sent to companies that operate regionally in the Arctic Ocean the author never received any reply and therefore he faced many difficulties in collecting information regarding the operational cost of a vessel sailing along the Northern Sea Route. Most of the conclusions the author made depended on past research papers of fellow students and academics as well as on private institutions' projects and simulations that date back to 1999. Even though everyone is aware of the great shipping opportunity to develop a new revolutionary trade route, very few academic studies exist and most of them simply state at the recognition of the obvious economic potential of using the NSR for commercial purposes without taking any further action or continuing the research on the viability of the idea. Nevertheless the author was surprised to find that many academic studies on piracy have been conducted but most of them are only focused on the theoretical side of the phenomenon while the practical -in terms of impacts- side of piracy, which is the most important, has been almost neglected. The author is fully aware of the fact that his attempt to link piracy and the Northern Sea Route in terms of economic approach is a very challenging one, however this very fact constitutes a motivation for further research in the future.

Chapter 2 Overview of Piracy

2.1 Definition of Piracy & Issues to be considered

According to the United Nations Convention on the Law of the Sea, (1982) Part VII, Article 101 piracy is defined as follows:

> (a) any illegal acts of violence or detention, or any act of depreda-tion, committed for private ends by the crew or the passengers of a private ship or a private aircraft, and directed: (i) On the high seas, against another ship or aircraft, or against persons or property on board such ship or aircraft; (ii) Against a ship, aircraft, persons or property in a place out-side the jurisdiction of any State;
> (b) Any act of voluntary participation in the operation of a ship or of an aircraft with knowledge of facts making it a pirate ship or aircraft;
> (c) Any act of inciting or of intentionally facilitating an act described in subparagraph (a) or (b) (Part VII, Section 1, Article 101)

The International Maritime Bureau, (n.d.) a specialized division of the International Chamber of Commerce (ICC) established in 1981 to fight against all types of crimes at sea defines piracy as follows:

> An act of boarding or attempting to board any ship with the intent to commit theft or any other crime and with the intent or capability to use force in the furtherance of that act, (IMB, n.d.)

The existence of two definitions with different scope creates significant problems regarding the prevention and reduction of piracy attacks. First of all we need to mention that both of the definitions refer to piracy as an attack on a ship, which actually differs from the piracy activities, of the past, to coast raiding for slaves and valuable goods (Warren, 2001). The definition of IMB is wider in scope since there is no distinction between territorial and high seas and the absent of the two ships requirement recognize violent acts, from a raft or a quayside of a port, as actual acts of piracy. IMB definition will also recognize attacks on a ship, for environmental or social political reason, as acts of piracy.

The question that rises from the existence of two definitions is whether the relevant statistical reports include the same number of piracy attempts or acts. The unwillingness of ship-owners to report incidents of violence at sea due to very long and expensive investigations is the main factor that restricts accurate statistical reports. IMB piracy reporting centre consider that 50% of the piracy incidents remain unreported while IMO assumes that only one third of actual and attempted piracy attacks are reported (Van der Meidjen, 2008, pp 19).

International Maritime Organization, (2002a) in an attempt to resolve the conflict between the two definitions adopted the "Code of Practice for the Investigation of Crimes of Piracy and Armed Robbery against Ships". According to this code an additional definition of "Armed Robbery" has been included to encounter the gaps between the UNCLOS and IMB definitions of piracy. IMO defines Armed Robbery as:

> Any unlawful act of violence or detention or any act of depredation, or threat thereof, other than an act of piracy, directed against a ship or against persons or property on board such ship, within a State's jurisdiction over such offences. (IMO, 200a)

The definitions of UNCLOS and the "Code of Practice for the Investigation of Crimes of Piracy and Armed Robbery against Ships" are closer with the definition of the IMB but still there are issues to be taken into consideration and critical thought must be developed towards the reliability of the statistical reports that will be also used in this thesis. According to International maritime Organization (1993) three kind of piracy exist: Low-Level Armed Robbery carried out by groups of petty thieves and small crafts, Medium-Level Armed Robbery carried out by better organized groups of people heavily armed, Major Criminal Hijacks involves cargo, ships and crews missing as well as extreme violent acts conducted by heavily armed well organized groups. Figure 1 depicts the development of piracy over the years, by location, from 1984 to 2007; it is obvious that since mid-90s piracy attacks increase at an alarming pace.

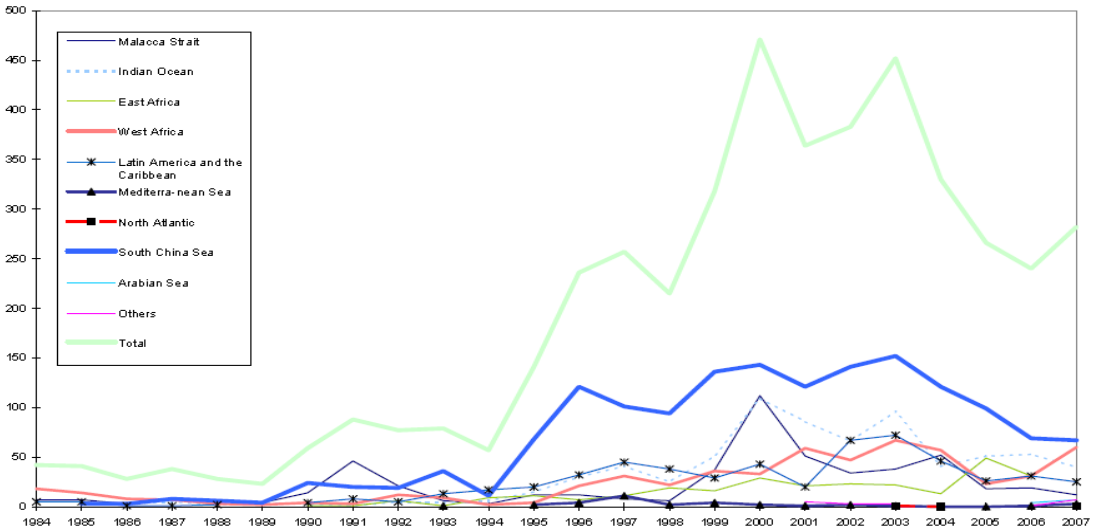


Figure 1- Annual Piracy Attacks by location since 1984
Source: IMO, (2009). *Piracy and Armed Robbery at Sea.* UK: IMO.
http://www.imo.org/includes/blastDataOnly.asp/data_id%3D25429/Piracy_30April2009_.pdf

2.2 Trends of Piracy along the Maritime Silk Road

During the last three decades seaborne trade has experienced a tremendous growth with an annual average rate of around 3.2 percent and with more than 80 percent of the world's merchandised goods being carried by sea (UNCTAD, 2008). Figure 2 depicts the development of world seaborne trade from 1994 to 2007 compared with world's Gross Domestic Product[5]. One of the most important shipping corridors in terms of cargo volume and vessels traffic is the Maritime Silk Road (MSR), stretching from the Red Sea to South China Sea, crossing the Indian Ocean and passing along the Gulf of Aden, Bay of Bengal and through the Malacca straights, linking the European and Asian economies (Wikipedia, 2009). The blue line of figure 3 depicts the Maritime Silk Road stretching from China to Europe.

5 Gross Domestic Product is a basic measure of world's economic performance and consists of the value of all the final products and service produced our the world, Wikipedia (2009).

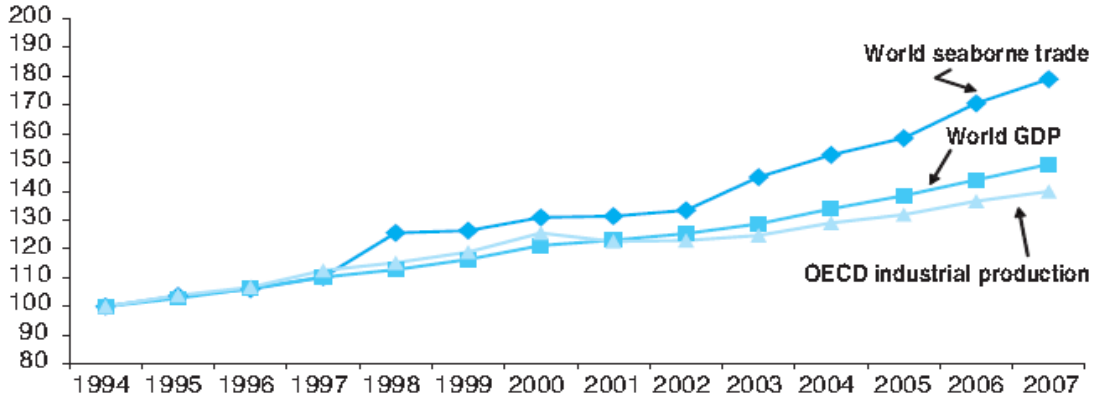


Figure 2-Growth of World Seaborne Trade
Source: United Nations Conference on Trade and Development, (2008). Review of maritime Transport. NY & Genova: UN. http:// www.unctad.org/en/docs/rmt**2008**_en.pdf

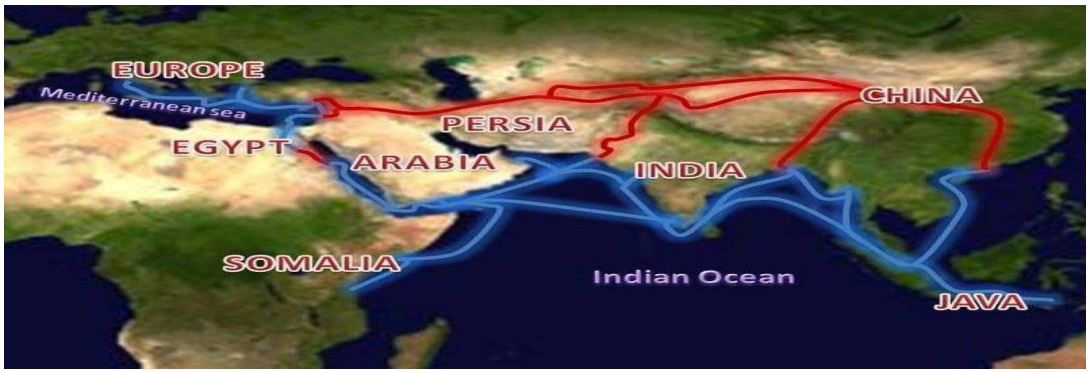


Figure 3- Maritime Silk Road
Source: Wikipedia,(2009).Maritime Silk Road
http://en.wikipedia.org/wiki/File:Silk_Route_extant.JPG

Approximately 60,000 vessels per year pass through the Malacca Straights carrying 30% of global trade between European and Asian markets. It has been estimated that each day 10.3 million barrels of oil are carried through Malacca Straights, an amount equal to 50% of the world's crude oil (Voon, 2008). In 2007 20,384 vessels have passed through the Gulf of Aden and Suez Canal carrying 700 million tones of cargo to Europe, Asia and Africa; an amount equal to 14% of world's goods carried by sea and 30% of global crude oil (Suez Maritime Authority, 2008). Figure 4 shows the number of ships passed through Suez Canal from 2000 to 2008 heading to Europe and Vice Versa.

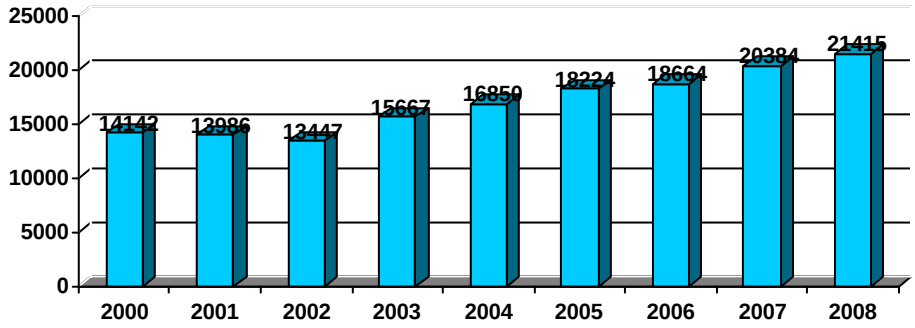


Figure 4-Vessels Passed Through Suez Canal
Source: Drawn by the Author © Petroskelaiditis WMU-SMU, (ITL 09) based on Suez Maritime Authority, (2008). Brief Yearly Statistical Report of Ships Traffic.

According to International Maritime Bureau, *Annual Report for piracy Annual report: Piracy and armed robbery against ships,* (2009) 293 actual and attempted piracy attacks were reported in 2008 which is 11% higher than what was reported in 2006 and 2007. The region of Gulf of Aden and Somalia has a catalytic role for this spate of violent acts at sea.

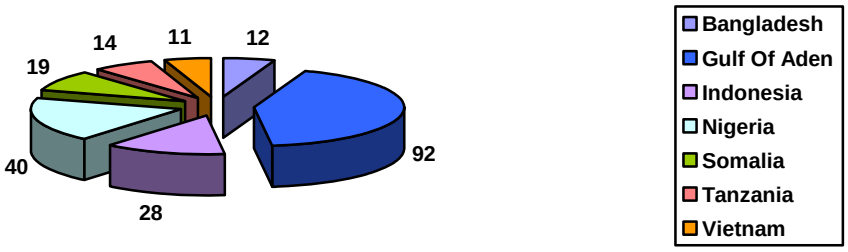


Figure 5-Piracy Incidents by Location, 2008
Source: Drawn by the Author © Petroskelaiditis WMU-SMU, (ITL 09) based on Piracy and Armed Robbery against Ships. Annual report, UK: ICC. http://www.icc-ccs.org (Requested via email)

In 2008, 139 cases of piracy attacks have been reported in which weapons have been used while 889 crew members have been taken hostage, 11 crew members have been killed and 21 never found and are presumed dead (International Maritime

Bureau, 2008). Along the coast of Somalia 42 vessels have been hijacked and 242 crews members have taken hostage for ransom. However, piracy in the maritime Asia has declined with only 26 incidents in Indonesia, six in Singapore straights and two in Malacca straights (International Maritime Bureau, 2008). The decline in the region of Indonesia can also be explained due to the disastrous Tsunami of 2004; pirates haven't developed yet a sufficient network to support frequent piracy attacks (Moller, 2009). Figure 5 depicts locations of piracy incidents that account for more than two thirds of the global reported piracy attacks. Table 1 Shows the Actual and Attempted piracy attacks along the MSR reported from 2003 to 2008.

Table 1- Annual Actual and Attempted Piracy Attacks along the MSR

Location Maritime Silk Road	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
China/HK/Macau	1	3	4	1	-	-
Indonesia	121	94	79	50	43	28
Singapore Str.	2	8	7	5	3	6
Malaysia	5	9	3	10	9	10
Burma	-	1	-	-	-	1
Malacca Str.	28	38	12	11	7	2
Thailand	2	4	1	1	2	
India	27	15	15	5	11	10
Sri Lanka	2			1	4	1
Bangladesh	58	17	21	47	15	12
Gulf of Aden	18	8	10	10	13	92
Somalia	3	2	35	10	31	19
Kenya	1	1	-	-	4	2
Eritrea	-	1	-	-	1	-
Total	**268**	**201**	**187**	**151**	**143**	**183**

Source: Drawn by the Author © Petroskelaiditis WMU-SMU, (ITL 09) ICC based on International Maritime Bureau, (2008). Piracy and Armed Robbery Against Ships. Annual report, UK: ICC. http://www.icc-ccs.org (requested via e-mail)

2.3 Factors that Fuel Piracy

There is no doubt that the main motive for the development of piracy is the economic gain combined with the low risk which usually accompanies such criminal acts; however, incidents that have taken place in different regions of the world

reveal the fact many factors and variables exists for the development of piracy (Pettreto, 2008). According to Daniel (2000) the end World War II decreased the ocean security patrol while the decolonization of many regions around the world created political instability of former colonies. Year's later containerization and globalization will fuel global trade and seaborne transportation. According to United Nations Conference on Trade and Development, *Review of Maritime Transport*, (2008) in 2007 the Europe-Asia lane overtook transpacific lane with 27.7 million tones, almost 17.7 million more than year 2005, while traffic moving East increased by 9.0 per cent reaching 10 million tones of goods carried by sea along the traditional Maritime Silk Road through Malacca Straights and the Gulf of Aden. The increasing volume of cargo carried by sea along the MSR combined with the expansion of the international merchant fleet in order to meet the high demand of international trade is one of the main factors that fuel the development of piracy. Figure 6 depicts the type of products carried by sea from 1968 to 2008 in billion tones per mile while figure 7 shows the expansion of the world merchant fleet from 1980 to 2008, in terms of dead weight.

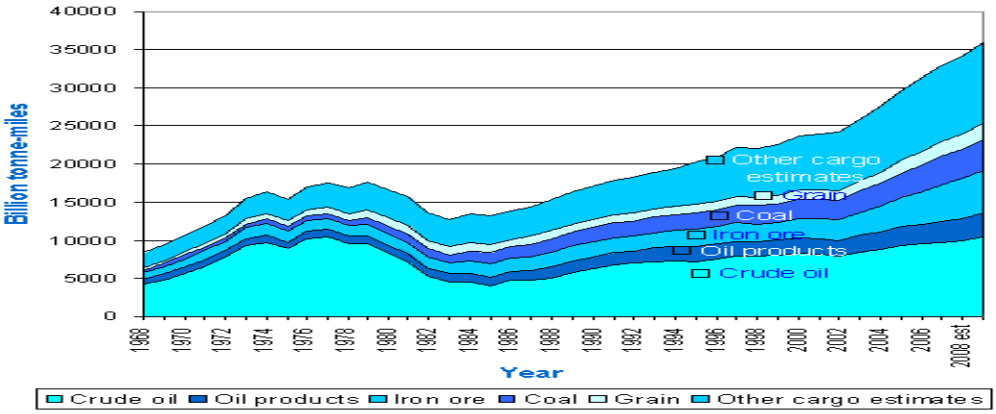
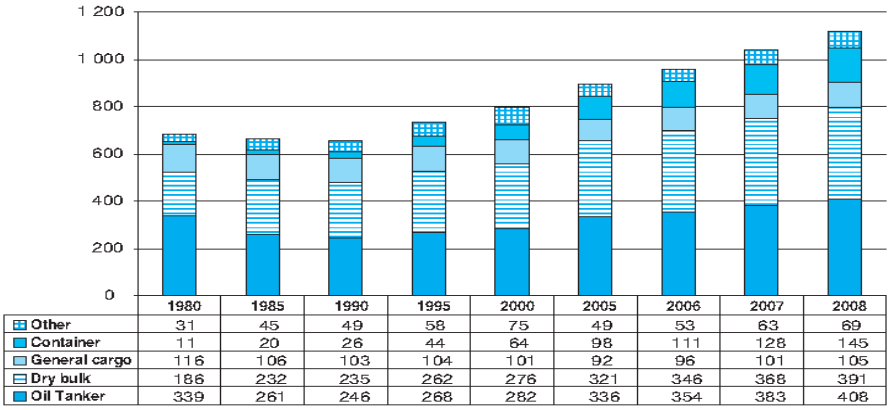


Figure 6- Types of Cargo Carried By Sea in Billion Tones per Mile
Source: International Champer of Shipping, (2008) *Shipping and World Trade*. UK, ICS



	1980	1985	1990	1995	2000	2005	2006	2007	2008
Other	31	45	49	58	75	49	53	63	69
Container	11	20	26	44	64	98	111	128	145
General cargo	116	106	103	104	101	92	96	101	105
Dry bulk	186	232	235	262	276	321	346	368	391
Oil Tanker	339	261	246	268	282	336	354	383	408

Figure 7- International Merchant Fleet Expansion
Source: United Nations Conference on Trade and Development, (2008). Review of maritime Transport. NY & Genova: UN.

2.3.1 Expensive Vessels and Cargos

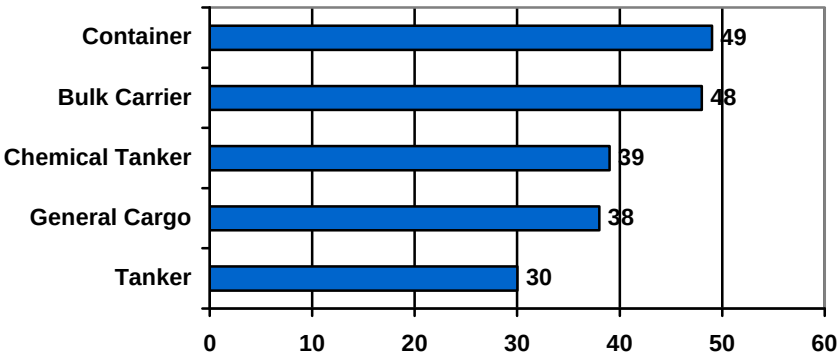


Figure 8-Type of Ships Attacked in 2008
Source: Drawn by the Author © Petroskelaiditis WMU-SMU, (ITL 09)

For the transportation of the increasing volumes of cargo sailing from East to West and vice versa new high tech and sophisticated vessels have been built to satisfy the need of trade and of course to meet the demand for highly responsive maritime transportation services, totally harmonized with the rhythm of logistics networks around the world. Over 80% of the global trade is moving through the Gulf of Aden while more than 60,000 ships carry 25% of the global trade through Malacca Str.

Tankers loaded with millions of barrels of crude oil, containers stacked with thousands of standardized containers loaded with high value cargo and chemical tankers carrying expensive, and dangerous are definitely easy and amazingly profitable targets for pirates. Ship-owners rather pay the amount of ransoms required from pirates than take the risk of loosing the crew and the ship alike or taking the risk of an environmental disaster (Reyes, 2008a). However, in most cases pirates will escape with the ship's expensive equipment and crew's personal belongings that afterwards will be sold to neighboring countries or used for a pirate's future attacks. Figure 8 show that the most favorable to pirate's type of vessel is the container, bulk carrier and chemical tankers.

2.3.2 Geography

The increased traffic between Europe and The East along the MSR in relation to the use of "chock points" [6] increases the possibilities of piracy attacks (Sakhuja, 2006). When the vessel approaches such "Chock Points" and needs to decrease the speed to be more maneuverable, it at the same time becomes an easy target for pirates. Coastal nations along the trade route between Europe and Asia with broad coastlines: such as Somalia, Bangladesh, Malaysia and India give a tempting opportunity to individuals to attack ships that sail along the coastal nations. Finally, nations with complexes of islands such as Indonesia and Malaysia will provide the most appropriate environment for pirates to exercise violent acts at sea, and activities such as smuggling, drug dealing and other illegal activities. The above mentioned islands will be the perfect place for pirates to hide and organize the next attack.

6 Choke Point is narrow passage of a maritime trade route such as Malacca Straights and Gulf of Aden.

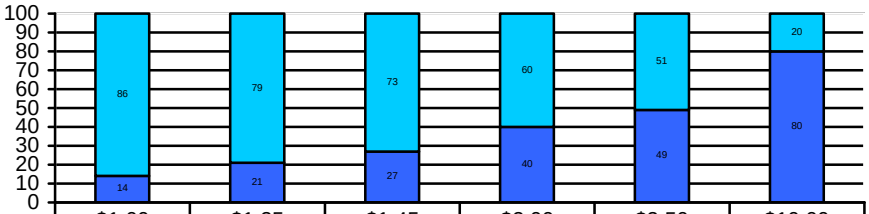
3.3 Failed Nation State

The increased traffic of trade lanes combined with the political instability and lack of governments to secure and control their sovereign territories is another factor that fuels piracy (Graham, 2006). People of Coastal-States with serious political instability like Somalia and absent of law enforcement agencies are more likely to slide into piracy (Murphy, 2007). However, this is not always the case, according to Burnet (2002, pp 227) piracy is not always a local organized act; but instead can be organized under the umbrella of organizations in relatively more political stable nations due to the need to know information such as ship destination, number of crew members and volume of cargo loaded. This information usually derives from military, police, port state control officers. The absent of law enforcement power in Somalia gives the tempting opportunity for pirates to organize and execute piracy attacks against ships of any type (Lehr & Lehman, 2006). In the case of Somalia piracy has turned to be more complicated and in favor of pirates. Hunter, (2008) in his article, "*How to pay pirate's ransoms*" states that pirates are getting stronger and stronger day by day. The amount of money they gain from ransoms, compared to the standards of life in Somalia, is enormously higher giving them the opportunity to buy guns, expensive houses, and corrupt local authorities strengthening their social profiles (Reyes, 2008b). In the end piracy will become a socially acceptable profitable business and will spread along the coast of Somalia and even to neighbor coastal nations of Africa that also face problems of political instability.

2.3.4 Poverty

Poverty in very simple words describes the living standards in terms of wealth, health and economic development of a nation. Despite the development of maritime transportation and global trade resulting from globalization there is still an imbalance between the countries that have actually benefited from the globalized economic era. According to the United Nations, "*growing number of poor countries plunged into*

food crises by soaring prices", (2007) forty countries face food crisis due to the increased price of food commodities and oil. Figure 9 shows the purchasing power of the world's population. The first column depicts the fact that 86% of world's population can actually spend 1 dollar per day while for the rest 14% is not economically feasible. When the daily amount of money is increasing, the purchasing power decreases to a level where only 20% of the population can actually spend $10 per day. According to World Bank's indicators 42% of the global population, which is equal to 2.6 Billion people, live in poverty. Petretto, (2008) states that the economic gain combined with the low risk that follows a piracy attack with no existence of defensive equipment on board the vessel, is definitely the main factor that actually promotes piracy combined with the level of poverty in some nations along the MSR. In terms of international trade Africa accounts for 13 per cent of the world's population but only 3 percent of global trade while the European Union counts as 7.4 percent of world population but contributes 18 per cent of the world's merchandised goods and 25 percent of its commercial services (United Nations, 2007). The above mentioned instability in terms of wealth, the continuous expansion of the merchant fleet, the volume of commodities carried by sea in relation to the current global financial crisis, followed by the slow responsiveness of the developed countries to solve the problem of poverty in developing countries, individuals are easily tempted to resort to and exercise the most ancient criminal act of violence at sea, Piracy (Pettreto, 2008).



	$1,00	$1,25	$1,45	$2,00	$2,50	$10,00
Above Proverty Line	86	79	73	60	51	20
Below Proverty Line	14	21	27	40	49	80

Figure 9- Purchasing power of World's Population
Source: Drawn by the Author © Petroskelaiditis WMU-SMU, (ITL 09) inspired by
The World Bank, (2008). *Poverty Data: a supplement to world development indicators*.
http://www.globalissues.org/article/26/poverty-facts-and-stats

Chapter 3 Economic Impact of Piracy

3.1 Impact of Piracy on the Shipping Industry

According to the Maritime and Port Authority of Singapore, (2009) approximately 50,000 vessels pass every year from the Malacca and Singapore Straights carrying a third of the global trade and almost half of the crude oil supplies (Bateman, 2007). On the other hand, Suez Canal Authority's *vessel traffic statistics* for 2008 states a number of 21,415 vessels to have passed through the Gulf of Aden and Suez Canal, heading to Europe and Asia, carrying a 7% of the global oil supplies and 7% of the global seaborne trade. IMB (2008) reported 42 actual and 39 attempted attacks in Somalia and Golf of Aden for the year 2008 which actually means that one out of every 261 transits would be involved in piracy attacks while one out of 509 transits would end in the hijacking of a vessel (Van Der Meijden, 2008). The economic impact for the shipping company in terms of ransom, damages caused during the attack and delays will be enormous. However, experts have estimated that costs of piracy are approximately $16 billion per year and keep on arguing that such costs -in a $7.8 trillion industry- are negligible (Van Der Meijden, 2008). Table 2 shows the actual and attempted piracy attacks along the MSR for the year 2008. The information of this table derives from an original table in the annual statistical report of ICC- International Maritime Bureau and for the purposes of the present thesis has been edited to present only information on piracy attacks along the MSR. A total of 183 piracy attacks have taken place along coastal nations of the Maritime Silk Road.

Table 2- MSR Actual & Attempted Piracy Attacks for 2008

Location Maritime Silk Road	**Actual**	**Attempted**
Indonesia	26	2
Singapore Str.	5	1
Malaysia	10	-
Burma	-	1
Malacca Str.	-	2
Thailand	-	-
India	9	1
Sri Lanka	-	1
Bangladesh	12	-
Gulf of Aden	34	58
Somalia	10	9
Kenya	-	2
Total	**106**	**77**

Source: Drawn by the Author © Petroskelaiditis WMU-SMU, (ITL 09) inspired by ICC, International Maritime Bureau, (2008). *Piracy and Armed Robbery against Ships.* Annual report, UK: ICC. http://www.icc-ccs.org (requested via e-mail)

According to Van Der Meijden (2008) the economic impacts of piracy can be direct or indirect. Direct piracy costs are those caused by the interaction of the ship with pirates during an actual or attempted piracy attack while indirect costs consist of the expenses that arise from the consequences of a piracy situation: higher insurance premiums, legal fees, delays of cargo and increasing operational cost.

3.1.1 Direct Economic Impact

3.1.1.1 Ship and Cargo Damages

Recently pirates have been more ruthless than even before and they wouldn't hesitate to use any available weapon against the ship. Rocket-propelled grenades[7] and guns of every type are the most common means with which pirates force the

7 Hand held-shoulder launched anti tank weapons capable of firing rockets with explosive warhead, Wikipedia, http://en.wikipedia.org/wiki/Rocket_propelled_grenade

vessel to decelerate in order to be more vulnerable (International Champer of Commerce, 2008). Even if the piracy attack is unsuccessful the hull of the ship, accommodation satellite navigation and communication equipment, containers loaded with sensitive cargos or even corrosive substances are exposed to disastrous rockets and bullets. Damages caused by armed piracy attacks have been estimated between $10,000 and $50,000 per attack (Van Der Meijden, 2008). 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 Millions per year.

- *Actual and Attempted Attacks* Average Loss per Attack= 5,490 Millions*

3.1.1.2 Robbery of Cash and Crew's Personal Belongings

In most cases pirates will not waist their time searching for high value importable equipment but will go direct for ship's cash in Captain's cabin and look for crew's high value personal belongings such as mobile phones, digital cameras, portable computers, jewelry, cash and other valuable things. In a 23 crew container vessel and with almost every crew member having a computer and cash, the estimated value of the stolen items is estimated between $4,000 and $20,000, per incident, including Captain's cash for ship's operational issues. According to Table 2 106 actual piracy attacks have taken place in 2008 along the MSR. If the average number of crew, of every of the above mentioned 106 vessels, is of 15 persons with personal belongings of $2,000 per person and ship's cash of $10,000 per vessel the total financial loss is equal to $1,272 million.

- *Actual Piracy Attacks*Average Crew Number*Personal Belongings ($)*Captain's Cash ($) = 106*15*2,000*10,000= $1,272 million.*

3.1.1.3 Cargo and Ship Loss

It is not uncommon that pirates attack a container vessel and go after a specific container loaded with high value electronic items or equipment. The very fact of the cooperation between pirates and state port control or military officers who reveal information such as position of the container, cargo loaded, destination and crew number demonstrates that pirates have found and secured a way to develop such a

network to ensure the longevity of their business. According to Clarkson's Monthly Intelligence Report, October 2008, the price of a five-year-old "panamax[8]" container vessel of 3,500 TEU's in 2007 was $64 million, carrying loaded standardized containers, consisting of low and high value cargos, of approximately $800 million (Munich Re Group, 2006). Hijacking of the vessel with her cargo will have an enormous economic impact on every part involved in the transportation and in the supply chain of the goods. We assume one 5,000 TEU container vessel full loaded to be lost with her whole cargo. The financial loss will be an average of $500 million.

3.1.1.4 Off-Hire and Investigations

Hill, (2003) in his book *Lloyd's Practical Shipping Guides, Maritime Law*, defines "off-hire", under the New York Produce Exchange clause 15, as:

> The event of the loss of time from deficiency of men or stores, fire, breakdown or damages to hull machinery or equipment, grounding, detention by average accidents to ship or cargo, dry-docking for the purpose of preventing the full working of the vessel, the payment of hire shall cease for the time thereby lost; and upon the voyage the speed be reduced by defect in or breakdown of any part of her hull, machinery or equipment, the time so lost, and thereof, and all extra expenses shall be deducted from the hire. (p. 181)

Investigations that will follow, incidents of piracy attacks, are conducted by authorities in probably not very organized and politically unstable nations leading to loss freight payment for which the ship-owners will provide transportation services. According to Clarkson's Monthly Intelligence Report October 2008 the daily average earnings of a 3,500 TEU "panamax" container vessel, for 2008, are approximately $30,000 per day. Bureaucratic investigations lasting one to two weeks could cause enormous financial loss, due to off-hire, in terms freight payment, estimated to be between $210,000 and $630,000 per one or two weeks. Assuming investigations of 3 days for only the actual 49 attacks of container vessels that have been reported by

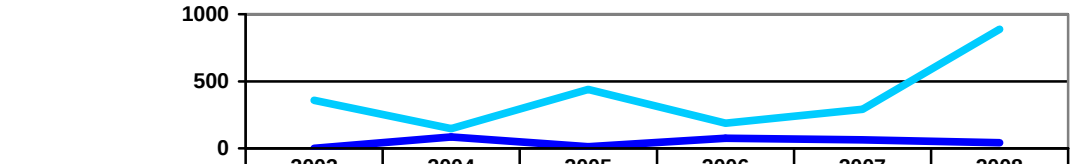
8 Panamax is the type of vessel with the maximum dimensions that will fit through the locks of the Panama Canal. Wikipedia. (2009). http://en.wikipedia.org/wiki/Panamax

the (IMB, 2008), with average daily earnings of $25,000, the total cost for these three-day-investigations of the 49 attacked container vessels will be around $3,675 million.

- *49 Container Actual Attacks*Average daily earning *3 days investigations=3,675 million.*

3.1.1.5 Ransoms.

Kidnapping the crew of the vessel for ransom has been a very profitable business for Somalian Pirates the last three years. Pirates will not hesitate to kill the crew and keep the whole vessel and its cargo, in case their requirements for ransoms are not fulfilled. According to several newspaper articles and taking into consideration the case of the 'Sirius Star' tanker vessel that was finally released after the payment of $3 million in ransoms, we can estimate the average rate for ransom settlement at around $2 million per incident (Rice, 2009). According to Beal, (2008) ransoms that have been paid can vary between $1 and $8 million while ransoms requested can exceed $25 million. Figure 10 depicts the number of crew members taken hostage and kidnapped for ransoms from 2003 to 2008.



	2003	2004	2005	2006	2007	2008
Taken Hostage	359	148	440	188	292	889
Kidnap/Ransom	0	86	13	77	63	42

Figure 10- Grew Members Taken Hostage and Kidnapped for Ransoms
Source: ICC, International Maritime Bureau, (2008). *Piracy and Armed Robbery against Ships.* Annual report, UK: ICC. http://www.icc-ccs.org (requested via e-mail)

What is more, negotiators for ransom settlements as well as means of transportation via which ransoms will be delivered to pirates also add a small but not negligible amount of money that can vary between $100 and $150 thousands (Hunter, 2008). Lawyers will receive an average fee of around $200,000 for legal issues during the

negotiation per piracy attack. With an average of $1.5 million paid for ransoms per incident of kidnapping, the above 42 cases of kidnappings will result to $63 million of loss, excluding the approximately $6.3 million paid for negotiators, $8.4 million for lawyers and $4.2 million for security companies that delivered the ransoms to the pirates. $150,000 for average fees for negotiators, $200,000 for lawyers and $100,000 for security companies per attack are assumed; a total of $81,900 million 42 for kidnapping incidents.

- *Incidents of Kidnapping*Ransoms Paid*Fees (Negotiators +Lawyers +Security Co) = 42*$1.5 million*$(150,000+200,000+100,000) =$81,900 million.*

3.1.2 Indirect Economic Impact

3.1.2.1 Anti-Piracy measures

When the vessel sails through dangerous waters it is obliged to operate at the highest requirements, level 3, of the International Ship and Port Security code (ISPS code) which was introduced on July 1, 2004 in response to the 9/11 terrorist attack in the United States. The implementation of the code is through chapter XI-2 "Special measures to enhance maritime security" in the International Convention for the Safety of Life at Sea, 1974, IMO, (2004). According to SOLAS (2004), Level 3 has been defined as:

> The level applying for the period of time when there is the probable or imminent risk of a security incident. Security level 3 means the level for which further specific protective security measures shall be maintained for a limited period of time when a security incident is probable or imminent, although it may not be possible to identify the specific target. (Chapter XI-2)

Operation at level 3 requires additional measurements to be adopted in order to avoid potential piracy attacks. The shipping industry and companies dealing with security issues have introduced several technologies as solution to piracy. The use of an electric fence around the vessel that will actually prevent pirates from boarding

the vessel is one of the innovating and expensive -$35,000- technologies that have been introduced so far. Night-vision cameras and binoculars that can actually identify pirates in the dark based on the temperature of their bodies, cost between $600 and $1000.

The Acoustic Defense System (LRAD) has the ability to transmit an effective high intensity sound that can be used to prevent an approaching piracy attack. The price for one LRAD is between $20,000 and $30,000. For the 71,415 vessels sailing the waters of the Gulf of Aden and the Malacca straights, the purchase of the above mentioned devise with an average price of $25,000 will cost $1.7 billion. On the other hand, the hire of security companies that will provide vessels with air and sea surveillance, using helicopters and high speed boats, as well as armed trained guards to accompany the vessel while sailing through high risk waters is becoming very common. The estimated price of the above mentioned private companies exceeds $10,000 per day. Lloyd's Shipping Economist (2002) mentioned prices of such private security companies between 12,000 and 24,000 for only three and five days. Finally, satellite tracking systems that can transmit emergency signals and the exact position of the vessel to the shipping company and alert the authorities by pressing only one button will cost approximately $400 per day (Van Der Meijden, 2008). A total of $3 billion is assumed to be spent on anti-piracy equipment, security companies and satellite tracking system.

3.1.2.2 Increasing Insurance Premiums

The increasing insurance premiums for vessels sailing through the Gulf of Aden, Somalia and the Malacca Straights reveal the responsiveness of the maritime insurance industry towards frequent piracy attacks. Marine underwriters[9] are aware of the danger and great risk in terms of Hull and Machinery (H&M) and Protection and Indemnity (P&I) issues. However, with more and more frequent piracy attacks

9 According to Gold, E., Chircop, A., & Kindred, H. (2003). cf reference list, Underwriter is defined the employee of that insurance company who is authorized to bind the company on insurance risks.

underwriters will have to increase the insurance premiums to maintain the profitability of their business but at the same time to provide the relevant acceptable amount of compensations to the ship-owners. According to (Van Der Meijden, 2008) apart from H&M or P&I issues an insurance company will provide compensation for ransoms/kidnapping and off-hire/operational loss. Insurance companies under the increasing numbers of piracy attacks will not be able to cover such financial loss with only H&M and P&I insurance premiums. Frank, (2008a) has mentioned that insuring a voyage against kidnapping for ransoms could cost around $16,000 per voyage for the area of the Gulf of Aden and $5,500 per voyage for navigation through the Malacca Straights. With 21,145 vessels sailing through the Gulf of Aden and 50,000 vessels through Malacca straights shipping industry will suffer of approximately $613 million per year.

3.1.2.3 Seafarers Double Pay

Sailing through high risk zones like Gulf of Aden and Malacca straights expose crews' lives at a great risk. Injuries, deaths, assassinations, man overboard situations and missing crew members have been reported in most cases of actual or attempted piracy attacks. The working environment on board the vessel is already difficult enough and the threat of piracy imposes additional pressure on the crew. Unpredictable pirates and crew's feeling of helplessness followed by the slow ransom negotiation process will have a great impact on crew's lives in terms of psychological concerns. According to BIMCO, Manpower 2005 Updated, (2005) by the year 2015 the shipping industry will have to deal with a 27,000 of officers' shortage despite the 44% of seaborne trade development that UNCTAD has estimated for the year 2020. The already existing problem of officers' shortage combined with the frequent piracy attacks it will but attract new young workers to begin a career at sea. Table 3 shows the crew shortage rates for the year 2000, 2005 and 2015. The less the available workers at sea, the higher the salary will be, excluding the additional amount of money that the ship owner will pay for every single crew member when the vessel sails though high risk waters. According to calculations made by Van Der Meijden (2008) and Osler (2008), the additional wage

cost for crew's double payment has been estimated between $16 and $24 million per year.

Table 3- Crew Shortage

Crew	**2000**		**2005**		**2015**	
	000s	%	000s	%	000s	%
Officers	-16	-3.3	-10	-2.1	-27	-5.9
Ratings	224	31	135	18.8	167	21.6

Source: Bimco, (2005). *The world demand for and supply of seafarers*. *Manpower Updated 2000&2005.*http://www.bimco.org/Corporate%20Area/Press/Releases/2005_12_02_Manpower2005update.aspx

3.1.2.4 Environmental Consequences

Although cases of pirates to cause voluntary cargo and ship damages or cases of abandoning the vessels with none to navigate it, at an operational level, have not been reported, the emerging nexus between piracy and maritime terrorism is of great concern. Snodon (2006) mentioned that Al Qaeda seems to own a fleet of vessels that can be used against ports or other ships around the world. Pirates acting under the umbrella of international terrorist organizations can cause an enormous environmental catastrophe and force major chokepoints such as the Malacca Straights and the Gulf of Aden to close for a long period of time. The impact on international trade and seaborne transportation could be uncountable while the cost of the environmental damages will be immeasurable; 21,145 vessels will be forced to sail around the Cape of Good Hope to reach destinations in Europe and vice versa increasing the daily operational cost. On November 13, 2002 the Liberian-flagged, single-hull tanker "Prestige" sunk off the Spanish coast of Galicia spilling more than 20 million gallons of crude oil into the sea. The cost for cleaning up the Spanish costs and the wreck of "Prestige" exceeded the amount of $4 billion; such an incident in the Gulf of Aden could cause enormous environmental catastrophe and financial loss.

3.1.2.5 Alternative Trade Routes

According to Tibbetts (2008), the increasing piracy attacks in the Golf of Aden has already forced strong players of seaborne transportation such as A.P. Moeller Maersk and the Norwegian chemical shipping company Odfjell to divert their existing tanker fleets and sail around the Cape of Good Hope in order to avoid piracy. Sailing around South Africa means longer distance, increasing operating costs and as a matter of fact increasing freight rates that will have a direct impact on consumers (Fremont, 2007). The existence of highly sophisticated logistics and supply chain networks brings out time as the most important factor for the global trade and industrial expansion worldwide. Utilization of time and cost will actually determine the shortest trade route to be followed by ships. Sailing around the Cape of Good Hope is definitely not the best maritime trade route in terms of cost and time. Vessels sailing around the Cape of Good Hope could add 5 to 21 days depending on the port of destination and origin. According to Van Der Meijden (2008), ships will have to sail an extra 3,500 nautical miles compared to the traditional route through the Gulf of Aden thus increasing the cost between $350,000 and $950,000 per transit. According to the Security Administration and Department of Transportation of the US (n.d.), a vessel sailing from Saudi Arabia to North America will sail 2,700 nm more and lead to an additional operational cost and fuel consumption equal to $3.5 million annually. However a container sailing from Europe to the Far East around the Cape of Good Hope will lead to $74.4 million of additional fuel consumption and $14.6 million for charter expenses. Assuming that out of the 21,415 vessels sailing through the Gulf of Aden 4,000 vessels sail around the Cape of Good Hope with an additional $500,000 operational cost, shipping industry will lose $2 billion. Table 4 provides the results of the average economic impact of piracy on the shipping industry which is approximately $10.2 billion without taking into consideration the impact on international trade and supply chains.

Table 4- Summary of Economic Impact of Piracy

Direct Economic Impact		
- Ship & Cargo Damages	5,490,000	$/year
- Crew Belongings & Cash	1,272,000	$/year
- Loss of Cargo & Ship	500,000,000	$/year
- Off-Hire (only for 49 Containers)	3,675,000	$/year
- Ransoms	63,000,000	$/year
-Negotiators	6,300,000	$/year
- Lawyers	8,400,000	$/year
- Security Companies	4,200,000	$/year
Total Direct Economic Impact	**592,337,000**	$/year
Indirect Economic Impact		
- Antipiracy measures	3,000,000,000	$/year
- Increasing Insurance Premium	630,000,000	$/year
- Seafarers Double Pay	20,000,000	$/year
- Environmental Issues (Prestige)	4,000,000,000	$/year
- Alternative Trade Routes	2,000,000,000	$/year
Total Indirect Economic Impact	**9,650,000,000**	$/year
Total Economic Impact	**10,242,337,000**	$/year

Source: Drawn by the Author © Petroskelaiditis WMU-SMU, (ITL 09) inspired from van der Meijden, (2008). Economic Influence of Modern Piracy on Maritime Commercial Transport. Master Thesis, Erasmus University, 2008.

Adding to the aforementioned the rapid environmental changes, a great opportunity is given to the shipping industry to explore the Arctic Ocean and develop a new maritime trade route that will be as revolutionary as the opening of the Suez and Panama Canal. A new trade, through the Arctic Ocean, could partly substitute the traditional MSR saving distance and eliminating piracy's financial losses and potential terrorist attacks. Further investigation and evaluation of the use of the Arctic Ocean for seaborne transportation follows in chapter four.

Chapter 4

The Northern Sea Route (NSR)

4.1 Global Warming

Twenty years ago very few scientists could have predicted the environmental changes that have been taking place in recent times. For most of the scientists around the world the phenomenon of global warming is a result of the "Anthropogenic Green House Gases"[10] that increase the average temperature of the earth on an annual basis. Very optimistic climate models of the Intergovernmental Panel on Climate Change (2009) estimate that the global temperature during the twenty first century will increase between 1.1 and 6.4 Celsius. The above mentioned gases have been concentrated in the atmosphere of the earth and as a matter of fact block the solar radiation that is reflected by the surface of the earth from passing through the atmosphere and out to space. A part of the solar radiation will remain in the atmosphere and be reflected back to the surface, warming up the lower atmosphere and adding Celsius decrees in the global average temperature (Dixon 2008). On the other hand the impact of the average temperature in the Arctic is rising twice as fast as elsewhere on the planet. The ice is melting slowly but steadily and decreases the surface of the Arctic Ocean that is actually responsible for reflecting the solar radiation back to the atmosphere (Shalina, Johannessen & Miles, 1999). The black color of the Arctic Ocean that is released from the ice attracts and absorbs more solar radiation increasing the temperature of the sea (Rodrigues 2008). With the ice melting so fast the idea of an ice free NSR is not just looming on the horizon but is just around the corner. According to studies the ice in the region of the Arctic Ocean is melting at the dramatic rate of 15% per decade while the permanent annual ice has been reduced by 14% between the period of 1980 and 1998 (Nor Shipping, 2007). The most conservative models have predicted that the Arctic Ocean will be completely ice free before the end of the century.

10 The greenhouse gases consist of carbon dioxide (76%), methane (13%), nitrous oxide (6%) and fluorocarbons (5%), (Bloomberg, 2007)

4.2 Geographical Morphology and Environment

As previously discussed in the literature review the Northern Sea Route can be defined as a “national transportation route under full Russian control and jurisdiction, stretching from the archipelago of Novaya Zemlya in the west to the Bering Strait in the east” (Ostreng 2002 77). The NSR connects the European and Asian continents, and passes through the seas of Barent, Kara, Laptev, East Siberian and Chukchi, saving up to 50% of distance between Europe and Asia compared to the MSR. Table 5 shows the distance-saving of a vessel sailing between Europe and Asia using alternative maritime trade routes. The above mentioned five seas are interspersed with islands that are located on the continental shelf of the Russian mainland. Starting from west, the Barent Sea is separated from the Kara Sea by the Novaya Zemlya island while the Kara Sea is separated from the Laptev Sea by Sevemaya Zemlya island. Novosibirskye and Wrangel islands divide the Laptev, East Siberian and Chukchi Seas and finally the NSR opens to the North Pacific Ocean though the Bering Straight (Kitagawa 2001). Figure 11 shows the Northern Sea Route stretching from Europe to Asia along the Russian continental shelf.

Table 5- Distance between Europe and Asia Using Alternative Routes

	From Hamburg to:		
Shipping Routes via:	Yokohama	Hong Kong	Singapore
NSR	6920	8370	9730
Suez Canal	11073	9360	8377
Cape of Good Hope	14542	13109	11846
Panama Canal	12420	12920	15208

Source: Ranger, C, L., (2000). *Northern Sea Route Cargo Flows & Infrastructure Present State and Future Potential*. The Fridtjof Nansen Institute. Norway.

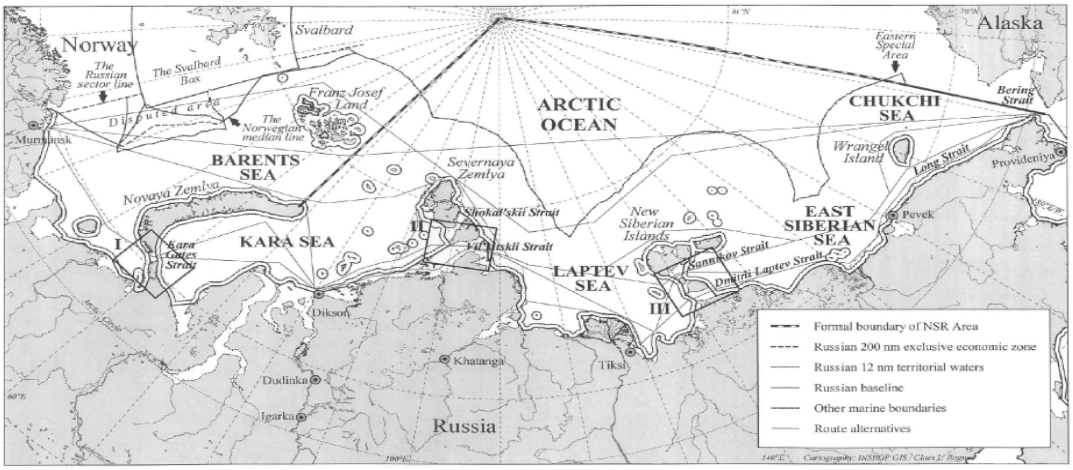


Figure 11-The Northern Sea Route
Source: Kitagawa, H. (2001). The Northern Sea Route: The Shortest Route Linking East Asia and Europe. Tokyo: Ship and Ocean Foundation.

4.2.1 Depths

The NSR consists of a number of straits that link the five seas, with different geographical and hydrographic morphology. Route selection will have to take into account the possible combination of the straights through which the vessel will navigate minimizing distance and operational cost. The depths of the seas are a matter that should be taken into consideration. Even though the depths of the five seas don't restrict navigation along the NSR, this is not the case for the straights that are located between the several islands and the Eurasian continent. Starting form the five seas, the Barent Sea is more than 200m deep while the Kara Sea's depth is less than 100m. Moreover, the Laptev Sea depth is more than 1,000m and the east Siberian is approximately 100m deep. Moving further east, Chukchi Sea is only 50m deep (Ranger, 2000). Table 6 gives more details of the straits along the NSR and their depths.

Table 6– Northern Sea Route Straights, Length and Depths

Straight Name	Length in Nautical Miles NM	Breadth in Nautical Miles NM	Depth in Meters East (E)/West(W)
Yugorkiy Shar	21 NM	5.5 NM	E 13-15/ W 16-30
Kara Gate	18 NM	61 NM	Minimum 21 E/W

Vilkitskiy	30 NM	Unrestricted	Unrestricted
Shokalskiy	80 NM	10 NM	Minimum 37 E/W
Dmitry Laptev	63 NM	30 NM	E 12-15/ W 14-18*
Sannikov	160 NM	16-18 NM	Minimum > 13
Long	120-160 NM	81 NM	Minimum 20-30

* Eastern approach has shallow waters of less than 10m restricting vessels of 6.7 drafts.
Source: Drawn by the Author © Petroskelaiditis WMU-SMU, (ITL 09)

4.2.2 Ice Condition

Apart from the shallow waters and numerous variations of depths of the five seas and straights along the NSR, ice formation is another factor that imposes limitations and exposes navigation and safety of life to several risks. The traditional navigating season along the NSR, is during summer time when the five seas have the most favorable ice conditions for navigation. Summer time has been defined as the season between June and October when the five seas are partly ice-free with a 50% of ice-covered waters and with relatively thinner ice (Kitagawa 2001). Conversely, navigation during winter is definitely more difficult due to the rough environmental conditions and thicker ice that covers almost every sea along the NSR, with the exception of the Barent Sea some parts of which are ice-free even during the toughest winter season (Breskin et al., 1998). Table 7 provides useful information regarding the percentage of ice formation of the five seas along the NSR. During summertime the most favorable month for navigation is June when the north-eastern Kara Sea, Western Laptev Sea and the eastern pat of the East Siberian Sea are ice-free.

Table 7- Sea Ice Extent during summertime

End of Month	Arctic Region						
	S-W Kara Sea	N-E Kara Sea	West Laptev Sea	East Laptev Sea	West Eastern Siberian Sea	East Eastern Siberian Sea	S-W Chukchi Sea
June	17%	0	10%	10%	0	0	27%
July	40%	18%	24%	33%	10%	6%	57%
August	85%	41%	45%	69%	31%	17%	75%

September	95%	53%	51%	80%	49%	27%	85%

Source: Kitagawa, H. (2001). The Northern Sea Route: The Shortest Route Linking East Asia and Europe. Tokyo: Ship and Ocean Foundation.

4.3 Financial Performance Overview

The future development of the NSR depends on the profitability and financial performance of a vessel operating along the NSR. According to Stopford (1997), for a successful financial performance three factors need to be taken into consideration. The revenue, the operation cost and the ways in which the ship-owner will finance the business. The key to a successful operation is the optimal ship operation in terms of costs and the "economies of scale[11]". Unfortunately, ship-owners can not do much to influence the price they receive for their transportation services but by increasing cargo capacity, decreasing ships turnaround time and running costs they can ensure profitability in short and long terms.

4.3.1 Economies of Scale

The NSR can be used for the transportation of the Arctic's natural resources and also for transit cargoes between Asia and Europe and vice versa. Container ships are the most appropriate ships to carry transit cargoes through the Arctic straights between East and West. Compared to bulk carrier and tanker vessels the size of the container vessels have not been optimized always in relation to the operating costs. The relationship between ship's size and cost is known as "Economies of Scale". According to Essallamy (2008), ship's size, speed and utilization of cargo capacity are some factors, the variable inputs of which can actually result in optimal economies of scales and profit maximization. However, the point at which the added value of inputs (speed, cargo capacity, size etc.) is not resulting in the same rate of revenues, a diminishing return phenomenon appears the name of which is "diseconomies of scale" (Ma, 2008). A diseconomy of scale, in simple words, means the decline of revenues after a certain amount of inputs that have been added. Figure 12 describes the behavior of ship's costs in relation to the increasing ship's

11 C.f Paragraph 4.4.1

size. It is obvious that the more we increase the size of the vessel the more profitable the operation of the vessel will be, therefore, at the point of 100,000 tons of ship's size, cargo and ship cost will interact reaching the optimal point. Further increasing the size of the vessel, exceeding the 100,000 tons, the output will not have the same rate and cargo and ship cost will start to increase.

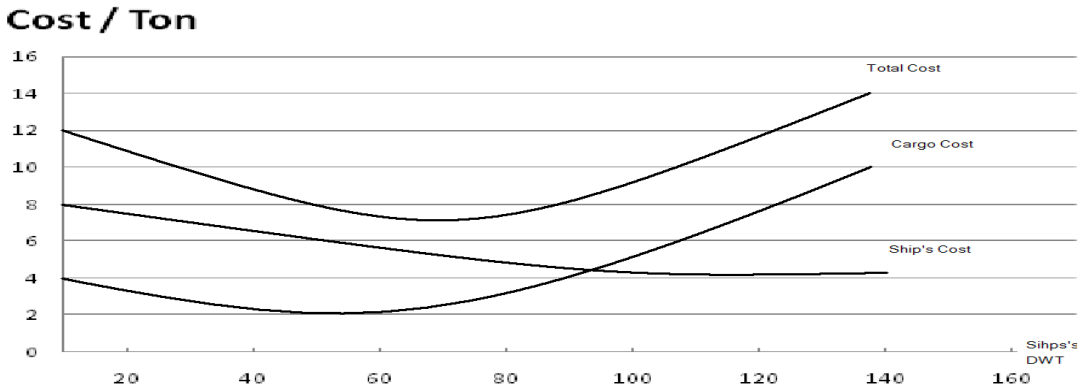


Figure 12- Economies of Scale in terms of Ship's Size
Source: Ma, S. (2008a). Maritime Economics. Unpublished Maritime Economics Handouts. World Maritime University.

The question arising here is whether economies of scale can actually apply to containers sailing along the NSR, taking always into consideration the constraints of the geographical morphology of the Arctic Ocean in terms of draft. The shallow waters of the five seas along the NSR in relation to the sea ice extent of the Arctic Ocean impose several restrictions on the size of the vessel. Figure 13 shows the decreasing expenses of a vessel when the size of the vessel increases.

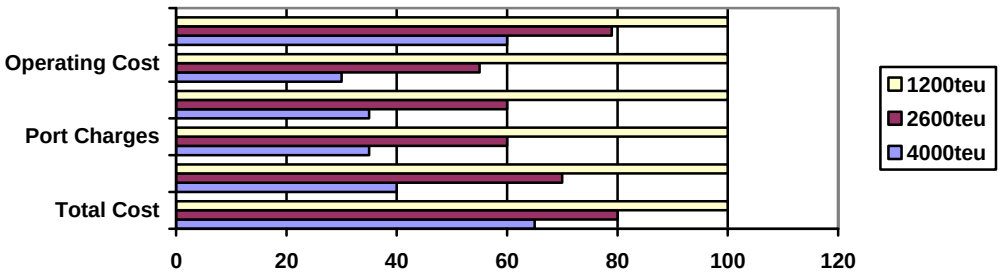


Figure 13-The bigger the Vessel the less the Expenses
Source: Ma, S. (2008a). Maritime Economics. Unpublished Maritime Economics Handouts. World Maritime University

4.4 Case Study

This case study will estimate the expenses of a container vessel sailing along the NSR and eventually will calculate the average cost for transporting one TEU. According to Arpiainen & Kiili (2006), a double-acting vessel (DAV) of 5,000 TEUs capacity is the most appropriate in terms of size and economy of scales for sailing along the NSR. The case study is partly based on a project conducted by Aker Arctic Technology Inc, in 2005, for the economic feasibility of the NSR using a 5,000 TEU container vessel, which was an improved version of the first arctic container vessel, “Norilskiy Nickel”, built by Aker Shipyards for the Russian company Norilsk Nickel. The 5,000 TEU Arctic container vessel, with a building cost of $295 million, is 281.3 meters long and 34.6 meters wide. The depth is 21.3 meters having an acceptable -for sailing in the shallow Arctic waters- draft of 13.5 meters. The vessel has eight cargo holds that can be loaded with twelve rows of containers with a maximum height of eight containers per row. On the other hand, the deck of the vessel can facilitate 14 rows of containers with a maximum height of seven containers per row. The total capacity of the vessel is 5,000 TEU equal to 68,000 dwt (Figure 14). The vessel has two Azipod propulsion systems that can produce power of 18MW each. When the vessel navigates in open waters can reach maximum speed of 19 knots while navigating in thick ice of 2.4 cm the maximum speed is 2.4 knots astern. Fuel consumption has been estimated to be 170 tones per day.

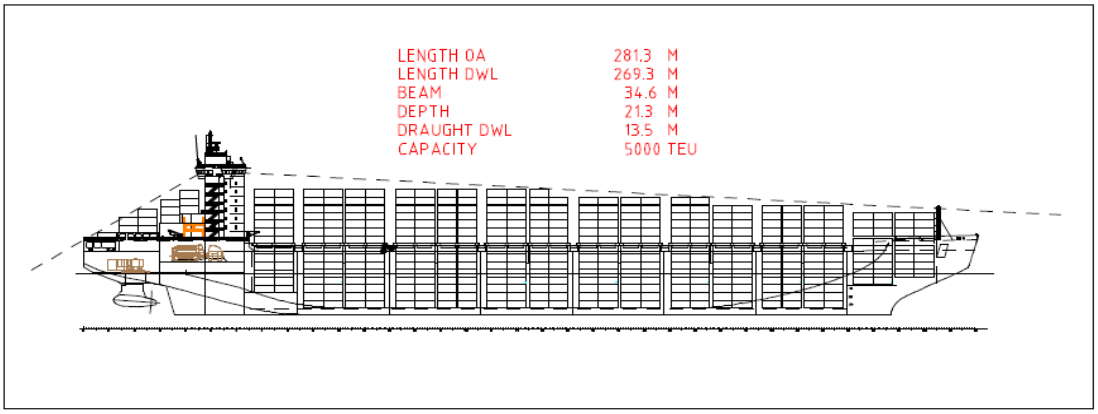


Figure 14- 5,000 TEU Arctic Container Vessel
Source: Arpiainen, M & Kiili, R. (2006). Arctic shuttle container link from Alaska US to Europe. Aker Arctic Technology Inc project, report K-63.

4.4.1 Route Selection

According to Arpiainen and Kiili (2006), the speed of a 5,000 TEU container vessel will vary significantly due to the different environmental conditions and ice formation along the NSR during the four seasons of the year. Arpiainen and Kiili (2006) based on "*Aker Arctic Technology Inc project, report K-63*" assumed that the most favorable months for navigation, in terms of speed and sailing days, are September and October with average 11 days for one-way trip, between Europe and Asia and 19 knots sailing speed. The distance between the two ends of the NSR, Bering and North Sea is approximately 4,963nm. For the case study we assume Hamburg and Yokohama the two points of arrival and destination of the container vessel with 2 days spent at every port for loading and unloading process. Table 8 provides more detailed information for the NSR in terms of optimal routes, length, ship's navigating time and speed.

Table 8- Speed variation and sailing times for different route

Leg	Bering Sea	Bering St	Chukchi	E Siberia	Laptev	Kara E	Kara N	Pechora N	North Sea	Total
Length [nm]	552	356	370	622	577	238	283	342	1623	**4963**
Length [km]	1023	659	685	1152	1069	442	523	633	3006	**9191**
Avg. Speed [kn]										
Jan	19.0	16.2	9.7	7.3	13.5	9.6	10.6	14.1	19.0	
Feb	19.0	15.4	7.3	4.1	11.6	5.5	8.9	13.9	19.0	
Mar	19.0	14.6	3.2	3.4	9.9	3.2	7.7	13.3	19.0	
Apr	19.0	13.9	3.4	3.0	7.6	3.5	7.8	13.0	19.0	
May	19.0	13.7	3.5	2.9	7.8	4.5	8.0	13.1	19.0	
Jun	19.0	14.5	3.8	3.1	9.2	4.5	9.4	13.8	19.0	
Jul	19.0	19.0	16.4	9.6	14.0	14.3	16.2	17.7	19.0	
Aug	19.0	19.0	19.0	15.0	17.2	19.0	19.0	19.0	19.0	
Sep	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	
Oct	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	
Nov	19.0	19.0	15.9	15.3	15.0	15.9	16.6	17.3	19.0	
Dec	19.0	17.3	12.9	11.8	11.3	13.1	13.8	15.3	19.0	
Time [h]										Total
Jan	29.1	22.0	38.1	84.9	42.8	24.7	26.7	24.3	85.4	**378.0**
Feb	29.1	23.1	50.6	153.3	49.6	43.0	31.9	24.5	85.4	**490.5**
Mar	29.1	24.4	115.3	182.5	58.5	73.5	36.6	25.6	85.4	**631.0**
Apr	29.1	25.6	107.6	209.5	75.9	68.2	36.1	26.2	85.4	**663.5**
May	29.1	25.9	105.3	214.5	73.9	52.6	35.1	26.0	85.4	**648.0**
Jun	29.1	24.6	98.4	200.4	62.4	52.7	30.0	24.8	85.4	**607.8**
Jul	29.1	18.7	22.6	64.6	41.1	16.7	17.5	19.3	85.4	**315.0**
Aug	29.1	18.7	19.5	41.5	33.5	12.5	14.9	18.0	85.4	**273.1**
Sep	29.1	18.7	19.5	32.7	30.4	12.5	14.9	18.0	85.4	**261.2**
Oct	29.1	18.7	19.5	32.7	30.4	12.5	14.9	18.0	85.4	**261.2**
Nov	29.1	18.7	23.2	40.7	38.5	15.0	17.0	19.8	85.4	**287.5**
Dec	29.1	20.6	28.7	52.6	50.9	18.2	20.4	22.3	85.4	**328.2**

Source: Arpiainen, M & Kiili, R. (2006). Arctic shuttle container link from Alaska US to Europe. Aker Arctic Technology Inc project, report K-63

4.4.2 Cargo Transportation

Based on the assumption that the NSR is ice-free for two months we can now calculate the monthly volume of containers transferred between East and West.
During the most favorable months, September and October, the vessel will complete transit transportation in loaded condition in 522 hours or 22 days. During the above mentioned 22 days the vessel will transfer 10,000 TEU containers. However, out of the eight remaining days of the month, the vessel will remain at port for loading and unloading operation for four days and another four at sea carrying approximately 1,805 TEU. As a matter of fact between September and October the vessel will carry 23,610 TEU containers. The number of the TEU transferred for the rest of the year is given in table 9 based on calculations conducted by Arpiainen & Kiili (2006). A total of 102,278 TEUs will be transferred between Europe and Asia.

Table 9- Assumed TEUs Transported along the NSR

Cargo capasity	TEU	5000

Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
One way sailing	h	378	490	631	663	648	608	315	273	261	261	287	328	
Roundtrip sailing	h	756	981	1262	1327	1296	1216	630	546	522	522	575	656	
Two loadings & unloadings	h	96	96	96	96	96	96	96	96	96	96	96	96	
Mean roundtrip time	h	852	1077	1358	1423	1392	1312	726	642	618	618	671	752	
Number of ships	pcs	1	1	1	1	1	1	1	1	1	1	1	1	
Mean loading frequency	h/load	426	538	679	711	696	656	363	321	309	309	335	376	
Loading availability in month	h	730	730	730	730	730	730	730	730	730	730	730	730	
Loadings per month	pcs	1.71	1.36	1.08	1.03	1.05	1.11	2.01	2.27	2.36	2.36	2.18	1.94	20.5
Trips/ship	pcs	0.9	0.7	0.5	0.5	0.5	0.6	1.0	1.1	1.2	1.2	1.1	1.0	
Cargo per month	**TEU**	**8568**	**6778**	**5375**	**5130**	**5245**	**5565**	**10056**	**11368**	**11805**	**11805**	**10880**	**9702**	**102278**

Source: Arpiainen, M & Kiili, R. (2006). Arctic shuttle container link from Alaska US to Europe. Aker Arctic Technology Inc project, report K-63.

4.4.3 Structure of Vessel's Costs

In order to calculate and estimate the cost for transporting on a container along the NSR all the expenses related with the operation of a vessel need to be considered.

According to Stopford (1997), the total cost of a vessel per dwt is the sum-up of the operating, cargo handling and capital cost divided by the dwt of the vessel. However, the purpose of this case study is to calculate the annual cost of a Double Acting container Vessel (DAV) sailing along the NSR and to estimate the transportation cost of one TEU per year. As a matter of fact the annual cost of a TEU is the sum-up of the operating, voyage and capital cost of the vessel divided with total amount of TEU transferred in one year. Table 10 shows the cost per TEU.

Table 10– Transportation Cost of One TEU

$$C/TEU = \frac{OC/y+VC/y+K/y}{T\text{-}TEU/y}$$

C/TEU = cost per TEU transported per annum
OC = operating cost per annum
VC = voyage cost per annum
K = capital cost per annum
T-TEU = total TEU transported in one year
y = Year

Source: Drawn by the Author © Copy write Petroskelaiditis WMU-SMU, (ITL 09), inspired by Stopford, M. (1997). *Maritime Economics,* 2nd Edition, UK: Routledge.

4.4.3.1 Operating Cost

The operating cost of the vessel consists of all the daily expenses of the vessel such as crew cost, insurance, administration, repairs and maintenance. Table 11 provides more details for the main components of the Operational cost of a vessel.

Table 11– Operational Cost per Year

$$OC/_y = M/_y + ST/_y + MN/_y + I/_y + AD/_y$$

M = Manning Cost
ST = Stores
MN = Repair-maintenance
I = Insurance
AD = Administration
y = Year

Source: Drawn by the Author © Petroskelaiditis WMU-SMU, (ITL 09),

inspired by Stopford, M. (1997). *Maritime Economics,* 2nd Edition, UK: Routledge.

Manning Cost. Manning cost consists of all the direct and indirect expenses of the crew on board the vessel. For a container ship navigating along the NSR, expenses such as salaries, insurance, pensions, airplane tickets for repatriation and other miscellaneous expenses form the basic manning costs. The most appropriate nationality of crews, in terms of experience, that can actual operate efficiently under such extreme environmental conditions is the Russian. Assuming that a crew of Russian nationality consists of eight officers (Captain, Chief mate, two 2nd officers, Chief Engineer, 2nd Engineer, two 3rd engineers) of an average salary of $270,000 per year and thirteen ratings (bosun, four Abs, a catering staff of three, oiler, electrician etc.) with an average salary of $200,000 per year, while miscellaneous costs such as repatriation, health insurance etc. have been estimated at around $7,619 per person or $100,000 per crew per year.

*Stores and Consumables Costs C*onsist of spare parts, lubrication oil for the main and auxiliary engines, consumable articles for the crew etc. Due to the sophisticated design of a DAV and its unique functions use of lubricants of around $270,000 per year is estimated while cabin stores and water are estimated to be approximately $20,000 per year. Finally, spare parts and other miscellaneous stores cost $80,000 per year.

Repair and Maintenance Costs. Sailing along the NSR due to the extreme environmental conditions and presence of ice extent in relation to high concentration of dissolved oxygen accelerate the corrosion of steel structures thus producing the need for the conduction of special and more frequent maintenance. On the other hand, *Breakdowns* or failures of equipment can be very expensive depending on how critical for the operation of a ship the equipment is. Breakdowns may lead to shipyards or to expert repair services groups. Based on the maintenance costs used by Kitagawa (2001), and adjusted to an annual currency inflation of about 2.49%, for the last nine years, we can approximately estimate maintenance costs around $320,000 and engine spare parts around $230,000 per year. Finally, annual expenses of $500,000 for technical, inspection and dry docking issues should be considered as well.

Insurance Costs consist of the Hull and Machinery (H&M) insurance and Protection & Indemnity (P&I). Hull and Machinery insurance will protect the ship-owner from any physical damages or loss while Protection and Indemnity will provide compensation for third party liabilities such as oil pollution, damage to cargo, collision damage etc. According to Stopford, the insurance cost of a vessel accounts for an average 30% of the total operational cost of a vessel. Liu & Kronbak (2007) have estimated, for 4,500 TEU container vessel, H&M costs of around $511,000 and P&I costs of around $383,250 per year. However, for a 5,000 TEU container vessel the author assumes an approximately cost of $375,000 for H&M and of $265,000 for P&I per year. Despite the persistent efforts made by the author of this thesis to acquire more accurate and exact figures, Russian insurance companies did not reply to questions related to the insurance premium of a vessel sailing along the NSR.

Administration Costs consist of management charges, communication charges between charterers and ship-owners and other miscellaneous general costs when the vessel operates at sea or at port. A daily rate of $700 is more than enough for administrative issues including also charges for weather reports and accurate ice formation predictions and route recommendations. According to Liu and Kronbak (2007), one-day forecast costs around $90. Total administration cost can be estimated to be around $260,000 per year.

4.4.3.2 Voyage Cost

Fuel consumption, NSR dues and port charges will determine the voyage cost of a vessel sailing along the NSR. Table 12 depicts the main components that form the voyage cost of a vessel.

Table 12– Voyage Costs

$$VC_{/y}=FC_{/y}+PD_{/y}+TP_{/y}+NSRD_{/y}$$

VC	= Voyage Costs
FC	= Fuel Costs
PD	= Port Dues
TP	= Tugs-Ice Pilot
NSRD	= Northern Sea Route Dues

y	= Year

Source: Drawn by the Author Drawn by the Author © Petroskelaiditis WMU-SMU, (ITL 09) inspired by Stopford, M. (1997). *Maritime Economics,* 2nd Edition, UK: Routledge.

Fuel Costs. The daily fuel consumption of the DAV container vessel is approximately 170 tones per day with 35 WM shaft power. The total one-way sailing time of the vessel is 5,143 hours or 214 days per year. The vessel will spend 4 days at port, or 96 hours for every one-way trip, which is equal to 48 days per year. One year one-way trip is equal to 262 days. The rest of 103 days will be spent at sea and as a matter of fact the total sailing time of the vessel is equal to 7,615 hours or 317 days. The total annually fuel consumption is equal to 53,890 tons. Despite the decrease of the crude oil price due to the current financial crisis the author assumes the price of fuel oil to be $300 per ton. As a matter of fact annual fuel consumption is equal to $16 million including the consumption of fuel consumed by auxiliary machineries and generators.

Port Charges. Transportation of cargo between Asia and Europe can link Yokohama, Japan and Hamburg, Germany. Kamesaki, Kishi & Yamauchi (1999) concluded that by producing the INSROP working paper No. 164 the amounts of $113,000 of port charges for Hamburg and $59,000 for Yokohama for six days are spent at each port. By adjusting a 2.52% of currency inflation for the last nine years we can estimate that for a “panamax” container vessel at the port of Hamburg the charges would be approximately $60,000 for two days while $30,000 for two days in Yokohama. The vessel would spend 24 days at each port every year and the total port charges would be $720,000 for Hamburg and $360,000 for Yokohama per year.

Ice Pilot Chares. Sailing along the NSR would definitely require the experience of the Russian ice pilots to guide the vessel through the narrow straights and ice covered waters. According to Liu & Kronbak (2007), the rate of such pilots is $1 per nautical mile. For 24 hours of navigation two pilots are needed with an average cost of approximately $7,000 per one-way trip or $80,000 per year.

NSR Dues. All vessels sailing along the NSR for transit or regional seaborne transportation need to pay the transit fees for the maintenance of the NSR infrastructure and ice breakers. According to Ranger (2000), NSR fees depend on vessel's ice clause, gross tonnage, nationality and season during which the vessel will sail along the NSR. However the construction of DA vessels with ice breaking capabilities will eliminate the need for icebreakers which is the main component of the NSR fees. As we can see from figure 15 in the year 1985 approximately six millions of bulk cargo was transferred along the NSR with an average NSR fee of $3 USD per ton. In 1995 the average cargo transferred along the NSR was 3 millions less than in 1985 with an average NSR fee of $7.5 per ton. Therefore it is obvious that the more cargo is transferred along the NSR the less NSR fees the ship-owners will pay.

Liu & Kronbak (2007) mentioned that since one TEU is equal to 24 tons and based on the current charge of $40.8 per tone one container TEU will cost approximately $979 which is extremely high especially for a 5,000 TEU container vessel. However, Russia needs to develop NSR fee charges independent of icebreakers use. Ranger (2000) has mentioned that NSR fees in the future will not exceed $5 per gross tonnage which could be a transit rate competitive enough without the need for ice breakers. A "Panamax" container vessel of 32,000 gross tonnage costs $160,000 in transit fees to ship-owners for a one-way trip. If a "Panamax" container can conduct five transit trips per year the total charge for the NSR dues will be $1,600 million.

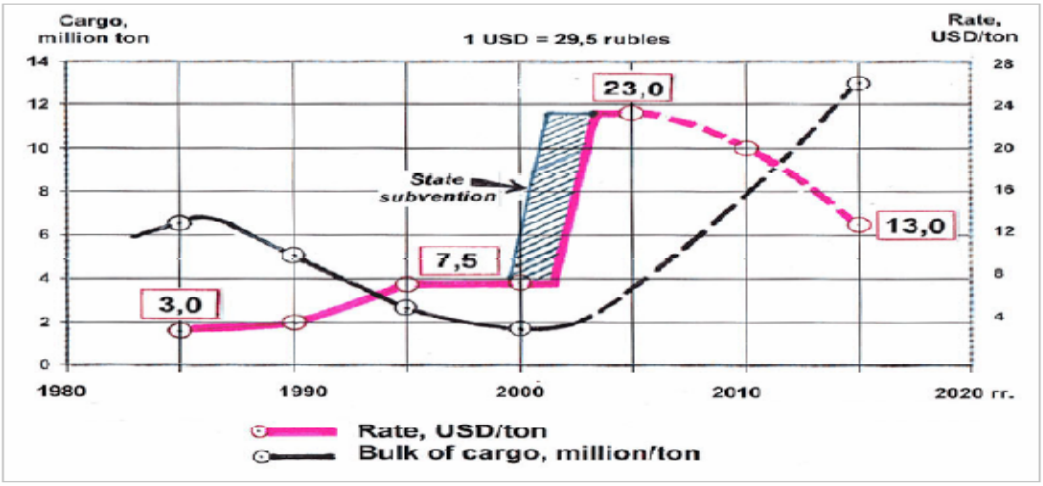


Figure 15– NSR fees through the Years
Source: Liu & Kronbak, (2007). *The economic potential of using northern sea route (NSR) as an alternative route between Asia and Europe.*

4.4.3.3 Capital Cost

Based on the information provided by Aker Arctic Technology the building price of a DAV 5,000 TEU container vessel is equal to $295 million, financed by bank loan to be paid back in 20 years in equal annual installments of $14,750 million per year and with an annual interest rate of 8% of the outstanding loan. The capital cost per year will be $19,861 million (Arpiainen & Kiili, 2006).

4.4.4 Total Arctic Transportation Cost

According to the above mentioned assumption and formulas the average cost for transporting one container TEU between Europe and Asia can now be calculated. Table 13 is a summary of all the assumptions related to operational, voyage and capital cost of the vessel.

Table 13– Summary of Operational, Voyage and Capital costs

General Specifications		
Ship Type	Container Vessel	Panamax
Deadweight	68,000	
Gross Tonnage	32,000	
Capacity	5,000	TEU
Cargo Transferred	102,278	TEU/y
Operating Cost		

Manning		
-Officers	270,000	$/y
-Ratings	200,000	$/y
-Repatriation/Insurance etc.	100,000	$/y
Stores		
-Lubricant Oil	270,000	$/y
-Cabin Stores	15,000	$/y
-Water Supply	5000	$/y
-Miscellaneous	80,000	$/y
Repair & Maintenance		
-Maintenance	320,000	$/y
-Engine/Deck Spare Parts	230,000	$/y
-Dry dock, Inspections	500,000	$/y
Insurance		
-H&M	375,000	$/y
-P&I	265,000	$/y
Administration	260,000	$/y
Total Operating Cost	**2,890,000**	$/y
Voyage Cost		
-Sailing days	317	days
-Fuel Consumption	170	Tons/day
-Price	300	$
Total Fuel Consumption	53,890	Tons/year
Total Fuel Price	16,000,000	$
Port Charges		
-Hamburg (24 days/year)	720,000	$/berthing/year
-Yokohama (24 days/year)	320,000	$/berthing/berthing/year
Ice-Pilot	80,000	$
NSR Dues/per year	1,600,000	5$/gross tonnage for 5transit trips per year
Total Voyage Cost	**18,720,000**	$
Capital Cost		$
-Building Price	295,000,000	$
-Interest Rate	8	%
Total Capital Cost	**19,861,000**	$/Per year
Total Cost	**38,581,000**	$/Per Year

Source: Drawn by the Author ©Copy write PetrosKelaiditis WMU-SMU, (ITL 09).

With average annual costs of approximately $38.5 million and with annual volume of containers transported between Europe and Asia estimated at 102,278 TEU the formula of table 9 can be applied to calculate the cost of transporting of one

container between Europe and Asia through the NSR. As a result the transportation cost of one container TEU along the NSR is equal to $377.

Chapter 5

Cost Comparison-Fuzzy Comprehensive Evaluation Model for the NSR

5.1 Comparative Analysis of Piracy's Economic Impact and NSR Costs

The average annual transportation cost of a TEU using the NSR, between Europe and Asia is equal to $377 compared to the transportation cost of a container using the MSR, through the Malacca straights and the Suez Canal, which is approximately $1,200 (Arpiainen & Kiili 2006). In addition, the estimated cost of piracy on the shipping industry is approximately $10.2 billion excluding the impact of piracy on international trade and supply chain networks due to cargo delays. With $10.2 billion spent on piracy related issues, 27,055,702 TEUs could be transported between European and Asian markets with direct benefits for the consumers in terms of lower final product market prices.

The shipping industry is definitely a highly profitable industry; however $10.2 billion should not be ignored. The capital cost for building a Double Acting container vessel, of 5,000 TEUs capacity, is $295 million; the construction of 20 DAVs that will operate all year long will cost $2.95 billion; a much lower sum than what the

shipping industry spends on piracy incidents per year. Although the cost of piracy, based on the economic analysis of chapter 3, has been estimated to be $10.2 billion, some experts believe that the cost of piracy per year is approximately $16 billion (Van der Meidjen 2008). If this is so, the substitution of the Maritime Silk Road, along which piracy has always existed, could save a lot of money to ship-owners and international trade. The cost of piracy along the NSR will be naught while the possibilities of the maritime terrorist attack will be eliminated. Taking also into consideration the continuous environmental changes and the melting of ice such a scenario could be the case in the following years. Less traffic along the traditional MSR will force inhabitants of coastal developing countries along the Maritime Silk Road to find other means of making a living than exercising piracy.

5.2 Comprehensive Analyses of the NSR

The establishment of the International Northern Sea Route Program (INSROP), in 1993, with the cooperation of the Central Marine Research & Design Institute (CMRDI) in Russia, The Fridtjof Nansen Institute (FNI) in Norway and Ship and Ocean Foundation (SOF) in Japan was undoubtedly the first organized attempt to investigate the economic potential of the NSR for seaborne transportation. Some years later in 2003 the Arctic Operational Platform (ARCOP) project was established to investigate if the transportation of oil and gas, through the NSR, was economically and technologically feasible. 21 organizations and private institutions from the European Union (EU), Russia Federation (RF) and Norway were involved in the project. The comprehensive analysis of the NSR that will follow is based on the conclusions of the above mentioned international programs.

5.2.1 NSR Policy and Legal Regime

The legal regime concerning the NSR in terms of national and international legislation has sparked heated debates concerning the Russian national legislation, which comes into conflict with international laws, raising strong objections -mainly on the part of the USA. Russia's territorial waters and exclusive economic zone conform to the interpretation of the Article 3 of the United Nations Convention on the Law of Sea (1982) according to which:

> Every State has the right to establish the breadth of its territorial sea up to a limit not exceeding 12 nautical miles, measured from baselines determined in accordance with this Convention. (Part II, Section 2, Article 3)

As a matter of fact the above interpretation gives the legal right to Russia to observe every activity of foreign vessels along the NSR. However, problems arise due to the claims of the USA that the ice covered straights along the NSR are international waters and transit passage should be a legal right of every vessel despite nationality. From another point of view, Russia claims the NSR straits, as internal waters, mainly based on the UNCLOS Article 234 which was adopted by the United Nations in 1982 and ratified by Russia in 1997. Article 234 of the United Nations Convention on the Law of Sea (1982) states that:

> Coastal States have the right to adopt and enforce non-discriminatory laws and regulations for the prevention, reduction and control of marine pollution from vessels in ice-covered areas within the limits of the exclusive economic zone, where particularly severe climatic conditions and the presence of ice covering such areas for most of the year create obstructions or exceptional hazards to navigation, and pollution of the marine environment could cause major harm to or irreversible disturbance of the ecological balance. Such laws and regulations shall have due regard to navigation and the protection and preservation of the marine environment based on the best available scientific evidence. (Part III, Section 8, Article 234)

However, the former Union of Soviet Socialist Republics (USSR), a coast state, based on the UNCLOS Article 234, approved the “Regulations for navigation on the seaway of the Northern Sea Route” in 1991 the purpose of which is to prevent pollution and protect the natural environment of the Arctic region and ensure safe navigation for the ships sailing along the NSR. All vessels willing to enter the NSR need to ask for the Northern Sea Route Administration’s permission by submitting an application for icebreakers assistance as well as to prove with relevant documents or certificates that the vessel or shipping company has the appropriate insurance contract with which the insurance company will cover liabilities in case of environmental pollution (Gorshkovsky 1999). Regulations become more contradictive to the international laws and Article 234 of UNCLOS 1982 in terms of innocent passage due to the legal right of Russia under which Russia can board, suspend or even remove any vessel from the NSR if there are concerns regarding

the safety of the vessel and crew due to extreme environmental conditions as well as due to disobedience of the vessel to the national regulations. As a consequence the requirements of the Article 234 of UNCLOS, for “innocent passage” and “nondiscriminatory” policy of the coastal state towards foreign vessels, under Russian national legislation are under further discussion (Brubaker & Ostreng, 1999). While It is unknown whether Russia applies the same passage fees to national vessels or not; at the same time the requirement for mandatory icebreakers escort sounds completely unreasonable especially for vessels that have been built for sailing in ice covered waters and have the ability to sail without the help of icebreakers (Arctic Platform, 2003b).

5.2.1.1 World Trade Organization (WTO)

In the long term the legal regime of the NSR will be further adjusted to comply with the international laws due to the willingness of the Russian Federation to join the World Trade Organization (WTO)[12]. Although it is a matter of time for Russia to join the WTO still more effort needs to be made on trade issues to convince the European Union (EU) and United States of America that Russia is ready to accept, adopt and apply new trade patterns and business practices according to the demands and standards of the WTO and the globalised economy of the present days (BBC, 2009). The change regarding the Russian national legislation that governs the NSR will eventually become a reality as soon as Russia becomes a member of the WTO and adopts the General Agreement on Trade in Services (GATS). The WTO established the GATS as a reaction to the fact that although the service industry supports more than 60% of the global production and employment, it is focused more on domestic than international levels, in terms of trade. Put simply, service needs to be traded like every tangible product. Under GATS services can be traded in the same way as tangible products within a reliable system of global regulations and of non-discriminatory nature, fueling the economic activity and

12 WTO is the only international trade organization that deals with trade regulations between nations that have joined it and fuels the continuous trade of products and services as well as imports and exports of the country-members, c.f. WTO, (1994).

promoting development. The Russian national legislation along the NSR will be restricted by the WTO and GATS requirements.

5.2.2 Maritime Insurance

It is a fact that trade activities along the NSR over the years have not been adequate for the establishment of a well structured insurance market while information, based on which foreign insurance companies could have estimated and analyzed the cost of insurance premium, has been restricted (Moon & Tukhfatullin 2003). Lack of statistical reports and figures regarding the frequency of ships accidents and damages, oil spills and ships' loss obstruct the conduction of an adequate analysis of the Russian insurance market and as a result foreign insurance companies can not confidently determine the price of the insurance premium and insurance policies to be applied while sailing along the NSR. According to Donner (2009), there are many interests involved in the maritime transportation such as the vessel, cargo, banks and freight payable for the transportation service provided. All the above interests are exposed to a number of different risks that need to be covered by different insurance policies[13].

Traditionally insurance companies will never create insurance initiatives unless it is demanded by the shipping market (Gold, Chircop & Kindred, 2003). As soon as ship owners start sending their vessels through the NSR, the insurance market will react to cover the need for insurance policies. However, even nowadays very few Russian private insurance companies exist to insure vessels navigating through the NSR, most of which in order to be more competitive and attract more costumers offer insurance premiums at a very low rate. Offering low insurance premium is extremely dangerous for insurance companies due to the fact that in order to bear the risk of environmental pollution or ship loss the insurance company needs to reinsure a part of the risk[14]. If the insurance premium is very low the reinsurer will refuse to share the risk and consequently the insurance company will bear the whole risk itself. As

13 The most common insurances are the Hull & Machinery Insurance, the Cargo Insurance, the Third Party Liabilities Insurance -such as Protection & Indemnity (P&I)- and Insurance of Miscellaneous Risks.

14 Reinsure the risk means the insurance company to share the risk with another insurance company called reinsurance.

soon as regular transportation will be a reality along the NSR there is no doubt that insurance market will react positively to service the demand for insurance along the NSR.

5.2.3 Environmental Issues

The 5 million square miles of Arctic Ocean is probably one of the last places on the planet that have remained almost untouched by human beings and hardly inhabited for the last 20,000 years (Yakovlev, et al, 1999). With a maximum winter temperature of -45o, its flora and fauna have been involved in physical adaptations to ensure the longevity of the Arctic ecosystem which is characterized by low species diversity (Borgerson, 2008).

5.2.3.1 Impact of commercial shipping along the NSR

In 1989 the crude oil tanker “Exxon Valdez” ran aground in Prince William Sound in Alaska spilling more than 10.9 million gallons of crude oil into the water causing a tremendous environmental disaster that even nowadays is considered to be a bad precedent of potential future oil spill incidents for future shipping activities along the NSR (Johnson, 2009). Shipping activities along the NSR expose the fragile ecosystem of the Arctic Ocean to several risks always related to environmental pollution. In a region with low levels of productivity and biodiversity such as the Arctic ecosystem oil spill can be disastrous. The impact of a year-round navigation along the NSR can be diverse depending on the pollution and disturbance of the ecosystem caused by the operation of the vessel, its interaction with the environment and human error accidents. Exhaust gases, sewage, garbage, discharges of ballast water, fuel residues and anti-fouling paints are some pollutant factors closely related to the daily operation of the vessel. As an example, the under water structure of the vessel, sailing along the NSR, will provide habitat for arctic marine organisms that will attach themselves to the hull and by growing will increase the sea resistance of the ship as well as the fuel consumption leading to higher operating costs. The use of anti-fouling paints will not allow the growth of such organisms by releasing small quantities of Tributiltyn (TBT), a toxic substance that

has been found to create abnormalities to several marine species such as snails and oysters (Fremantle Ports, 2009).

5.2.3.2 International Conventions Wanted for the Arctic Ocean

It is surprising that although the Arctic Ocean in terms of size, environmental morphology and ecosystem structure is similar to the Antarctic one and although commercial shipping is taking place along the NSR since many years ago, it wasn't fortunate enough to get the international recognition as a "Special Area" (SA) under the International Convention for the prevention of oil pollution by ships, MARPOL 73/78. MARPOL was adopted by the International Conference on Marine Pollution convened by the IMO in 1973 and 5 years later it was modified by the protocol of 1978. MARPOL consists of five annexes that set the regulations for pollution prevention at sea. Under the Convention, special sensitive environmental areas have been determined to receive a higher level of protection. The Antarctic Ocean, the North and Baltic Sea, the Gulf of Aden, the Black Sea, the Mediterranean sea, the Red sea, etc. have been recognized as SA under MARPOL 73/78. According to MARPOL (1973/78):

> Defines certain sea areas as "**special areas**" in which, for technical reasons relating to their oceanographically and ecological condition and to their sea traffic, the adoption of special mandatory methods for the prevention of sea pollution is required (Annexes I, II, V)

Lack of international regulations to govern the navigation along the NSR in terms of environmental pollution may be very critical for the Arctic ecosystem. In 2002, under the rapid environmental changes and due to the lack of international conventions IMO (2002b) responded with the adoption of "Guidelines for Ships Operating in Arctic Ice Covered Waters" recognizing the need for recommendatory provision for ships sailing in the Arctic. According to the IMO (2002b) the purpose of the guidelines is to:

> Address those additional provisions deemed necessary for consideration beyond existing requirements of the SOLAS Convention, in order to take into account the climatic conditions of Arctic ice-covered waters and to meet appropriate standards of maritime safety and pollution prevention. (Annex, p.2)

The guidelines consist of five parts providing recommendations for Ship's Construction, Equipment, Operational and Environmental issues for vessels navigating in the Arctic Ocean. Governments of coastal nations that are involved in shipping activities need to ensure that all members involved in the shipping industry such as ship-owners, ship designers, ship-builders and ship-repairers will be fully aware of the guidelines on operating in Arctic ice-covered waters (IMO, 2002b).

5.2.4 Technical Issues

Navigation along the NSR, due to the extreme environmental conditions and due to the ice covered Arctic Ocean, demands vessels with specialized hull structural features and design in order to resist the enormous ice load. However, except for hull structure other issues also need to be taken into consideration such as speed, size and level of maneuverability (Arctic Platform 2003a).

5.2.4.1 Ice-Strengthened Vessels & Icebreakers.

When ships sail along the NSR, part of the ship's hull interacts with sea ice, causing damages that sometimes can lead to sinking. Navigation in the Arctic Ocean requires vessels to ensure safety and optimal operation. The above mentioned vessels can be classified as Ice-Strengthened and Icebreaking vessels. Although there is no universal recognized definition for ice-strengthened and ice breaking vessels we can distinguish them based on the structure of their hull and their ability to break the ice or just resist it. An icebreaking vessel can sail along the NSR regularly breaking the ice and assisting ice-strengthened vessels by opening a safe passage for them. The hull of an ice-strengthened vessel will resist the pieces of ice that have been broken by the icebreakers. Vessels with only ice-strengthened capabilities sailing along the NSR will definitely need the assistance of the existing expensive Russian icebreaking fleet and as a result no adequate profitability will be achieved.

5.2.4.2 Double Acting Vessels

Building vessels that can operate efficiently in both open and ice-covered waters with breaking ice capabilities is definitely a challenge. The above mentioned structure optimization for operational efficiency, in both open and ice covered waters, is based on the idea that a vessel will have the ability to provide an icebreaker's efficiency and optimal, open water, performance. The solution to this problem has been found with the construction of the first Double Acting Vessel (DAV). The concept of DAV is based on the idea that a vessel can operate astern in thick ice and ahead in thin ice and open waters. The catalytic role for the Doubling Acting development has the electric-podded propulsion devises "consisting of a transformer, frequency converter and an electric motor" (Bergh & Hellden, 2007). The electric motor which is located under the ship's hull in a pod shaped body is used to convert the electric power to mechanical with which the propeller will rotate (Figure 16). The pod can rotate 360 degrees without the need of a steering system, providing the vessel with a high degree of maneuverability due to the fact that the propulsion system can turn in any direction.

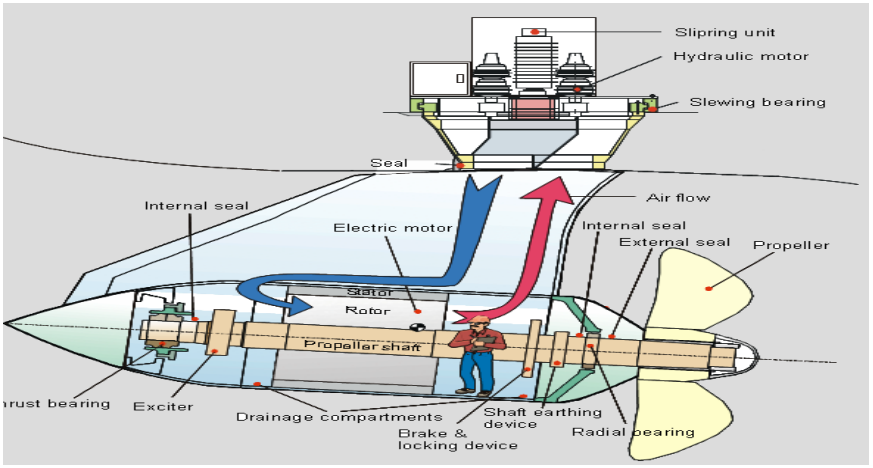


Figure 16- Cross section electric podded propulsion devises
Source: Bergh, L & Hellden, U. (2007). *Electrical Systems in Pod Propulsion*. MSc Thesis Chalmers University of Technology, 2007. Sweden Goteborg.

5.2.4.3 Information Technology

Ships design is not the only technological issue that needs to be taken into consideration for navigation along the NSR. Infrastructure of Information Technology that will support Search and Rescue operations, Arctic satellite communication,

'real-time' ice observation that while determine the alternative routes through the five seas of the Arctic Ocean, navigation aid, radio communication, weather forecasting and ice-extent forecasting are some of the basic investments that will fuel the development of the NSR in terms of IT. Under the extreme environmental conditions of the Arctic Ocean flow of information should never be restricted and sufficient communication between the mainland and vessels sailing along the NSR should be maintained all year long.

5.3 Fuzzy Comprehensive Evaluation Model for the NSR

The development of the NSR is a relatively complicated project with many multi-nature and volatile factors that can influence the decision for the establishment of the NSR. According to Wang, Ho and Chen (2007), different factors, indicators and objectives will increase the uncertainty of the project while different people will judge differently the importance of the factors that need to be considered for the potential use of the NSR. This study introduces the Fuzzy Comprehensive Evaluation Method (FCEM) in order to evaluate a rather small number of statistical reports that have derived from a questionnaire regarding the importance of factors that will determine the development of the NSR. According to Sun, Wu, Hao and Dai (2006), FCEM quantifies the uncertain factors of the evaluation objects like the NSR by establishing and evaluating fuzzy or uncertain secondary factors that will be integrated by utilizing the "fuzzy variable principle"; finally a comprehensive decision will be made. The main steps for the FCEM are the "factor set", "weight set" and "evaluation set" (Shang, 2006). Based on the comprehensive analysis of the NSR of paragraph 5.2 and environmental description of paragraph 4.2 the most important factors that can actually influence the development of the NSR -due to high levels of uncertainty- are the Environment, Technology and Policies.

5.3.1 Factors Set

The set of factors (U) for the NSR can be defined as: $U= \{u_1, u_2, u_3...u_n\}$ where $u_i (i= 1, 2, 3)$ stands for each factor that can be uncertain or not. The main set of factors (U) for the NSR consists of Environmental, Technological and Policy factors. As a result *U= {Environment, Technology, Policy}.* On the other hand, each factor (u_i) consists of three secondary level factors equal to $u_i= \{u_{i1}, u_{i2}, u_{i3.....}u_{in}\}$ $i= 1, 2, 3$ where *n* is equal to the factor in which the secondary factor belongs to. For example secondary level factors for factor u_1 is equal to $\{u_{11}, u_{21}, u_{31}\}$ or *Environment= {Ice, Pollution, Draft}*, *Technology= {Ship Design, Icebreakers, IT}* and Policy= {fees, Laws, Politics}. Figure 17 depicts the first and secondary level factors of the factor set (U) that influences the development of the NSR. Each first level factor consists of three secondary level factors.

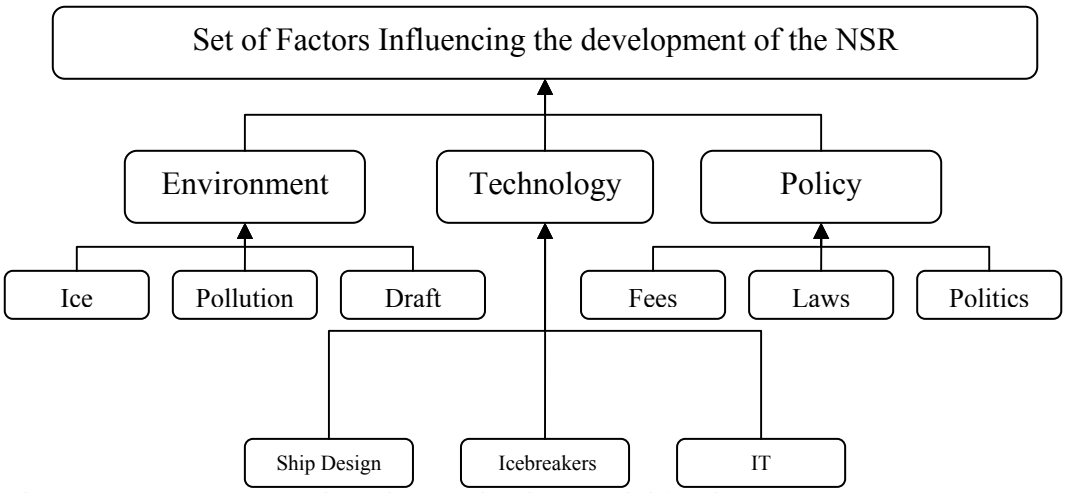


Figure 17-Fuzzy comprehensive evaluation model for the NSR
Source: Source: Drawn by the Author ©Copy write PetrosKelaiditis WMU-SMU, (ITL 09).

5.3.2 Evaluation Set

The evaluation set V consists of all the various and possible results of the evaluation process. Evaluation set V is equal to $V= \{v_1, v_2, v_3\}$ where v_i *(i=1, 2, 3.., n)* defines

the possible results of the evaluation. The evaluation set V of the factors that influence the development of the NSR is equal to *{v_1, v_2, v_3}* where:

v_1= Important, v_2= Less Important & v_3= Not Important

Using a scale of 100 to describe the maximum result and weight of importance of the evaluating factors, we can categorize v_1, *v_2* and *v_3* into three levels based on the importance of the possible results. As a mater of fact *v_1* has the maximum weight of importance ranging between 100-67, while *v_2* is defined between 66-34; finally *v_3* is defined between 33-0. More specifically:

V= {v_1, v_2, v_3} or V= {Important, Less Important, Not Important} or V= (100, 66, 33)
If the final results of the comprehensive evaluation are between 67 and 100 then the first and second level factors need to be taken seriously into consideration for the development of the NSR due to the great influence they may impose on the final decision.

5.3.2.1 Questionnaire and Statistical Report

Based on the allocation of first and second level factors that influence the development of the NSR the author designed a questionnaire and sent it to ten people in order to measure the level of importance of the different secondary factors that form the factor set V. The receivers of the questionnaire had simply to allocate the different secondary factors into three judgment levels of importance: important, less important and not important. Table 14 shows a sample of the table which was included in the questionnaire and filled by the evaluators. Table 14 also provides the number of people who determined the level of importance for each of the secondary level factors. As an example, eight people determined ice as an important secondary level factor whiles only two as less important.

Table 14–Secondary Factors Allocation into Three Judgment Levels

Name		Judgment Level		
		Important	Less Important	Not Important
Environment	Ice	8	2	0
	Draft	6	3	1
	Pollution	5	4	1

Policy	Fees	6	3	1
	Legal	2	1	7
	Political	3	5	2
Technical	Ship Design	4	5	1
	Icebreaking	6	1	3
	IT	6	4	0

Source: Source: Drawn by the Author ©Copy write PetrosKelaiditis WMU-SMU, (ITL 09).

Finally, normalization of the statistical results will help to express the number of people who allocated the different secondary level factors into different judgment levels in measurable value that will be used for the establishment of the single factor matrix R. Assuming the total number of people who participated in the questionnaire equal to one, then table 15 shows the number of people expressed in decimals.

Table 15- Normalization of the Results

Name		Judgment Level		
		Important	Less Important	Not Important
Environment	Ice	0,8	0,2	0
	Draft	0,6	0,3	0,1
	Pollution	0,5	0,4	0,1
Policy	Fees	0,6	0,3	0,1
	Legal	0,2	0,1	0,7
	Political	0,3	0,5	0,2
Technical	Ship Design	0,4	0,5	0,1
	Icebreaking	0,6	0,1	0,3
	IT	0,6	0,4	0

Source: Source: Drawn by the Author ©Copy write PetrosKelaiditis WMU-SMU, (ITL 09)

5.3.3 Weighting Set

The level of importance for every first level u_i factor is not the same. For every factor u_i the author will set a weight a_i (i=1,2,3…n) that will determine the level of importance and form the weight set A. The weight set A will be equal to A= {a_1, a_2, a_3…a_n} where a_1 has no negative value, a_1>0. Based on the comprehensive analysis of the NSR in paragraph 5.2 environmental issues are the most important that need to be taken into consideration for the development of the NSR (Pharand, 1984). On other hand policy issues although they raise several constraints for navigation along the NSR, future adjustments will eliminate any restrictions and force Russian national legislation to operate under the umbrella of international conventions

(Brubaker & Ostreng, 1999). Finally, technical issues due to the continuous technological development of aspects related to the Arctic Ocean will not raise any limitations for the potential economic use of the NSR (Arpiainen & Kiili, 2006). Based on the above mentioned and on experts opinion the author recognized the environment as the most important factor and weighed it with 0.5 while policy and technology with 0.3 and 0.2 respectively.

$$A = (a_1, a_2, a_3)$$
$$a_i, i = 1, 2, 3$$
$$\sum_{i=1}^{n} a_i = 1, n = 3$$
$$A = (0.5 \quad 0.3 \quad 0.2)$$

The second level factors weight set W consists of weights w_1, w_2, w_3 or
W= {w_1, w_2, w_3…w_n} where w_i (i=1,2,3…n) has been assigned by the author based on the comprehensive analysis of the NSR in paragraph 5.2; w_i has no negative value since w_i >0. For example the secondary factors of the environment (u_1) such as ice, pollution and draft have a weight value of w_1= *(0.6 0.2 0.2).* While the secondary factors of policy (u_2) such as fees, legal and politics have a weight value of w_2= *(0.5 0.3 0.2)*

$$W = (w_1, w_2, w_3)$$
$$w_i, i = 1, 2, 3$$
$$\sum_{i=1}^{n} w_i = 1, n = 3$$
$$w_1 = (0.6 \quad 0.2 \quad 0.2)$$
$$w_2 = (0.5 \quad 0.3 \quad 0.2)$$
$$w_3 = (0.4 \quad 0.2 \quad 0.4)$$

Figure 18 depicts the value of weight that has been determined by the author for every first and second level factors of the FCEM based on the opinion of experts regarding environmental, legal and technical issues that have been already discussed.

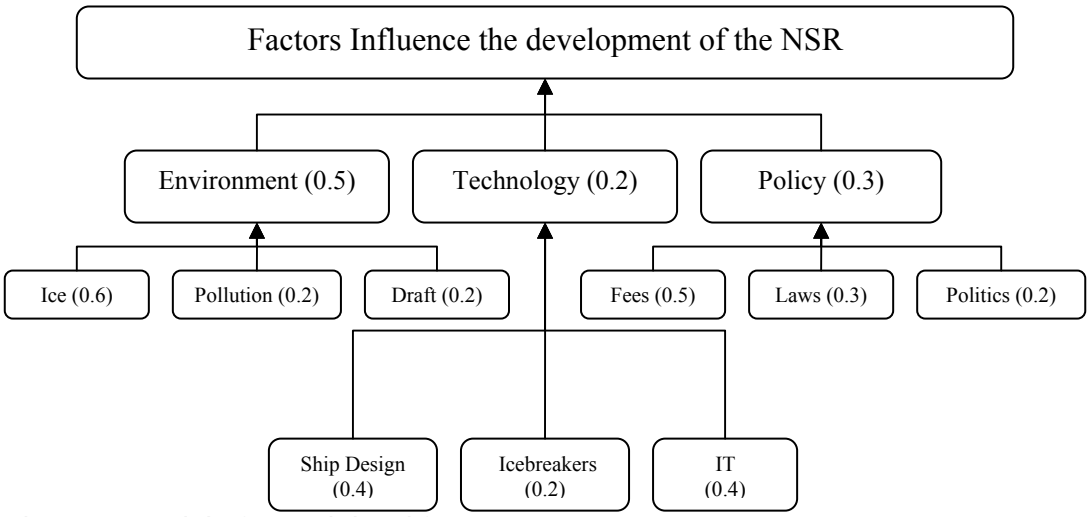


Figure 18-Weight for each level factor
Source: Source: Drawn by the Author ©Copy write PetrosKelaiditis WMU-SMU, (ITL 09)

5.3.4 Single Factor Fuzzy Evaluation

The next step is the establishment of the fuzzy relationship matrix *R* for the evaluation of every single factor in the *U* factor set. The evaluation matrix derives from the function $R_i = (r_{ij})_{nxm}$ where r_{ij} *(ij= 1, 2, 3)* represents the membership grade of secondary j factors in v_i judgment level, (Sun, Wu, Hao & Dai, 2006, p2). For every single first level factor three series of single evaluation sets exist equal to:

$R_1 = (r_{11}, r_{12}, r_{13} \ldots r_{1n})$
$R_2 = (r_{21}, r_{22}, r_{23} \ldots r_{2n})$
.
.
.
$R_{mn} = (r_{m1}, r_{m2} \ldots r_{mn})$

While the single factor evaluation matrix is:

$$R = \begin{pmatrix} R_1 \\ R_2 \\ \vdots \\ R_m \end{pmatrix} = \begin{vmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{vmatrix}$$

The single factor matrix for each of the three factors environment, technology and policy of the comprehensive analysis of the NSR have been defined as follows based on the normalization of the evaluation data that have been determined by the evaluators in table 17.

$$R_1=\begin{bmatrix}0.8 & 0.2 & 0\\ 0.6 & 0.3 & 0.1\\ 0.5 & 0.4 & 0.1\end{bmatrix} \quad R_2=\begin{bmatrix}0.6 & 0.3 & 0.1\\ 0.2 & 0.1 & 0.7\\ 0.3 & 0.5 & 0.2\end{bmatrix} \quad R_3=\begin{bmatrix}0.4 & 0.5 & 0.1\\ 0.6 & 0.1 & 0.3\\ 0.6 & 0.4 & 0\end{bmatrix}$$

5.3.5 Evaluation Results of Secondary and First Level Factors

The evaluation result of the secondary level factors can be found with the below function:

B= [Second Level Weighting Set (w_1, w_2, w_3)]x[Second Level Factor Set(R_1, R_2, R_3)]

$B_1=w_1xR_1$ or $B_1=(0.7 \quad 0.26 \quad 0.04)$

$B_2=w_2xR_2$ or $B_2=(0.42 \quad 0.28 \quad 0.3)$

$B_3=w_3xR_3$ or $B_3=(0.52 \quad 0.38 \quad 0.1)$

While the evaluation results of first level factors can be found with the below function:

$$C=\text{Weight Set A x}\begin{pmatrix}B_1\\ B_2\\ \vdots\\ B_m\end{pmatrix} \text{ or } C=(a_1, a_2, a_3)\text{ x}\begin{pmatrix}B_1\\ B_2\\ \vdots\\ B_m\end{pmatrix}$$

$$C=(0.5 \quad 0.3 \quad 0.2)\text{x}\begin{bmatrix}0.7 & 0.26 & 0.04\\ 0.42 & 0.28 & 0.3\\ 0.5 & 0.38 & 0.1\end{bmatrix} \text{ or } C=(0.58 \quad 0.29 \quad 0.13)$$

5.3.6 Results of Fuzzy Comprehensive Evaluation Model for the NSR

Finally the results of the comprehensive analysis derive from the evaluation results of the first level factors multiplied by the evaluation set *V= {v_1, v_2, v_3} or V= (100, 66, 33).*

As a result:

$$D= Cx\begin{pmatrix} v_1 \\ v_2 \\ \vdots \\ v_m \end{pmatrix} \quad or\ D=(0.58 \quad 0.29 \quad 0.13)\,x\begin{bmatrix} 100 \\ 66 \\ 33 \end{bmatrix} \text{ gives } D=81.43$$

In paragraph 3.2.2 setting of the Evaluation Set the author determined three levels of judgment: important, less important and not important ranging of 100-67, 66-34 and 33-0 respectively. The result of the comprehensive analysis is equal to *D=81,43* showing the fact that in peoples' eyes the factors such as environment, policy and technology are of great importance and need to be seriously considered before any further development of the NSR. Factors such as environment, technology and Policy increase the uncertainty of the NSR for seaborne transportation and as a matter of fact need to be evaluated deeply. The results of the fuzzy evaluation comprehension analyses depicts the importance for further consideration and discussion of the factors that may have an impact on the future development of the NSR for commercial purposes. However, with only exception the environment any other factor in long terms will not impose any restrictions on NSR.

Chapter 6 Conclusion

This thesis “Economic Approach of Piracy along the Maritime Silk Road and Cost Analysis of the Northern Sea Route” investigates and evaluates the economic impact of piracy on the shipping industry and analyzes the viability of the implementation of the NSR as an alternative trade route. A case study of a 5,000 TEU container vessels sailing along the NSR has been conducted, based on the assumption that the NSR during September and October is completely ice-free and that the vessel can operate at ‘open water’ speed of 19 knots. However, the above mentioned assumption will not be the reality in the short term, and the shipping industry will have to wait a bit longer before they can utilize the NSR to its full potential. The continuous environmental changes and the increasingly fast melting of ice confirms the fact that a totally ice free NSR is just a matter of time. The economic impact of piracy along the Maritime Silk Road has been estimated to be around $10.2 billion including costs such as ship and cargo damages, robbery of cash and crew’s personal belongings, cargo and ship loss, off-hire and investigations, ransoms, anti-piracy measures, increasing insurance premiums, seafarers double pay, environmental consequences and alternative trade routes excluding the impact of piracy on international trade and supply chain.

The cost for the transit transportation of one TEU, along the Northern Sea Route, has been estimated around $377; a sum competitive enough compared with the transportation cost of one TEU along the Maritime Silk Road which, based on market studies, has been estimated at around $1,200. Sailing along the NSR could not only save money in terms of distance and fuel consumption but also eliminate the financial loss the shipping industry suffers due to piracy incidents. Russia’s attitude, in terms of national legislation, towards foreign vessels sailing along the NSR needs to be further negotiated and considered. Nevertheless, the willingness of Russia to become a member of the World Trade Organization and as a result to adopt the “General Agreement on Trade in Service” will definitely change the current policy of the Russian Federation regarding the management of the NSR. All the costs related to the NSR will be restricted under the regulations of the WTO to be

the same for every country-member, making the idea of a free of legal restrictions NSR feasible.

The rather isolationist policy Russia has developed over the years towards western countries -fueled by suspicions of foreign-flagged vessels brings out the present lack of international conventions to govern seaborne transportation along the NSR. Russia fears oil pollution that exposes the Arctic ecosystem to a great risk. However, the fact that Russian national legislation has adopted the “Regulations for navigation on the seaway of the Northern Sea Route” along with the IMO’s “Guidelines for Ships operating in Arctic ice-covered waters” will eventually entice ship-owners of foreign-flagged vessels to demand international safety and navigational standards to use the alternative route of the NSR. The increasing traffic along the NSR will impose further pressure on international conventions to adopt regulations, of compulsory nature, for navigation along the NSR in safety of life and environmental protection terms. Nevertheless the insurance premiums for a vessel sailing along the NSR can not be estimated accurately due to the lack of transit transportation between Europe and Asia. However, the marine insurance industry is reactive towards the demands of the ship-owners and generally of the shipping industry. Thus, apart from the high risk of a vessel sailing along the NSR due to current environmental circumstances, there is no reason to restrict marine insurance companies from providing ship-owners with competitive insurance premiums in the future.

Finally, container vessels with the ability to operate in both open and ice-covered seas will optimize the operational cost of the vessel all year long even during the toughest months for navigation. DAVs or Double Acting Vessels provide opportunity for the development of the NSR despite the very short navigation period between June and October when the five seas are partially ice-free with only 50% water covered in and thinner ice. Although, DAVs will not be able to navigate at an open water speeds of 19knots the shipping industry can take full advantage of them by letting them navigate along the NSR during the most favorable months for navigation, and the rest of the year traversing along the traditional maritime trade routes such as the Maritime Silk Road. The vessel will sail along the NSR during

summer months and along the MSR during the winter. Alternating between the seasons allows shipping companies to take full advantage of the NSR during prime periods for navigation. With the current environmental conditions transportation of containerized cargo through the NSR is not economically feasible. Tough environmental conditions, thus delaying shipment arrival could add millions of dollars to the operating cost of the vessel. However, the operational costs of the vessels are not the only aspect to be painstakingly measured by the shipping industry. An acceptable infrastructure to support navigation along the NSR could cost millions of dollars to every member involved in Arctic transportation. The development of Satellite communication systems, Search and Rescue centers, as well as Environmental Emergency response capabilities are needed to provide immediate clean-up services must be developed by the shipping companies in order to make the NSR a viable shipping route. Navigation along the NSR in the long term is economically feasible while the creation of infrastructure to support shipping activities along the NSR is just a matter of time.

International environmental protection organizations will impose great pressure to prevent the development of the NSR. The assumption being transportation activities along the NSR could accelerate the melting of ice and the destruction of the local environment. However, the impact of shipping on the environment will be negligible compared to the continuous crimes against the environmental conducted for many years in the developed countries. The development of a new maritime trade route that will link Europe and Asia is probably the only good thing which stems from the environmental changes the planet has experienced over the last few decades. However, the environmental benefits all can not be ignored, the melting sea ice will open up a sea route which has the revolutionary opportunity for the shipping industry to slash its shipping time in half, thereby cutting oil consumption and shipping emission by a vessel by half.

The fuzzy comprehensive evaluation of the NSR, in terms of environmental, insurance, technical and policy issues, stimulate the optimism of the shipping industry for the budding economic use of the NSR, however, special attention needs to be paid on the first and second level factors that will influence the development of

the NSR. Based on the research conducted for the purposes of the FCEM second level factors such as ice, draft, pollution, IT, ship design, icebreakers, politics, legal and NSR fees are of great importance and as a matter of fact distance and fuel consumption redundancy should not be the only factor to be considered for the development of the NSR. Transit transportation along the NSR between Europe and Asia is economically viable and could eradicate the costs and risks stemming from piracy incidents as well probable maritime terrorism along the MSR. Piracy will always be a mean for survival in developing countries and will never be successfully eliminated. Yet the nexus between maritime piracy and terrorism operating under the umbrella of international criminal organizations impose great pressure on the shipping industry to develop a new secure maritime trade route that could actually eliminate piracy and terrorist. The development of the Northern Sea Route will be the second biggest revolution in which the shipping industry undertakes since the time of Malcolm Mclean who established containerization and advanced the development of a new shipping globalized economic era with no trade barriers and increased global seaborne trade transportation.

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