UNIVERSITY OF PIRAEUS
SCHOOL OF ECONOMICS, BUSINESS AND INTERNATIONAL STUDIES
DEPARTEMENT OF INTERNATIONAL AND EUROPEAN STUDIES
POSTGRADUATE PROGRAMME
"MASTER IN INTERNATIONAL AND EUROPEAN STUDIES"

THESIS

SAFE TRANSPORT OF FOSSIL FUELS THROUGH THE MARITIME ROUTES

Postgraduate Student Name: Sotiria Verropoulou

Piraeus
2017

I certify that the work carried out and presented in the submitted thesis is exclusively individual mine. Any information and material contained from other sources are, appropriately, reported in this thesis. Additionally, if no sure customs found on my part, the title will be removed anytime.

Signature

Acknowledgments

Before the presentation of this thesis concerning “Safe Transport of Fossil Fuels through the Maritime Routes” on behalf of the Postgraduate Program at the Department of International and European Studies of the University of Piraeus, I would like to express my sentiments to special people who offered their valuable help to me in order to proceed with this work.

At first, I would like to thank my Supervisor and Associate Professor John Paravantis for the time he spent enhancing me to develop this thesis and offering me valuable information for the writing of this postgraduate work making me a better student and scientist.

Then, I would like to express my thanks to Professors Aggelos Kotios and Nikolaos Farantouris for their estimations and comments on my work encouraging me to continue with further university studies and research.

It is, also, worth to mention the contribution of the Head of the Secretariat of the Department of International and European Studies Konstantina Maniati and her partners granting me with scientific material and supporting me to complete my research.

Finally, it is necessary to thank my family, my husband and my friends motivating me to attend this postgraduate program and completing my scientific work with prudence and patience.

TABLE OF CONTENTS

List of Tables

List of Figures

Chapter 1: Introduction

1.1. Preamble

The majority of the countries of the world has been concerned about energy as the existing resources have been extensively exploited by heavy and maritime industry, while further research has been done in order to discover new energy sources (Sato, 1990).

Recently, geologists have discovered huge quantities of fossil fuel in different types and forms in the bottom of the seas and the oceans ready to be extracted and produced by international oil and natural gas companies (U.S. Department of Energy, 2016).

Furthermore, long-standing discussions, global conferences and international treaties have been signed among the countries of the world in order to obtain the biggest energy share and guarantee the safe transport of fossil fuel through the maritime routes (IMB, 2009).

Meanwhile, the International Community has increased the current safety measures through the establishment of international organizations and the validation of international agreements in order to preserve the global energy resources and allocate the energy shares globally (UNEP, 1997).

For this reason, the purpose of this thesis is to present the great role of fossil fuels in our life, the method followed by heavy industry for the production and the consumption of energy and the procedure of oil and natural gas transportation through the sea routes.

1.2. Structure of Thesis

Safety problems that tanker ships deal with at the high seas due to environmental restrictions and organized criminal groups are developed in this work (IBM, 2009).

Extensive comparative research has been done in order to collect information and data from reliable scientific bibliography, articles, reports, papers and links analyzing the importance of safety on vessels.

Particularly, the international situation concerning the domain of energy and security is presented in *chapter 2*, while the methodology and the research questions are developed in *chapter 3* describing the extent and the impact of safety problems to the maritime industry, the ecosystem and the marine environment.

The solution to the ecological problem and the confrontation of piracy and terrorism at sea are given in *chapter 4* as a diversity of plans have been in action by the International Community in order to reduce the ecological devastation and suppress pirate and terrorist attacks against vessels carrying flammable cargo (UNEP,1997).

Finally, an essential assessment to this thesis is presented in *chapter 5* with more topics being released for further discussion, contemplation and thinking for the discovery of a new method or technique that could eliminate – if it is possible – any problem posing restrictions to the industrial activities, promote further protection of the environment and guarantee the safety of vessels.

Chapter 2: Review of Literature

2.1. Multiple Use of the Sea

The Sea as a system of oceanic waters is divided into up to main five large oceanic sectors covering major parts of the planet - *the Atlantic, the Pacific, the Indian, the Arctic and the Southern Ocean* - and other smaller sections, such as the Mediterranean Sea (Karleskint et al., 2009), modifying the global climate and the carbon dioxide cycle through the *thermoline circulation* (Falkowski et al., 2010).

The seawater of the ocean consisted of 90% of salty water, sodium (Na), chloride (Cl), magnesium (Mg), calcium (Ca), sulfate (SO_4), carbonate (CO_3), bromides and solutes is coming from inflowing river water (Swenson, n.d.) playing an important role in water cycle, travelling through the atmosphere as vapor and returning to the sea or land building up permanent salt lakes, such as the Caspian Sea ("Endorheic Lakes: Waterbodies that don`t flow to the Sea", n.d.).

The standard survey, charting and mapping of the seas had already been proceeded by the *International Hydrographic Organization* in 1921 and the *Discovery Investigations* in 1924 (Monkhouse, 1975), while the oil and natural gas exploration had already began in the past including the conservation of the marine environment, the chemistry of the oceans, the renewable energy and the evolution of technological equipment for further investigation at sea ("Research at Sea", 2013).

Nowadays, a variety of products are transferred through the sea, especially across the Atlantic Ocean to a major trade route passing through the Mediterranean Sea and the Indian Ocean (Halpern et al., 2008) with the routes on the open sea being, constantly, trespassed by cargo and container vessels, while huge quantities of valuable dissolved minerals, such as salt, silver, gold, copper, lead, zinc, are being extracted from the floor of the deep sea with robotic techniques (Al-Weshah, 2000).

In addition, quantities of methane and diamonds are being, also, extracted from seabed of the oceans in order to be used as a potential energy source, while deep mineral resources have, already, been classified into manganese nodules and hydrothermal deposits through developed methods and technological equipments ("Diamonds", 2006).

2.2. Types of Fossil Fuels

Fossil fuels discovered, studied and extracted from the bottom of the oceans contain high percentages of carbon, petroleum, natural gas, coal, kerosene, propane and methane conquering the industrial domain and bringing up environmental and economic effect to the hydrocarbon field (Sato, 1990).

According to estimations, the primary sources of energy consisted of petroleum, coal and natural gas, considered to be non-renewable resources as they take millions of years to form, although the known viable reserves are being depleted much faster than new ones are being made (Novaczek, 2000).

Petroleum and natural gas have been formed by the decomposition of organisms` remains founded mixed with mud under the surface of earth or at the bottom of the sea in large quantities due to lack of oxygen. Although the heat had driven energy transformations million of years ago, the energy still remains photosynthetic in origin. (Bilkadi, 1992)

Moreover, the mixture of hydrocarbons have presented a fuel with characteristic properties containing very low gaseous components constituting the exploitation of petroleum and natural gas as a very important source of energy for daily consumption (Halbouty, 2003) and commercial production presenting high levels of primary energy sources reserve in the ground (Ball et al., 1965), while the seabed of the oceans provides huge quantities of fossil fuels being analyzed as the main economic principle of supply and demand (Ball et al., 1965).

When hydrocarbon supplies diminish, prices are rising and the renewable energy sources are requiring more expensive production and developed technologies than conventional petroleum reserves (“The State of Consumption Today”, 2012).

Also, one of the most promising energy alternatives instead of carbon dioxide captures as well as biofuel with biodiesels being produced by several companies processing conversion of renewable lipids in to usable fuels through chemicals procedures (Hope et al., 2015).

For instance, the United States of America consume more than a quarter of the world`s supply of fossil fuels with shale gas being rapidly increased as an available

source of natural gas led by new fracturing technology declining the production of conventional gas and leading to major increases of shale gas (International Energy Agency, 2015).

On the other hand, Europe has spent three times more than the cost of the Greek bailout on importing fossil fuels, according to investigation done by the *European Wind Energy Association* in 2014. In addition, the fossil fuel industry has collected billions of dollars in global government subsidies, while twenty fossil fuel companies are found highly profitable, although the cost of carbon dioxide emissions was too large and greater than the tax profit (University of Cambridge Judge Business School, 2015).

Furthermore, natural gas, described as a crystalline element occurring in the ocean-floor sediments at depths greater than 500 meters/1,650 feet and containing hydrogen sulphide or carbon dioxide rising to the earth`s surface when it is not trapped by dense rock layers, is used after undergo extensive cleaning process (Whelan, 2004).

Shale gas, also, constituting another form of natural gas trapped into shale formations, is being an important rising source of natural gas, especially, in the U.S.A., although China is possessing the largest shale gas reserves in the world (Davis, 2016).

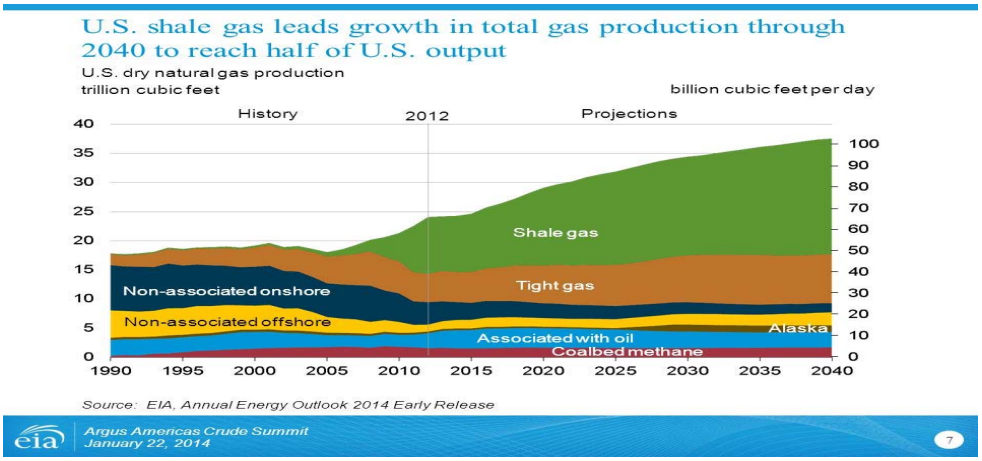

Figure 2.1. U.S. Shale Gas Production (U.S. Energy Information Administration, 2014)

Moreover, shale gas as an unconventional source of natural gas is produced in commercial quantities through developed technology and special drilling equipment creating larger hole at shale gas areas, increasing shale gas production with high profits across Canada and U.S.A (Howarth et al., 2010), while Europe`s geology is being more complicated with limited shale gas reservoirs and more expensive oil and natural gas production (Mackay & Stone, 2013).

2.3. Global Oil and Natural Gas Production

Carbon as the fourth most abundant chemical element in the world is found in large quantities in the U.S.A., Mexico, Greenland, Russia and India (Musk, 2015), while the largest oil and gas companies founded in Asia are gaining billions of dollars per year with *Saudi Arabian Oil Company* (Saudi Aramco) possessing the first place among forty-five huge oil and gas companies around the world (Forbes, 2016).

Saudi Aramco has been estimated with the largest crude oil reserves and the highest oil production per day in the world, while the company`s operations span the world including exploration, refining, chemicals, distribution and marketing with the Saudi Arabian Ministry of Petroleum and Mineral Resources monitoring the above mentioned activities and dealing with oil production (Natural Resource Governance Institute, 2013).

In addition, several tanker ships have been employed by the company to transfer gas, crude and refined oil to various countries through North America, Europe and Asia ("The Report: Saudi Arabia", 2009)

Also, China as one of the *emerging national economies*, occupies the second place in oil and natural gas production and extraction through three colossal national companies – *Sinopec, China National Petroleum Corporation, Petro China* – which promote petrochemicals, crude oil pipelining transportation, hydrocarbon refining and natural gas production (Sinopec, 2012), while the non-governmental American Oil Company, *Exxon Mobil*, constitutes the third largest oil company in the world producing oil, thus, organizing functionally a number of international operating divisions that conclude oil exploration, production, extraction, refining, marketing, shipping and chemical division (Vassiliou, 2009).

Furthermore, economic reforms in South America, including, also, the *privatization* of state-owned oil and natural gas industries, had led every country of Latin America in different roads concerning the oil and gas production and exploitation (U.S. Geological Survey, 2000).

For example, Brazil had been a new important oil and gas producer since 80`s containing the second largest oil reserves in South America with the oil and natural gas company *Petrobras* expanding company`s oil and gas operations outside

the country, even, acquiring a majority stake in Argentina`s *Perez Companc* increasing, significantly, the company`s oil and natural gas reserves (Oil and Gas Journal, 2002).

In addition, the Government of Brazil was owning 51% of Petrobras with exclusive rights for oil and natural gas exploration, production, refining, distribution and price distortion, locating, also, further offshore companies in deep water with extensive capital investment and drilling operations (U.S. Geological Survey, 2000).

On the other hand, Argentina had completely privatized the national petroleum company, *Yacimientos Petroliferos Fiscales* (Repsol - Y.P.F.), although the company had been estimated as the fourth largest oil producer in Latin America with the Spanish Oil Company, *Repsol,* having bought Argentina`s formerly state-held Y.P.F., retaining a position of dominance to oil and natural gas exploration and production from onshore wells (U.S. Geological Survey, 2000).

Although, the company was established as a state enterprise advocating economic independence and nationalization of oil supplies, the Y.P.F. was bought by the Spanish firm *Repsol S.A*. in 1999 (U.S. Geological Survey, 2000).

Finally, the government of Argentina gained the renationalization of 51% of the firm in 2012 paying $5 billion compensation to Repsol constituting oil and natural gas production as an important factor for the economic development of Latin America (Argentina Star, 2014).

2.4. Oil and Natural Gas Industry in India

The fourth largest energy consumer in the world, the *emerging* India, could successfully cover the energy demands of the country through reforms in the financial sector and the Indian economy, generally, spurring growth in all other sectors, while the current demand for imported coal, oil and natural gas is significantly outpacing domestic production. For that reason, the sedimentary basins of the country have yet to be adequately explored, while only seven basins are currently producing oil and gas (GE`s Bulletin).

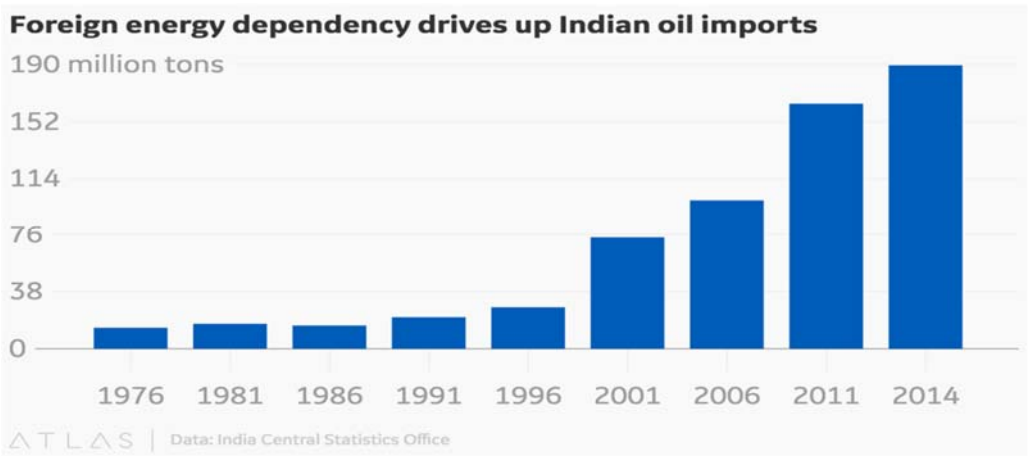

Figure 2.2. Foreign Energy Dependency on Indian Oil Imports (India Central Statistics Office, 2017)

The country is being forced to make valuable foreign capital investment in oil and natural gas exploration in order to procure additional energy resources as oil, natural gas and coal constitute the dominant energy commodities for domestic and industrial consumption with rising prices being an important matter of discussion in Indian politics trying to release the country from further foreign energy imports (Mallet, 2016).

India`s largest national flagship enterprise, *Indian Oil Corporation*, is, fully, covering the energy demands of the country, overlapping the entire hydrocarbon value chain from refining, pipeline transportation and marketing to exploration and production of crude oil, venturing into alternative energy of downstream operations, searching for new business opportunities in the energy markets across Asia and Africa and pursuing diverse business interests accounting for half of India`s petroleum

products market share, national refining capacity and downstream sector pipelines (Indian Oil Corporation, 2013).

Proven natural and shale gas reserves have been, also, discovered and developed in the Western Indian Ocean with several Africans countries enduring generation and distribution efficiency in the energy sector (Cordesman & Toukan, 2014).

Furthermore, the oceanic renewable energy demand and offer has been increasingly recognized globally with tidal power being deployed in India and current ocean power being thoroughly used in South East Africa (International Renewable Energy Agency, 2014).

Most ocean energy techniques are still at a pre-commercial stage, although some of the basic concepts had been developed just a century ago with studies focusing on available resources in the Indian Ocean with India`s and South East Africa`s energy future remaining hidden and unexplored and dealing with problems, such as: access to basins across the countries and infrastructure challenges (Hammar, 2012).

With further motivation from India to take on these exploratory and expansion projects, there is an incredible opportunity to reduce energy imbalance through commitment to oil and gas innovation introducing technologies that eliminate dependence on foreign energy and nuclear inputs, while concerns for the long term availability of fossil fuels supplies are leading the interest in renewable energy (Sharma & Sharma, 2013).

It is, also, worthy to mention that India has the exclusive right to mine precious metals and variable constitutions of hot fluids founded on the seabed of the Indian Ocean through contract with the *International Seabed Authority* (I.S.A.), while these ocean compounds have already attracted international attention for commercial and strategic values (The Hindu, 2016).

2.5. Oil and Natural Gas Industry in Europe

On the other hand, Europe had always wondered and concerned about the lack of energy and the insufficient energy resources in the mainland of the European continent, while the continuous petroleum and natural gas consumption was playing a decisive role to the European market (Engerer, 2010).

Except for North Europe, the majority of the European countries are still depending on oil and natural gas imports as there is no tradition to use natural gas as fuel and infrastructure with some European governments developing incentives and tax reductions in order to promote the further use of natural gas and the reduction of high oil prices (Lange et al., 2010).

In addition, the European Union makes efforts to diminish gas imports, to improve the energy efficiency, to promote the use of renewable energy, to liberate the European market from penetrations and to increase the European natural gas exports and production (Eurostat, 2016).

The Norwegian multinational company, *Statoil ASA*, constitutes a typical example of a European oil and gas company operating and exploiting up to 60% of the country`s oil and gas production looking, also, for further investments in Central America and the United Arab Emirates (Statoil, 2013).

The company, also, takes part in operations, such as: *Europipe I and II,* for the construction of pipelines and retail stations, the transfer of crude oil, refined petroleum products and natural gas liquids and the exploration of petroleum, natural gas and methane released from the Arctic Ocean (Haaland, 1981).

Furthermore, the *British Petroleum Company* (B.P.) is, also, involved in oil and natural gas and renewable energy exploration, production, distribution, refining, marketing and trading as the company possess a high position among the seven super major oil and gas companies in the world operating in all areas (Bergin, 2008).

Russia, in turn, possesses one of the largest petroleum industries in the world - *the Public Joint Stock Company Gazprom* – carrying on the business of natural gas extraction, production and transport. Although, Gazprom is a private company, the Russian Government holds a majority stake in order to enforce Russia`s diplomatic

efforts concerning the distortion of gas prices and the access to pipelines globally (Crumley, 2009).

Added to this, Russia`s oil and gas exports account more than half of the national budget coupled with low prices as the country is covered with large reserves full of natural and shale gas across West Siberia and Uras - Volgas region providing, mainly, Europe with natural gas and financing new energy projects all around the world (U.S. Energy Information Administration, 2015).

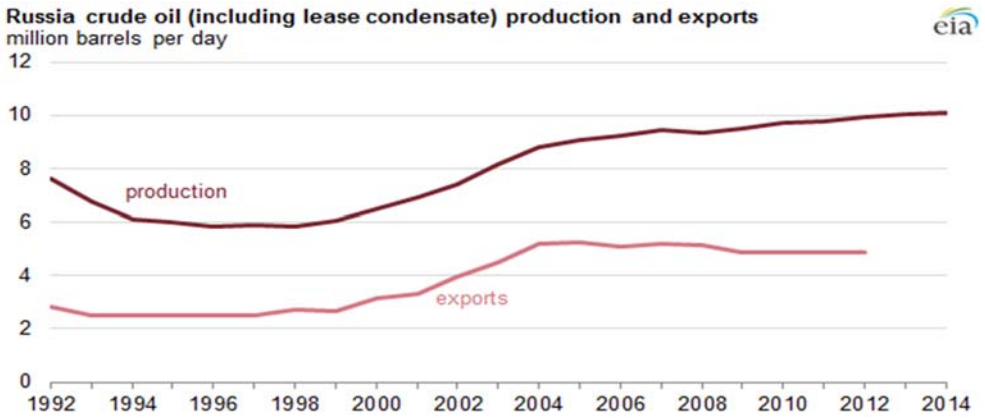

Figure 2.3. Russia Crude Oil Production and Exports (U.S. Energy Information Administration, 2017)

In the list with the global largest oil and gas companies, Greece, also, conquers in the domain of energy in South East Europe through two major oil and gas companies - *Hellenic Petroleum, Motor Oil Hellas* – operating refineries, gas stations, petrochemicals, electricity and oil and hydrocarbon exploration and production with exclusive rights through government law 2298/95, holding, also, 35% of shares in the Greek Natural Gas Company, *DEPA,*(Hellenic Petroleum, 2015), while *Motor Oil Hellas* constitutes a leading force in the energy sector operating the second-largest refiner in South East Europe, trading with Egypt, holding marine fuel logistics, marketing refined marine fuel and lubricants and supplying the United States Navy in the Mediterranean Sea (Hoovers, 2015).

2.6. Fossil Fuel Transportation

Although oil and gas production has been, mainly, proceeded through operations on reservoirs under the earth`s surface, maritime industry, has, also, contributed in the total oil and gas production as it is consisted of a wide range of companies with products, services and activities related to the traditional maritime sector including the designing, the construction and the repair of special vessels for oil and natural gas extraction and transportation (UNCTAD, 2006).

All the maritime companies are assigned to the European statistical classification methodology, *Nomenclature of Economic Activities* (NACE Code) (Siccode, 2016) in order to be categorized on management systems related to companies` products, services and business, such as: support for the petroleum and natural gas extraction (NACE Code B0910), the repair of vessels and floating constructions (NACE Code C3011) and the installation of industrial machinery and equipment (NACE Code C3320) (Central Statistics Office, 2014).

Furthermore, statistics and data produced on the basis of NACE Code are in line with the *International Standard Industrial Classification* (ISIC) grouping similar economic activities and identifying the division, the category and the class of every maritime company (Siccode, 2014).

On behalf of ship owners, the shipping agents are taking care of all the regular routine tasks of a shipping company ensuring the freight in transit, the essential supplies, the customs documentation and the waste declarations arranged with the port authorities (Wijnolst, 2009).

Also, the division of shipping companies into categories according to their economic activities and the types of vessels they use is necessary as every freight requires special handling, specific type of ship and different transportation conditions (Wijnolst, 2009).

For example, tanker ships and gas carriers are merchant vessels classified according to their capacity and designed to load, transport and discharge gas cargoes, such as chemicals, hydrocarbons, *liquefied petroleum gas* (LPG) and *liquefied natural*

gas (LNG) in refrigerated and pressurized storage facilities at low temperature and atmospheric pressure between the terminals (Evangelista, 2002).

Additionally, three *Gas Codes* have been developed by the *International Maritime Organization* (IMO) and been applied to all new tanker ships and gas carriers in order to regulate shipbuilding practice, registration and port entry through the *International Code for the Construction and Equipment of Ships carrying Liquefied Gases in Bulk* (the ICG Code) (IMO, 1993), the *Gas Carriers Code* (the GC Code) implemented on national laws and the *Existing Ship Code* (the EGC Code) remaining as an IMO recommendation (IMO, 1976).

Although, petroleum is consumed within the countries or exported to other countries by pipeline due to difficulties in transportation across long distances, the natural gas technology has been, significantly, improved permitting gas transportation into tankers in limited liquefied quantities depending on tankers` availability (Wang et al., 2012).

Due to their colossal size and capacity based on their convey limit in dead weight (DWT), tanker ships offer a simple and cheap oil and gas transportation and a huge platform for big corporations to maximize their profit, such as: Panamax, Aframax and Suezmax with oil tankers traveling around the world (MI News Network, 2016).

LPG and LNG tankers conveying oil and its by-products from point of extraction to the point of refinement have, already, found their importance in liquefied hydrogen gas transportation and been put under control in order safety procedures complied with on board ships at terminals are ensured (Eyres, 2001).

Tanker ships constitute, also, a modern production structure as well as a major type of vessel for petroleum exports assisted by tugboats with special-design mobile production units tethered or moored at the sea floor (Moatsos & Purnendu, 2006).

If an underwater pipeline is not used for fluid transportation to production platforms, tanker ships have, also, the potential to accomplish oil and gas exports from offshore fields to onshore market accommodating fluid properties (Moatsos & Purnendu, 2006).

As the reliability of tanker ships is being insured through deep-water maintenance and repair through new methods of construction and new processes of operation decreasing the quantities of freight transported, pipeline leaks and accidents can be detected and further prevented in advance (Primorac & Parunov, 2015).

The “black gold” transported more carefully in a raw condition from oil and gas reservoirs to the refineries, is sold to markets for consumption purposes, while the underwater oil and gas extraction, storage and transportation between ports and terminals can be done through the extensive use of tankers as they have the potential to be used as floating storage units, too (Carter & Foolen, 1983).

For that reason, two different classifications scales are used to categorize tanker ships, the *Average Freight Rate Assessment System* (AFRA) and the *Flexible Market Scale*, diversifying tankers according to their size, weight limits and type of cargo transported (Hamilton, 2014).

Table 2.1. Oil Tanker Size Categories (ChemEngineering, 2017)

Oil tanker size categories			
AFRA Scale		Flexible market scale	
Class	Size in DWT	Class	Size in DWT
General Purpose tanker	10,000–24,999	Product tanker	10,000–60,000
Medium Range tanker	25,000–44,999	Panamax	60,000–80,000
LR1 (Large Range 1)	45,000–79,999	Aframax	80,000–120,000
LR2 (Large Range 2)	80,000–159,999	Suezmax	120,000–200,000
VLCC (Very Large Crude Carrier)	160,000–319,999	VLCC	200,000–320,000
ULCC (Ultra Large Crude Carrier)	320,000–549,999	Ultra Large Crude Carrier	320,000–550,000

2.7. Oil and Natural Gas Extraction Procedures

Petroleum is a non-toxic refinery mixture of hundreds different hydrocarbon molecules with high calorific value when burned, settled into oil reservoirs thousands of feet underground or in the sediments of the sea (Pike, 2011).

Once the reservoirs has been selected, geologists determine oil and natural gas reservoirs boundaries through maps of rocks, while engineers are drilling under the earth`s surface with a rig bringing a steady flow of oil and natural gas transported through pumps and travelled in pipelines (Wang & Economidis, 2009).

Also, the developed technology allows the oil and natural gas industry to drill directionally to the target area avoiding environmentally sensitive areas or other inaccessible locations needed lease agreements, titles and right away accesses as drilling mud mixed with well fluids is coming to the surface prepared for transportation and refinery process (Lyons et al., 2016)

The total oil and natural gas amount found into proved reservoirs constitutes the whole quantity of oil and gas expected to be recoverable with current technology and suitable economic conditions, although North America and Europe have already began to explore new sources in remote areas, thus, many countries have increased oil and gas production affecting the oil price distortion (World Energy Council, 2013).

While new global oil and gas deposits are waiting to be found in the Indian Ocean, in the Gulf of Mexico, in Alaska, in Russia, in Latin America and in West Africa, most researchers come to an agreement that significant oil and gas deposits still remain undiscovered in the Middle East with unstoppable oil and gas production and consumption (World Energy Council, 2013).

However, the *National Institute of Ocean Technology* and the *National Centre for Antarctic and Ocean Research* in India both estimate that petroleum and metals should be extracted from the seabed of the Indian Ocean with specialized drills and developed technology depending on results of detailed survey and exploration (Ravindra, 2012).

Oil and gas offshore operations in ultra-deep water level (3,000 meters/10,000 feet) require billions of dollars and boundless technical expertise

hitting tiny targets floating on waves that cannot been seen under the surface (9,000 meters/30,000 feet) presenting a new territory that oil and gas remains left unknown on land and at sea (Lange et al., 2010).

Furthermore, advanced technology contributes to the discovery of new energy resources found at ever greater depths, enables more accurate drilling, taps resources in deep-seas fields and reservoirs, replaces oil and gas production from existing wells and assures adequate oil and gas supplies with production rates being higher than ever (Shell, 2012).

Not only does petroleum seems making daily life easier in several aspects, such as: heat and electricity, it is, also, have an extensive use in medicine and transportation. For that reason, business and individuals of developing countries are demanding even greater quantities of liquid fuels and other products made with oil and gas for daily use and consumption (World Energy Council, 2013).

Emerging economies, such as: China, India and West Africa constitute a typical example of developing countries accounting 60% of the world`s growth in energy demand, but still relying on oil, gas and coal production with a far reach"peak plateau" that has been predicted over the coming years for the world`s annual oil production (World Energy Council, 2013) .

For that reason, the demand for oil and natural gas production from deep-water will, extremely, rise oil prices up, although some countries, such as the United Kingdom, have already experienced peak oil industry (World Energy Council, 2013).

While oil and natural gas companies are, constantly, moving into dipper waters, around a third of oil and gas will continue be extracted from offshore sources with the Indian Ocean being a paradigm of oil and gas extraction area from the deep sea, despite all the oil and gas production restrictions to shallow waters (Sharma&Sharma, 2013).

On the contrary, the oil and gas production held by a platform located in the Gulf of Mexico still remains the best water-depth subsea oil and gas extraction that has ever been recorded in the world (Lange et al., 2010), while the oil and gas consumption in Europe has been decreased due to the use of modern machinery and efficient electric engines (Lahidji et al, 1999).

In addition, oil and gas shallow water production is defined through three depth categories with deposits detected to a depth of 12km/40 feet in the seabed, while new oil and gas deposits are being, constantly, discovered at offshore fields through revolutionary geophysical exploration technology (CCST, 2014).

These deposits have, already, engaged major countries in deepwater production, such as: Iran, Russia and Romania with huge gas fields being discovered close to Cyprus in the Mediterranean Sea revolutionizing the gas supply in these regions, while Israel is having the potential to avoid gas imports from Saudi Arabia through oil and gas production systems installed on the sea floor (Nathanson & Levy, 2012).

But the offshore oil and gas extraction from unconventional deposits may, also, become an increasingly attractive option for oil and gas production in the deep sea, while the Santos Basin located thousands of meters under the sea in Brazil is holding major oil and gas fields producing billion tones of oil and billion cubic meters of natural gas per year (Lange et al., 2010).

Furthermore, floating platforms standing on the sea floor and resembling as a maquette of small industrial cities dispose a variety of developed drilling and production rigs for oil and gas operations thanks to underwater technology developed in South America, West Africa and Norway (Lange et al., 2010)

Underwater robots are, even, connected together in order to search for oil and gas samples from deep and ultra – deep sea sending the products back on shore via pipeline and electronically controlled equipment during drilling operations in single seabed facilities (Shell, 2012).

The petroleum industry, also, is making, constantly, investments in oil and gas explorations under the sea floor, while offshore operations are causing seismic waves in the crust of the sea floor in order to identify and map rocks containing petroleum reservoirs and to perform oil and gas extractions worldwide (American Petroleum Institute, 2014).

Moreover, the exploitation of oil and gas reserves pass, necessarily, through the horizontal drilling process at a specific angle to distances greater than 12km/40 feet to emerge other oil and gas reservoirs in purpose (CCST, 2014) ensuring maximum production with formations that have been identified during the exploration stage and

methods that have been used in current operations at the Caspian Sea (Lange et al., 2010).

If the results from oil and gas reservoirs and fields are economically possible, additional drilling equipment is installed for full oil and gas exploitation, while pipelines are installed in the sea floor connected into systems of flow lines serving oil and gas reserves and delivering products at ports and transportation terminals (Varhaug, 2016).

Chapter 3: Methodology

3.1. Research Questions

3.1.1. Environmental Pollution

In regards to environmental pollution with an emphasis at the main environment what kind of pollution results from the maritime transportation of fossil fuels?

Although oil and gas industry is, constantly, promoting the international economy, oil pollution continues to pose a threat to the marine environment as major oil and natural gas spills from shipping inputs or effluents are found on the seawater (Marks, 1972)

While a diversity of various conventions are being signed up to protect the marine environment with sea surveillance and contingency plans for the marine ecosystem conservation, the reduction of the oil volume entering the sea still constitutes an international matter for discussion among the international community, the oil and natural gas industry and the maritime sector (UNEP, 1997).

The onshore oil contamination and the natural gas pipeline leaking caused by damaged tankers polluting coast lines, posing a great danger to marine life and increasing the death of sea animals and birds, is associated with the increased crude oil production and transportation through supertankers that came into service during the 60`s and the 70`s augmenting the potential threat to the environment (Marks, 1972).

Tanker ships are known as a devastating factor that causes tremendous oil and natural gas explosions as few oil and gas spills released in the sea are enough to occur into the marine environment and cause huge disaster accounts in a short period of time all over the world (Fossheim, 2005).

Added to this, the ocean or marine pollution has been widely spread all over the world due to floating harmful substances, such as oil and

natural gas spills from tanker ships and chemical particles from industrial and agricultural waste spurred into the sea (Rahman, 2006).

For instance, the tanker ship *Torrey Canyon* constitutes a typical example of an oil vessel spilling her entire cargo of 120,000 tons of crude oil into the sea, while she was entering the English Channel in 1967 causing the biggest oil pollution ever recorded to that time (Rafgard, 2011)

In addition, this incident raised questions about measures that should be taken by IMO in order to prevent further oil pollution from ships with technical plans and legal aspects that could prepare a suitable international agreement imposing restrictions for vessels` contamination and changing the compensation system that follows accidents at sea (Rafgard, 2011).

3.1.2. Crime of Piracy

Seaborne piracy against vessels still remains a significant matter for discussion as $1 billion is lost per year, especially in the sea routes from the Red Sea to the Indian Ocean and from the Strait of Malacca to Singapore (Meijden, 2008)

Piracy is defined as an act of robbery or as a criminal violence by ship or boat attackers upon another ship or a coastal area with the purpose of possessing cargo and other valuable items and properties from other vessels illegally (UNCLOS, 1982).

While the International Community is facing many challenges to bring pirates on court, these attackers are being steadily increased in the oceans and the high seas, although the majority of the countries have, already, used their naval forces to pursue pirates and protect vessels carrying liquefied freight (Toomse, 2009).

For instance, nearly 1,000 pirates threatening oil and gas offshore production were captured by radars and restrained by local naval power near Madagascar and the Persian Gulf (Forbes, 2014).

The tanker ship, *Orkim Harmony*, has been a recent example of a vessel that was captured by pirates stealing her fuels near Singapore in 2015, while another Malaysian ship had been similarly captured at the same time (IMB, 2016).

On the contrary, piracy has been occurred in narrow channels and predictable sea routes, such as the Mediterranean Sea, and has given the chance to pirates to privateer and raid against vessels, although they are aware about the consequences related to the customary international law (Elleman et al., 2010).

In addition, pirate incidents near the coasts of West Africa and Indonesia have been risen up to 50% including boarding to ships without permission, scrounging ship items and equipment, kidnapping and murdering

ship crews and sinking vessels intentionally in order to gain political goals (Mair et al., 2011)

Also, the Malaysian and the Indonesian authorities have taken anti-piracy measures in South East Asia, according to the *Regional Cooperation Agreement on Combating Piracy and Armed Robbery Against Ships in Asia* (ReCAAP) (Seacurus, 2014).

3.1.3. Terrorism at Sea

A terrorist attack against a huge oil vessel is, also, a frightening matter for discussion, even, between shipmasters who prefer hiding rather than mentioning reported attacks in purpose to avoid further delays and higher insurance rates as the Persian Gulf constitutes the main energy sea lane supplying East Asia with oil and natural gas (Elleman et al., 2010).

But analysts are still aware about the speed that terrorist attacks against oil vessels have increased in the area between the northwestern Indian Ocean and the Gulf of Aden, where terrorists cooperating with Somali pirates and directing attacks on tanker ships that pass across the east coast of Africa (Forbes, 2014).

After increased attacks been reported in the Indian Ocean, the discussion for terrorism against tanker ships was put on the table with the USA earning a reputation for disclosing suspicious people taking part in terrorist attacks (Forbes, 2014).

It is, also, worthy to mention that professional analysts have difficulty to distinct piracy from terrorism as either nationalist and religious groups or ruling and revolutionaries governments often collaborate together in order to perform paramilitary operations against oil vessels (Parfomak et Frittelli, 2007)

Terrorism is considered to be as the major crime against humanity and as the fourth generation warfare under the intentional use of violence to achieve political or religious goals, while oil tanker hijacking and explosions are constituting a type of terrorism occurring at seas and affecting the global economy (Marquardt et Heffelfinger, n.d.).

While individual terrorists were tended by their personal intimacy for gaining either political or strategic objectives through social solidarity with other members or paramilitary organizations, it was obvious that terrorism was related with hostile feelings against states and citizens (Bjelopera, 2013).

Al Shabaab terrorists, for example, were giving money to Somali pirates as a ransom in order to introduce new Islamist fighters, import clandestine weapons from Afghanistan and Pakistan and keep the control of the ports (US Department of SPOCC, 2010).

A closer analysis of the matter is related with the terrorist attack against vessels as an early warning for the reduction of global energy storage and maritime commerce near the Strait of Hormuz as pirates and terrorists have occurred in the area (Dane, 2014).

As terrorists with ideological and political bent are trained on speedboats equipped well enough with global positioning systems and automatic weapons, they will not stop attacking and cause effects to the energy markets as the world`s oil and natural gas quantity is shipped via dangerous sea routes (Parisis, 2015).

3.1.4. Crew Ship Safety

Every oil and gas company in the world still concerns about the safe transportation of fossil fuel through the maritime routes as tanker ships constitute the main type of vessels carrying fossil fuels and dealing with a wide range of hazards imposing the liquefied fright in danger (Parisis, 2015).

As tanker ship crews are obliged to lead vessels with safety and confront with unusual conditions in ports and terminals, the handling of these conditions does not guarantee the protection of the ships due to insufficient training of the ship crews (ISGOTT, 1996).

While marine security operations are being performed by the international community against piracy and terrorism, pirates and terrorists still make efforts to attack and capture tanker ships in purpose to scrounge gallons of oil and natural gas gaining millions of dollars at stake (Nelson, 2008).

As foreign naval forces are not allowed to deter and suppress piracy and terrorism across territorial waters or particular areas known as *"right of hot pursuit"*, terrorists and pirates have the potential to escape rapidly from one country to another leaving security forces frustrated (Alfaleh, 2010).

Risk defined as the high possibility of undesirable scenario occurring in certain situations is followed by factors maximizing or minimizing the likelihood of danger occurring during the travel (European Environment Agency, 2010).

Oil tanker ships, especially, are likely than any other type of ship confronting with certain type of risks except for some other specific risks, such as piracy, terrorism, fire, explosion, shipwrecking and sinking due to their valuable liquefied freight (Nelson, 2008).

3.2. Research Methods

Questions concerning the safety of fossil fuel maritime transportation have been investigated through extensive scientific and qualitative research using case studies and comparison analysis in order to give answers concerning a wide range of dangers that tanker ships deal with during the travel.

3.2.1. Environmental Pollution

Floating sewage and polluting substances released into the ecosystem of the oceans lead to plant life decay and severe sea water quality decline, while industrial toxic chemicals waste is increasing the ocean temperature - *thermal pollution* - destroying the marine flora and fauna (Bobat, 2015).

In addition, ballast waters and oil spills still constitute a huge source of ocean pollution as they are consisted of high toxicity suffocating marine animals and plants and lasting for many years in the surface of the sea water (Blackburn et al., 2014).

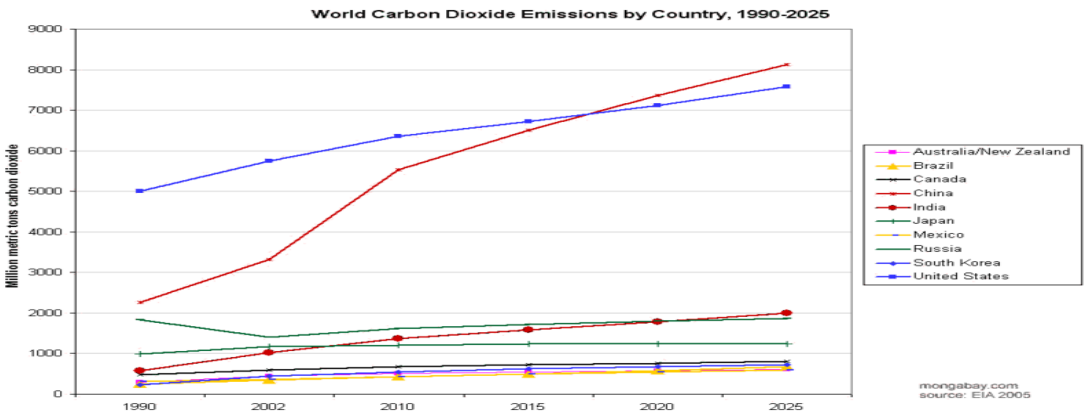

Figure 3.1 World Carbon Dioxide Emissions, 1990-2025 (Energy Information Administration, 2005)

3.2.2. Crime of Piracy

Furthermore, the increased piracy attacks had put into action the U.S.A. Government to patrol the international waters creating an anti-piracy unit inside the European Union`s territorial waters (Sakurai, 2013), as tanker ships were vulnerable to pirates attacking against vessels and gaining traffic control (Mair et al., 2011).

Attacks involving hostage, kidnapping and guns were constituting the 35% of reported pirate attacks in that time with tanker ships and tanker crews being constantly targeted by pirates (Hurlburt, 2011).

Figure 3.2. Piracy Threatens Major Oil Tanker Routes (China Daily, 2017)

For that reason, the American Congress reclaimed the constitutional right to enact penal legislation against piracy offenses, although pirates were using developed technology to attack against vessels carrying oil, natural gas and hydrocarbons (Sorensen, 2012).

Furthermore, international anti-piracy efforts had been made by *Small Arms Survey* (SAS) of thirty private heavily armed ships doing patrols to the Indian Ocean and the South East Asia permitting ships to travel with safety (Herbert-Burns, 2012).

NATO, also, did not follow a certain piracy detention policy, although suggestions for international naval intervention in the territorial waters of Somalia had been made by the International Community in order to protect the area (Andreone et al., 2013).

3.2.3. Terrorism at Sea

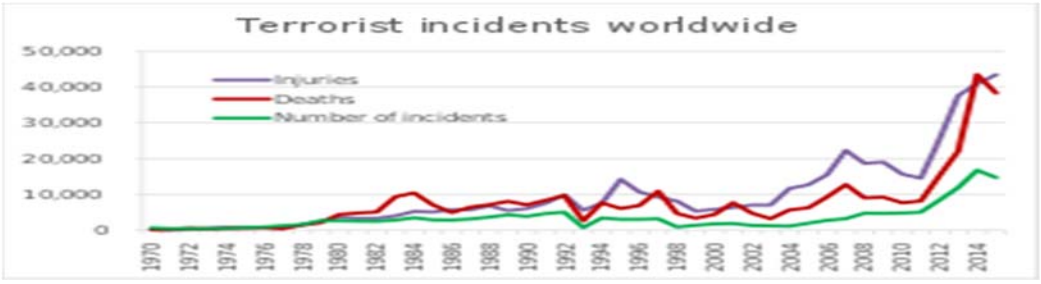

Figure 3.3. Terrorist Incidents Worldwide (National Consortium for Terrorism & Responses to Terrorism, 2016)

Attacks against oil and natural gas tanker ships still remain an Islamic phenomenon, although the officers of the ships have changed the sea route near South Africa in order to reduce terrorist and pirate attacks (Hecker, 2012).

Some tankers have, also, taken more precautions as they ride down slowly to the area avoiding Somali pirates and Islamist terrorists as vessels laden with oil and natural gas attract pirates and terrorists twice as much as any other type of vessel (Herbert-Burns, 2012).

Furthermore, the U.S. Navy intervention has become necessary for the protection of global economy and the reduction of piracy and terrorism at sea constituting the key tactic for targeting weak international economy links (Daxecker et Prins, n.d.).

3.2.4. Crew Ship Safety

Especially, the maritime industry causes effects to the marine ecosystem and provokes the climate change, while joint activities and energy conservation constitute important matters for discussion among people and international organizations (OECD, 2010).

For example, one hundred thousand tons of oil spilled in the Black Sea in 2007 due to the construction of the TAP Line caused serious problems to the area, although the geostrategic role of the whole region was available for hundred of ships transporting million of tons of oil across the Aegean Sea (Souleimanov et Cerny, 2012).

For that reason, the International Community needs to take measures against the problems affecting maritime transportation, train and practice shipping crews and pose regulations to vessel officers in order to be capable enough dealing with dangers during the travel (OECD, 1999).

Chapter 4: Results

4.1. International Community and Shipping Safety

So further information are rising up through this investigation giving answers to certain questions and presenting solutions for the development of maritime safety during the fossil fuel transportation (OECD, 1999).

Shipping Safety is being regulated by the International Maritime Organization through the development and the correction of a framework based on shipping knowledge, maritime law, legal matters, environmental issues and technical co-operation and international security (IMO, 2008).

Increasing pirate and terrorist attacks against tanker ships at the high seas constitute, also, a main issue for discussion among the countries of the globe, while thousands of tons of oil and diesel are being captured by pirates and terrorists as they have the chance to steal vessels` communication devices and special navigation equipment (Nelson, 2012).

As piracy has been a growing international problem in the recent years due to the inability of the international legislation to reduce the phenomenon, responses on a systematic and global level focusing on all forms of modern piracy do not occur on the High Seas and do not have private motivation (Daxecker & Prins, n.d.).

While the United Nations Convention on the Law of the Sea is applied to maritime questions and offences, the original statement defines that the *"high seas are open to all states and provides a non-exhaustive list of freedoms including navigation, scientific research and the building of artificial islands for oil and fossil fuel extraction from the bottom of the seas and the oceans*" (UNCLOS, 1982).

It is, also, mentioned, that the territorial waters and the *Exclusive Economic Zone* (E.E.Z.) of every country offer a wide range of energy carried by the ocean waves and the ocean thermal power, while colossal extractive oil and gas industries, offshore platforms and drilling rigs are being set, constantly, beneath the oceans` seabed for oil and gas extraction and transportation (UNCLOS, 1982).

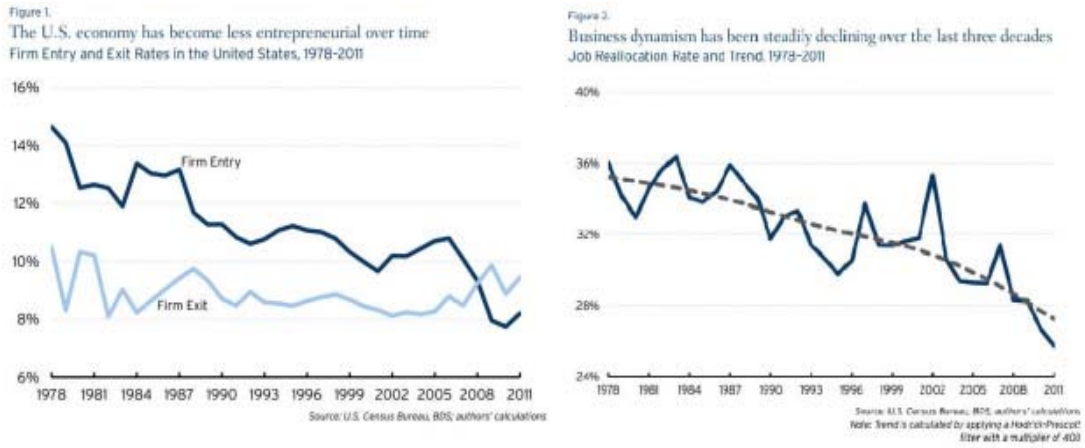

Figure 4.1. U.S. Economy and Business Dynamism (U.S. Census Bureau, 2015)

Meanwhile, the International Maritime Organization (IMO), also, known as *Inter-Governmental Maritime Consultative Organization* (IMCO), constitutes a specialized department of the United Nations regulating, developing and maintaining international shipping and navigation, thus, dealing with environmental problems and maritime shipping efficiency and safety (IMO, 2008).

IMO`s council elected from the organization`s assembly observes the status of granted, qualified non-governmental organizations through sixty legal instruments guiding the regulatory of marine safety and environmental protection in order to improve the safety at sea, to protect the marine environment and to facilitate the trade among seafaring states (IMO, 2008).

Under the *"Universality Principle"* of the International Law, every country has the right to exercise jurisdiction outside its territory if any offense is universally dangerous to state and their nationals, while this principle purposes that states have, also, the right to punish certain acts wherever may occur as a means of protecting the global community applying to the crime of piracy, terrorism or any other crime or offense (Dinstein, n.d.).

In addition, the *Regional Maritime Security Initiative* (RMSI) being a more, operationally, oriented instrument of cooperation among Asian nations, purposes to combat the trans-national threats of maritime piracy and terrorism through joint naval exercises and information on law enforcement operations (Rahman, 2008).

For example, the United States of America have the right to impose a sentence of life in prison for piracy or terrorism anywhere on the high seas regardless the nationality of victimizers or victims through the statute 1651 of title 18 of the United States Code "*as it is defined by the law of nations*" (Kontorovich, 2012).

Furthermore, the *International Convention for the Safety of the Sea* (SOLAS), the *International Convention on Oil Pollution Preparedness, Response and Co-operation* (OPRC) and the *International Oil Pollution Compensation Funds* (IOPC) function as a depository of ratified treaties imposing regulations broadly and being enforced by national and local maritime authorities (IMO, 2008).

Moreover, the prevention of collisions at sea and the inspection of foreign-flag ships are being regulated by signing protocols - *Memoranda of Understanding* - with some countries including Port State Control procedures and upgrading fire protection standards on ships among the signatories (IMO, 2008).

To this end, the *International Safety Guide for Oil Tankers and Terminals* (ISGOTT) published in 1978 meant to regulate the activities of vessels and terminals through guidance and operational advice to oil tankers and terminal operations concerning the operational security and the safer handling of oil and petroleum on tankers (ISGOTT, 1996).

4.2. Environmental Security

At fundamental level, the term *security* refers to the effort of nations to protect their territory and population against foreign state organized force and competitive behavior associated with historical quest for wealth and power (Pirages, 2011).

In other parts, also, concerns over various kinds of environmental threats have been growing as the ravages of nature have been responsible for killing and injuring large numbers of people and animals over time than traditional security threats (Pirages, 2011).

As the *environmental security* examines threats posed by environmental events to individuals, communities or nations focusing on the impact of human conflict to the environment and the international relations, thus, dealing with environmental problems located across state borders (Biswas, 2011).

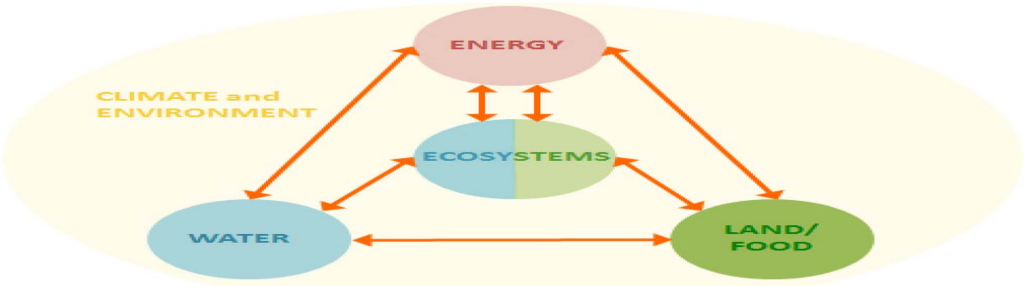

Figure 4.2. Climate and Environment (U.N. Economic Commission for Europe – UNECE, 2015)

The environmental viability for life support has been, also, categorized into three sub-elements, such as the prevention, the repair and the security of the environment from devastating military operations and conflicts (Biswas, 2011).

Due to its inherent moral value as academic discussion, safety has been, also, associated with political implications and a wide range of threats including environmental problems or resource of pollution (Vergragt, 2006).

While this field was being studied by the mid-80`s, the *environmental security* sector had widely acknowledged that the environmental factors were having a huge impact in violent conflicts and turbulent international political relationships

among nations concerning, also, the global oil and natural gas industry (Matthew, 2008).

Although a diversity had been occurred concerning the terms “environmental security” and “ecological security” both terms referred more precisely to the resource protection and to the physical surroundings of a community covering the daily needs of its inhabitants without diminishing its natural stock (U.N., 1992).

For example, the coastal environment was considered to be as a delicate ecosystem as the terrestrial and the marine environment being in constant interaction with numerous rocks and reefs found all over the oceans causing troubles to the maritime transportation (U.N., 1992).

VLCC tanker ships with a dead-weight of 300,000 tons carrying crude oil could decrease, significantly, the water quality and if an accident may occur ecological areas, marine life and maritime industry could, also, be imposed in a great danger (IMO, 1998).

Although plenty of maritime spatial plans have been developed around the protection of the marine environment and the confront of the pollution, ship diseases, ship ballast waters, ship chemicals, exhaust emissions and oil spills have been an increasing concern for ecological risk in the marine environment (Matthew, 2008).

4.3. International Maritime Organization Legal Framework

4.3.1 OILPOL Convention

The *International Convention for the Prevention of Pollution of the Sea by Oil* (OILPOL) concluded to take measures against oil pollution at the sea and the marine environment as tanker routine operations and oily wastes from engines resulted as the main factors for the marine pollution (IMO, 1998).

The OILPOL Convention recognized, also, crude oil, fuel oil, lubricating oil and heavy diesel as derivatives of oil industry responsible for oil pollution at the sea and recorded the prohibited zones where tanker ships shall not pass within fifty miles from land with the following exceptions, such as the Arctic Zone, the North Sea Zone, the Atlantic Zone, the Australian Zone and the Adriatic Zone (Fournier, 2006).

In addition, IMO developed the most important international marine environmental convention - *the International Convention for the Prevention of Pollution from Ships* (MARPOL 73/78) - in combination with the Protocol of 1978 in order to pose regulations to ships responsible for operational or accidental causes at sea and to reduce the ocean pollution (Fournier, 2006).

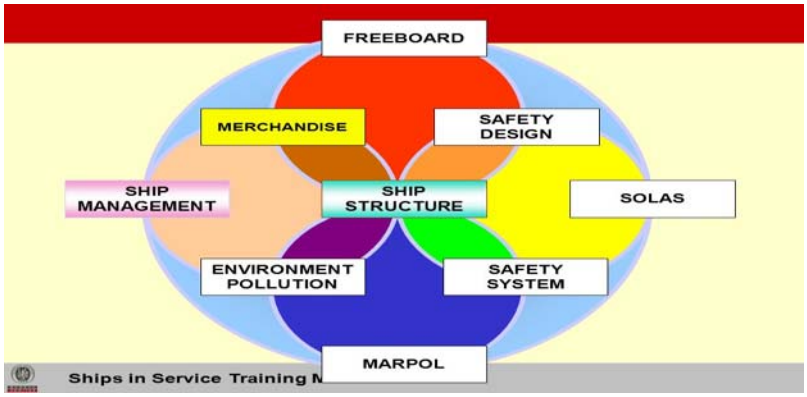

Figure 4.3. Ships in Service Training - ISM Code 2005 (Bureau Veritas, 2005)

4.3.2. MARPOL Convention

MARPOL 73/78 Convention – divided into six different Annexes - attempted, also, to eliminate the use of harmful substances from ships, to reduce noxious ship emissions and to decrease ship garbage, sewage and liquid spills with all countries signing the convention being subjected to MARPOL`s requirements regardless vessels` nationalities (IMO, 1998).

The *Oil Record Book* had been, also, added into the convention in order to prevent oily waste water from ship engines and to regulate the emission of ozone-depleting substances, such as Nitrogen Oxide (NOx), Sulphur Oxides (SOx), Volatile Organic Compounds (VOCs) applied within twelve miles of the nearest *Sox Emission Control Areas* (SECAs) with tight restrictions keeping of Ozone Depleting Substances (Dewan, 2014).

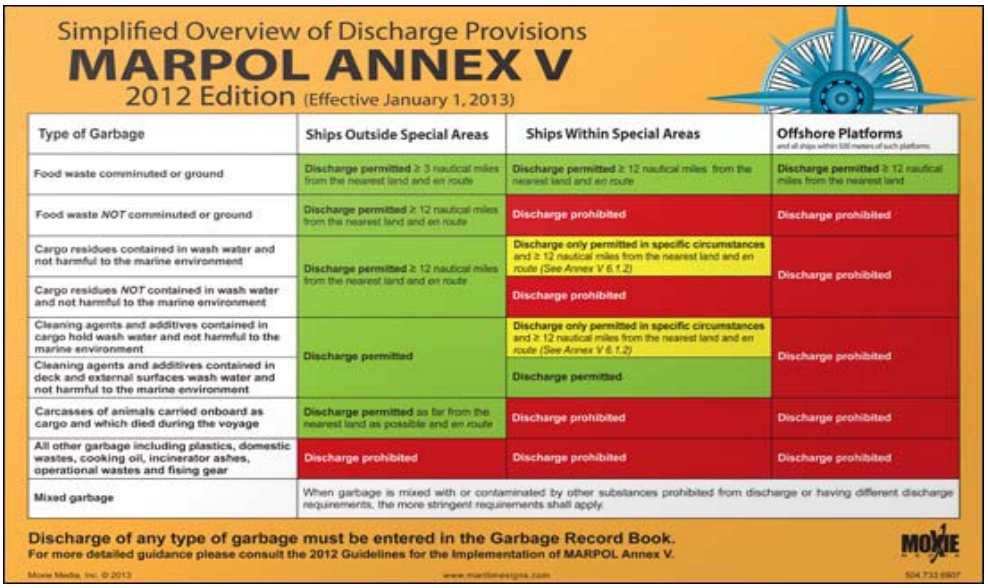

Figure 4.4. Marpol Annex V (Moxie Media, 2013)

Moreover, IMO enforced a system of compensation on behalf of bulk carrier ship owners for vessels responsible for oil spillage and pollution damage through two separate conventions – *Civil Liability Convention* (CLC 92) and *International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage* (Fund Convention or Fund 92) - in purpose to settle all the claims from vessels` pollution (IMO, 1996).

Although the Fund Convention adopted in 1971, it was replaced by the Protocol 1992 provided by oil cargo receivers depending on individual import quantities and applying to tankers dealing with persistent spillage within the Exclusive Economic Zone (EEZ) of contracting countries (Jacobsson, 2005).

The FUND 92 was, also, administered by the *International Oil Pollution Compensation* (IOPC) receiving less than 150,000 tons of oil cargo per annum taking the benefit from the compensation regime in case of oil spillage (Wang, 2000).

Added to this, a *Supplementary Fund Protocol* was established by IMO increasing the amount of available compensation to around US$ 1 billion in participating countries (IMO, 1996).

The development of new techniques and the use of offshore floating devices contribute to the easier collection and removal of oil spills from the sea surface, prevent oil expansion at the sea and protect the marine environment from further oil pollution (Lange, 2010) .

In addition, sweeping devices placed on the sides of ships pass through the oil slicks and collect them at large storage tanks or keep them in a liquid state in order to prevent large oil quantities returning to the shore (ISGOTT, 1996).

The harmless procedure of biodegration has been, also, widely, used from the international community through the use of substances sprayed over the surface of the sea-water forcing oil slicks into the water and breaking them down into small droplets protecting the marine life and the coastal surroundings from oil spillage (Slingenberg et al., 2009).

Although coastal areas can be protected from oil pollution, the effectiveness of the above mentioned method can be reduced by weather conditions enabling oil spills reaching the coast and polluting vulnerable areas (U.N., 1992).

Oil spills and crude oil in combination with polycyclic aromatic hydrocarbons (PAHs) are extremely toxic and difficult to be cleaned up causing devastating effects to the marine life and the reproductive cycle (Helfre et Boot, 2013).

The *Exxon Valdez* constitutes the most known incident of sunk vessel spilling a massive amount of oil into the Arctic Ocean, destroying marine life and harming the fauna and the flora around Alaska in 1989 (Skinner et Reilly, 1989) .

In addition, a high percentage of climate change emission is caused by shipping carbon dioxide increasing the impact of greenhouse gas emissions, but the *Energy Efficiency Design Index* (EEDI) has counted the percentage of carbon dioxide emitted per ton in the atmosphere based on IMO calculations and regulations concerning the characteristics of vessels` capacity and fuel consumption (Helfre et Boot, 2013).

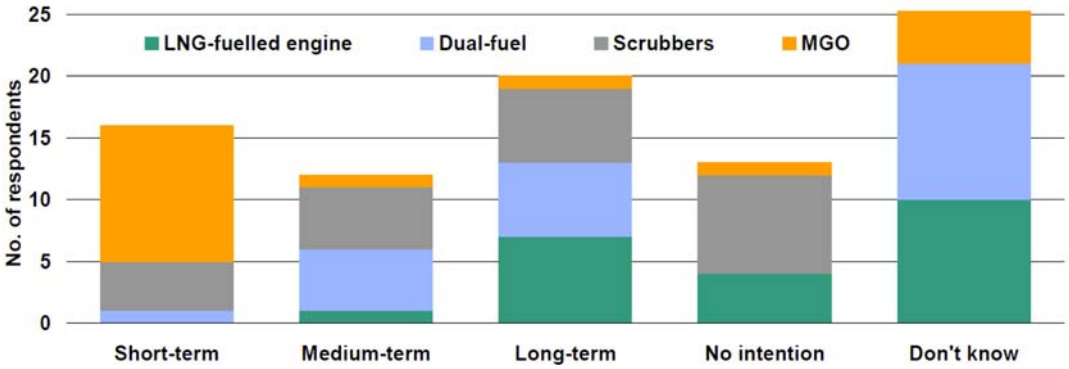

Figure 4.5. LNG-fuelled Deep Sea Shipping (Lloyd`s Register, 2012)

The MARPOL Convention attempted to reduce the harm of crude oil by prohibiting discharges within 80 km / 50 miles of most land and 160 km / 100 miles of certain particularly sensitive areas as the mixture of crude oil and sea-water had been used for washing tanker ships (U.N., 2008).

For that reason, a multi-level system - the *Marine Fuel Management* (MFM) – has been developed in recent years in purpose to measure, monitor and report fuel usage on ship, increase operational efficiency, improve fleet management and reduce the marine pollution (U.N., 2008).

Moreover, the MFM regulates the type and the quantity of fuel is likely to be used, describes the impact of the fuel usage in the environment, explains the methods needed for the measurement of the fuel consumption and presents results of how a vessel uses its fuel (U.N., 2008).

4.4. Anti-Piracy and Anti-Terrorism Measures at Sea

The *Best Management Practices to Deter Piracy* (BMP4) constitutes the recent authoritative guide in order to advance UNCLOS Convention and encourage vessels crews dealing with pirates and travelling near the coast of Somalia and the Strait of Aden in the Arabian Sea with safety (House of Commons, 2011).

The guide ratified by a consortium of international shipping and trade organizations - the *Oil Companies International Marine Forum* (OCIMF) - includes the Europe Union Naval Forces (EUNAVFOR), NATO and the International Maritime Bureau (IMB, 2016).

BMP4 presents the "*Self-Protective Measures*" that ship crews should take when pirate attacks occur against merchandise vessels through the use of razor wires and fire-hoses around the deck to spray pirates in purpose when they approach the ships (House of Commons, 2011).

Although, private security guards are hired by shipping companies to patrol dangerous sea routes and deter pirates more effectively, special equipment and satellites - the *WatchStander* and the *Automatic Identification System* (AIS) – are being used by vessel crews for the collection of information about suspicious movements and the location of areas where armed pirates swoop, constantly, against merchandise vessels (BMP4, 2011).

In case of emergency, international naval forces, especially, U.S. Navy patrol dangerous coastal areas and capture pirates with *Rocket Propelled Grenade Launchers* (RPGs) near the Horn of Africa or the Arabian Sea (Ploch et al., 2009).

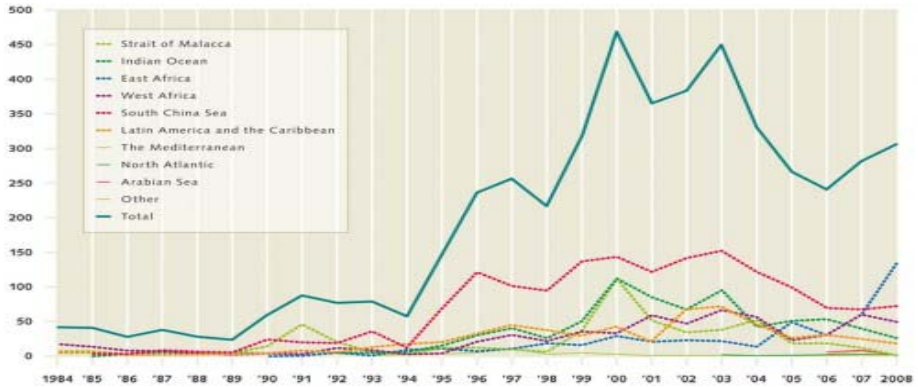

Figure 4.6. Piracy and Terrorism at Sea (World Ocean Review, 2007)

Furthermore, "*Articles 101 to 103 of the UNCLOS 1982 define any illegal act of violence or detention committed by the crew of a private ship directed on the high seas against another ship or property on board in place outside the jurisdiction of any state*" (UNCLOS, 1982).

The problem is that the above mentioned articles confine piracy to the High Seas as the majority of pirate attacks occur within territorial waters, although the IMB defines piracy "*…as the act of boarding any vessel with an intent to commit theft or any other crime and with an intent or capacity to use force in furtherance of that act*" (IMB, 2009).

In addition, the *European Court of Human Rights* (ECHR) declares that every country should pay thousands of dollars in compensation to pirates for "*..not providing them with basic human and juridical rights during arrest and transfer in court by sea*" (Dubner et Otero, 2016).

In other words, the ECHR states that every pirate has the same rights as any other European Citizen allowed the same protection, the representation of a lawyer, the rejoice of liberty and the stand on court (Dubner et Otero, 2016).

Although *Risk Management* is focusing on vessels carrying oil with SAFETY, fuel transportation is threatened, also, by terrorists defying NATO`s *Operation Active Endeavour* program against terrorism at sea (NATO, 2008).

U.S. Naval Forces patrolling the Gibraltar Strait as well as other hot points in order to keep the Mediterranean`s routes safe and free from pirates and terrorists as 65% of the oil and natural gas consumed in Western Europe pass through pipelines connecting North Africa with South Europe (NATO, 2008).

For that reason, NATO is searching for passages, harbors and sea routes where terrorist groups enforce to take control of ports and oil terminals and blow tanker ships up near the Persian Gulf (NATO, 2008).

While the International Community is trying to sign a global *Comprehensive Convention on International Terrorism*, the U.S. Code, Title 22, Chapter 38, Section 2656(d) defines terrorism:

"*….as premeditated, politically motivated violence penetrated against non-combatant targets by sub-national groups or clandestine agents, usually intended to influence an audience with ineluctably political in aims and motives designed to have*

far-reaching psychological repercussions beyond the immediate victim or target" (U.S. Code, 1994).

In addition, the U.S. Congress has given the right to officers of Merchant Navy to carry weapons and hire security guards on board or place well trained ship crews on ports to incommode terrorists and reduce attacking (Rosenberg, 2009).

Furthermore, the UN Convention on the Law of the Sea gives the right to every country to arrest pirates and terrorists and determine their penalties in purpose to repress piracy and terrorism at the high seas (Wolfrum, 2006).

But some experts are worried about this lasting U.S. interference and the constant supply of naval forces in the territorial waters of other countries, while the convention declares that every country should be responsible for its own security on its territory (Wolfrum, 2006).

The officers, also, need to write their vessel`s IMO Number in a visible point, surround their ship with electric fences discouraging attackers, report suspected vessels under dubious "flags of convenience" and call strong national or international naval forces in case of emergency (IMO, 1998).

For example, the Indonesian Navy patrols the coastline every day, while China, India, Japan and South Korea are contributing financially to the security of sea lanes where tanker ships transfer oil and natural gas from the Middle East (Rosenberg, 2009).

States, also, should come to an agreement for the enhancement of measures against piracy and terrorism, while the existing procedures are inadequate to ensure security at the high seas (Rosenberg, 2009).

In addition, IMO cannot ensure that every ship is legitimate, while the "*phantom ships*" are blacklisted and forbidden to enter the territorial waters of other countries as the majority of cargo is transferred through ships under foreign flags (IMO, 1998).

For that reason, vessels and cargo should be checked by experts responsible for searching and testing the entire tank for dangerous cargo according to IMO regulation and procedure (ILO, 1996).

Furthermore, tanker officers should be aware of the cargo they carry as different types of cargo lack sun light and oxygen causing severe or fatal problems during the transportation (ILO, 1996).

Therefore, the ratification of the *Maritime Labour Convention* (ILO) guarantee the safety and the security of tanker ships, provide crews with better conditions on board, protection fuel and refined cargo during the transportation and reduce the cost of the repair of pipeline facilities on ports or floating platforms (ILO, 1996).

Special guides have been, also, published by classification societies presenting risk assessment techniques, various risks during the construction and the manufacture of ships and types of cargo suitable for transportation (Li, Meng et Qu, 2012).

Furthermore, tanker ships follow the model of the *Quantitative Risk Assessment* (QRA) to evaluate vessel designs and the advantages and the disadvantages of special equipment on board during maritime operations (Li, Meng et Qu, 2012).

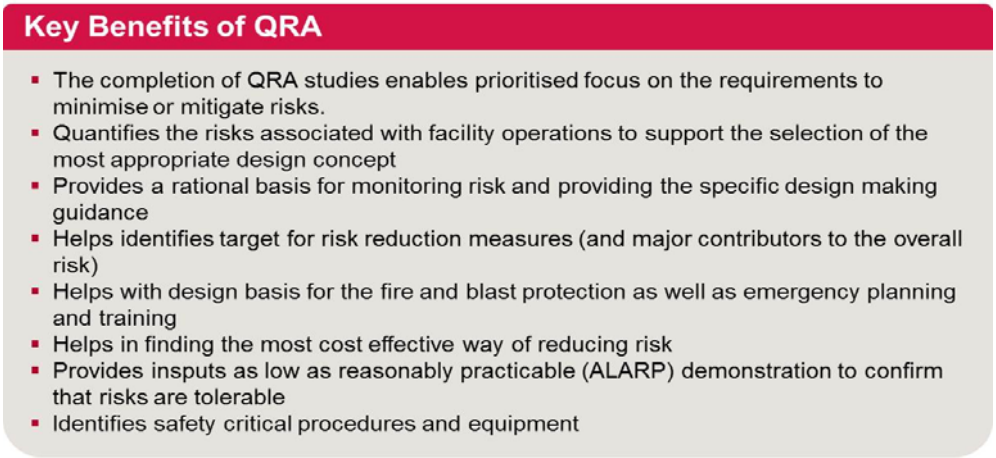

Figure 4.7. Key Benefits of QRA (Bureau Veritas UK & Ireland, 2016)

Although tanker ship insurance is focusing on property, liability, collision, protection and indemnity, pirates and terrorists still prefer to attack against tankers due to the high cost of construction, cargo and the essential role playing in the maritime industry (Muller, Steino et Hansen, 2013) .

As insurance constitutes a very important procedure, the oil and the natural gas are transferred with safety limiting the risk of explosion or casualty responsible for injured people or death in the past due to oil or gas leaking (Muller, Steino et Hansen, 2013).

For that reason, precautions must be followed by tanker ship crews in order to prevent the risk of fire or explosion as tanker ships are, also, known as “bombs on wheels” due to faulty or overweight flammable cargo (BMP4, 2011).

Furthermore, the extensive research for oil spillage or gas leakage in cargo compartments, in pump rooms and in deck is necessary for the prevention of fire hazard or marine pollution and the disinfection of contaminated areas (International Safety Guide, 2010).

In addition, potential sources of ignition, such as naked lights, electrical appliances and smoking on deck must be prohibited or permitted in certain areas under specified conditions designated in writing between the Responsible Person and the Terminal Representative due to the high flammable risk (International Safety Guide, 2010).

Chapter 5: Conclusion

5.1. Main Findings

While the majority of shipping companies are being aware of high insurance cost and time-consuming investigations, they do not report the precise number of pirate and terrorist attacks constituting the international community unable to deal, effectively, with the crime of piracy and terrorism occurring at the high seas (Meijden, 2008).

Furthermore, pirates and terrorists have already improved the tactic of attacking against tanker ships through the use of firing equipment and the formation of organized crime syndicates cooperating with corrupt officials and port workers in the Arabian Sea, the South China Sea and the coast of Somalia (Meijden, 2008).

For example, the "*Free Aceh Movement*" constitutes the most radical Islamic group in the world procuring weapons, attacking against vessels, taking crew hostages and demanding extremely high ransom approximately $100,000 per ship (IMO, 2007).

In addition, the above mentioned group is, constantly, attempting to be provided with speedboats loaded with explosives and suicide bombers in order to blow tanker ships up, cause damage to major international ports and terminals, threat energy targets in the West and diminish the global economy affecting the oil prices (IMO, 2007).

For instance, oil facilities in Nigeria and Iraq have undergone more than one hundred attacks on the countries` pipeline system resulting in the national oil production, while tanker ships are having little protection when pass through strategic checkpoints affecting the international energy market and causing congestion in sea lanes and ports (Human Rights Watch, 2015).

Added to this, freighters loaded with every type of cargo pass through the checkpoints in a daily basis, "while every state is trying to deal effectively with this threat, prevent other countries from further harm and improve maritime security in the industrialized world" (OECD, 2003).

But pirates and terrorists have, still, the intention to attack against vessels and territorial waters, although severe measures have been taken by the international community in order to protect the maritime industry and destroy the connective tissue between piracy and terrorism (Nelson, 2012).

As the measures against piracy and terrorism at sea demand years of procedure, the global energy producers and consumers should make efforts to prevent oil traffic from further damage through the protection of strategic petroleum reserves and checkpoints, the mapping of alternative sea routes and the replacement of conventional energy with "next generation energy" minimizing the oil transportation through the sea (Luft et Korin, 2004).

Although tanker ships constitute a huge international business, the safety measures are inadequate for the protection of vessels that carry flammable or toxic freight as a tanker explosion could cost more than US$1 million per ship posing human and marine life in great danger due to oil spills and fumes (OECD, 2010).

For that reason, certain tanker areas are defined by international conventions in order to prevent the leakage or the violent sparking of flammable gases and liquids from other approved tanker locations that could cause explosions (CCNR/OCIMF, 2010).

In addition, the safety and the security of tanker ships has been assigned to the appropriate authorities through recommendations and inspections in order to check the situation of flammable cargo, the vessel`s equipment and the operation conditions during the cargo loading on terminals (CCNR/OCIMF, 2010).

Thus, the MSC Circular 1045 Code has, already, presented the necessary measures should be taken to ensure crew safety during onboard or onshore operations and protect terminals from chemical exposure (IMO, 2014).

Although tanker ships consume less gas than needed and transport more freight than other type of vessels, the marine environment is threatened by oil spillage and natural gas leakage causing death to animals and humans (OECD, 2010).

Furthermore, the decision should be taken in order to administrate that kind of ship depends on high earnings, on certifications formed for tankers and on highly educated officers (OECD, 2010).

Table 5.1. IMO MSC 91 Report-ANNEX 1 - List of Decisions (Lloyd`s Register Group Limited, 2012)

Instrument	Agenda Item	Title	Expected Entry into Force/Effective Date
SOLAS	7	Regulation III/19 Emergency training and drills	1 January 2015
ISM CODE	11	Various sections	1 January 2015
SOLAS	13	Regulation III/19 Emergency training and drills	1 January 2015
CSC 1972	13	Various sections	1 January 2015

Added to this, tanker ship crews feel more safe travelling with that vessel than any other type of ship as less cargo operations need to be done and higher salaries they can get (CCNR/OCIMF, 2010).

On the other hand, tanker ships spend more money and time travelling at sea, deal with hazardous cargo and increase the responsibility and the amount of stress on crews during cargo operations onboard or onshore (Veritas, 2001).

5.2. Limitations of Research

Ever since, oil and natural gas has been transported through a variety of methods presenting a diversity of advantages and disadvantages including the cost, the dangers and the environmental impact as pipelines have not the potential to provide the international market, totally, with oil and gas from point to point (Veritas, 2001).

On the contrary, tanker ships have the ability to transfer as much as two million barrels of oil per year through the globe affecting the scale of oil demand and supply regardless of the ecological disaster could cause at sea or onshore (Teague, 1975).

Although navigation has been an important human activity, "the maritime industry has become one of the four cornerstones of globalization along with communications, international standardization and trade liberalization" as many countries have come up with economic growth through foreign investments and trade" (Teague, 1975).

Therefore, *globalization* is defined "…*as the increased flow of knowledge, resources, goods, and services among world`s nations and as the development of an increasingly integrated global economy marked especially by free trade, free flow of capital and the tapping of cheaper foreign labor markets*" (UN, 2006).

In fact, the maritime industry has been customized in globalization demands through modern technology, highly expert labor resources and international oil and natural gas transportation system including the oceans and the coastal routes (Corbett et Winebrake, 2008).

Although marine transportation has been an important part of the global economy, an important volume of global freight is transferred through the air with the oil industry being forced to ship larger amounts of oil and natural gas in the global markets (Corbett et Winebrake, 2008).

Globalization encouraging the production and the transportation of products made with low-cost manufacturing materials and shipped with low-cost petroleum energy replaced the coal consumption with oil and natural gas energy

promoted by the global commercial domain in order to reduce the per unit cost of shipping transportation and achieve better vessel performance through the installation of internal combustion engines (UN, 2006).

Military vessels, also, adopted that kind of energy presenting more accelerating diesel engines accomplishing higher speeds at sea forcing maritime industry to replace, totally, coal with oil and natural gas energy and reduce seafaring labor (Veritas, 2001).

5.3. Recommendations for Further Study

According to the *Energy Information Administration*, marine transportation has managed to transfer any type of cargo with low shipping cost and low fuel consumption operating ships more efficiently, while the *Organization of Economic Cooperation and Development* (OECD) has discouraged maritime industry to use heavy fuel oil (HFO) or intermediate fuel oil (IFO) (Stopford, 2003).

Furthermore, the term "*international marine fuel*" has introduced an era of energy co-operation among nations signing the *Agreement on International Energy Program* (IEP) in order to enhance the oil and natural gas production and consumption, the safety of the environment and the enforcement of international relationships in the domain of energy (Stopford, 2003).

As the international community makes an effort to deal, effectively, with the marine pollution caused by the commercial and maritime industry, international regulations are followed by the majority of the countries (Corbett et Winebrake, 2008).

For example, many efforts have been done in order to reduce environmental impacts and solve environmental issues caused by shipping operations through the research of alternative energy sources, the development of technology and the construction of larger and faster vessels under certain environmental standards and economic demands (Corbett et Winebrake, 2008).

Therefore, the maritime industry should follow certain rules for the protection of the ecosystem and the global climate, the extensive use of alternative energy and the improvement of maritime transport through IMO standards and European Union and North American Regulations modifying the nature of shipping competitiveness through the use of less toxic fuel (Stopford, 2003).

References

1. (2013). Action Plan for Response to Marine Pollution from Oil and Gas Installations. European Maritime Safety Agency, Lisbon, Portugal, 71
2. (1996). Accident Prevention on Board Ship at Sea and in Port. International Labour Office, Geneva, Switzerland
3. (2014). Advanced Well Stimulation Technologies in California: An Independent Review of Scientific and Technical Information. California Council on Science and Technology, U.S.A., 62
4. Alfaleh, F. (2010). The Role of Naval Forces in the Non-Military Maritime Domain. World Maritime University, Malmo, Sweden
5. Al-Weshah, R. A. (2000). The Water Balance of the Dead Sea: An Integrated Approach: Hydrological Processes. 145–154, doi:10.1002/(SICI)1099-1085(200001)
6. Andreone, G. , Bevilacqua, G. Cataldi, G., & Cinelli, C. (2013). Insecurity at Sea: Piracy and Other Risks to Navigation. Giannini Editore, Italy
7. (2012). Annual Report and Accounts. Sinopec Corporation, 6-194
8. (2013). Annual Report 2012: Annual Report on Form 20-F. Statoil ASA, Norway
9. (2014). Asian Attacks Dip, but Petro Crime Rises. *Seacurus 40*, Insurance Bulletin, IMO Conventions, United Kingdom, 15
10. (2014). Avoiding Fossil Fuel Costs with Wind Energy. European Wind Energy Association, 4
11. Ball, M. W., Douglas B., & Daniel S. T. (1965). This Fascinating Oil Business. Bobbs-Merrill, Indianapolis, U.S.A.
12. Bergin, T. (2008). Oil Majors' Output Growth Hinges on Strategy Shift. Reuters. Retrieved from: http://www.reuters.com/article/us-oilmajors-production-idUSL169721220080801
13. (2011). Best Management Practices for Protection against Somalia Based Piracy: Suggested Planning and Operational Practices for Ship Operators and Masters of Ships Transiting the High Risk Area. BMP4, Edinburg, Scottland
14. Bilkadi, Z. (1992). Bulls from the Sea : Ancient Oil Industries. Aramco World
15. Biswas, N. (2011). Is the Environment a Security Threat? Environmental Security beyond Securization. *International Affairs Review, 20* (1)
16. Bjelopera, J. (2013). The Domestic Terrorist Threat: Background and Issues for Congress. Congressional Research Service, U.S.A.

17. Blackburn, M., Mazzacano, C., Fallon, C., & Black, S. (2014). Oil in our Oceans: A Review of the Impacts of Oil Spills on Marine Invertebrates. The Xerces Society for Invertebrate Conservation, U.S.A.
18. Bobat, A. (2015). Thermal Pollution caused by Hydropower Plants. University of Kocaeli, Turkey
19. Carter, J.H.T., & Foolen, J. (1983). Evolutionary Developments Advancing the Floating Production, Storage, and Offloading Concept. *J. Pet. Technol*, *35*(4), U.S.A.
20. (1976). Code for Existing Ships Carrying Liquefied Gases in Bulk. IMO, London, United Kingdom
21. (2008). Contribution of the International Maritime Organization to the Secretary-General`s Report on Oceans and the Law of the Sea: Maritime Safety and Security. IMO, London, United Kingdom
22. (1982). *Convention on the Law of the Sea*, *57*, United Nations, New York, U.S.A.
23. Corbett, J., & Winebrake, J. (2008). The Impacts of Globalization on International Maritime Transport Activity. Energy and Environmental Research Associates, U.S.A.
24. Cordesman, A., & Toukan, A. (2014). The Indian Ocean Region: A strategic Net Assessment. Center for Strategic and International Studies, 85
25. (2010). Country Reports on Terrorism 2009. US Department of State Publication Office of the Coordinator for Counterterrorism, U.S.A., 240
26. Crumley, B. (2009). Russia's Gazprom Diplomacy: Turning Off Europe's Heat. *Time*, Paris, France. Retrieved from: http:/ /content.time.com/time/world/article/0,8599,1870111,00.html
27. Dane, F. (2014). Multilateral Security Governance. Konrad-Adenauer-Stiftung, Rio de Janeiro, Brazil
28. Davis, N. (2016). Commentary: China next in Shale Gas?. ICIS Chemical Business, Retrieved from: www.icis.com
29. Daxecker, U., & Prins, B. (n.d.). Insurgents of the Sea: Institutional and Economic Opportunities for Maritime Piracy. Universities of Colorado and Tennessee, U.S.A.
30. (2012). Deepwater. Shell International Exploration and Production, the Netherlands, 19-24
31. Dewan, M. (2014). MARPOL Regulations for Ships 1973 –Modified by the Protocol of 1978. Energy Efficiency in Shipping Industry, Malaysia
32. (2006). Diamonds. Geological Survey of Namibia. Ministry of Mines and Energy, Namibia

33. Dinstein, Y. (n.d.). The Universality Principle and War Crimes. *International Law Studies*, *71*, Schmitt & Green Editors, U.S.A.
34. Dubner, B., & Otero, B. (2016). The Human Rights of Sea Pirates: Will the European Court of Human Rights Decisions Get more Killed?. Washington University Open Scholarship, U.S.A.
35. Elleman, B., Forbes, A., & Rosenberg, D. (2010). Piracy and Maritime Crime: Historical and Modern Case Studies. Naval War College Press, Rhode Island, U.S.A., 12
36. (n.d.). Endorheic Lakes: Waterbodies That Don't Flow to the Sea. The Watershed: Water from the Mountains into the Sea. United Nations Environment Program. Retrieved from: http://www.unep.or.jp/ietc/publications/short_series/lakereservoirs2/10.asp
37. Engerer, H. (2010). Natural Gas Vehicles: An option for Europe. *Energy Policy, 38*(2), 1020
38. (2010). Environmental and Climate Change Issues in the Shipbuilding Industry. OECD Council Working Party on Shipbuilding, Paris, France
39. (1997). Environmental Management in Oil and Gas Exploration and Production: An Overview of Issues and Management Approaches. UNEP Industry and Environment, London, United Kingdom, 11-15
40. Evangelista, J. (2002). Scaling the Tanker Market. *Surveyor*, American Bureau of Shipping, U.S.A., 29-32
41. Eyres, D. J. (2001). Ship Construction. Butterworth-Heinemann, Oxford, United Kingdom, 254-264
42. Falkowski, P., Scholes, R. J., Boyle, E., Canadell, J., Canfield, D., Elser, J., Gruber, N., Hibbard, K., Högberg, P., Linder, S., MacKenzie, F. T., Moore, B., Pedersen, T., Rosenthal, Y., Seitzinger, S., Smetacek, V., & Steffen, W. (2000). The Global Carbon Cycle: A Test of Our Knowledge of Earth as a System. *Science*, *290,* 291-296.
43. (2014). Five Billion Compensation by Argentina for Y.P.F. Assets Accepted by Repsol. Argentina Star, Retrieved from: http://www.argentinastar.com/index.php/sid/220229237
44. (1998). Focus on IMO: MARPOL- 25 years. IMO, London, United Kingdom
45. Forbes, A. (2014). Naval Diplomacy and Maritime Power Projection. Sea Power Centre, Australia
46. Fossheim, M. (2005). Climate Change: Human-Induced Greenhouse Effects cause Climate Change. Bellona Foundation, Norway, 3-11

47. Fournier, A. (2006). Controlling Air Emissions from Marine Vessels: Problems and Opportunities. University of California, U.S.A.
48. (1982). Freedom of the High Seas: General Provisions. *United Nations Convention on the Law of the Sea*, *87(*1), United Nations, New York, U.S.A.
49. (2010). General Hazards for Tanker and Terminal: Chapter 4. International Safety Guide for Inland Navigation Tank-barges and Terminals, CCNR/OCIMF
50. Haaland, S.E. (1981). Simple and Explicit formulas for the friction factor in the Turbulent Pipe flow. Norwegian Institute of Technology, Norway
51. Halbouty, M. (2003). Giant Oil and Gas Fields of the Decade, 1990–1999. American Association of Petroleum Geologists, U.S.A., 50
52. Halpern, B. S., Walbridge, S., Selkoe, K. A., Kappel, C. V., Micheli, F., Agrosa, C., Bruno, J. F., Casey, K. S., Ebert, C., Fox, H. E., Fujita, R., Heinemann, D., Lenihan, H. S., Madin, E. M. P., Perry, M. T., Selig, E. R., Spalding, M., Steneck, R., & Watson, R. (2008). A Global Map of Human Impact on Marine Ecosystems. *Science, 319*, 948–952.
53. Hamilton, M. (2014). Oil Tanker Sizes Range from General Purpose to Ultra-Large Crude Carriers on AFRA Scale. U.S. Energy Information Administration, Washington, U.S.A. Retrieved from: www.eia.gov
54. Hammar, L. (2012). Renewable Ocean Energy in the Western Indian Ocean. vol. 16, issue 7, 4939
55. Hecker, B.T. (2012). Combating Piracy around the Horn of Africa. Kas International Reports, University of Bonn, Germany
56. Helfre, J.F., & Boot, P. (2013). Emission Reduction in the Shipping Industry: Regulations, Exposure and Solutions. Sustainalytics, Toronto, Canada
57. Herbert-Burns, R. (2012). Indian Ocean Rising: Maritime Security and Policy Challenges. Stimson, Washington, U.S.A.
58. Hope, C., Gilding, P., & Alvarez, J. (2015). Quantifying the Implicit Climate Subsidy received by Leading Fossil Fuel Companies—Working Paper No. 02/2015. Cambridge Judge Business School, Cambridge, United Kingdom
59. (2016). How Fossil Fuels Were Formed. U.S. Department of Energy, U.S.A. Retrieved from: http://www.fe.doe.gov/education/energylessons/coal/gen_howformed.html
60. Howarth, R. W., Santoro, R., & Ingraffea, A. (2010). Methane and the Green-House Footprint of Natural Gas from Shale Formations. Department of Ecology and Evolutionary Biology, U.S.A., 9

61. Hurlburt, K., (2011). The Human Cost of Somali Piracy. One Earth Future Foundation, U.S.A.
62. (2013). Hydrocarbons and Petrochemicals: Building Blocks of a Vibrant India. Indian Oil Corporation, India, 68-82
63. (2016). India sets Sights on Gold in Ocean. The Hindu, India.
Retrieved from:
http://www.thehindu.com/news/national/india-sets-sights-on-gold-in-ocean/article8733453.ece
64. (n.d.). India`s Massive Untapped Natural Gas Reserves could help free up $306 million a day on Imported Oil", GE`s Bulletin series.
Retrieved from: http://qz.com/460957
65. (2007). Information Resources on Piracy and Armed Robbery at Sea. no. 28, IMO Library Services, External Relations Office, London, United Kingdom
66. (1993). International Code for the Construction and the Equipment of Ships Carrying Liquefied Gases in Bulk (ICG Code). IMO, London, United Kingdom, 1-27
67. (1996). International Convention on Civil Liability for Oil Pollution Damage (CLC). IMO, London, United Kingdom.
Retrieved from:
http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International-Convention-on-Civil-Liability-for-Oil-Pollution-Damage-(CLC).aspx
68. (1996). International Safety Guide for Oil Tankers & Terminals. International Chamber of Shipping, London, United Kingdom
69. Jacobsson, M. (2005). The International Compensation Regime and the Activities of the International Oil Pollution Compensation Funds. Shanghai, China
70. Karleskint, G. (2009). Introduction to Marine Biology. Cengage Learning, Boston, U.S.A., 47
71. Kontorovich, E. (2012). The Penalties for Piracy: An Empirical Study of National Prosecution of International Crime. Northwestern University School of Law Scholarly Commons, Chicago, U.S.A.
72. Lahidji, R., Michalski, W., & Stevens, B. (1999). Energy: The Next Fifty Years. OECD Publication Services, Paris, France, 14
73. Lange, E, Peterson, S., Rupke, L., Soding E., & Wallmann, K. (2010). Oil and Gas from the Sea. Hamburg, Germany, 10-35

74. Li, S., Meng, Q., & Qu, X. (2012). An overview of Maritime Waterway Quantitative Risk: Assessment Models. vol. 32, No. 3, University of Singapore, Malaysia
75. Luft, G., & Korin, A. (2004). Terrorism goes to Sea. Council on Foreign Relations, New York, U.S.A.
76. Lyons, W., Plisca, G., & Lorenz, M. (2016). Standard Handbook of Petroleum and Natural Gas Engineering. Gulf Professional Publishing, Elsiever, Amsterdam, The Netherlands, 121-189
77. Mackay, D., & Stone, T. (2013). Potential Greenhouse Gas Emissions Associated with Shale Gas Extraction and Use. Department of Energy and Climate Change, London, United Kingdom, 14-18
78. Mair, S., Petretto, K., Mildner, S.A., Grob, F., Tull, D., Ruddolf, B., Weber, A., Loewen, H., Bodenmuller, A., Brombacher, D., Maihold, G., Schaller, C., Kupferschmidt, F., Paulus, A., & Comnick, M. (2011). Piracy and Maritime Security: Regional Characteristics and Political, Military, Legal and Economic Implications. German Institute for International and Security Affairs, Berlin, Germany, 6-12
79. Mallet, V. (2016). India targets $4 Billion of Untapped Oil and Gas. Financial Times, New Delhi, India.
    Retrieved from:
    https://www.ft.com/content/dda3f270-ea5d-11e5-bb79-2303682345c8
80. (2010). Mapping the Impacts of Natural Hazards and Technological Accidents in Europe: An Overview of the Last Decade. Copenhagen, Denmark, 18-20
81. Marks, R. (1972). Pollution of the Seas by Crude-Oil: A Proposal for Effective Remedial Action. Ohio State University, U.S.A.
82. Marquardt, E., & Heffelfinger, C. (n.d.). Terrorism and Political Islam Origins, Ideologies and Methods. U.S. Military Academy, New York, U.S.A.
83. Matthew, R. (2008). Resource Scarcity: Responding to the Security Challenge. International Peace Institute, New York, U.S.A.
84. (2015). Measuring Fossil Fuel 'Hidden' Costs. University of Cambridge Judge Business School, Cambridge, United Kingdom.
    Retrieved from:
    http://insight.jbs.cam.ac.uk/2015/measuring-fossil-fuel-hidden-costs/
85. Meijden, L. (2008). The Influence of Modern Piracy on Maritime Commercial Transport. Erasmus University Rotterdam, Rotterdam, The Netherlands

86. Moatsos, I., & Purnendu, D. (2006). Structural Reliability Framework for Floating Production, Storage, and Offloading Vessels/ Floating Surface Units. Universities of Glasgow and Strathclyde, Scotland
87. Monkhouse, F.J. (1975). Principles of Physical Geography. Hodder & Stoughton, London, United Kingdom, 327-328
88. Muller, P., Steino, M., & Hansen, T. (2013). Maritime Risk International: P&I, Claims Management and Loss Prevention. Copenhagen, Denmark, vol.27, No.5
89. Musk, E. (2015). If I Cared About Subsidies, I Would Have Entered the Oil and Gas Industry. Los Angeles Times, U.S.A.
Retrieved from:
http://www.latimes.com/business/autos/la-fi-hy-musk-subsidies-20150602-story.html
90. Nathanson, R., & Levy R. (2012). Natural Gas in the Eastern Mediterranean: Casus Belli or Chance for Regional Cooperation?. Institute for National Security Studies, Tel Aviv, Israel, 58-62
91. (2008). NATO Active Endeavour: Combating Terrorism at Sea. NATO Public Diplomacy Division, Belgium
92. (2016). Natural Gas Consumption Statistics. Eurostat Statistics Explained.
Retrievedfrom:
http://ec.europa.eu/eurostat/statisticsexplained/index.php/Natural_gas_consumption_statistics
93. Nelson, E. (2012). Maritime Terrorism and Piracy: Existing and Potential Threats. vol. 3, issue 1, Norwich University, Vermont, U.S.A.
94. Novaczek, I. (2000). Canada's Fossil Fuel Dependency.
Retrieved from: http://www.elements.nb.ca/theme/fuels/irene/novaczek.htm
95. (2015). Oil and a Low-Oil Price World. International Energy Agency, Paris, France, 3
96. (2000). Oil and Gas in Latin America: Open-File Report 97 - 47D. U.S. Geological Survey World Agency Assessment Team, Denver, U.S.A.
97. (2016). Panamax and Aframax Tankers: Oil Tankers with a Difference. MI News Network, Bangalore, India.
Retrieved from: www.marineinsight.com
98. Parfomak, P., & Frittelli, J. (2007). Maritime Security: Potential Terrorist Attacks and Protection Priorities. Congressional Research Service, Washington, U.S.A.

99. Parisis, I. (2015). The Maritime Dimension of European Security: Strategies, Initiatives, Synergies. TUFTS University, Boston, U.S.A.
100. (2002). Petrobras to acquire Control of Perez Companc. Oil and Gas Journal, Tulsa, U.S.A. Retrieved from: http://www.ogj.com/articles/print/volume-100/issue-30/general interest/company-news-petrobras-to-acquire-control-of-perez-companc.html
101. Pike, W. (2011). Introduction to Oil and Gas. U.S. Department of Energy, Washington, U.S.A.
102. (2016). Piracy and Armed Robbery Against Ships. ICC International Maritime Bureau, London, United Kingdom
103. (2009). Piracy - Frequently Asked Questions (FAQs). IMB, New York, U.S.A.
104. (2011). Piracy off the Coast of Somalia: Tenth Report of Session 2010-2012. House of Commons Foreign Affairs Committee, London, United Kingdom
105. Pirages, D. (2011). Ecological Security: A framework for Analyzing Non-traditional Security Issues. no. 28, University of Nevada, U.S.A.
106. Ploch, L., Blanchard, C., O`Rourke, R., Mason, C., & King, R. (2009). Piracy off the Horn of Africa. Congressional Research Service, Washington, U.S.A.
107. Primorac, B., & Parunov, J. (2015). Structural Reliability Assessment of Accidentally Damaged Oil Tanker. Universities of Zagreb and Split, Croatia
108. (2008). Progress reported in UN-Backed Efforts to reduce Pollution, Emissions from Ships. UN News Centre, New York, U.S.A. Retrievedfrom: http://www.un.org/apps/news/story.asp?NewsID=28563&Cr=maritime&Cr1
109. Rafgard, T. (2011). Tankers, Big Oil & Pollution Liability. Oslo, Norway, 48-66
110. Rahman, C. (2008). The Global Maritime Partnership Initiative: Implications for the Royal Australian Navy. Sea Power Centre, Australia
111. Rahman, M. (2006). A study on Coastal Water Pollution of Bangladesh in the Bay of Bengal. BRAC University, Dhaka, Bangladesh, 78
112. Ravindra, R. (2012). National Centre for Antartic and Ocean Research. Sci Acad 78, no3, India, 591-600
113. (2014). Report to the Maritime Safety Committee. IMO, London, United Kingom
114. (2013). Research at Sea. National Oceanography Centre, Southampton, United Kingdom Retrieved from: http://noc.ac.uk/research-at-sea

115. (2015). Revenue and Financial Reports. Motor Oil Hellas S.A., Greece.
Retrieved from: www.hoovers.com
116. (2006). Review of Maritime Transport: 2006. United Nations Conference on Trade and Development Secretariat, Geneva, Switzerland, 1-18
117. Rosenberg, D. (2009). The Political Economy of Piracy in the South China Sea. vol.62, no.3, Naval War College, Rhode Island, U.S.A.
118. (2015). Russia is the World`s Largest Producer of Crude Oil and Lease Condensate. U.S. Energy Information Administration, Washington, U.S.A.
119. Sakurai, T. (2013). The Fact Sheet of Anti-piracy Activities off the Coast of Somalia and the Gulf of Aden. Ministry of Defense, Tokyo, Japan
120. Sato, M. (1990). Thermochemistry of the Formation of Fossil Fuels, U.S. Geological Survey, Virginia, U.S.A., 271-282
121. (2013). Saudi Arabia: Revenue Watch Institution. Natural Resource Governance Institute, London, United Kingdom.
Retrieved from: http://www.resourcegovernance.org/our-work/country/saudi-arabia
122. (2014). Search Nace Codes. Central Statistics Office, Ireland.
Retrieved from: www.cso.ie/en/
123. (2003). Security in Maritime Transport: Risk Factors and Economic Impact. Maritime Transport Committee, OECD, Paris, France
124. (2014). Seismic Surveying 101. American Petroleum Institute, Washington, U.S.A.
125. (2008). Shareholders Structure. Hellenic Petroleum, Athens, Greece.
Retrieved from: http://www.helpe.gr/en/the-group/
126. Sharma, R.C., & Sharma, N. (2013). Energy from the Ocean and Scope of its Utilization in India. *Research India Publications*, *4*(4), India, 397-404
127. Skinner, S., & Reilly, W. (1989). The EXXON VALDEZ Oil Spill: A Report to the President. U.S. Coast Guard, Washington, U.S.A.
128. Slingenberg, A., Braat, L., Windt, H., Rademaeckers, K., Eichler, L., & Turner, K. (2009). Study on Understanding the Causes of Biodiversity Loss and the Policy Assessment Framework. Euroepan Commision Directorate-General for Environment, Rotterdam, The Netherlands
129. Sorensen, J. (2012). Terrorism in Violation of the Law of Nations. *Notre Dame Journal of International & Comparative Law*, *2*(2), Indiana, U.S.A.
130. Stopford, M. (2003). Maritime Economics. London, United Kingdom

131. Suleimanov, E., & Cerny, F. (2012). The Souther Caucasus Pipelines and the Caspian "Oil Diplomacy": The Issue of Transporting Caspian Oil and Natural Gas to World Markets", vol.11, No. 4, University in Prague, Czech Republic
132. Swenson, H. (n.d.). Why is the Ocean Salty?. US Geological Survey, Virginia, U.S.A.
133. Teague, O. (1975). Oil Transportation by Tankers: An Analysis of Marine Pollution and Safety Measures. Office of Technology Assessment, U.S. Congress, Washington, U.S.A.
134. (1999). The Future of the Global Economy: Towards a Long Boom?. OECD, Paris, France
135. (2006). The State of the Marine Environment: Regional Assessments. United Nations Environment Program, the Hague, The Netherlands
136. (2016). The 25 Biggest Oil and Gas Companies in the World. Forbes
137. (2009). The Report: Saudi Arabia. Oxford Business Group, Oxford, United Kingdom, 130
138. (2012). The State of Consumption Today. Worldwatch Institute, Washington, U.S.A. Retrieved from: http://www.worldwatch.org/node/810
139. Toomse, R. (2009). Piracy in the Gulf of Aden: Considering the Effects of Private Protection. Baltic Defence College, Tartu, Estonia, 6-7
140. (1982). United Nations Convention on the Law of the Sea: High Seas-Part VII. United Nations, New York, U.S.A.
141. (1992). United Nations Conference on Environment & Development: Agenda. United Nations, Rio De Janeiro, Brazil
142. Varhaug, M. (2016). Subsea Infrastructure. Oilfield Review, Schlumberger, Texas, U.S.A
143. Vassiliou, M. (2009). Historical Dictionary of the Petroleum Industry. no 3, 186–189, 472–474.
144. Vergragt, P. (2006). How Technology could contribute to a Sustainable World. Tellus Institute, Boston, U.S.A.
145. Veritas, D. (2001). Marine Risk Assesment. Health & Safety Executive, London, United Kingdom
146. Wang, H. (2000). The New International Regime of Liability and Compensation for Oil Damage: Status and Trends. World Maritime University, Malmo, Sweden
147. Wang, H., Huang, S., Liu, Z., & Zheng, L. (2012). Optimal Tanker Chartering Decisions with Spot Freight Rate Dynamics Considerations. Elsevier, Amsterdam, The Netherlands

148. Wang, X., & Economides, M. (2009). Advanced Natural Gas Engineering. Gulf Publishing Company, University of Houston, Texas, U.S.A., 42-46
149. (2014). Wave Energy: Technology Brief. International Renewable Energy Agency, Berlin, Germany, 3-14
150. (2016). What is a NACE Code?. Retrieved from: www.siccode.com
151. Whelan, J. K. (2004). When Seafloor meets Ocean, the Chemistry is Amazing. vol. 42, no.2, Woods Hole Oceanographic Institution, Massachusetts, U.S.A.
152. Wijnolst, N. (2009). Shipping Innovation: Niko Wijnolst tor Wergerland. Delft University Press, Amsterdam, The Netherlands, 98-120, 436-448
153. Wolfrum, R. (2006). Fighting Terrorism at Sea: Options and Limitations under International Law. University of Virginia, U.S.A.
154. (2013). World Energy Resources: 2013 Survey. World Energy Council, London, United Kingdom
155. (2015). World Report: Events 2014. Human Rights Watch, New York, U.S.A.