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Exploring the Plausible Impacts of Increasing Commercial Transportation of Liquid Bio-Fuel on the Tanker Market

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ABSTRACT

In the challenges of energy security, climate change and raising fossil fuel prices, the world is committed to finding solutions to address these problems. As a result, there have been considerable efforts aimed at sustainable development of bio-fuel to compliment fossil fuels. An example is European Union policy target to achieve a 10 % usage of liquid bio-fuel in the road transport sector by 2020. Due to such policy implementation, international liquid bio-fuel trade in the coming years is projected to grow considerably. This is as a result of trade imbalances among countries. The paper adopts open-ended questionnaire, to explore the likely impacts that the increasing commercial transportation of bio-ethanol and bio-diesel will have on the tanker market. The survey reveals that, the impact rests on factors within and outside the market mechanics of the shipping industry.

Keywords: bio-fuel, bio-ethanol, bio-diesel, shipping, tanker market

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DEFINITIONS

Afromax: Tankers with GT between 38,000 to 57,000

Bio-mass: Any renewable energy source such as wood, waste or alcohol fuel

Chemical tanker: A ship constructed or adopted for the transportation of liquid cargo in bulk listed in chapter 17 of the IBC code

Chemical/oil tanker: A tanker used in the transportation of chemicals and clean petroleum products

Coaster: Tankers with GT between 480 to 9,600

Crude oil tankers: Tankers used in the transportation of crude oil

Dwt (Deadweight): Amount of weight a ship can carry without riding dangerously low in the water.

GT (Gross tonnage): A ship overall internal volume.

Handy-size: Tankers with GT between 9,600 to 24,000

IBC Code: International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk

IMO: International Maritime Organisation

IMO II: International Maritime Organisation Type II ship

IMO III: International Maritime Organisation Type III ship

IMO I, II, III: International Maritime Organisation Type I, II and III ship

IMO II, III: International Maritime Organisation Type II and III ship

IMO I, III: International Maritime Organisation Type I and III ship

In service: Ships that are in use

Keel laid: Ships at the initial stage of construction

LPG tanker: A tanker used in the transportation of liquefied natural gas

MARPOL: International Convection for the Prevention of Pollution from Ships

NLS (Noxious liquid substances): Any substance indicated in the Pollution Category Column of chapter 17 and 18 of the International Bulk Code or previously assessed under the regulation as falling into category X, Y, Z

Oil product tanker: Tankers used in the transportation of clean petroleum products

Oil product/chemical tanker: means a tanker used in the transportation of clean petroleum products and chemicals

Panamax: Tankers with GT between 24,000 to 38,000

Suezmax: Tankers with GT between 57,000 to 96,000

Tanker: A ship or vessel used in the transportation of liquid cargo in bulk

Type II ships: A chemical tanker intended for the transportation of chapter 17 products, of the IBC code with appreciably severe environmental and safety hazards

Type III Ships: A chemical tanker intended for the transportation of chapter 17 products of the IBC code with sufficiently severe environmental and safety hazards

ULCC (Ultra large crude carrier): Tankers with GT between 153,000 to 268,000

VLCC (Very large crude carrier): Tankers with GT between 96,000 to 153,000

W.O.C: Without any IMO classification, as used only in this paper

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EXECUTIVE SUMMARY

Bio-ethanol and bio-diesel with its low emission of green house gases such as CO_2 and its renewable nature has shown to have great potential for the road transport sector hence, it increasing production. A research by International Energy Agency (2008) reveals that the production of bio-fuel energy is expected to increase from 11% to 14% by the year 2030. DNV (2010) also predicts a yearly bio-ethanol and bio-diesel trade by 2020 will be: 154 billion liters for bio-ethanol and 67 billion liters for bio-diesel.

There have been researches on bio-ethanol and bio-diesel, but there has not been much research on its increasing commercial transportation in relation to the shipping industry. Thus, this paper *investigates how the increasing commercial transportation of bio-ethanol and bio-diesel would impact on the existing tanker market*. The focus is on the tanker segments, since bio-ethanol and bio-diesel are considered as liquid bulk in their transportation. *To answer the question "How would the increasing commercial transportation of liquid bio-fuel affect the tanker market in relation to freight rates, capacity, and standards and regulations?"* The paper adopts an open-ended questionnaires answered by players in the shipping industry namely Tanker ship owners, Ship brokers involved actively in liquid bulk, Classification societies and Maritime organizations to support the analysis. 20 participants were selected from Sweden, Denmark, Norway, The United Kingdom, China, and The United States of America. The analysis is based on competition for capacity with existing products of the same categories, freight rates and standards and regulations of the liquid bulk shipping market.

Results from the questionnaire

- Do you see a future for increasing commercial transportation of bio-fuel? Yes (100%)
- Do you think there would be increased competition in the tanker market through an increasing commercial transportation of bio-fuel? No (100%)
- Do you think the increasing commercial transportation of bio-fuels would have an impact on freight rates in the tanker market? Yes (66.7%), No (33.3%)

- Are you concerned that the increased commercial transportation of bio-fuel may require changes in the current safety and fire standard, and MARPOL Annex I and II regulation? Yes (17%), No (83%)

DNV (2010) predicts a yearly approximated production of 154 billion litres of bio-ethanol and 67 billion litres of bio-diesel by the top 14 bio-fuels producing countries by 2022. Research conducted by Market Research Analyst (2008) presents projected figures for bio-ethanol and bio-diesel from 2008 to 2012, an analysis of the figures shows that the projected figures from 2008 to 2010 fall within actual world production. The tanker market is flexible in terms of supply of tonnage hence; Type II and III tankers have a very high potential threat of entry from tankers under construction, NLS tankers without IMO classification and other tanker such as crude tanker. Among the substances listed in chapter 17 and 18 of the IBC code, in the last decade only bio-ethanol and bio-diesel has recorded increases in their commercial transportation. Freight rate in the shipping industry and the NLS tanker market is as a result of the interaction between demand and supply. Stopford (1993) stated that the charter market is a very competitive place where freight rate can drastically change anytime depending on the supply and demand for shipping capacity. The industry has become used to frequent changes in its standards and regulations, hence should there be any changes to its standards and regulations due to commercial transportation of bio-ethanol and bio-diesel, no impact will be felt in its operations but even if any marginally. The tanker industry is used to adapting to changing regulations by conversions or ordering of new ships in accordance with the new specifications.

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CHAPTER ONE: INTRODUCTION

This first chapter aims to introduce the reader by providing a background of the proposed study, problem discussion, research objective and question that the authors seek to address, and finally a thesis structure to the remaining chapters of the thesis.

1.1 Background of the study

In the challenges of energy security, climate change and raising fossil fuel prices, most industrialized countries have to a significant degree committed to the Kyoto protocol. The main policy objective of the Kyoto protocol is to reduce environmental pollution (International Center for Trade and Sustainable Development, 2008). As a result there have been considerable efforts aimed at the development of sustainability criteria for bio-fuel; both within regions and in the context of international trade. With low emission of green house gases such as CO_2, its renewable nature, and the ability to improve the living standard of people in rural communities (International Center for Trade and Sustainable Development, 2008), the use of bio-fuel energy is expected to grow considerably (Bradley *et al*, 2009). According to International Energy Agency (IEA, 2008) with appropriate policies, bio-fuel production is expected to increase from 11% to 14% by the time 2030.

Bio-fuel is basically a wide range of fuel derived from bio-mass. The term covers solid bio-mass, liquid fuels and various gases. Some examples of bio-fuel include wood, oil from plants and manure from cows. Specifically solid bio-fuel includes products like wood pellets, torrefied wood, grass pellets and bio-carbon. While liquid bio-fuel includes refined products like bio-ethanol, bio-diesel, pyrolysis oil and vegetable oil, with anaerobic digestion and landfill gas constituting gaseous bio-fuel (Bradley *et al*, 2009).

The introduction above is just to give an insight into bio-fuel. However the paper will now focus on liquid bio-fuel (bio-ethanol and diesel) as fuel in the road transport sector. The motivation for this choice can be read in the problem discussion page 7. According to United Nations Economic Commission for Africa (2008), bio-ethanol is an alcohol produced from the fermentation of sugar contained in plants that are rich in sugar such as beets, sugarcane, etc. or in starch like cereals and cassava, through the action of micro-organisms, yeast and bacteria. Bio-diesel on the other hand is famous in Europe. According to Bradley *et al.* (2009) bio-diesel is a type of bio-fuel that is produced by processing vegetable oils or animal fats. The images below show ethanol made from maize and bio-diesel.

Figure 1.1: Bio-ethanol

Figure 1.2: Bio-diesel

1.1.1 History of liquid bio-fuel

The usage of ethanol and hemp oil as transportation fuel has been in existence in the USA since the 1908s with the development of Ford Model T, which could be modified to run on either gasoil or pure alcohol. With this invention, Henry Ford was able to create partnership with natural oil companies, with the notion that bio-ethanol and bio-diesel were the future fuels. Thereafter ethanol was well used into the 1920 and 1930s to fuel cars, alongside an effort to sustain a United States ethanol program; however this program failed (United Nations Economic Commission for Africa, 2008). According to United Nations Economic Commission for Africa (2008) oil-based fuels became popular in the road transport sector in the 1930s. But following the first oil shock in 1973, Brazil and the United States started to look for ways of diversifying their energy sources. As a result they launched ambitious bio-ethanol production programmes to blend bio-ethanol with petrol used in the transport industry. Ethanol production in the United States during the 1970 grew from 175 million gallons to 1.4 billion gallons in 1988. This was made possible through the supports from the federal and ethanol tax subsidies; and the usage of high oxygen gas oils. Unlike after the 1973 oil shock where USA and Brazil were the only nations actively involved in liquid bio-fuel, today world liquid bio-fuel trade includes countries such as Sweden, Finland, Norway, UK, Belgium, Canada, and the Netherlands. Their uses include heating, electricity and primarily as transport fuel for road engines (United Nations Economic Commission for Africa, 2008).

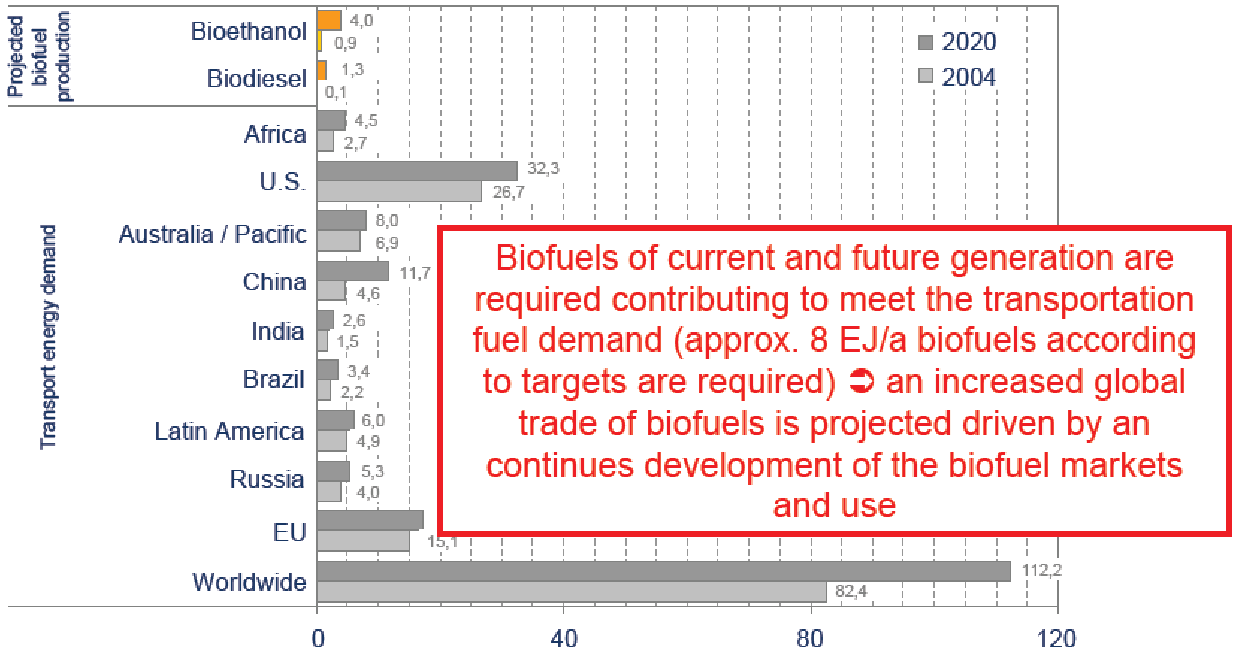
1.1.2 Evolutional development of liquid bio-fuel

Evolutional development in the production of liquid bio-fuel includes 1st, 2nd, 3rd and today we speak of 4th generational bio-fuel. 1st generational bio-fuel such as bio-ethanol and bio-diesel are made from human consumable products such as starch, vegetable oil, sugar and animal fat using conventional techniques. Problems associated with these types of bio-fuel is that, their inputs are still in the food chain. As a result they could raise the prices of food. Examples of these 1st generations of bio-fuel include E10, E100 and E85 for bio-ethanol and B100, B5 and B2 for biodiesel. To solve the problem of using products already in the food chain, 2nd generation bio-fuel was developed. These are made from non food crops and inedible wastes, chiefly among them include cellulosic materials. In this way there is no direct competition for food crops, but the competition for land and water for growing them still remains. Some examples of these include tropsch diesel and cellulose ethanol. Both 3rd and 4th generation of bio-fuel are attempts to further reduce competition for land with human crops by planting algae which has been identified to be a very high efficient crop, and also through various gasification processes (IEA, Dec 14 2009 & Joshua Kagan, 2010).

1.1.3 Liquid bio-fuel trade

According to FO Licht *et al.* (2004), about 700 million liters (4.4 million barrels) of ethanol were traded internationally in the year 2004, less than 20 % of the overall traded volumes domestic and international and a relatively low figure given the market potentials. Tradable liquid bio-fuel today still constitutes 1st generation, at least in very significant quantities awaiting the breakthrough of the others. Furthermore 2nd generation is argued to have a better chance of reaching world trade soon (Bradley *et al*, 2009). The figure below shows the projection of transportation fuel demand till 2020.

Figure 1.3: Projection of transportation fuel demand till 2020



Transport energy demand vs. (projected) bio-fuel production (EJ/a)

Source: (Franziska Muller-Langerc *et al*, 2008 p 3)

From the figure above it can be deduced that, the current production of bio-ethanol and bio-diesel both local and international is far behind the quantities required to complement the projected road transport fuel demand. With the development and implementation of policy measures by countries seeking ways to lessen the adverse impact of higher oil prices on national economies as well as mitigate climate change through initiatives such as Kyoto protocol, EU Bio-fuel Directive and the US Oxygenated Fuels Program (Nyberg, undated), international bio-ethanol and bio-diesel trade is expected to grow considerably in the coming years given the divide between countries with comparatively low production costs, and countries with the greatest demand for it (International Center for Trade and Sustainable Development, 2008). The diagram below shows the key demand and supply areas of bio-fuel with their shipping route.

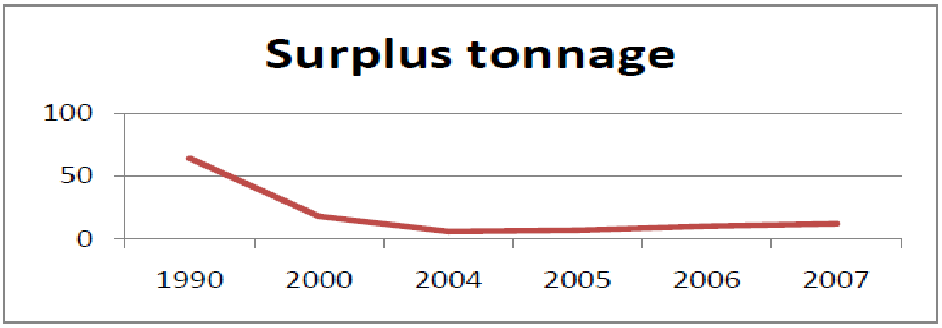
Figure 1.4: The diagram below shows the key production areas and current shipping route of liquid bio-fuel.

Source: (Bradley *et al*, 2009 p 29)

1.1.4 Shipping of liquid bio-fuel

Ensuring this international trade of liquid bio-fuel is only made possible through the shipping industry, particularly the liquid cargo in bulk market segment as the main method for international transportation. In the years from 2004 to 2007, world shipping volume increased almost 5% annually. However shipping capacity growth was not enough to handle demand. In 1990, an average of 9.7% shipping capacity was in surplus as shown in figures 2 and 3 below. However, this surplus slipped to 2.2% by 2000 and to 0.7% by 2004-05. Indicating that world fleet was operating at full capacity (Bradley *et al*, 2009).

Figure 1.5: world surplus tonnage



Source: (Bradley *et al*, 2009 p 20)

Figure 1.6: Tonnage oversupply in the world merchant fleet-selected years

	1990	2000	2004	2005	2006	2007
World Merchant Fleet	658	808	896	960	1042	1118
Surplus tonnage	64	18	6	7	10	12
Surplus % of total	9.7%	2.2%	0.7%	0.7%	1.0%	1.1%

Source: (Bradley *et al*, 2009 p 20)

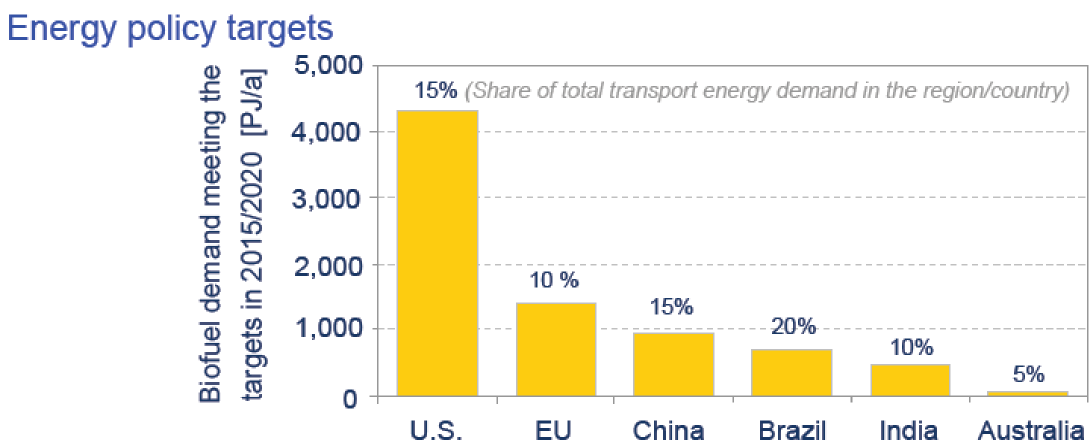
Based on a five years booming manufacturing, the shipping industry was operating on its optimum capacity before the hit of the financial crisis. Under these conditions there is intense competition for shipping space, and prices also tend to spill out of control as it happened between 2006 and 2007.

Stopford (2009) explains that ship economic cycles are determined by the continuous adjustment for demand and supply for shipping services, where demand is directly related to the world economy along other factors such as the supply of vessels, fleets productivity, shipbuilding and scrapping. As the global economy gradually picks up again, the implications for the shipping industry are very significant regarding the increasing commercial transportation of liquid bio-fuel s, particularly bio-ethanol and bio-diesel. According to Sadler (2008) shipping will still be at the heart of the supply chain of transporting bio-fuel be it 1^{st}, 2^{nd}, or 3^{rd} generation.

1.2 Problem discussion

The usage of bio-ethanol and bio-diesel to compliment fossil fuel in the road transport sector is expected to grow considerably, as research continues to prove them as a sustainable energy source. Today bio-ethanol and bio-diesel take up 3% of the world road transport fuel but expected to reach 27% by 2050 (IEA, 2010). The table below shows the share of total transport energy policy target of bio-ethanol and bio-diesel in various countries.

Figure 1.7: Share of total transport energy policy target of bio-ethanol and bio-diesel in various countries



Source: (Franziska Muller-Langerc *et al*, 2008 p 4)

In the wake of these occurrences, there would undoubtedly be an increased commercial transportation of bio-ethanol and bio-diesel, which will in effect place new demands on the shipping industry. In view of this happening, it is worthwhile to study the shipping industry but more specifically that part of the industry which is directly involved in their transportation.

There are many researches on bio-ethanol and bio-diesel, but there has not been much research on its increasing commercial transportation in relation to the shipping industry. In view of these, this research serves as a stepping stone, focusing on exploring the likely impacts an increasing commercial transportation of bio-ethanol and bio-diesel will have on the shipping industry. Specifically the tanker segments, since bio-ethanol and bio-diesel are considered as liquid bulk in their transportation.

The discussion is based on competition for capacity, freight rates and standards and regulations of the liquid bulk shipping market.

The authors seek to explore these plausible impacts by questioning players in the shipping industry, namely Tanker ship owners, Ship brokers actively involved in liquid bulk, Classification societies and Maritime organizations to support the theories used in their analysis.

1.3 Research Objective & Question

The objective of this paper is to *investigate how the increasing commercial transportation of bio-ethanol and bio-diesel would impact on the existing tanker market*. This paper is analyzed based on market freight rates, capacity and how standards and regulation within the market could be affected. Our motivation for having our analysis based on these factors is that, the increasing commercial transportation of bio-ethanol and bio-diesel will require some capacity. In this light, it will be interesting to investigate if the rise of this new trade will affect capacity in the tanker market, which will intend affect freight rate. We also wish to see if the regulations for operating in the tanker market will require some changes. With our objective, we thus formulate our research question as:

> *How would the increasing commercial transportation of liquid bio-fuel affect the tanker market in relation to freight rates, capacity, and standards and regulations?*

With this research question, the authors aim to explain how the shipping industry, especially the chemical and the product segment of the tanker market will be affected (freight rates, capacity and standards and regulation) through the increasing commercial transportation of bio-ethanol and bio-diesel.

1.4 Limitations of the study

As stated above, there are different types of bio-fuel, among them includes green diesel, bio-gas, bio-ethers, bio-ethanol, bio-diesel, torrefied woods etc. But for the reasons stated in the problem discussion, this study will only focus on bio-ethanol and bio-diesel. The focus of this paper is on the general chemical and product tanker segments of the shipping industry. This is as a result of data constraint on specific bio-ethanol and bio-diesel trade as well as specific location's freight rate. The analysis on the standard and regulation will only reflect the views of the respondents used in the survey. This is because we do not want to go into the technical aspects involved in structuring the standards and regulations, as it is not within our field of study.

1.5 Thesis Structure

This thesis is organised into seven chapters, which are outlined as follows:

- The first chapter of this thesis is an introduction which provides a background into the topic of study. The problem discussion gives the reader an insight to the rationale and importance attached to the study of the topic. Then the objective for which this research is undertaken is discussed and the question needed to fulfil the research is also presented. This chapter ends with a presentation of the thesis structure on what the other five chapters entails.

- Chapter two outlines the methodological approach taken by the authors to collect data for the thesis, which involves primary and secondary data sources. The chapter also talks about the evaluation of the research design and the method in relation to the ethical issues of validity, reliability and transferability of the results from the study, and finally concludes with a description of the survey.

- Chapter three provides an overview and discussions on the relevant literatures and theories significant to the thesis.

- Chapter four entails a presentation of data from the research participants collected for the study.

- In chapter five, the theories and the relevant literatures are analyzed against the results from the participants and conclude with findings from the analysis.

- Chapter (six) brings the thesis to a close with a conclusion and recommendations on the study and a discussion of the thesis's contribution to research and finally ending with suggestions for future research on the subject topic.

CHAPTER TWO: METHODOLOGY

The aim of this chapter is to present the approach and the relevant methods used in the collection of data to answer the research question of this paper.

In this chapter we start with the definitions of relevant methods use in research. After we present our chosen methods, describe how our survey is conducted and finally give an account of the credibility of this study.

2.1 Research design

Blumberg *et al* (2008) explained research design as the blue print for fulfilling the objective and answering the questions of a proposed research. It was further explained by Blumberg *et al,* as carefully selecting and following methods that will enable the attainment of the research objective. However they also admitted selecting a design for a research may be complicated and time consuming resulting from the large availability of methods, techniques and sampling plans. Yin (1989) describes a research design, to deal with the logical problem and not the logistical problem of a proposed research.

According to Blumberg *et al* (2008), there are many definitions of research designs but none of them impacts the full range of its importance. One notable definitions observed in their book is that: A research design entails collecting, measuring and analyzing data. This helps researchers in the allocation of their limited resources, by posing crucial choices. Exploratory and formal studies are the two mentioned as major classification of research design.

2.1.1 Exploratory study

This type of study is particularly useful in a new field of study, where existing knowledge and ideas of problems that are likely to be encountered are lacking. Through exploration, researchers are able to develop concepts more clearly, establish priority, develop operational definitions, and also bring out other interesting areas of study. Exploratory studies are aimed to answer *why* questions by developing causal relationships between or among variables studied. An exploratory study is finished when it has served the following objectives: established the major dimension of the research task, defined a set of subsidiary investigative questions that can be used as guideline to a detailed research design; develop several hypotheses about the possible cause of a management dilemma, learned that certain hypothesis are much more remote and thus can be ignored, and conclude that additional research is needed or otherwise (Blumberg *et al*, 2008).

2.1.2 Formal study

A formal study on the other hand is in direct contrast to an exploratory study. Formal studies according to Blumberg et al (2008) are well structured with clearly stated hypothesis or investigative questions, which are usually conducted after exploratory studies. A formal study serves the purpose of describing a phenomenon or an item associated to a population, estimating the proportion of the population that have this characteristics or even discovering of the association among this variable (Blumberg *et al*, 2008).

2.2 Research Approach

Hyde (2000) explains that there are three distinctive ways of creating, developing and collecting knowledge in the research field. These are namely inductive, deductive and adductive approach. Basically, deductive or inductive approach is determined by how the research was started. Whether it started with an observation in the reality or with a hypothesis derived from theories.

According to Saunders *et al.* (2007, p 117) in Fenalai & Mohnata, (2010) "deductive approach to research is where a theory or hypothesis is developed and a research strategy is designed to test the theory". Also Jacobsen (2000) stated that, this is where new hypothesis developed from theories are proved of their validity through empirical data testing. However Jacobsen (2000) in Channan and Tian (2009) argues that, though deductive method is a very useful tool in quantitative studies, it only tests the hypothesis that the researcher believes in, thus, anything outside the scope is difficult.

Clara & John (2005) explain inductive approach studies, as one in which no theoretical study is required before the research. Rather the theories are gathered or developed based on the structure and pattern of the empirical data studied. Strauss & Corbin (1998, p. 23) also explain "inductive approach as one in which results are arrived from observation of phenomenon and theories based on the phenomenon studied".

Adductive approach to research according to Blumberg *et al* (2008) is when both inductive and deductive approaches are used in a research study. Kovacs and Spends (2005), argues that adductive approach can be useful only when the researcher has examined the present phenomenon and tries to explain things from a creative point of view.

Based on the work of Arbnor & Bjerke (1997), business scientific research can be broadly grouped as analytical, system and actor approach. Analytical approach is when the entire work is a sum of the various parts. Thus the whole can be explained as long as the various parts are together. On the other hand, system approach is not the sum of the various parts. According to Clara & John (2005) analytical approach looks for causality relationship in problem solving but system approach looks for a force that influences that system. Lastly actors approach means that the whole only exists in the observers mind. Arbnor & Bjerke (1997) describes it as a social construction depending on the social mix of actors.

2.3 Strategies of inquiry

Creswell (2009), explained strategies of inquiry as models or different kinds of qualitative, quantitative or mixed methods which provides guidance in relation to procedures of research design. Mertens (1998) in Fenalai & Mohnata (2010), on the other hand describes strategies of inquiry as the research methodology.

2.3.1Qualitative method

Strauss & Corbin (1998) describes qualitative method as any type of research that arrives at findings without any statistical procedures or other means of mathematical methods. Hardy & Bryman (2004), also explains qualitative method as one in which a large amount of data and information is collected, which in the ends could leads to information overload. Creswell (2009) also states that qualitative research follows patterns like Grounded theory, Ethnography, Phenomenological Narrative research and case studies.

2.3.2 Quantitative method

Creswell (2009) explains that this type of research requires the study of trends, altitudes and options. Experimentation is also needed in gathering and analyzing data collected. This type of method is argued to be single and requires a particular subject (Cooper *et al,* 1987). Basically this type of method is characterized by equation models. Muijs (2004, p 1) defined quantitative research as "exploring phenomenon by collecting numerical data that are analyzed using mathematical based methods".

2.3.3 Mixed methods

Transformative, concurrent and sequential are some examples of mixed methods of inquiry strategies. The source of this method can be trace back to Campell and Fish (1959) in Fenalai & Mohnata, (2010), when they first used multiple approaches for data collection. Basically this method involves a combination of observation and or interviews (qualitative data) with traditional survey (quantitative data).

2.4 Methods to gather data

This represents a tools by which data is collected, analyzed and interpreted in a manner that is advocated by the researchers for the purpose of their work using either quantitative, qualitative or both (Creswell, 2009). This involves tools such as questionnaires, interviews, observation, and or a combination of any of these tools.

2.4.1 Questionnaire

Blumberg *et al* (2009) states that questionnaires could either be structured or open-ended type. Generally a questionnaire is a set of constructed questions that are to be answered by a sample group called respondents, and approved by the author. Whereas standard questionnaires involves standard list of questions covering all or important aspects of the research topic, with options to choose from, open-ended questionnaires requires the respondent to write and describe their responds in words.

The strength of questionnaires include: quick and ease of achieving data, information can be gathered in a short period of time, may not require trained respondents, can be carried out on field at the convenience of the respondent, and it is relatively less expensive. Better yet, the weak sides of questionnaires are that: they most often than not need follow ups; they can be very difficult to construct and to extract the needed information, and response may be incomplete (Blumberg *et al,* 2008).

2.4.2 Interviews

This is a two way conversation usually initiated by an interviewer to obtain information form a participant, where the difference between the interviewer and the participant is clearly pronounced. Usually personal and telephone interviews are the two mostly used in surveys. The greatest value of this method lies in the depth of information and details that can be secured within a very short period, with a knowledgeable participant. This is even stronger with personal interview as the interviewer can ask a lot of follow up questions for clarification. The interviewer can also take note of the condition of the interview. Despite these advantages they are usually expensive and time consuming, especially in the case when the participants are hard to get and the research cover a very wide geographical area (Blumberg *et al,* 2008).

2.4.3 Observation

Observation qualifies as a scientific method of inquiry when it is systematically planned and executed to answer a research question, which in the end provides a valid and reliable account of what happened. The versatility of observation makes it an indispensable primary data source and a good supplement to the other methods, but has been relegated as a minor method due to limited academic perception about the method. Observation could be carried out as either non behavioural which involves record analysis or behavioural which has do with body movement, motor expressions or even exchanged glances. However like interviews observation can be very expensive and time consuming when the factors to be observed are many and are spread over a wide geographical area (Blumberg *et al.* (2008).

2.5 Primary and Secondary data sources

Two sources for data collection are used in research, these are primary and secondary. Primary data are data collected by the investigators conducting the research. According to Bryman and Bell (2007) secondary data is the information or data that has been collected and recorded by someone else, usually for other purposes. The common sources of secondary data include censuses, surveys, organizational records and data collected through qualitative methodologies or qualitative research.

2.6 Evaluation of research design and method

Certain criteria exist in order to evaluate a qualitative research. These include the issues of reliability, validity and transferability.

2.6.1 Validity

Finn *et al.* (2000) defines validity as the use of a measurement instrument and whether or not it measures the purpose it is set out for. Thus, the issue of validity encompasses the entire experimental concept and establishes whether the results obtained from a study meet all of the requirements of the scientific research method. Validity can be distinguished between internal and external validity. According to Bryman and Bell (2007) internal validity addresses the "true" causes of the results that one has observed in a study while external validity addresses the ability to generalise the study to other individuals and other circumstances.

2.6.2 Reliability

Joppe (2000 p 1) in Golafshani (2003) defines reliability as "... the extent to which results are consistent over time and an accurate representation of a total population under study. If the results of a study can be reproduced under a similar methodology, then the research is considered reliable" (Golafshani, 2003). Also, Kirk and Miller (1996; pp. 41-42) identify three types of reliability situations: the degree to which a measurement given repeatedly remains the same, the similarity of measurement within a given time period and the similarity of measurement within a given time period. A reliable data input is vital to ensure consistency in the measurement of a study. To achieve this, the same questions were answered by all the participants of the study.

2.6.3 Transferability

Transferability in research refers to the degree to which the results obtained from a qualitative research can be transferred to other contexts. From a qualitative perspective the issue of transferability is primarily, the responsibility of the person generalizing the findings. The goal of qualitative research is transferability, thus the ability to transfer the results to similar settings (Bryman and Bell, 2007).

In a summary, the issues of validity, reliability and transferability are necessary to discuss in qualitative research since social phenomenon is not static and can be viewed differently depending on the existing situation. It is necessary to note that the principles of validity and reliability are fundamental cornerstones of scientific method and internal validity and reliability are at the core of any experimental design (Patton, 2002).

2.7 Chosen methods

To effectively serve the research objective, which is how the increasing commercial transportation of bio-ethanol and bio-diesel could affect the tanker market? We adopted the exploratory research design. This is because the paper looks into a relatively new concern in the shipping industry (increasing commercial transportation of bio-ethanol and biodiesel), with limited research on how the market could be affected. As a result this paper investigates whether the shipping industry (tanker market) will be affected in terms of freight rate, capacity and standards and regulation. Based on this motive, this study hopes to achieve all the parameters as stated by Blumberg *et al.* (2008) on the expectations of an exploratory study.

The research approach used in answering the research question is deductive. The research started with a general study of both the world bioefuel market and the shipping industry. But particularly liquid bio-fuel and liquid cargo in bulk market segment respectively, where we looked into trends and pattern of trade. Based on the data and information obtained, we gathered theories from Business and Economics to analyze our research question. As stated the approach is from the general to the specific: bio-ethanol and bio-diesel and the tanker market, particularly chemical and clean product tanker market segment. The research also intends to give a strong link between the reasons stated and the conclusion. Regarding the classification made by Arbnor & Bjerke (1997), this thesis can be grouped under analytical as the researchers look for causal relationships in answering their research question.

Qualitative method was adopted as our strategy of inquiry. This is because we wish to pass our experiences based on this paper to our readers on the topic at hand (Strauss & Corbin, 1998). Also the design of the paper being exploratory is another reason why qualitative method was adopted in this paper. This is because qualitative method will enable us to find out the reasons behind the outcome of our research, as it often provides more information than quantitative. Again qualitative method comes in as a requisite in answering our research question as it will enable us to follow through systematically to the end of the research giving us a deeper understanding of the subject matter.

Regarding data sources both primary and secondary data were adopted in this thesis. The primary data for this thesis has been obtained through questionnaires, which were answered by the respondents involved in the study and information about ships from the IHS Fairply World Shipping Encyclopaedia. Secondary data information utilised in this study includes research from existing literature based on bio-fuel, the shipping industry, and the liquid bulk market among others. These literatures are obtained from books, journals, articles, information and news from bio-fuel, renewable energy, shipping market websites among others. We used this source of primary data because it provided us with first-hand information from actors in the industry. Since these actors cannot give us all the information we need in this research, we supported it with some secondary data.

Due to the busy working condition of the participants involved in the study, an interview was difficult to arrange, although an interview would have been very good for a study of this kind. To still meet the objective of this thesis, without compromising on the quality of the research, the researchers choose to use open-ended questionnaire to gather data from their respondents. The motive behind the method is that, the respondent will have the liberty to justify their answers. In our attempt to reduce non response error, we constructed 10 broad questions divided into sub categories, relating to the main areas of our research: freight rates, competition and regulation. However owing to the time consuming nature of answering this type of questionnaire as they required detail and expect information of the questions asked, the effect is that the responses are usually reasonably low compared to quantities needed to make a quantitative study but sufficient enough for a qualitative analytical study.

2.8 The survey

The participants of our survey included organizations in the shipping industry, particularly the tanker market segment because of their direct involvement in the transportation of bio-ethanol and bio-diesel. They include Shipbrokers, Tanker owners, Classification societies and other Maritime organization.

Ship brokers were selected as part of our survey group because of their direct involvement in the activities in bulk trade, for which the tanker market forms part. In our survey, we focused on tanker ship brokers. They specialise in chartering of tankers, negotiate maritime charter parties and study the market in terms of demand and supply source. Their main responsibility is to be intermediaries between ship owners and charterers who use ships to transport cargos. As a result they have good knowledge of the tanker market.

Tanker owner were also selected because they provide shipping capacity used in the transportation of cargo. For this group of actors, their main aim is to provide shipping capacity. As a result they are concerned about demand source, and freight rates. This is because a good freight rate means they will be able to cover the cost of transportation as well as make some profit.

Classification societies and Maritime organisations are non-governmental bodies that establishes and maintain technical standards for the construction and operations of ships and offshore structures.

To increase the reliability of the data collected and also deal with the effects of low response rate of open-ended questionnaire, we carefully selected our participants by placing very strict emphasis on the fact that, they are directly involved with bio-ethanol and bio-diesel in their niche areas of business. Concerning ship brokerage firms, preference was given to companies with personnel's having specific knowledge in bio-ethanol and bio-diesel trade. Regarding Tanker shipping companies, we choose those who have the appropriate certification to transport bio-ethanol and bio-diesel. It is explained in the theoretical background which tankers can transport bio-ethanol and bio-diesel. For that of classification and maritime organizations we choose those who have made some research and published some articles about the growing bio-ethanol and bio-diesel trade. Examples of such companies include DNV and Fairplay. The motivation for this critical selection is to ensure that, we get in-depth information from our respondents in other to answer our research question.

Based on our criteria for each group, we selected 20 participants basically from Sweden, Denmark, Norway, The United Kingdom, China, and The United States of America. This is because we did not want to limit the coverage of the survey to one geographical area. The choice of the countries is motivated by the availability of the participants that met our criterion. The table below shows the number of participants selected for such group and their countries.

Table 2.1: Participants selected for such group and their countries for the survey

Group	Number	Countries
Tanker owners	6	China, Denmark, Sweden
Ship brokers	9	Denmark, Norway, Sweden, United Kingdom
Classification and maritime organizations	5	Sweden, United Kingdom, United states

The questionnaire was carefully drafted after reading articles and text books. This is to ensure that the topic was well understood, and also to construct very relevant questions that will enable us to extract the needed information from our respondents in other to serve the purpose of this thesis.

To reduce cost and also easily reach our targeted participants, we adopted the web based survey system. In the beginning we sent the participants' emails requesting their companies to help in a survey by answering a questionnaire. 8 of the participants replied pledging to contribute to the survey while the other 12 did not reply to our mail. Out of the 8 that replied, 3 were Tanker owners, 3 were classification and maritime organisation and the other 2 were ship brokers.

In the second stage we sent them the questionnaire, due to the fact that the questions were open-ended and critical in nature, we dedicated one month in the data collection process. We completed and sent them in the first week of the one month, giving companies enough time to get back to us. The motivation is that we do not exert unnecessary pressure on the companies to reply to us, so they can get time to deal with their responsibilities as well as find enough time to attend to the questionnaire. In effect, this means that the response can be argued to be a sound feedback of the respondent.

Within the one month period, we made an average of 5 calls and sent 6 emails to each of the participants that promised to answer the questionnaire as follow ups to the questionnaire.

In the end, we received 6 responses to the questionnaire. Out of the 6 responses received, 3 came from Tanker owners in Sweden and Denmark in the ration 2:1. The other 3 responses came from Classification and Maritime organizations in Sweden and United Kingdom in the ration 2:1. The responses came from Head of Chartering for Tanker owners and senior researchers for Classification and Maritime Organizations.

2.9 Quality and Credibility of the research

Regarding the issues of validity, reliability and transferability, we give an account of how the research was conducted.

The research process is organised in such a way that, we were in constant communication with our supervisors, who are working on similar topics as Established Researchers. By this, they ensured we used relevant literatures and also focussed on our research questions. We also communicated back with the respondents of our survey for clarifications on any ambiguities in their responses. The fact that the study was carried out by two authors also means the study does not lack insightful evaluations from a variety of sources. As a result, based on how the research process was organised, we believe the result is reliable.

Gillham (2000) explains that solid validity calls for adequate theorizing, our research is not based on a single respondent, but on a cross sectional analysis of the survey as well as references to the theories used in the study. The limitations on this study also further strengthen the validity of this paper as it narrows the scope of the study.

Silverman (2005) explains that social representativeness goes beyond the limits of statistical representativeness in the sense that, it aims to observe a phenomenon extensively. This extensive study hopes to provide a deeper understanding of the phenomenon, so that the researcher is able to transfer the knowledge to other cases of the same kind. In our case after questioning the respondents used in our survey, we believe other Tanker companies, Ship brokers; Maritime and Classification societies who did not take part in this survey will yield averagely the same response as the one we had on our survey.

CHAPTER THREE: THEORETICAL BACKGROUND

The aim of this chapter is to present the relevant literatures and theories that can be used to evaluate freight rate, market competition and standards and regulations pertaining to the shipping industry. This is by highlighting on different evaluations which will assist further when analyzing the area of study.

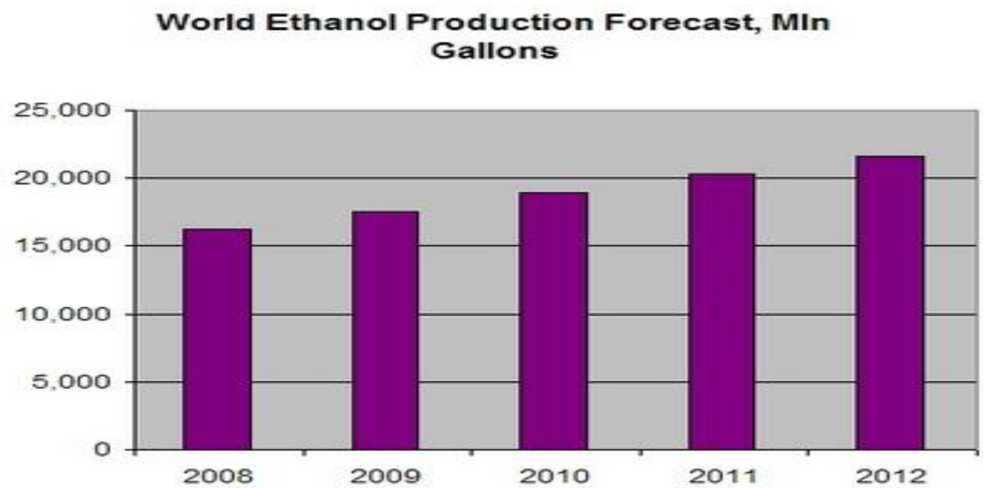
In this chapter, we present some data about ethanol and bio-diesel production and forecast about future trade. A description of the shipping industry is given, particularly the tanker market in terms of available capacity in the transportation of bio-ethanol and bio-diesel, and finally some theories that will be used in the analysis.

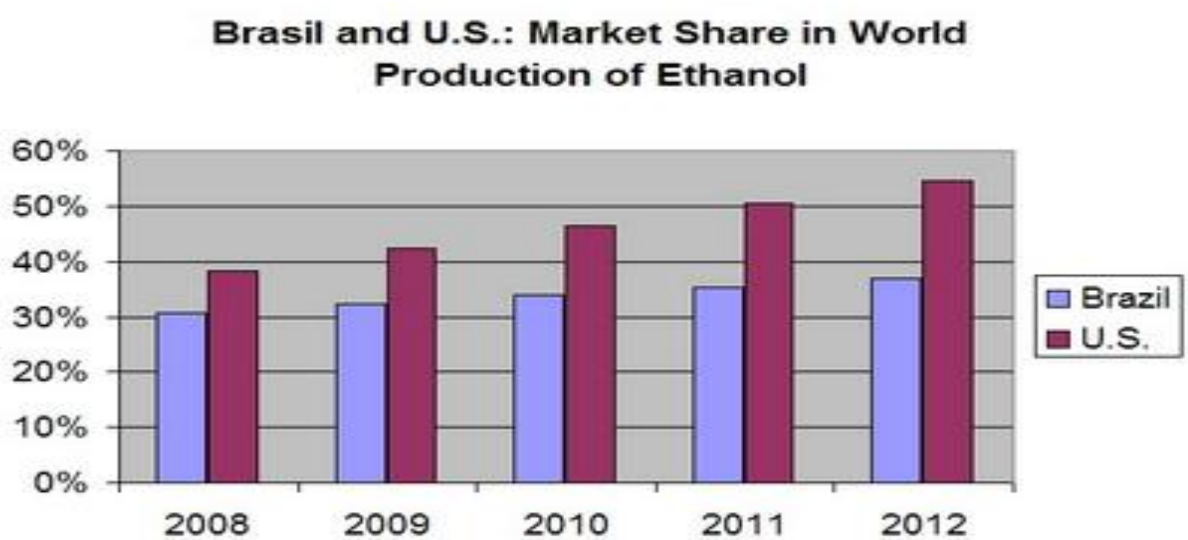
3.1 Ethanol and bio-diesel markets (production and forecast of future trade)

As part of a wider European Union commitment to reduce carbon emissions, using bio-ethanol and bio-diesel as a transport fuel can help contribute to reducing carbon dioxide emissions in the atmosphere and provide fuel security for the future. Several countries have passed legislations to promote the production of bio-ethanol and bio-diesel to guarantee certain production targets in order to meet the steady increase of energy demand. According to D. G. de la Torre Ugarte (2009) there are common mechanisms like mandatory blends and utilization targets established by several countries to promote the use of bio-ethanol and bio-diesel. A mandatory blend refers to the percentage of bio-fuel that a transportation fuel needs to have, when it is sold to the end customer. Brazil and a number of other developing countries have adopted this system.

According to a market analysis report by RNCOS (2008), the world bio-fuel markets value is likely to attain a Compound Annual Growth Rate **(**CAGR**)** of around 14.7% during 2006-2016. The global ethanol production is expected to reach 26,071 million gallons in 2014, while the global bio-diesel production is projected to accelerate at a CAGR of 4.5% during 2007-2015. Ethanol consumption pattern in China is likely to move faster than the production and expected to attain a CAGR of 2.51% from 2007 to 2015, while ethanol consumption in India is anticipated to move at a CAGR of over 2% during 2007 -2015. Nastri (2008) also suggested that due to the rapid increase in fuel demand, the projected fuel consumption could be up to 40% higher than anticipated. Market Research Analyst (2008) outlined some factors driving ethanol market which includes: high oil prices, national energy security considerations, ethanol tax incentives, improvements in technology which results in lower costs of ethanol production and climate change concerns which is changing the behaviour pattern of humans towards the environment.

Figure 3.1: Presents the world ethanol production forecast in million gallons from 2008-2012 and the world market production share for Brazil and U.S.





Source: Market Research Analyst (2008)

Table 3.1: Presents the world ethanol production forecast 2008 - 2012 by country in millions of gallons

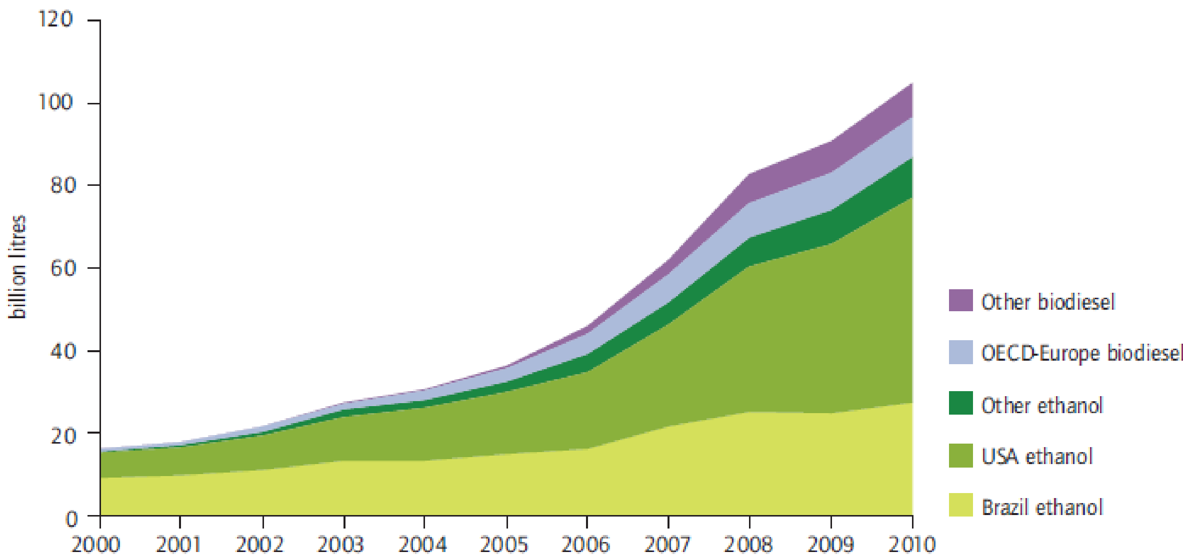
	2008	**2009**	**2010**	**2011**	**2012**	**CAGR, %**
Brazil	4,988	5,238	5,489	5,739	5,990	2.8%
U.S.	6,198	6,858	7,518	8,178	8,838	5.7%
China	1,075	1,101	1,128	1,154	1,181	1.4%
India	531	551	571	591	611	2.2%
France	285	301	317	333	349	3.2%
Spain	163	184	206	227	249	6.9%
Germany	319	381	444	506	569	9.7%
Canada	230	276	322	368	414	9.9%
Indonesia	76	84	92	100	108	5.6%
Italy	50	53	55	58	60	2.8%
ROW	2,302	2,548	2,794	3,040	3,286	5.7%
World	**16,215**	**17,574**	**18,934**	**20,293**	**21,653**	4.6%

Note: 4 liters = 1 gallon

Table source: Market Research Analyst (2008)

A study by IEA (2010) in the figure below, revealed the world liquid bio-fuel production from 2000 to 2010. This constitutes only ethanol and bio-diesel from the USA, European Union and other production sites in the world.

Figure 3.2: Global bio-fuel production 2000 to 2010



Source: (IEA 2010 p 12)

From the forecasted figures presented in Figure 3.1, on the world ethanol production, it can be seen that the projected figures from 2008 to 2010 were within the range of world production as we can see in Figure 3.2. As the forecast estimated so far falls within the range of actual production. It can be said that, the projections were carefully made taking into account likely future occurrences. This makes us accept the future projected figures.

According to Heinimo & Junginger (2009) the amount of directly traded bio-fuel is increasing strongly, especially for liquid bio-fuel (ethanol and bio-diesel), for which demand has grown tremendously in recent years in the European Union and the United States of America. A study by United Nations Economic Commission for Africa (2008) states, that the most widely commercialized liquid bio-fuel are obtained from two main feedstock which are oil from rapeseed, palm, sunflower, cotton, jatropha, etc of which the end product is biodiesel; and the alcohol feedstock from the fermentation of sugar produced from beet, wheat, sugarcane, maize, cashew, etc. of which bio-ethanol is the end product. These are termed first generation bio-fuel. This increase in demand has triggered the export of ethanol (mainly from Brazil), vegetable oil (e.g., palm oil and soya bean oil), and bio-diesel from South-East Asia and Latin America.

A research by DNV (2010) indicates that by 2022, the top 14 bio-fuel producing countries will need approximately 154 billion liters, which are 971 million barrels of ethanol and approximately 67 billion liters which are 424 million barrels per year to meet the targets. Thus, if new and planned production facilities are included in the global capacity, a total of 1,000 million barrels could be produced per year by 2022, exceeding the mandated requirements.

3.2 Shipping industry

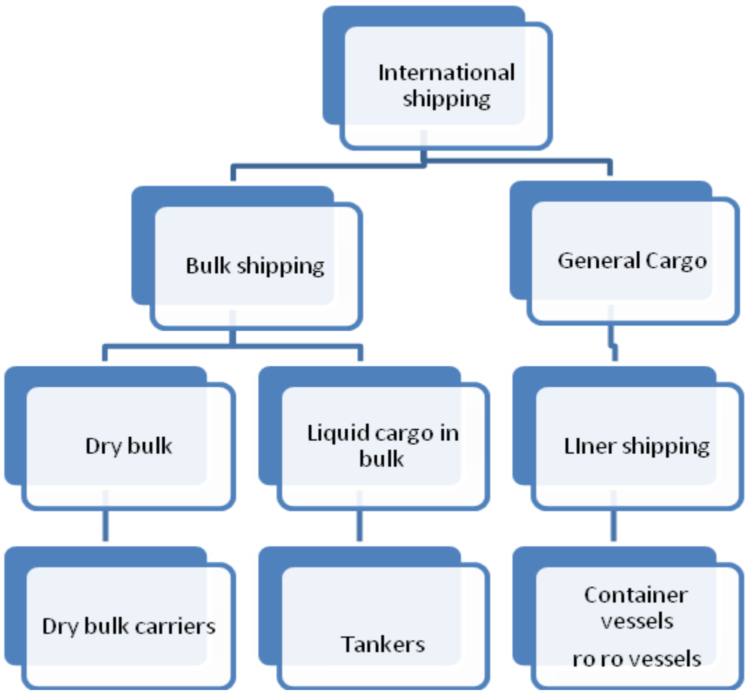
The sub-topics below present an overview of the shipping industry, looking at the industry at the international level as well as the shipping market. A background on MARPOL Convention, which forms the basis for which tankers can be used in the transportation of bio-ethanol and bio-diesel, is also presented.

3.2.1 An overview of the shipping industry

Shipping is a general term which describes the creation of time and space utility, using one or combined modes of transport. However the focus here is sea transport, which involves using vessels or ships to transport cargoes from one point to another. The history of the world has been through exploration, conquest and trade by sea. This as a result led to increased ship building and movement of trade using internal waterways for local transportation, and subsequently through the high sea for intercontinental trade (IMO, 2009).

The international shipping industry can be broadly divided into two groups: bulk and liner shipping. Most of the bulk shipping constitutes the transportation of raw materials from their sources in different countries to production sites. Liner shipping on the other hand deals with the movement of these manufactured goods to consumption base worldwide. In the last century, the shipping industry and world trade have grown steadily year on year, and through booms and recession owing to the recognition and embracement of globalization. This globalisation has been made possible through the progressive dismantling of trade barriers, capital mobility, fundamental technological advances, falling transport cost, communication and computing (IMO, 2009). The figure below gives an overview of the international shipping industry.

Figure 3.3: A simple overview of the international shipping industry



Shipping is regarded as a truly international and risky industry regulated by the United Nations Laws of the Sea (UNCLOS). It comprises of shipping nations and provides a very significant source of income to many developing nations leading the world in some of shipping most pertinent businesses. Some examples of such business include shipping building, ship registration, supply of sea going man-power, recycling, repairs and port services. The MARPOL convection is an example of such regulations that deals with marine pollution from liquid cargo in bulk. Shipping has been noted to be the most economical, cheapest and in the last decades the most environmentally friendly mode of transportation, considering the volumes moved per voyage compared with the other modes (UNCTAD, 2009).

The shipping industry operates on very high valued assets, costing an average of 100 to 150 million US Dollars to build depending on the time of the shipping market cycle. This has made shipping today more technologically advanced, sophisticated, immense, and safe to carry more cargos than the industry could ever imagine (IMO, 2009).

3.2.2 Shipping market

The international shipping industry is notably known to have four major markets under which several other segments exists. They are freight, sale and purchase, second-hand and the demolition market. Each of these markets interacts in a cycle to form the shipping industry. All other things being equal; when there is a favourable change in freight rates, it triggers into the ordering of new ships; however the reverse is the issue when freight rates change unfavourably. Or when ship owners wish to exist the market, they sale their ships on the second-hand market till ships becomes operationally inefficient where they are sold at the demolition market (Stopford, 2009).

The market place described by Jevons the nineteenth century economist, in the context of shipping refers particularly to the freight market (Stopford, 2009). Segments that falls under the freight market include dry bulk, tanker (product, gas and chemical) and container. Each of these markets requires specialized ship that together actually performs the world total sea transport. Though each market behaves differently it is however the same broad traders, so occasionally what happen in one market gradually ripples into the other market (Stopford, 2009).

3.2.3 The MARPOL Convention

The International Convention for the Prevention of Pollution from Ships (MARPOL) is an international convention developed by IMO in 1973 and revised in 1978 to deal with pollutions that stems from operations and accidents in the marine environment (International Convention for the Prevent of Pollution from Ships, 1973).

Since then its responsibilities has been widen through the creation of Annexes to deal with peculiar marine pollution issues, such as pollution from oil, noxious liquid substances, harmful substances in packed form, sewage, garbage and air pollution. There are intotal six Annexes that deal with the various aspects of marine pollution. In 2004 the MARPOL Convention was significantly revised to make it simpler for use, and also to involve the effects of some new products in the marine environment. It came into force in January 2007.

MARPOL Annex I came in force in October 1983 to cover prevention of pollution of oil from operational measures as well as accidental discharge. The 1992 amendment of Annex I made it mandatory for new oil tankers to have double hull and also brought a phase in for existing capacity to fit double hull, which was subsequently revised in 2001 to 2003 (Gard AS, 2010).

The 2007 revised Annex I amended regulation 22 pump room bottom protections: oil tanker with 5000 tons deadweight and over constructed on and after January 2007 must have double bottom pump room, and regulation 23 accidental outflow of oil performance.

MARPOL Annex II came into force in October 1983 through the Resolution Maritime Environmental Protection Committee (MEPC) 16 (22) to protect the environment, by controlling operations and reducing accidental pollutions from grounding and collisions from vessels carrying Noxious Liquid Substances (NLS) in bulk. MEPC adopted the revised MARPOL Annex II under Resolution 118 (52). The old Annex II contained four categories: A, B, C, and D in addition with Appendix III to cover those products which fell outside the domain of the four named categories. The appendix III products did not pose any environmental threats. As such did not get any discharge restrictions. The most peculiar amendments of the 2007 revised Annex II was that, products were reclassified into 3 plus 1 category system. The new classification contained four categories namely X, Y, Z, and Other Substances (OS). Just like the Appendix III of the old Annex, OS also dealt with products that did not pose any environmental risk. Examples of such products include slurry and apple juice (United States Coast Guide, 2006).

The IBC code main responsibility is to reduce risk prone to ships, the crew and the environment. The code prescribes ship design, construction standard and the equipment she should carry with regards to the nature of the product carried.

The revision of the IBC code came into force hand in hand in 2007 with the revised MARPOL Annex II. It applied in all extent to new ships and existing ships carrying NLS and oil like substances in bulk. The IBC code defined NLS as any substance indicated in the pollution category column of chapter 17 and 18 of the IBC Code or provisionally assessed under the provisions of regulation falling into category X, Y, Z, as in the revised Annex II. The implication here is that with the classification of substances, others have had their carriage requirement upgraded from Type III to II ships, others substances have been added to the list of NLS for the first time, while others have been removed. This required that ship modifications made if vessel would continue to carry the reclassified substances (ABS, 2006).

Ethanol is listed in chapter 18 of the IBC code and classed as category Z: as a mild pollutant and not a safety hazard, but having a low flashpoint requiring explosion proof vessels for it transportation. Bio-diesel under its various trade names are listed in chapter 17 and classed as category Y: as products with severe environmental and safety hazards which requires significant preventive measures to avoid the escape of cargo (Bradley *et al*, 2009).

The term bio-ethanol and bio-diesel involves a number of different products, because of this they cannot be shipped under the revised MARPOL Annex II with their trade names. Most of the discussion regarding the classification of liquid bio-fuel s has been particularly about biodiesel. Bio-ethanol and bio-diesel classified as category Z and Y respectively in the IBC Code are grouped as NLS, as such they fall under the purview of the revised MARPOL Annex II and International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC code) see chapter 2.1.2 (Bradley *et al*, 2009). The majority of bio-diesel are fatty acid methyl esters (FAME) which can have various compositions. Under the revised MARPOL Annex II there are only three types of bio-diesel shipped and they are transported under the names of Palm oil fatty acid methyl esters, coconut fatty acid methyl esters and Rapeseed fatty acid methyl ester (Intertanko, 2006).

According to the revised MARPOL Annex II (2006), NLS tankers are to be used in the transportation of NLS. The IBC code stresses that Type II ship must be used in the transportation of biodiesel.

However bio-ethanol is listed in chapter 18 of the IBC code among substances that does not apply to the code but has a pollution category Z placing Type III ship as suitable for its transportation but as mandatory (IBC code 2007).

3.2.4 Tanker market

Tankers are the most highly specialised sector in the shipping industry. They are vessels designed to carry liquid cargo in bulk (McConville, 1999). Tanker types comprise of chemical, LPG, oil product, oil product/chemical, chemical/oil and crude oil tankers. Tanker sizes include coaster, Panamax, Handy-size, Afromax, Suezmax, VLCC and ULCC. Below is an image of a tanker in the pacific sea.

Figure 3.4: A tanker ship in the pacific sea

Liquid cargo in bulk shipped by sea fall into three main groups: crude oil and petroleum product, liquefied gas principally LNG and LPG, vegetable oil and liquid chemicals. However within these main groups there are many sub divisions (Stopford, 2007). Notable among this segment is the increasing commercial transportation of bio-ethanol and bio-diesel classified as NLS.

At the beginning of 2010, world tanker fleet comprised of 12,560 tankers totalling 501.2 million dwt. As of March 2010, deliveries of new tankers amounted to 948 vessels with 54.4 million dwt, up from 43.4 million dwt compared to the previous year. Looking at the period between 2006-2010, total tanker tonnage increased by an average of (6.6%) per year (Institute of Shipping Economist and Logistics 2010). The net tonnage changes for the various tanker market segments during 2009 are: 34.0 million dwt increase for oil product and oil chemical tankers, 4.9 million dwt increases for liquid gas tankers, and a 0.9 million dwt decrease for pure chemical tankers. The decrease was in the form of converting tanker into bulk carriers.

Table 3.2: World fleet by type from January 1st 2006 to 2010

Ship type	2006 No	2006 mill. dwt	2010 No	2010 mill. dwt	Av. dwt growth '06-'10 (%)	Average size (1000 dwt) 2006	Average size (1000 dwt) 2010
Total oil tankers	7863	353.5	9740	452.0	6.3	45.0	46.4
- Crude/products tankers	*6023*	*315.9*	*6536*	*382.8*	*4.9*	*52.5*	*58.6*
- Oil/chemical tankers	*1840*	*37.6*	*3204*	*69.1*	*16.4*	*20.4*	*21.6*
Chemical	1354	9.9	1331	8.5	-4.0	7.3	6.4
Liquid gas	1184	24.2	1489	40.8	13.9	20.5	27.4
Total	**10401**	**387.7**	**12560**	**501.2**	**6.6**	37.3	39.9

Source: (Institute of Shipping Economist and Logistics 2010 p 3)

3.2.4.1 Noxious Liquid Substance tankers

As established earlier, NLS tankers are to be used in the transportation of NLS. An NLS tanker means a ship constructed or adapted to transport a cargo of noxious liquid substance in bulk. This includes oil tankers as defined in Annex I of the present convention as certified to carry a cargo or part of cargo as noxious liquid substance in bulk. Annex I of the MARPOL convention defined "oil tankers as a ship constructed or adapted primarily to transport oil in bulk in its cargo space" (MARPOL 2006 p 45). This includes combination carriers, any NLS tanker as defined in Annex II of the present convention and any gas carrier defined in regulation 3.20 of chapter II-1 of SOLAS 74 (as amended) when carrying a cargo or part cargo of oil bulk. It further stresses that a ship carriage of NLS is subject to the possession of a certification called International Pollution Prevention Certification for the Carriage of Noxious Liquid Substance in Bulk which is to be renewed on a five years period basics based on survey in accordance with the provisions of Regulation 10 of Annex II of MARPOL 73/78 (MARPOL, 2006).

As of 14th of April 2011, an extraction made from the IHS Fairplay World Shipping Encyclopaedia database revealed that oil product tanker, chemical/oil tanker and LPG/chemical tankers fall in as NLS tankers.

IHS Fairplay World Shipping Encyclopaedia database is a maritime reference, which provides comprehensive quarterly updated information. It has 200 data files covering 116,000 vessels (100 GT and above), 124, 000 maritime related companies and more than 100, 000 ports and terminal. The table below shows how the extraction was made (HIS Fairplay, 2011)

Table 3.3: How the extraction of Type II and III ship was made for this study

Ship-type	Oil product tankers	Chemical/oil tankers	LPG/chemical tankers
Status	In service, and on order	In service, and on order	In service, and on order
IMO chemical classification	I,II, III	I,II, III	I,II, III
Hull type	N/A	N/A	N/A
GT	Above 300	Above 300	Above 300

The hull type includes Single Hull, Double Hull, MARPOL Double hull, Double Bottom Entire Compartment Length and Double Sides Entire Compartment Length tanker

The tables below detail each tanker group capacity, with a summary at the end giving the total GT of NLS tanker per the date of extraction.

Table 3.4: Oil product tankers from the IHS World Shipping Encyclopaedia as of 14/04 /11

Status	Number of ships	GT	IMO II,III % of GT	IMO II% of GT	IMO III% of GT	W.O.C % of GT
In service	2842	32,852,614	0.78	0.81	2.6	95.7
Laid up	13	72586	0	0	0	100
On Order	274	6306918	0	0.57	1.3	98
Pending	13	244405	0	0	0	100
Casualty	9	36383	0	0	0	100
Conversion	2	6205	0	0	0	100

Note W.O.C means without any IMO classification

Out of the 2,842 oil product tankers in service as of 14/04 /11, Type II ships were 30 in number making up a GT of 267,447.Type III were 50 totaling 862351 GT while Type II, III ships were 15 in number making up 256,068 GT.

Out of the 7,315,892 GT on order, (16.86%) represent tankers that have been keel laid, (12%) represents tankers that have been launched, (68.9%) represents tankers that the orders have not been commenced; while the rest of the (2.24%) represents tankers that are under construction.

Table 3.5: Chemical /oil tankers from the IHS World Shipping Encyclopaedia as of 14/04 /11

Status	Number of ships	GT	IMO I,II % of GT	IMO I,II,III% of GT	IMO I,III % of GT	IMO II,III % of GT	IMO II % of GT	IMO III% of GT	W.O.C % of GT
In service	3340	45690238	0.09	1.92	0.08	29.6	25	33.6	0.86
Laid up	9	106459	0	0	0	54	11.2	34.7	0
On Order	488	7315892	0	0	0	9.6	14.7	9.7	66
Pending	28	581606	0	0	0	23	22	0	52
Casualty	6	33398	0	0	0	0	89.2	10.8	0
Conversion	1	22607	0	0	0	0	0	100	0

Note: W.O.C means without IMO chemical classification

Out of the 7,315,892 GT on order, (15%) represent tankers that have been keel laid. From this, (18%) were IMO chemical tanker Type II; (19%) were chemical tanker Type II, III; (7%) were Type III and (56%) were tankers without any IMO chemical class.

(12%) of the GT on order constitutes tankers that have been lunched. From this (33%) constitute Type II ships; (16%) were Type II, III; (7%) were Type III and the rest of the (44%) makes up those tankers without any class.

(67%) of the GT on order constitutes tankers that orders have not been commenced. Out of this (11%) constitute Type II; (7%) Type II, III; (9%) were Type III and the rest of the (73%) makes up tankers without any class.

Lastly the (6%) of the GT on order constitutes tankers that are currently under construction. This is also broken under to be (14.1%) for tankers of Types II; (7.1%) for tankers of Type II, III; (32%) for tankers of Type III and the rest of the (46.8%) being tankers without any class.

Table 3.6: LPG/chemical tankers from the IHS World Shipping Encyclopaedia as of 14/04 /11

Status	Number of ships	GT	IMO I,II,III % of GT	IMO I,III% of GT	IMO II,III % of GT	IMO II % of GT	W.O.C % of GT
In service	22	21122	14.4	4.8	9.7	39	32.1

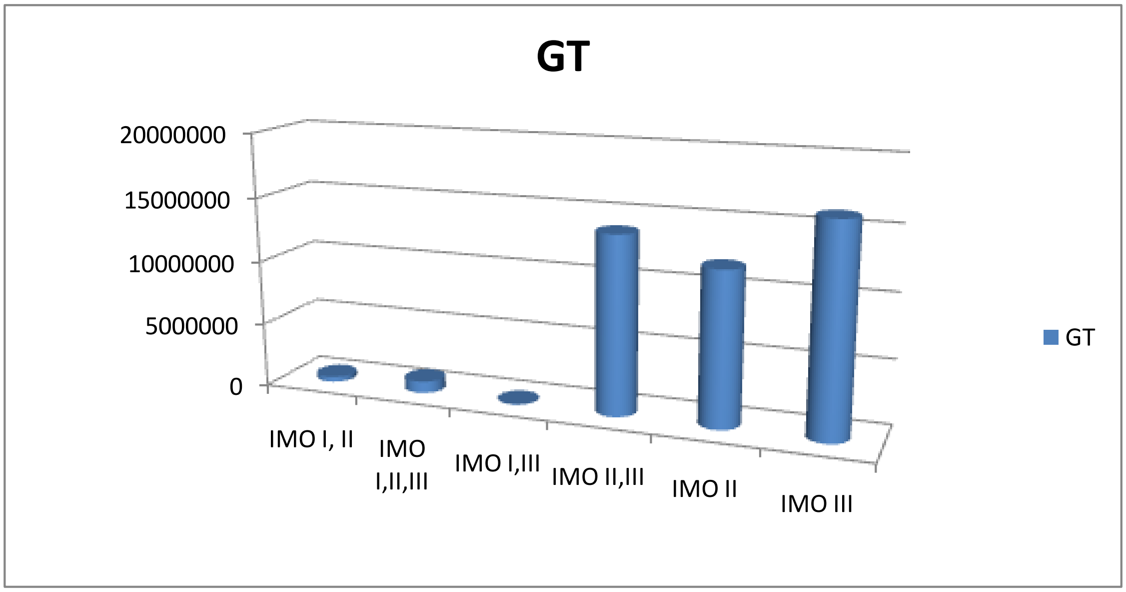
Note: W.O.C means without IMO chemical classification

3.2.4.2 Summary on NLS Tankers

In total there were 5134 NLS tankers in service, with a total GT of 75,947,589 as per the definitions in the MARPOL convection extracted from the IHS World Shipping Encyclopaedia database. The order books for this type of tankers stood at 773 tankers with a GT of 13,620,508. This comprises of tankers at their various stages of construction.

To fully meet the needs of the IBC code on the carriage of bio-ethanol and biodiesel, the graph below shows the capacity currently in service as of the date 14/04 /11 for the transportation of NLS: IMO I, II 395,733GT; IMO I, II, III *910,020 GT*; IMO I, III 48,133 *GT*; IMO II, III *13,827,806 GT*; IMO II *11,916,862 GT*; and IMO III 16,101,578 *GT*.

Figure 3.5: The capacity currently in service of NLS tankers as of the date 14/04/11



NB: the GT includes only those tankers above 300 GT as the standard for research at our department. IMO I, II, III ships with other similar categorizations are ships having Type I, II, and III tanks on the same ship. Due to data constraints on the specific GT on those tanks, the paper thereby focuses on ships with exclusive IMO Type II or III tanks. This is because they are ships that the IBC Code established as the requirement for the transportation of bio-diesel and bio-ethanol.

The IMO Type II ships have an age profile of about (96%) of the fleet below 25 years. 752 ships reaching 3,639,021GT are Coasters. 264 ships having a GT of 3,645,839 are Handy -size and lastly 156 ships making up a total of 4,507,717 GT are Panamax.

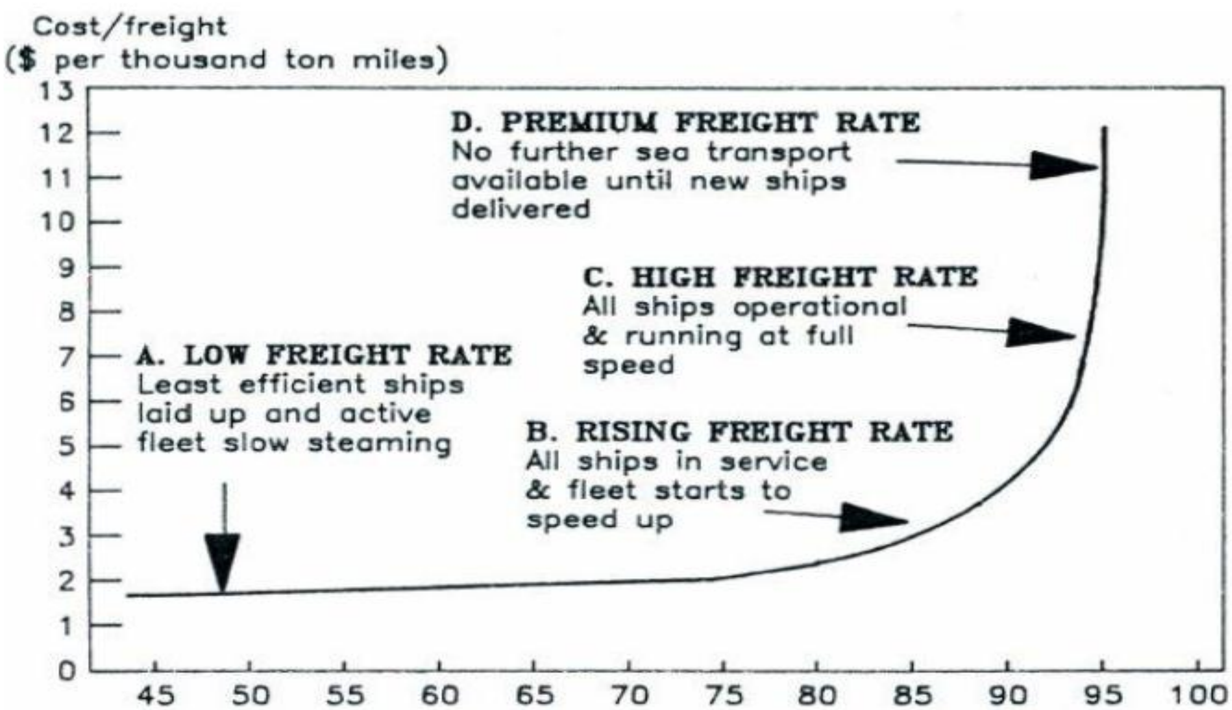
The IMO Type III ships have an age profile of about (87%) of the fleets below 25 years. 206 ships with a total GT of 694,183 are Coasters. 167 ships having a GT of 3,561,299 are Handy-size. 396 ships with a total GT of 11,148,924 are Panamax. Lastly 17 ships with total GT of 696,123 are Afromax.

3.2.5 Freight rates in the tanker market

The first half of 2009 saw freight rates falling very low as a result of the financial crises, but bounced back in the second half. A VLCC on the Gulf to Asia route for example sailed for

$25000 per day in December, but this figure dropped averagely to $15,000 two months after (Institute of Shipping Economist and Logistics 2010). According to Stopford (1993) the charter market is highly competitive. Freight rates can change drastically any time depending on the demand for capacity and their supply. If there is high demand for shipping supply and supply is not readily available, freight rate shoot up, and vice versa. Generally the cost of shipping is determined by the supply demand balance of ships and goods (Bradley *et al*, 2009 p 30). Stopford (1993) gives a good supply curve for sea transport. Its shows transport capacity (billion ton miles) that ship owners supply at each freight rate.

Figure 3.6: Typical supply curve for a given size of fleet



Source :(Bradley *et al*, 2009 p 30)

At low demand (point A), the least efficient ships are not able to cover operating cost and then move into lay-ups. The rest of the ships reduce speed to converse fuel. When demand increases all ships are back in operations and then rates increase marginally. To earn maximum possible revenue transport is expanded without the increase of new ships, by running at full speed (point C), when no further sea capacity is available, freight rates skyrockets (Bradley *et al*, 2009).

3.2.6 Liquid cargo in bulk trade

In 2005 world liquid bulk trade amounted to 2.42 billion tons. Out of this crude oil accounted for 1.86 billion tons, oil products was 0.57 billion tons (Forum of Shipping and Logistics, 2007). The table below gives an account of bulk commodities shipped; however attention is given only to the liquid cargo in bulk because they are the main focus in this paper.

Table 3.7: Bulk commodities traded by sea in million for selected years intons

Year	Oil			Iron ore	Coal	Grain[a]	Five main dry bulks[b]	Other dry cargoes	World total
	Crude	Products	Crude plus products						
1970	5 597	890	6 487	1 093	481	475	2 049	2 118	10 654
1980	8 385	1 020	9 405	1 613	952	1 087	3 652	3 720	16 777
1990	6 261	1 029	7 290	1 978	1 849	1 073	5 259	3 891	16 440
2000	8 180	1 319	9 499	2 545	2 509	1 244	6 638	6 790	22 927
2001	8 074	1 345	9 419	2 575	2 552	1 322	6 782	6 930	23 131
2002	7 848	1 394	9 898	2 731	2 549	1 241	6 879	7 395	23 516
2003	8 390	1 460	9 850	3 035	2 810	1 273	7 118	7 810	25 124
2004	8 795	1 545	10 340	3 444	2 960	1 350	9 521	8 335	26 814
2005	8 875	1 652	10 527	3 918	3 113	1 686	9 119	8 730	28 376
2006	8 983	1 758	10 741	4 192	3 540	1 822	9 976	9 341	30 058
2007	9 214	1 870	11 084	4 544	3 778	1 927	10 676	9 665	31 425
2008	9 300	1 992	11 292	4 849	3 905	2 029	11 209	10 245	32 746

[a] =*includes wheat, maize, barley oats, rye, sorghum and soya beans*

b=*includes grain, iron ore, bauxite, alumina, coal and phosphate*

Source: (UNCTAD, 2009 p 14)

The table above shows that, the shipment of crude oil constitutes the greatest share of sea transport year on year. According to UNCTAD (2009) crude oil and petroleum products presents about one third of world trade.

According to IEA (July 1, 2009) the most transported liquid bio-fuel is ethanol, 2.8 billion liters was exported in 2008, Brazil shipped 97%, primarily to Europe, Japan, India and the US. Net exports of bio-diesel was 1.1 billion liters in 2007, the largest shippers being the US, Indonesia and Argentina, primarily to the EU and Japan. The tables below show the world trade of ethanol and bio-diesel from 2006 to 2008.

Table 3.8: Ethanol trade (million liters)

				Brazil Exports
Net Exporters	**2006**	**2007**	**2008**	**2005**
Brazil	3,511	2,450	2,722	2,598
China	158	29	20	
ROW	88	66	58	
	3,757	**2,544**	**2,799**	
Net Importers				From Brazil 2005
European Union-25	-268	-469	-489	-509
India	-447	-576	-556	-414
Japan	-649	-744	-790	-318
South Korea	-282	-319	-339	-75
United States	-2,571	-896	-1,084	-261
	-4,217	**-3,004**	**-3,258**	**-1,577**

Source :(Bradley *et al*, 2009 p 19)

Table 3.9: Bio-diesel trade (million liters)

Net Exporters		**Net Importers**	
Argentina	227.2	European Union	451.1
Brazil	-1.5	Japan	254.7
Indonesia	325.5	ROW	398.5
Malaysia	137.5	Net Imports	1,104.3
United States	415.6		
Net Exports	1,104.3		

Source :(Bradley *et al*, 2009 p 20)

3.3 Economic theories

In the sub-topics below, the structures within which an industry operates are presented as well as the theories that govern the structures for pricing. Porter's competitive framework which discusses five competitive forces that determine an industry's competition is also presented, this is because it will be used to analyze how capacity in the tanker market will be affect as the trade of bio-ethanol and bio-diesel increases commercially. We also write about market structures because McConville (1999) established the tanker market as a close perfect market, where the price theory is used to determine freight rates.

3.3.1 Market structures

According to Baumol, (1982) market structure is best defined as the organisational as well as other characteristics of a market, it is also known as the number of firms producing identical products. Microeconomic theory describes these market forms using various models.

These market forms include: perfect competition, monopolistic competition, oligopoly and monopoly (McConville, 1999).

Perfect competition; this is a market structure in which no participant is large enough to control the market by setting prices for homogeneous products. *Monopolistic competition;* this market is also called competitive market. It is a market structure where there are large number of firms, each having a small proportion of the market share and offering slightly differentiated products. *Oligopoly;* this is a structure in which a market is dominated by a small number of firms that together control majority of the market shares. *Monopoly;* this is a market where there is only one provider of a product or service (Colton, 1993).

Colander, (2008) described the most important features of market structures as *the number of firms* in the market including the scale and extent of foreign competition, *the market share of the largest firms, the nature of costs* including the potential for firms to exploit economies of scale, *the degree to which the industry is vertically integrated* explained as the process by which different stages in production and distribution of a product are under the ownership and control of a single enterprise. A good example of vertical integration is the oil industry, where the major oil companies own the rights to extract from oil fields, run a fleet of tankers, operate refineries and have control of sales at their own filling stations, *the extent of product differentiation*, *the structure of buyers in the industry* and the *turnover of customers* that is how many customers are prepared to switch their supplier over a given time period when market conditions change. The diagram below gives the basic structure of the shipping industry.

3.3.2 Perfect competitive market

Perfect competition describes a market where there are large numbers of individual sellers. All these participants are not large enough to influence prices of the homogeneous services produced and purchased by many sellers and buyers. However there is few, if any perfectly competitive market (McConville, 1999). In a perfectly competitive market, a firm's demand curve is perfectly elastic thus; market power is not bestowed in the hands of the consumer or the producer but by the forces of demand and supply of the products (Roberts, J., 1987).

Perfect competition similar like other economics models is underpinned by some set of basic assumptions which are detailed below.

- *The existence of a large number of small firms*: The consequence here is that, each firm produces or consumes at the same level of output which is relatively small considering the industry's total. The implication here is that, the number of buyers and sellers in the market are infinite. Since only one product is being sold in the market, neither single buyer nor a single seller can determine or influence the price of the product. Firms cannot also collaborate in any way to affect the market. The price is determined by the market as a whole, depending on the total demand and requisite supply of the product in question. In this sense all firms are price takers as accept price quotations from the market (McConville, 1999).

- *The provision of homogeneous services sold by all firms*: This is important to make the first assumption operative in a perfect competitive market model. This is the prime characteristic of a perfect competition, thus the existence of a homogeneous service sold by all suppliers at a common price, with the quality of the service being exactly the same. The service cannot be differentiated by advertising, branding or even branding to influence the buyer. The standard nature of the service means any attempt to influence the market will fail as there are many other operators providing the same services (McConville, 1999).

- *The existence of perfect knowledge:* the buyers are completely aware of and are exposed to information about the production process and its economics. This means that the buyers and sellers are in close communication. On these basics, they can asses themselves (McConville, 1999).

- *The existence of perfect resource mobility or the freedom of entry into and exit out of the industry:* There is no natural or artificial impediment that holds firms who wish to enter or exit the market. Any supplier is free to enter the market at his or her will, and exit when he or she wishes to do so. Capital and other assets are such that they do not deter entry or exit in the industry. This is because if there were barriers to entry and exit the number of firms will be reduced. The implications here are in two ways. When freight rates and profit are high other firms enter the market, while if there low they exist (McConville, 1999).

- *No government interference*: the government does not interfere with the mechanics of the market in any way, they refrain from subsiding or rendering any special kind of service that might affect the mechanics of the market (McConville, 1999).

3.3.3 Price theory

According to Brody, A. (1987) prices and quantities have been described as the most directly observable attributes of products produced and exchanged in a market economy. Besanko & Braeutigam (2005) in their book "Microeconomics" stated that the theory behind the supply and demand model is contingent on the idea that in a free market economy, the amount of an item that the producer supplies, and the amount that the customer demands both depend on the item's market price. Supply and price are proportional. Demand is inversely proportional to price thus, the higher an item's price, the less demand there will be among customers. Hence, both supply and demand vary according to the price.

According to Besanko & Braeutigam (2005), economic theory may also specify conditions such that supply and demand through the market is an efficient mechanism for allocating resources.

The market price of a good, according to supply and demand should be at the intersection of customer demand and producer supply. Jordan (1982) stated that if the desire for goods increases while its availability decreases, its price rises, however if availability of the good increases and the desire for it decreases, the price falls. Hence, if an item's price is at a low level, then there will be more demand for the item than the producers are able to supply; thus, this will result in a shortage, so customers will be willing to pay more for the item. This enables the producers of the item to raise the price until it gets to the point where the customers are no longer willing to pay that much for it.

3.3.3.1 Demand

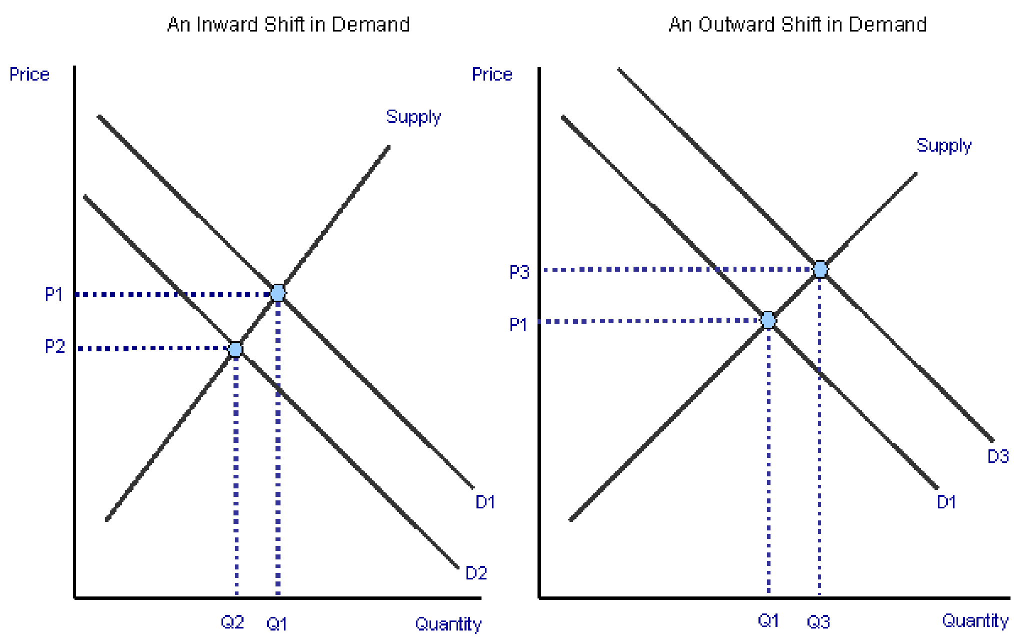
Demand is a relationship between two variables, price and quantity demanded, with all other factors that could affect demand being held constant. Thus, Demand is the amount of an economic good or service that consumers are willing and able to purchase at a given price. The demand curve is usually downward sloping, this is because consumers will want to buy more of a good or service when its price decreases (Goodwin, N *et al.*, 2009, pp 88).

Some of the more important factors affecting demand are: *price of the good*: The basic demand relationship is between potential prices of a good and the quantities that would be purchased at those prices. Generally, the relationship is negative meaning that an increase in price will induce a decrease in the quantity demanded. This negative relationship is embodied in the downward slope of the consumer demand curve. *Price of related goods:* the principal related goods are complements and substitutes. A complement is a good that is used with the primary good. If the price of the complement goes up the quantity demanded of the other good goes down. Substitutes are goods that can be used in place of the primary good. The mathematical relationship between the price of the substitute and the demand for the good in question is positive. If the price of the substitute goes down the demand for the good in question goes down. *Personal disposable income*: in most cases, the more disposable income you have the more likely you buy. *Tastes or preferences:* the greater the desire to own a good the more likely a person would want to buy the good. *Consumer expectations about future prices and income:* if a consumer believes that the price of a good will be higher in the future the consumer is more likely to purchase the good now. In other words positive expectations about future income may encourage present consumption (O'Sullivan & Sheffrin, 2005, pp. 74-75).

3.3.3.2 Change in demand

This is a bodily shift either inward or outward of the demand curve as a result of other factors that influence demand as discussed above, other than the price of the commodity in question. It results in a change in the entire price quantity relationship, which makes up the demand curve. Change in demand means a different demand is paired at a given price which in the end leads to the establishment of a new equilibrium price in a perfect competitive market (O'Sullivan & Sheffrin, 2005). Below is a diagram of a change in demand.

Figure 3.7: Changes in Market Demand and Equilibrium Price



Elaborating on the outward change in demand, we observe that at the same supply level, demand was of D2 while the equilibrium price was of P2. However when there was a change in demand outward to D1 there is a new equilibrium price at P1. The same applies for the inward change in demand as well (O'Sullivan & Sheffrin, 2005).

Given all that assumption and their implications above, there can only be one market price in a perfect competitive market, where the ruling price is determined by the equilibrium point of the market demand and supply. The market demand is given as the aggregate of all individual demand while the market supply on the other hand is the aggregate of all individual owners' supply (O'Sullivan & Sheffrin, 2005).

3.3.4 Porter's competitiveness framework

According to Porter (1990) in modern international competition, firms need not be confined to their home nation. They can compete with global strategies where their activities are located in many countries. The basic unit of analysis in understanding competition is through the industry, thus, a group of competitors producing products or services that compete directly or indirectly with each other. A strategically distinct industry encompasses products where the sources of competitive advantage are similar. It is changes in the industry structure or the emergence of new bases for competitive advantage that underlie substantial shifts in competitive position.

In any industry whether domestic or international, the nature of competition is embodied in five competitive forces. These are: the threat of new entrants, the threat of substitute products or services, the bargaining power of suppliers, the bargaining power of buyers and the rivalry among the existing competitors (Porter, 1990).

- *The threat of new entry*: According to the Porter (2008), new entrants to the industry bring in new capacity with the desire to take put some of the market share. This intends puts pressure on prices, cost and rate of investment necessary to compete. When new entrants diversify from other market, they can leverage existing capability and cash flow to shake up competition. The threat of entrants depends on the heights of barriers to the industry, which puts a cup on the profit potentials of the industry.

- *The threat of substitutes*: Porters (2008) explained this as a suitable product or service that can serve the same purpose as the commodity in question. When the threat to substitutes is high, the profit potentials of the industry suffers as customers can always do with the alternatives

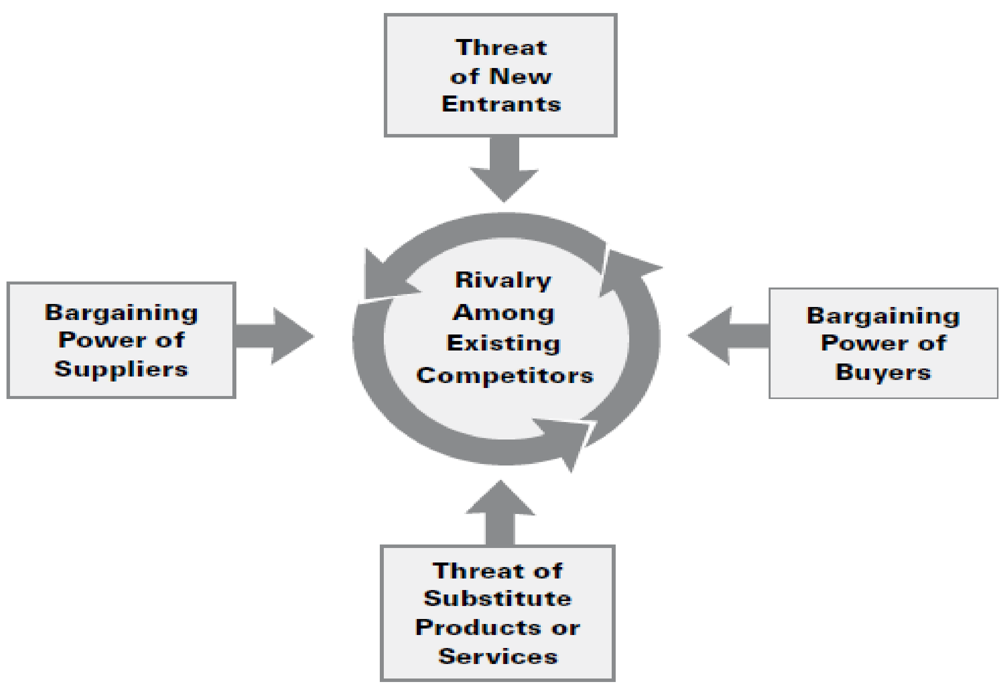
- *Rivalry among exiting competitors:* Porter (2008) explained that rivalry among existing competitors may take one of various forms: price discrimination and product differentiation, advertising, campaign and service improvement. High barriers are a limit to profitability. According to Porter, the degree of rivalry in an industry is determined by the intensity as well as the basics on which firms compete.

- *The bargaining power of the buyer:* Porter (2008) explained that powerful customers can capture more value by pressing prices down, demand more quality and play industry participant against one another, all at the expenses of the industry profitability.

- *The bargaining power of supplier:* Just like that of the customers, powerful suppliers capture more value for themselves by charging prices, limiting quality and shifting cost to the industry participants .

Figure 3.8: The five competitive forces that determine industry competition

The Five Forces That Shape Industry Competition



Source: (Porter 2008, p 4)

Porter (2008) identifies five forces that drive competition within an industry; the strength of the five competitive forces model is that, it is a strong tool for competitive analysis at the industrial level, as Porter discusses the structural analysis of industries offering an excellent framework for competitive analysis. The framework also discusses how resources are distributed in a competitive environment.

In conclusion, the strength of each of the five competitive forces is a function of the industry structure or the underlying economic and technical characteristics of an industry. Firms through their strategies can also influence the five forces for better or for worse. The extended rivalry that results from all five forces defines an industry's structure and shapes the nature of competitive interaction within an industry (Porter, 2008).

3.3.5 Summary

Bio-ethanol and bio-diesel mass production begun in the 1970s with Brazil and USA producing bio-ethanol from sugar and corn respectively. In the twentieth century the constant shortage of fuel, rising prices of oil, emission of green house gases being at the centre of world discussions, shifted people towards the use of bio-fuel as a means to solve these issues. This world development is pushing for high demand for bio-ethanol and bio-diesel as vital fuels for road transport, thus causing an increase in the trade of these fuels.

IMO (2009) describes shipping as the lynchpin of world trade, which has recorded and accommodated in the last decade, the increasing transportation of bio-ethanol and bio-diesel particularly in the tanker segment.

The revised IBC code (2007) and the MARPOL (2006) particularly the Annex II made a reclassification of products and established new ship criteria to ensure safe transportation, so as not to pollute and endanger the marine environment. This had an impact on tonnage supply as some products were added for the first time, others removed and others also had their category upgraded or downgraded. Bio-ethanol and bio-diesel were classified as NLS having a pollution category Z and Y respectively, but they are hardly found in the revised MARPOL and IBC code as they involve a lot of different products. As a result they have hardly been transported under their name. The revised MARPOL Annex II (2006) and the IBC code (2007) established Type III and II ships as most suitable for the transportation of bio-ethanol and bio-diesel respectively.

The period following the recovery of the recession has been noted to have the greatest delivery of shipping capacity as the tanker market is already expected to record 8% delivery in 2011. With the world economy still struggling to climb up, the shipping industry especially those segments with long list on their order books waiting to be delivered in the years that follows, have been marked for freight rates to be impacted negatively, till demand for transportation comes at parallel with tonnage. In the tanker market, notably concerns have been whether the increasing transportation of bio-ethanol and bio-diesel on the high sea would cause a major revolution which will impact capacity and then subsequently freight rates.

Perfect competitive market is described in the literature as a market situation where no player is large enough to dictate the market conditions, as well as set price for its homogeneous product. The theory of demand and supply is an organizing principle for explaining how prices coordinate the amount produced and consumed. Jordan (1982) also stated that demand and supply analysis is used to explain the behavior of perfectly competitive markets.

Porter’s five competitive forces that shapes an industry competition is used since it helps in analyzing the competitive nature of firms and industries in the modern world. According to Porter (1990) the five competitive forces determine industry profitability since they shape the prices firms can charge as well as the costs they have to bear and the investment required to compete in the industry. The threat of new entrants limits the overall profit potential in the industry, due to the fact that new entrants bring new capacity and seek market share thus pushing down margins. Powerful buyers or suppliers bargain away the profits for themselves. Fierce competitive rivalry erodes profits by requiring higher costs of competing or passing on profits to customers in the form of lower prices. The presence of close substitute products limits the price competitors can charge without inducing substitution and eroding industry volume.

CHAPTER FOUR: PRESENTATION OF DATA

The aim of this chapter is to present the data gathered from respondents in our survey. The respondents constituted Ship brokers, Tanker shipping companies, Classification societies and other Maritime Organizations. The questionnaire was divided into three sections regarding questions on freight rate, increased competition, and standard and regulation in the tanker market (chemical and product tankers)

We present the responses from the survey. In total we received 6 responses from the 20 questionnaires. Out of these responses 3 were from ship owners and the other 3 from Classification and Maritime organizations. We had no response from shipbrokers.

4.1 Respondent 1: Swedish ship owner

To begin with, the respondent answered YES when asked if they see a future for increasing commercial transportation of bio-fuel: there are a lot of projects in this direction. It is politically correct for governments to support such projects. There is a general awareness of the environmental issues. It is a huge market which makes it possible for several different initiatives to make money.

4.1.1 Freight rates about the tanker market

Respondent answered YES to the question if they think the increasing commercial transportation of bio-fuel would have an impact on freight rates in the tanker market, their motivation was that there are concerns for bio-fuel to be a cargo before certain petroleum grades which makes the availability of suitable tonnage somewhat restricted. Several of present projects involve very long voyages for relatively small vessels which takes away capacity from the market. However they see a very limited impact of changes in freight rates but expect a much stronger effect with increasing volumes and a better general market situation. But also argued that these impacts would not have a negative impact in the foreseeable future, as such the market mechanic would be required to maintain its strategies.

4.1.2 Competition for space in the tanker market

The respondent thinks the increased commercial transportation of bio-fuel will not caused increased competition in the tanker market. This is because even though bio-fuel will increase ton miles, the issue with cargo will restrict tonnage availability somewhat. Similarly they did not see any impacts on the tanker market should competition increase. To them the market would be required to respond to its environment to deal with any situation.

4.1.3 Standards and regulation in tanker market

To add up, the respondent disagreed strongly to the issue, if an increased commercial transportation of bio-fuel may cause further changes in the current safety and fire standard, and MARPOL Annex I and II regulation, they explained that bio-fuel are less poisonous and dangerous. Regarding impacts on MARPOL I and II, the respondent answered they are sure there were some, but not aware of any presently. Better yet the tanker market has proved to be able to cope with any new requirements and restrictions very quickly and efficiently.

4.2 Respondent 2: Danish ship owner

This respondent was certain of the future potentials of bio-fuel, and explained clearly that the demand for use of bio-fuel will be going up as well as the derived demand for transporting bio-fuel.

4.2.1 Freight rates about the tanker market

To this respondent, the increasing commercial transportation of bio-fuel would have an impact on freight rates in the tanker market; and explained that rates will be going down for some types of tankers and up for others. The downward pressure will however be the general picture as bio-fuel will substitute other oil products. Whereas oil/oil products have long distance from production to consumption bio-fuel can easier be grown and harvested closer to the consumption areas. However this is quite speculative. Concerning strategies, they answered ship owners might rethink what they want to offer to the market players.

4.2.2 Competition for space in the tanker market

The respondent thinks there would be NO increased competition in the tanker market through an increasing commercial transportation of bio-fuel. This is because there are few ships capable of transporting bio-fuel compared to ships capable of transporting petroleum products. Which means the bio-fuel transportation market is more consolidated. The respondent thinks there would be no impacts as there is likely not to be any competition in this direction. But just like the freight rates, ship owners might rethink what they want to offer to the market players as a strategy.

4.2.3 Standards and regulation in tanker market

The respondent is not concerned that the increased commercial transportation of bio-fuel may cause further changes in the current safety and fire standard, and MARPOL Annex I and II regulation. The respondent explained that safety is never a concern or something that should be compromised. They believe that safety standards will increase is the answer. But that is not due to bio-fuel transportation. There would be NO impact on standard and regulations as bio-fuel is not the reason for the changes, but as always ship owners might rethink what they want to offer to the market players as a strategy.

4.3 Respondent 3: Swedish based maritime organisation

The respondent sees a future for the increasing commercial transportation of bio-fuel. This is because up to now it has been required in many countries to increase the use of bio-fuel, and this will most probably continue. However, according to new EU studies, the production of bio-fuel based on today's methods will give a higher GHG emission to air than previously assumed which may have a negative impact the next years.

4.3.1 Freight rates about the tanker market

When asked if they think the increasing commercial transportation of bio-fuel would have an impact on freight rates in the tanker market, they answered YES and explained that the new MARPOL Annex II result will be that more cargoes will have to use Product/Chemical Tankers. More refineries will most probably be built closer to the production of crude oil, which will have some impact on the trading pattern. Regarding impacts that changes in freight rates would have on the tanker market, the respondent said we will see more tankers which can be used for bio-fuel. However, as the freight rates will be depending on much more than bio-fuel, it is difficult to say the impact on bio-fuel, as such for the next coming years. For strategies, the respondent said the market will have to maintain its course.

4.3.2 Competition for space in the tanker market

The respondent was not sure if there would be any increased competition in the tanker market through an increasing commercial transportation of bio-fuel, however the respondent stated that Bio-fuel are a new group of products which is expected to grow in volume, due to global warming effect. However, bio-fuel "ethanol (ethyl alcohol) and bio-diesel, can be carried under Annex I or Annex II. Bio-diesel are FAME, Palm oil fatty methyl esther, Coconut oil fatty methyl esther, Rapeseed oil fatty methyl esther, are covered by Chapter 1, requiring chemical tanker type II (not 2k), Category Y, bio-methanol are covered by Chapter 17, requiring Chemical tanker type III, Category Z bio-ethanol are covered by Chapter 18, Category Z, Single hull oil tanker. The respondent was not sure of increased competition, so they were not also sure of the impacts as well, however it was added that the carriage of bio-fuel and bio-fuel blends as given above based on Interim Guidelines from BLG 10, extended until 2011-07-01, Blends with up to 15 % bio components may be carried under Annex1. Blends with more than 15% must be carried under Annex II. In the future it is expected that blends up to 25% will be carried under Annex I. For strategies, the respondent again said the market will have to maintain its course.

4.3.3 Standards and regulation in tanker market

The respondent answered YES when asked if they are concerned that the increased commercial transportation of bio-fuel may cause further changes in the current safety and fire standard, and MARPOL Annex I and II regulation, the respondent explained that because more cargoes will have to use Product/Chemical tankers as stated above, the regulations might be further strength for these cargos. Regarding impacts, the respondent could not give precise answers like that of the freight rates and competition. Their response about strategy is similar to that of freight rates and competition

4.4 Respondent 4: Swedish based maritime organisation

The respondent see a future for increasing commercial transportation of bio-fuel, this they explain as the continued use of diesel as the main fuel for cars in Europe, an increased use of diesel in cars in the US, and an increased use of diesel within the maritime sector will put further stress on already stretched supplies of diesel. The market opportunities for bio-fuel s will thus increase.

4.4.1 Freight rates about the tanker market

The respondent did not agree to the statement, the increasing commercial transportation of bio-fuel would have an impact on freight rates in the tanker market. The respondent explained that the oversupply of tanker tonnage will remain in the next three year period. The respondent added that demand for transport will remain unchanged regardless of freight rates, since the cost for transport represent such a small share of the total cost for the final product. However the respondent said the tanker market will need to continue low-cost strategies combined with increased market or product differentiation.

4.4.2 Competition for space in the tanker market

The respondent rather said due to the over-supply of tonnage there would be no increased competition in the tanker market through an increasing commercial transportation of bio-fuel, rather the opposite is possible. They said the impact that will be felt is that freight rates will go down due to the over-supply of tonnage. The strategy they stated will be the above where the tanker market will need to continue low-cost strategies combined with increased market or product differentiation.

4.4.3 Standards and regulation in tanker market

Here the respondent answered NO to the question, if they are concerned that the increased commercial transportation of bio-fuel s may cause further changes in the current safety and fire standard, and MARPOL Annex I and II regulation, the respondent added also no impact will be felt, but even if any marginally. Regarding strategy, they said the tanker industry is used to adapting to changing regulations by conversions or ordering of new ships in accordance with the new specifications.

4.5 Respondent 5: UK based maritime consultant

The respondent answered YES to the question if there will be an increased future demand for bio-fuel: EU and other national mandates for bio-fuel usage, hence requiring quantities of bio-fuel in excess of national capacity. The deficit will need to be made up by imports. Imports may take the form of bio-fuel (ethanol, fatty acid methyl ester bio-diesel or the new Neste bio-diesel product) or feed stocks (vegoils).

4.5.1 Freight rates about the tanker market

The respondent agreed that the increasing commercial transportation of bio-fuel would have an impact on freight rates in the tanker market, because they are a new source of demand growth and a factor in demand growth that cannot be over looked. However, fleet growth and other factors will also be affecting freight rates. The respondent mention that in response individual owners and charterers will use normal mechanisms to manage market risks and plan for vessel availability with proper technical characteristics in the proper size. The respondent also mentioned that should long haul trades in bio-fuel or feed stocks emerge, larger vessel sizes may be needed, to use economies of scale to reduce freight rates.

4.5.2 Competition for space in the tanker market

The respondent said, though the future will see more of increasing commercial transportation of bio-fuel, competition for space with other existing similar commodities will not be the issue. This is because existing players will use existing market structures to meet bio-fuel requirements. New players enter the tanker segment and existing companies leave as part of normal market mechanisms.

4.5.3 Standards and regulation in tanker market

The respondent answered NO to the question if the increasing commercial transportation of bio-fuel may cause further changes in the current safety and fire standard, MARPOL Annex I and II regulation, they explained that bio-fuel and feed stocks prompted a major regulatory revamp enacted in 2004 and took effect in 2007. Many issues were addressed during the revamp, the work of GESAMP (Group of Expect on Scientific Aspect of Marine Environmental Protection), the IMO Bulk Liquids and Gases subcommittee and Marine Environmental Protection

Committee. As a result there will be no impact on the market due to the increasing transportation, but the market as always will use it normal mechanics to deal with the behaviours.

4.6 Respondent 6: Swedish ship owner

The respondent agreed that the future will witness more increased commercial transportation of bio-fuel. The respondent explained that the recent soaring oil prices, insecurity, encouraging government policies for the usage of bio-fuel in the road transport industry, concerns about the environment and the interest in reducing all unsustainable practices are all indications that the usage of bio-fuel will grow leading to its increased international trade.

4.6.1 Freight rates about the tanker market

The respondent argued that, though there will be increased transportation of bio-fuel; there would be no effect on freight rates in the tanker market. The explanation given is that bio-fuel is only another commodity that fits in the tanker market for which no special equipment will have to be built after the reclassification of the MARPOL Annex I and II. However the growth in its trade will be handled by the market in its own mechanisms.

4.6.2 Competition for space in the tanker market

The respondent did not agree that the increasing commercial transportation of bio-fuel will bring up competition for space in the tanker market. The explanation given was that there are strong voices against the increase usage of crude oil; bio-fuel will only increase to fill that gap. Therefore still equating market demand to the supply of vessels at any given moment. The respondent further stated that though particular impacts cannot be pointed out now due to the commercial transportation, the market mechanics will play its role to maintain a balance should any impact be experienced in the future.

4.6.3 Standards and regulation in tanker market

The respondent answered NO to the question if the increasing commercial transportation of bio-fuel may cause further changes in the current safety and fire standard, MARPOL Annex I and II regulation, The statement was supported by adding that bio-fuel s and all its various components have been effectively dealt through the recent reclassification of the MARPOL Annex I and II, as well as the IBC code.

4.7 Summary of the response from our participants

Below we present a summary of the responses from our participants

General Question on the subject

1. Do you see a future for the increasing commercial transportation of bio-fuel?

   a. Yes (100%), global warming and development and implementation of policies

   b. No ( )

Questions on increased competition for space in the tanker market

2. Do you think there would be increased competition in the tanker market through an increasing commercial transportation of bio-fuel?

   a. Yes ( )

   No (100%), the industry is flexible enough to respond to capacity issue

Questions on freight rates about the tanker market (chemical and product tanker segment)

3. Do you think the increasing commercial transportation of bio-fuel would have an impact on freight rates in the tanker market?

   a. Yes (66.7%), the revised MARPOL requires some type of ships which will take away tonnage.

   b. No (33.3%), the reason being over supply of tonnage

Questions on how increased commercial transportation of bio-fuel could affect standards and regulation in tanker market

4. Are you concerned that the increased commercial transportation of bio-fuel may require changes in the current safety and fire standard, and MARPOL Annex I and II regulation?

    a. Yes (17%), MARPOL Annex II might have to review the carriage requirement for bio-fuel s again.

    b. No (83%), the revised MARPOL Annex II dealt with all the issues on bio-ethanol and biodiesel.

All the respondents answered the market mechanics of the shipping industry will be used to cope with the new challenges of the increasing commercial transportation of liquid bio-fuel.

CHAPTER FIVE: ANALYSIS AND FINDINGS

This chapter presents an analysis of the results on the data obtained through the questionnaire from the players of the shipping industry. The empirical data obtained in this research study are analyzed to validate the research question whilst connecting the relevant literature applicable.

We analyse the data in the theoretical framework, using the responses from the survey to support the analysis.

5.1 The future commercial transportation of bio-ethanol and bio-diesel

The supply of energy issue is a problem worldwide. As a result there continues to be researches to solve this crisis. The growth of the world thrives on international global trade, but with environmental problems being a stumbling block to trade, it is necessary to find ways environmental friendly for transportation.

Bio-ethanol and bio-diesel international trade will continue to grow into the future. The usage of bio-ethanol and bio-diesel is growing as the alternative fuel for road transportation gradually worldwide (IEA, 2010). A research by DNV indicates that the top 14 bio-fuel producing countries will need approximately 154 billion liters which is 54, 384,587 tons of ethanol, and 67 billion liters which is 23, 660, 826 tons yearly by 2022 to meet their targets (DNV 2010). For reasons such as the recent soaring oil prices, energy insecurity, encouraging government policies for the usage of liquid bio-fuel in the road transport industry, growing concerns about the environment and the interest of reducing all unsustainable practices, this study has a (100%) YES response on Question 1 (Do you see a future for the increasing commercial transportation of bio-fuel?). From a study by IEA (2010) on the world production of bio-fuel from 2000-2010, the study showed an increase in yearly production for ethanol and bio-diesel. Comparing production figures to projected figures from 2008 to 2012 by Market Research Analyst (2008); it was observed that the projected figures from 2008 to 2010 fell within actual world production. Hence, it can be said that if trade conditions continuous as expected, there will be an increase in production for ethanol and bio-diesel and hence its transportation also increasing. We observe that bio-ethanol and bio-diesel trade will continue to grow, but the expected future quantities cannot be foreseen; as a result we use the projected future trade figures from DNV for 2022, 154 billion liters for bio-ethanol and 67 billion liters for bio-diesel (DNV 2010) as the basics of our analysis, an eleven year period from now.

5.2 The effect of the increasing commercial transportation of liquid bio-fuel s on capacity in the tanker market.

The NLS tanker market is highly flexible. Though all our respondents agreed to a future increased commercial transportation of bio-ethanol and bio-diesel, they on the other hand doubt the possibility of an increased competition for capacity as a result of their increased commercial transportation. They explain that, the tanker market is flexible enough to respond to demand. Established earlier in the theoretical background, is the fact that the revised MARPOL Annex II (2006) and the IBC code (2007) named Type II and III ships among NLS tankers as the most appropriate for the transportation of bio-diesel and bio-ethanol respectively.

A careful study of the past and the projected trade figures for bio-ethanol and bio-diesel reveals that, though growth in production and international trade of bio-ethanol and bio-diesel is expected. More production and international trade is expected of bio-ethanol compared to bio-diesel. As illustrated in Figure 1.3, whereas 2020 transport fuel demand for bio-ethanol is 4.0 million tons, bio-diesel is only 1.3 million tons (Franziska Muller-Langerc *et al*, 2008). A research by DNV further strengthen this observation by quoting the projected yearly figures of bio-ethanol and bio-diesel by the year 2022-154 billion liters (54, 384,587 tons) for bio-ethanol and approximately 67 billion liters which is (23, 660, 826 tons) for bio-diesel (DNV, (2010). Given this observation and the fact that these two substances have different carriage requirements, we examine the individual trades separately as their implications could be different.

5.2.1 Capacity issues regarding bio-ethanol transportation

The revised MARPOL Annex II (2006) and the IBC code (2007) require Type III tankers for the transportation of bio-ethanol. As per the demands of the revised MARPOL Annex II (2006) and the IBC code (2007), world shipping capacity available for the transportation of bio-ethanol of more than 300 GT retrieved from the IHS world shipping encyclopaedia as of the 14th of April, 2011 is about16,000,000 GT for ships in service and 530,571GT for ordered ships. This excludes combination carriers such as IMO Type I, III and Type II, III tankers. This is because their specific capacity available for the transportation of bio-ethanol cannot be readily known. Comparing the yearly quantities of bio-ethanol shipped in the previous years-3,757 million liters (1,326,772 tons) for 2006, 2,544 million liters (89, 8405 tons) for 2007 and 2,799 million litters (98, 8457 tons) for 2008 (Bradley *et al*, 2009) and the projected yearly value by 2022-154 billion liters (54, 384,587 tons) (DNV, 2010), it can be seen that the future expects to see a huge increase in the transportation of bio-ethanol as argued above. Evaluating the supply of ships as of the day we extracted the data from the world shipping encyclopaedia (14th of April, 2011). It can be said that Type III ships hold in total a huge capacity.

Respondent 1(Swedish Ship owner) said that "several of present projects involve very long voyages for relatively small vessels which take away capacity from the market". But our study reveals that, Coaster tankers which are the smallest category in this paper have a total fleet of 752 ships summing up to 3,639,021GT. Also we see that Type III ships as of the day we extracted the data from the world shipping encyclopaedia (14th of April, 2011), had a good distribution of tankers in the Handy-size and Panamax section to accommodate the increasing commercial transportation of bio-ethanol, with other competing substances like sodium acetate solutions mentioned in chapter 18 of the IBC.

5.2.2 Capacity issues regarding bio-diesel transportation

The revised MARPOL Annex II (2006) and the IBC code (2007) require Type II tankers for the transportation of bio-diesel. To satisfy the demands of the revised MARPOL Annex II (2006) and the IBC code (2007), world capacity in service, available for the transportation of bio-diesel of more than 300 GT retrieved from the IHS world shipping encyclopaedia was about 12,000,000 GT while the order books recorded 537,256 GT. This also excludes combination carriers such as IMO Type I, II tankers as the specific capacity available for the transportation of bio-diesel cannot be readily known. Considering the yearly quantities of bio-diesel shipped in the previous years between 2006 and 2008 as observed from Table: 3.9 being 358,090 tons (Bradley *et al*, 2009) and the projected yearly value by 2022 23, 660, 826 tons (DNV, 2010), it can be seen also here that, the future expects to see a huge increase in the transportation of bio-diesel. Evaluating the supply of ships as of the day we extracted the data from the world shipping encyclopaedia (14th of April, 2011). It can also be said that Type III ships hold in total a huge capacity.

Respondent 2 (Danish ship owner) established that "there are few tankers capable of transporting bio-fuel due to limited quantities for transportation". We however notice that not only did Type II ships have a huge capacity available, but also have a good distribution as stated earlier among the various tanker fleet sizes to accommodate the increasing commercial transportation of biodiesel-206 ships with a total GT of 694,183 are Coasters. 167 ships having a total GT of 3,561,299 are Handy-size. 396 ships with a total GT of 11,148,924 are Panamax. Lastly 17 ships with total GT of 696,123 are Afromax.

The Porters framework shows that the supply of NLS tankers is highly flexible. Porter (2008) established that the nature of competition is embodied in five competitive forces. These are: the threat of new entrants, the threat of substitute products or services, the bargaining power of suppliers, the bargaining power of buyers and the rivalry among the existing competitors (Porter, 1990). However in this paper where our interest is to analysis competition for capacity in the NLS tanker market and not profitability, our focus will primarily be on the threat of new entrants, the rivalry among the existing competitors and the threat of substitute products or services as they directly serve the purpose here.

The threat of new entrants: In this context, the threat of new entrants will be the supply of Type II and III vessels to trade in the transportation of bio-diesel and bio-ethanol respectively. As established by our respondents, the tanker market is flexible in terms of tonnage supply. The IBC code (2007) explains that a ship which has no IMO chemical classification can be upgraded to transport NLS. The ship will have to also pass a survey to obtain the appropriate certification like International Pollution Prevention Certification for the Carriage of Noxious Liquid Substance in Bulk to also transport bio-diesel and bio-ethanol. From Table 3.5, we observe that 1,954 tankers in service as of the day we extracted the data (14/04/2011), making up a total of 32,916,378 GT are without IMO classification: thus Type I, II or III ships. Out of these, Coasters were 1,076 with a total GT of 4,000,373. Handy-size tankers were 200 with a total GT of 3,383,610.

Panamax were 366 with a total GT of 10,367,090. Afromax were 299 with a total GT of 9,855,568. Lastly Seuzmax were 86 with a total GT of 5,309,737. This means that, they can be a good source of potential threat of entry by upgrading and obtaining the International Pollution Prevention Certification for the Carriage of Noxious Liquid Substance in Bulk. Ordered tankers without IMO classification can also be a source of threat of entrant. Lastly other tankers outside the category of NLS can also be argued as a good source of entry. This is because of the possibility to convert or upgrade the tanker into an NLS tanker. This analysis explains what respondent 6 (Swedish ship owner) stated that bio-fuel will increase to take up the capacity of crude tankers. ABS (2006) also explains that, the conversion into NLS tanker depends on the ship and the category of substance that the ship will want to transport after conversation. Conversion into Type II ships has strict measure as the transportation of such substance poses severe environmental hazards. As a result entrants are limited in this direction compared to Type III tankers.

From the analysis above, we see that Type II and III tanker have a very high potential threat of entry from tankers under construction, NLS tankers without IMO classification and other tanker such as crude tanker.

Rivalry among existing competitors: In the case of this paper, rivalry among existing competitors is how bio-ethanol and bio-diesel will compete with other category Y and Z substances listed in chapter 17 and 18 of the IBC code for capacity. Some examples of competitors include Dodecyl Alcohol and Acrylonitrile for bio-diesel and Diethylene Alcohol and Ethylene carbonate for bio-ethenol (IBC code, 2006).

Among the substances listed in chapter 17 and 18 of the IBC code, bio-ethanol and bio-diesel have in the last decade recorded increasing commercial transportation compared to the others, as countries continue to find ways to reduce the use of fossil fuel in the road transport sector. As a result rivalry among competing substances for capacity will be low. This is because, as analysed above NLS tankers particularly Type II and III have a huge capacity and high potentials of entry, to provide enough capacity for the commercial transportation of these products.

Threat of substitute products or services: Here substitute service implies other equally efficient substances that Type II and III ships can be used in their transportation. These substances include other chemicals and clean petroleum products that are transported on the regular basics globally. We learn that clean petroleum products and crude oil constitutes about one third of world trade (UNCTAD, 2009). Since clean petroleum products and chemicals use tankers in their transportation, and are also traded internationally in commercial quantities, it is possible to substitute the capacity of bio-ethanol and bio-diesel for the transportation of these products. This makes threat of substitutes is very high.

We realise from the analysis using the Porters framework that, the tanker market is highly flexible as stated by our respondents. This is because it has a high threat of entry which makes it possible for capacity to be increased any time needed, it has low rivalry among exiting competitors and a high threat of substitute which can take away capacity, and as such affect the freight rate in the transportation of bio-ethanol and biodiesel.

5.3 The effect of the increasing commercial transportation of liquid bio-fuel s on freight rates in the tanker market

(67%) of our respondents agreed that the increasing commercial transportation of liquid bio-fuel (bio-ethanol and bio-diesel) will affect the tanker market in relation to its freight rates, the other (33%) disagreed. Arguments presented in support of changes in freight rate includes, the revised MARPOL Annex II(2006) and the IBC code (2007) required some types of ships which will take away tonnage from the market with respect to the transportation of these products. The motivation for the other (33%) was that, there was over supply of tonnage.

5.3.1 Establishment of freight rates

Freight rate in a perfect competitive market like NLS tanker market is as a result of demand and supply. (McConville, 1999) argued that, though there is no perfect competitive market, the tanker market could be argued as a close one. This is because, it satisfies most if not all of the basic assumptions that unpin a perfectly competitive market described earlier: large number of firms, with free entry and exist and each firm producing homogeneous services, without any government influence.

The tanker market is a truly international industry with numerous ship owners all over the world providing the basic service of transporting liquid cargo in bulk from one port to the other in return for a fee. Notable ship owning nations include Panama and Liberia. Operators are countries and individual firms that produce and trade internationally liquid cargo in bulk. Some examples of liquid cargo in bulk are refined crude oil, bio-ethanol and biodiesel. Resource mobility in the tanker market is in the form of shipping building and purchase of tankers on the second market for the entry side, while exit takes places in the form of selling ships, sending for scrap or even laying up the vessel. The presumption here is that laying up is to exit the market, because vessels are temporarily taken of the market (McConville, 1999).

Microeconomics perceives perfect competition as an elaboration of Marshall's demand and supply analyzes, and provides insight into how equilibrium prices, being freight rate in the shipping industry is fixed. This is a confirmation of Stopford (1993) establishment that, the charter market is a very competitive place where freight rate can drastically change anytime depending on the supply and demand for shipping capacity.

Discussed above is the fact that, the tanker market can be grouped as a close perfect competitive market, where the price theory is the main tool in the allocation of resources such as freight rates. In transport economics, the supply of vessels is made up of new construction, scrapping, changes in speed and laying up of vessels (McConville, 1999), summed up as the vessels in service and on order at any given period of time. However demand is of derived nature. This means that the demand for transport services depends on the need to move products from one place to the other at anytime. An example is the need to transport products like bio-ethanol and biodiesel. Ceteris paribus, freight rate in the NLS tanker market is the interaction between demand which is NLS substances to be transported and supply which is shipping capacity as explained above.

5.3.2 The effect of change in demand of bio-ethanol and bio-diesel

We learned from figure 3.7 that a change in demand possess the potential of establishing a new equilibrium price (freight rate).This is when there is a movement either inward or outward of the demand curve as a result of demand factors, other than the price of the commodity in question. In the case of bio-ethanol and diesel, we observe that, there would be a huge outward movement in world demand for their transportation-from 2,722 million liters in 2008 to 154 billion liters by 2022 (DNV 2010) for bio-ethanol and 1,104 million liters to 67 billion liters (DNV, 2010) for bio-diesel not because of their prevailing freight rates, but as a result of other demand factors such as policies to curb soaring oil prices and also to mitigate climate change. Giving the supply of tankers at any time, this outward movement in the demand for the transportation of bio-ethanol and bio-diesel can cause the establishment of a new equilibrium price (freight rates) in the market. This proves why (67%) of our respondent agreed that, the increasing commercial transportation of liquid bio-fuel (bio-ethanol and biodiesel) will affect the tanker market in relation to its freight rates.

A further study reveals that, the rate at which the old equilibrium price (freight rate) will be affected depends on the percentage of change in demand. That is, if the change in demand is very small, it cannot have an effect on the old equilibrium price (freight rate). On the other hand, if the change in demand is large, there will be the establishment of a new equilibrium price (freight rate). Taking into considering the previous trade for bio-ethanol and bio-diesel and the projected figures from DNV-2,722 million liters in 2008 to 154 billion liters by 2022 (DNV 2010) for bio-ethanol and 1,104 million liters in 2008 to 67 billion liters by 2022 (DNV 2010) for biodiesel. This reveals that the change in demand in the transportation of bio-ethanol and bio-diesel over this eleven year period is huge, and as such can affect the market freight rate in the establishment of a new one.

Established earlier is the fact that the revised MARPOL Annex II (2006) and the IBC code (2007) requires Type II and III ships for the transportation of bio-diesel and bio-ethanol as stated by (67%) of our respondents in support of their arguments, as basics for a change in freight rate. However it was realized in our analysis made earlier regarding the increasing commercial transportation of bio-ethanol and capacity that, NLS tankers particularly Type II, and III ships has a very large GT in service and in the order book at of the day we extracted the data (14/04 /11), with also a very high degree threat of entry as explained in the Porters five forces which even makes it possible for the supply of shipping capacity to be increased whenever necessary.

As analysed above the percentage increase in the coming years in the demand to transport bio-ethanol and bio-diesel is significant enough to cause the establishment of a new market freight rates. However as stated above, the tanker market has been analysed to be a close perfect market, having a high potential threat of entry with a very large GT to accommodate growth in demand. This means that at any time if the freight rate should raise unfavourably supply will also increase by that same margin to take out the new profit margin till the old equilibrium is achieved again. This analysis confirms what our respondent stated, as the market mechanics of the shipping industry will be used to cope with the new challenges of the increasing commercial transportation of liquid bio-fuel.

5.4 The standard and regulations for bio-ethanol and bio-diesel commercial transport

The smooth operation and success of any industry depends on the standards and regulations set out to guide the industry. The shipping industry is one of such volatile industry and as such prone to frequent changes in its operations and hence frequent changes to its standards and regulations. There are some standards and regulations set out for the transportation of bio-ethanol and bio-diesel that is The International Convention for the Prevent of Pollution from Ships (MARPOL) developed by IMO in 1973 and revised in 1978 to deal with pollutions that stems from operations and accidents in the marine environment. As the industry is used to regulatory modifications there has been revisions to the MARPOL in 2004 and also in 2007. There is also the IBC code which came into force hand in hand in 2007 with the revised MARPOL Annex II.

It is interesting to know the effects of regulatory changes on the players in the industry. Hence this study supports its analysis through the views of the players of the shipping industry on how an increased commercial transportation of bio-fuel could affect the standards and regulations on their operations in the tanker market. Their responses reveal that bio-fuel and all its various components have been effectively dealt with through the recent reclassification of the MARPOL Annex I and II, as well as the IBC code. Also there was a major regulatory revamp enacted in 2004 and took effect in 2007 as a result there will be no impact on the market with an increasing transportation. As the industry has become used to frequent changes in its standards and regulations, no impact will be felt in its operations but even if any marginally. The tanker industry is used to adapting to changing regulations by conversions or ordering of new ships in accordance with the new specifications. With these reasons a strong 83% of the respondents stated that they are not concerned that an increased commercial transportation of bio-fuel may require changes in the current safety and fire standard, MARPOL Annex I and II regulations and also the industry is always prepared for its challenges.

5.5 Analysis review

Although the purpose of the research is to investigate how the increasing commercial transportation of bio-ethanol and bio-diesel will affect the tanker market by conducting open-ended questionnaire to support the theories used in our analysis.

The study refers to theories, as a result our analysis maybe different from our respondents' point of view. It is interesting to also point out that, the survey constitutes a very small fraction of the tanker market. As a result the conclusion presents only the findings of this work giving the conditions under which it is carried.

5.6 Summary of analysis

This part of the paper presents a sum-up of the analysis on the theories, literatures and findings from the study.

Study by IEA (2010) shows that the usage of bio-ethanol and bio-diesel is growing as the best alternative fuel for road transportation gradually worldwide. Also, research by DNV (2010) predicts a yearly approximated production of 154 billion litres of bio-ethanol and 67 billion litres of bio-diesel by the top 14 bio-fuels producing countries by 2022. Research conducted by Market Research Analyst (2008) presents projected figures for bio-ethanol and bio-diesel from 2008 to 2012, an analysis of the figures shows that the projected figures from 2008 to 2010 fall within actual world production. These study's shows a growing production for bio-fuels and hence a concern for their transportation. The respondents for this study also see a future commercial transportation of bio-ethanol and bio-diesel, as a result of its potentials for the road transport and its increasing production. Studies reveal that due to worldwide policies, more production and international trade is expected of bio-ethanol compared to bio-diesel, and from Figure 1.3, the 2020 transport fuel demand for bio-ethanol is 4.0 million tonnes but bio-diesel is only 1.3 million tonnes.

MARPOL Annex II and the IBC code named Type II and III ships among NLS tankers are the most appropriate for the transportation of bio-diesel and bio-ethanol respectively. MARPOL Annex II and the IBC code, world capacity in service, available for the transportation of bio-diesel of more than 300 GT retrieved from the IHS world shipping encyclopaedia as of the 14th of April, 2011was about 12,000,000 GT. Type II and III ships in total hold a huge capacity and operate in a very flexible market. Also Type III ships as of 14 of April 2011, had a good distribution of tankers in the Handy-size and Panamax section to accommodate the increasing commercial transportation of bio-ethanol, with other competing substances like sodium acetate solutions mentioned in chapter 18 of the IBC.

The study adopted Porter (2008) which establishes that the nature of competition is embodied in five competitive forces but the focus will primarily be on the threat of new entrants, the rivalry among the existing competitors and the threat of substitute products or services. The tanker market is flexible in terms of supply of tonnage hence; Type II and III tanker have a very high potential threat of entry from tankers under construction, NLS tankers without IMO classification and other tanker such as crude tanker. One notable threat of substitute to the commercial transportation of bio-ethanol and bio-diesel is other oil substances. Among the substances listed in chapter 17 and 18 of the IBC code, in the last decade only bio-ethanol and bio-diesel has recorded increases in their commercial transportation.

McConville (1999) argued that, though there is no perfect competitive market, the tanker market could be argued as a close one, as it satisfies most if not all of the basic assumption that unpins a perfectly competitive market (large number of firms, with free entry and exist and each firm producing homogeneous services, without any government influence). Freight rate in the shipping industry and the NLS tanker market is as a result of the interaction between demand and supply. Stopford (1993) stated that the charter market is a very competitive place where freight rate can drastically change anytime depending on the supply and demand for shipping capacity.

Bio-fuel and all its various components have been effectively dealt with through the recent reclassification of the MARPOL Annex I and II, as well as the IBC code. Also there was a major regulatory revamp enacted in 2004 and took effect in 2007 as a result there will be no impact on the market with an increasing transportation. As the industry has become used to frequent changes in its standards and regulations, should there be any changes to its standards and regulations due to commercial transportation of bio-ethanol and bio-diesel, no impact will be felt in its operations but even if any marginally. The tanker industry is used to adapting to changing regulations by conversions or ordering of new ships in accordance with the new specifications.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

This chapter ends the study with a consolidation of the overall findings obtained from the research study and also compile recommendations where applicable for future researchers and practitioners within the shipping industry.

6.1 Conclusion

The recent soaring oil prices, energy insecurity, encouraging government policies for the usage of bio-fuel in the road transport industry, growing concerns about the environment and the interest in reducing all unsustainable practices, explains why our survey from the respondents had a (100%) YES response rate, on the question if the increasing commercial transportation of bio-ethanol and bio-diesel will be sustainable in the future. Though the study reveals that the future will see more of bio-ethanol and bio-diesel transportation, (87%) of our respondents were not concerned about the fact that the increasing commercial transportation of bio-ethanol and bio-diesel might call for changes in the revised MARPOL Annex II. The reasons they gave is that the revised MARPOL Annex II (2006) has covered all regulatory aspects of bio-ethanol and bio-diesel.

The revised MARPOL Annex II (2006) and the IBC code (2007) named Type II and III ships for the transportation of bio-ethanol and bio-diesel. Our study reveals that Type II and II ships have a large GT and a good distribution of the tanker fleet among Coaster, Handy-size, Panamax, Seuzmax. The analysis using the porter's framework also reveals that Type II and III ships have a high threat of entry, high threat of substitutes and a low rivalry with competing products. These shows that Type II and III ships have a flexible structure that makes it possible for capacity to be increased and decreased when needed. As a result, our study reveals that the increasing commercial transportation of bio-ethanol and bio-diesel will not a major effect in the NLS, but more tankers will convert into Type II and III as the trade in bio-ethanol and bio-diesel continues to grow.

The analysis using change in demand reveals that, the projected change in demand for bio-ethanol and bio-diesel is very large enough to cause a change in freight rate. We also learn that the supply of Type II and III ships is very flexible to increase as demand increases, thereby preventing the establishment of higher freight rate. However any time the supply of tankers become more than the demand to transport NLS (bio-ethanol and bio-diesel) freight rates will be affected negatively.

The demand for transport is of derived nature. Meaning the need to transport liquid cargo in bulk at anytime depends of the global economy. In this case given the supply of vessels at any time, the impact of the increasing commercial transportation of bio-ethanol and bio-diesel will be very significant in terms of capacity and freight rates, if there is a corresponding increase in the demand for the transportation of its competing substances listed in chapter 17 and 18 of the IBC code and other oil substances that are transported as liquid cargo in bulk.

6.2 Recommendations for further studies

The International Maritime Organisation has given up to the years 2015 for single hull tankers to be removed off the market. It will be interesting to see how Type II and III ships could be affected.

According to Heinimo & Junginger (2009) the amount of directly traded liquid bio-fuel is increasing strongly, especially in the European Union and the United States of America from Brazil for bio-ethanol and Argentina for biodiesel. Extensive research could be carried on specific routes like from Brazil to Europe for bio-ethanol, and from Argentina to Europe for bio-diesel on the implications of the increasing commercial transportation of bio-ethanol and bio-diesel.

The shipping industry should try to direct researchers to accurate problems that the industry faces so that solutions can be found together, which will provide better opportunities for the industry and students as well.

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Appendix

Table 1: showing the pollution category and ship type of the reclassified substances, both the old and the revised from IBC code chapter 17.

Product	Pollution Category		Ship Type	
	Current	Revised	Current	Revised
Acetic Acid	D	Z	3	3
Acetone	III	Z	Chapter 18	Chapter 18
Acrylonitrile	B	Y	2	2
Benzene	C	Y	3	3
Coconut Oil	**D**	**Y**	**Chapter 18**	**2(k)***
Coconut Oil Fatty Acid	**D**	**Y**	**Chapter 18**	**2**
Dodecyl Alcohol	**B**	**Y**	**3**	**2**
Ethanolamine	D	Y	3	3
Ethyl Acetate	**D**	**Z**	**Chapter 18**	**3**
Ethyl Acrylate	A	Y	2	2
Ethyl Alcohol	III	Z	Chapter 18	Chapter 18
Ethylbenzene	**B**	**Y**	**3**	**2**
Ethylene Cyanohydrin	(D)	Y	3	3
Ethylenediamine	C	Y	2	2
Ethylene Dichloride	B	Y	2	2
Ethylene Glycol	**D**	**Y**	**Chapter 18**	**3**
Fatty Acid (Saturated C13+)	**III**	**Y**	**Chapter 18**	**2**
Formic Acid	D	Y	3	3
Furfural	C	Y	3	3
Furfuryl Alcohol	C	Y	3	3
Heptene (All Isomers)	C	Y	3	3
Hexamethylene Diamine Solution	C	Y	3	3
Hexane (All Isomers)	**(C)**	**Y**	**3**	**2**
Hexanol	**D**	**Y**	**Chapter 18**	**3**
Hexene (All Isomers)	(C)	Y	3	3
Isopropyl Alcohol	III	Z	Chapter 18	Chapter 18
Methyl Alcohol	**D**	**Y**	**Chapter 18**	**3**
Methyl Ethyl Ketone	**III**	**Z**	**Chapter 18**	**3**
Methyl Isobutyl Ketone	**D**	**Z**	**Chapter 18**	**3**
Methyl Methacrylate	D	Y	2	2

Product	Pollution Category		Ship Type	
	Current	Revised	Current	Revised
Methyl Tert-Buytl Ether (MTBE)	**D**	**Z**	**Chapter 18**	**3**
Molasses	III	OS	Chapter 18	Chapter 18
Nonene (All Iisomers)	**B**	**Y**	**3**	**2**
Octanol (All Iisomers)	**C**	**Y**	**3**	**2**
Olefins (C5-C7) **	**C**	**Y**	**3**	**3**
Olefins (C5-C15) **	**B**	**X**	**3**	**2**
Olefins (C13+, All Isomers)		**Y**		**2**
Palm Kernel Oil	**D**	**Y**	**Chapter 18**	**2(k)***
Palm Oil	**D**	**Y**	**Chapter 18**	**2(k)***
Palm Olein	**D**	**Y**	**Chapter 18**	**2(k)***
Palm Stearin	**D**	**Y**	**Chapter 18**	**2(k)***
Paraffin Wax	**III**	**Y**	**Chapter 18**	**2**
Pentene (All Isomers)	C	Y	3	3
Perchloroethylene	**B**	**Y**	**3**	**2**
Phenol	C	Y	2	2
Phosphoric Acid	D	Z	3	3
Pine Oil	**C**	**X**	**3**	**2**
Potassium Hydroxide Solution	C	Y	3	3
Propyl Benzene (All Isomers)	A	Y	3	3
Propylene Glycol	III	Z	Chapter 18	Chapter 18
Rapeseed Oil	**D**	**Y**	**Chapter 18**	**2(k)***
Sodium Hydroxide Solution	D	Y	3	3
Soyabean Oil	**D**	**Y**	**Chapter 18**	**2(k)***
Styrene Monomer	B	Y	3	3
Sulphuric Acid	C	Y	3	3
Sunflowerseed Oil	D	Y	Chapter 18	2(k)*
Tall Oil, Crude ***	**(C)**	**Y**	**3**	**2**
Tall Oil, Distilled ***	**(C)**	**Y**	**3**	**2**
Tall Oil Fatty Acids ***	**(C)**	**Y**	**2**	**2**
Tall Oil Pitch ***		Y		2
Tallow	**D**	**Y**	**Chapter 18**	**2(k)***

Product	Pollution Category		Ship Type	
	Current	Revised	Current	Revised
Tetrahydrofuran	D	Z	3	3
Toluene	C	Y	3	3
Toluene Diisocyanate	C	Y	2	2
Trichloroethylene	**C**	**Y**	**3**	**2**
Triethanolamine	D	Z	3	3
Urea/Ammonium Nitrate Solution	**D**	**Z**	**Chapter 18**	**3**
Urea Solution	**III**	**Z**	**Chapter 18**	**3**
Vegetable Acid Oils*** (m)****		Y		2
Vegetable Fatty Acid Distillates*** (m)****		Y		2
Vinyl Acetate	C	Y	3	3
Xylenes	**C**	**Y**	**3**	**2**

Table 7.2.2: showing the pollution category and ship type of the reclassified substances, both the old and the revised from IBC code chapter 18.

Chapter 18	
Substance	**Category**
Acetone	Z
Alcoholic beverages, n.o.s.	Z
Apple juice	OS
n-Butyl alcohol	Z
sec-Butyl alcohol	Z
Clay slurry	OS
Coal slurry	OS
Diethylene glycol	Z
Ethyl alcohol	Z
Ethylene carbonate	Z
Glucose solution	OS
Glycerine	Z
Glycerol monooleate	Z
Hexamethylenetetramine solutions	Z
Hexylene glycol	Z
Isopropyl alcohol	Z
Kaolin slurry	OS
Magnesium hydroxide slurry	Z
N-Methylglucamine solution (70% or less)	Z
Methyl propyl ketone	Z
Molasses	OS
Noxious liquid, (11) n.o.s. (trade name ...., contains ....) Cat. Z	Z
Non-noxious liquid, (12) n.o.s. (trade name ...., contains ....) Cat. OS	OS
Polyaluminium chloride solution	Z
Potassium formate solutions	Z
Propylene carbonate	Z
Propylene glycol	Z
Sodium acetate solutions	Z
Sodium sulphate solutions	Z
Sulphonated polyacrylate solution	Z
Tetraethyl silicate monomer/oligomer (20% in ethanol)	Z
Triethylene glycol	Z
Vegetable protein solution (hydrolysed)	OS
Water	OS

Questionnaire

TOPIC: EXPLORING THE PLAUSIBLE IMPACTS OF INCREASING COMMERCIAL TRANSPORTATION OF BIO-FUEL ON THE TANKER MARKET.

Background Information: This study is a partial requirement for the award of Master of Science in Logistics and Transportation Management from the Gothenburg University, Sweden. The research topic will be analyzed based on freight rates, competition for space with existing commodities in the same market and how standards and regulation within the market could be affected. The outcome of this research will help the shipping industry when it starts transportation of bio-fuel (*bio-ethanol and bio-diesel*) on an increasing commercial basis. The results would be presented as general view which cannot be traced to individual respondents. Since your response is vital for the reliability of the results of this study and its subsequent recommendations, we humbly ask you to answer the questions as honestly as possible. We will be delighted to send you a copy of the report. Thanks!!

General Question on the subject

1. Do you see a future for increasing commercial transportation of bio-fuel?
   a. Yes ( )   No ( )   Don't know ( )
   b. Please motivate your answer…………………………………………………………

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      ……………………………………………………………………………………………
      ……………………………………………………………………………………………

Questions on increased competition for space in the tanker market

2. Do you think there would be increased competition in the tanker market through an increasing commercial transportation of bio-fuel?
   a. Yes ( )   No ( )   Don't know ( )
   b. Please motivate your answer………………………………………………………

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3. What impacts would the increased competition have on the tanker market? ...….......................…………………………………………………………………………
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4. In your opinion what strategies would the tanker market require to cope with the increased competition?

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<u>Questions on freight rates about the tanker market (chemical and product tanker segment)</u>

5. Do you think the increasing commercial transportation of bio-fuel would have an impact on freight rates in the tanker market?
   a. Yes ( ) No ( ) Don't know ( )
   b. Please motivate your answer…………………………………………………

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   …………………………………………………………………………………………
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6. What impacts would the changes in freight rates have on the tanker market? ....……………………………

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7. What strategies would the tanker market require to cope with the freight rates impact

<u>Questions on how increased commercial transportation of bio-fuel could affect standards and regulation in tanker market</u>

8. Are you concerned that the increased commercial transportation of bio-fuel may require changes in the current safety and fire standard, and MARPOL Annex I and II regulation?

    a. Yes ( ) No ( ) Don't know ( )

    b. Please motivate your answer…………………………………………………

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9. What impacts would the changes in the standard and regulation have on the tanker market? ....

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10. How would the tanker market cope with the new challenges of the standard and regulation? ....