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στην

ΝΑΥΤΙΛΙΑ

DEVELOPMENT OF TANKER SHIPPING OVER THE LAST 20 YEARS

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Διπλωματική Εργασία

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Abstract

We live in a world where people started to trade different kinds of goods since the ancient years. Many of these people began to think that they had to find a way allowing them to import and export goods at the place they lived and satisfy their needs (Chrzanowski, I., 2002). It is common knowledge that there are countries that do not produce all the kind of goods that their people require in order to satisfy their needs and therefore one should find a means of transport in order to transport different kind of commodities from one place to another. Faced with this problem, people thought that the best solution for this problem would be the use of vessels and the carriage of goods by sea.

The sea transport from the early ages until our era continues to be a means of transport which can offer some reliable solutions for the transport of different cargoes around the world and sometimes these transports may be realized in a quick transit time. All analysts who are focused on the shipping industry have observed that since the beginning of the trade by sea, there is a development in the way that these transports are made and also a development at the vessels which affected and continue to affect the transports realized.

During the development of sea transport, vessels and services have been categorized, in order to guarantee better performance and in order for ship-owners be in a position to choose the best suitable seafarers for their ships. However, irrespective of the vessels that will be used according to the sea transport of each commodity, there is also a sector inside shipping industry which is concerned with the development and operation of tankers during the last 20 years.

Thirty seven percent of the world wide dead weight tonnage (DWT) is located on the tanker sector, dealing with the profitable trade of oil. The use of such vessels is imperative for the transport of liquid products in bulk, such as oil and its derivatives. Tanker vessels have several peculiarities that we will in the present try to underline and explain, in order to understand the differences and evolution of their intended use over the last twenty years.

1. Introduction

Shipping is considered to be one of the most interest aspects of worldwide trade. All those years of shipping operations, people have realized that it concerns a variety of duties and responsibilities that should be taken in order to effectively complete the various operations included. As there are different types of ships that are used in order to cover the needs to transport various cargoes at the time, it should be stressed that there are also different modes of operation that need to be effected for each type of transfer.

Currently, the most common ships which are used for the transport of goods by sea are those of bulk carriers (figure 1) and tankers (figure 3). Of course there are also some ships that are characterised as special ones, and those might include Ro-Ro passenger ships (figure 5), liquefied natural gas (LNG) carriers (figure 2), liquefied petroleum gas (LPG) carriers (figure 4), reefer (figure 6), containerships (figure 7), etc (Huges, L., 2002).

Figure 1 [1]

Figure 2 [2]

Figure 3 [3]

Figure 4[4]

Figure 5 [5]

Figure 6 [6]

Figure 7 [7]

[1] http://paul.kedrosky.com/WindowsLiveWriter/BulkCarriersFrom91000DaytoZeroinFiveMont_787B/bulk_2.jpg
[2] http://www.kline.co.jp/news/2006/060215.gif
[3] http://img.nauticexpo.com/images_ne/photo-g/cargo-ship-chemical-tanker-194832.jpg
[4] http://www.uniqueship.com/Portals/9/Images/Oriental_Queen_2004.jpg
[5] http://www.traderscity.com/board/userpix22/20536-passenger-car-truck-ferry-boat-roro-ropax-barge-cargo-ship-crane-pusher-1.jpg
[6] http://img.nauticexpo.com/images_ne/photo-g/reefer-ship-194830.jpg
[7] http://www.j-mcapital.co.uk/containerships.jpg

Each of these vessels requires the management of different operations and of types of charter contracts and conditions, as they transport various commodities and their ship-owners need to employ experienced crew and managers ashore.

Of course, the days that entrepreneurial people and especially ship-owners were considered as most efficient with respect to shipping investments seem to belong in the past. More specifically, it could be argued that the world of shipping and the market of tankers carriers are going through a difficult financial situation that has made most of ship-owners that used to operate their ships in such market to sell or even stop their shipping transports. Their major concern is to find the most efficient way to overcome this crisis.

Shipping is considered to be a private and very competitive industry worldwide. The activities occurring in this industry are divided into various categories, such as liner service, tramp shipping, industrial service or tanker operation and each of them operate on specific established routes. According to Bloor, M., Thomas, M. and Lane, T., (2000), the prosperity of shipping is however very much dependent on a healthy world economy and a stable situation in the hinterland of the world ports and the overall financial situation.

The exact number of shipping companies which exist and operate worldwide, cannot actually be calculated. This is mainly due to the existence of law regulations in various countries, according to which it is very easy for someone to set up and operate a shipping company in these jurisdictions. However, this often leads to the establishment of inactive companies. Moreover, the large number of shipping companies is also justified by the fact that each vessel belongs to a different shipping company.

Tanker shipping is a major part of this market and ship-owners in different countries around the world are called to take the most appropriate decisions so as to overcome any eventual crisis and lead their companies in the path of success and development. The crisis is mostly affecting the market of tanker carriers and there are actually many ship-owners who are obliged to adopt and apply alternatives and policies in order to overcome its adverse effects. Chartering contracts in such cases are those deemed to play characteristic role in the employment of ships and the profits that will be generated to ship-owners after their operation. The main purpose of this dissertation, is to present

and analyze accordingly all the principles which are mentioned and found in the tanker market and most of the times those principles are being modified on the basis of the developments and recent operations in the area of shipping.

2. Literature Review

2.1 Definition of a Tanker Ship

An oil tanker, which is also known as a petroleum tanker, is a ship designed for the bulk transport of oil. There are two basic types of oil tankers, i.e. the crude tanker (figure 8) and the product tanker (figure 9) (Alderton, Patrick, 2004).

Figure 8 [8]

Figure 9 [9]

Crude tankers also transport some large quantities of unrefined crude oil from its point of extraction to refineries. The product tankers are generally much smaller and are designed to move petrochemicals from refineries to points near consuming markets.

Oil tankers are often classified by their size as well as their occupation. The size classes range from inland or coastal tankers of a few thousand metric tons of deadweight (DWT) to the mammoth ULCCs of 550,000 DWT. Tankers move approximately 2,000,000,000 metric tons (2.2046×109 short tons) of oil every year (Alderton, Patrick, 2004). In advance only to pipelines in terms of efficiency, the average cost of oil transport by tanker amounts to only two or three United States cents per 1 US gallon (3.8 L) (Alderton, Patrick, 2004).

There are also some specialized types of oil tankers which have evolved over the years. One of these is the naval replenishment boiler, a tanker which can fuel a moving vessel (Alderton, Patrick, 2004). A combination ore-bulk-oil carriers and permanently moored floating storage units are two other variations on the standard oil tanker design.

[8] http://www.msnbc.msn.com/id/14352482/
[9] http://img.alibaba.com/photo/108279488/Product_Tanker.jpg

The oil tankers have been involved in a number of damaging and high-profile oil spills and as a result, they are subject to stringent design and operational regulations (Alderton, Patrick, 2004).

Moreover, concerning the tanker vessels, we could say that a tanker is a ship which is designed to transport liquids in bulk. Tanker vessels can nowadays range in size of capacity from the several hundred tons which can also include vessels for the servicing of small harbors and coastal settlements, to several hundred thousand tons and for long-range haulage. There is a wide range of products which are also carried by tankers and those include commodities such as the hydrocarbon products which are the oil, the liquefied petroleum gas (LPG) and the liquefied natural gas (LNG), the chemicals which are products such as ammonia, chlorine and styrene monomer and products such as the fresh water and the wine (Alderton, Patrick, 2004).

It should be noted that there is one major difference that someone could observe at first sight and this is of course the structure of those vessels, whereas from a distance it is possible to confuse a bulk carrier for an oil tanker. Although, bulks and tankers are divided into a series of huge cargo holds, the bulk carriers have hatch covers which have to be opened when cargo is loaded and discharged. Those can extend almost the width of the ship and in advance can represent a point of weakness in the hull structure of the bulk carriers.

One important operation of a tanker concerns its loading (figure 10) and unloading (figure 11) procedures of bulk liquids.

Figure 10 [10]

Figure 11 [11]

[10] http://img.nauticexpo.com/images_ne/photo-g/marine-loading-arm-with-separate-fluid-line-190808.jpg

[11] http://img.nauticexpo.com/images_ne/photo-g/marine-loading-arm-double-counterweight-190771.jpg

The loading and the discharging of bulk liquids in a tanker must be pumped, whereas the development of efficient pumps and piping systems are vital for the development of the tanker. The Steam engines are developed as prime movers for early pumping systems. Some specific dedicated cargo handling facilities are now required ashore as huge quantities of bulk cargoes have to be loaded and discharged everyday. It is easier for example to load or unload the cargo of bulk liquids in a tanker as the procedures are being made in a simpler way and upon the use of piping systems which can carry the oil products into the hatches in a limited time (Alderton, Patrick, 2004).

2.2 Operation of International Tanker Shipping Industry

Ship-owners and generally all those shipping companies which operate bulk carriers in our days, need to consider that they have to concentrate mainly on bulk cargo where the fluctuation of freight rates is significantly firming up in the last few years. Economic growth and globalization in promising markets, especially in the Far East and increasing global production has been pushing up freight rates in the tanker cargo segment. Industry analysis that has been conducted, it has pointed out to increasing voyage lengths as tanker ships are now travelling longer distances and this is one of the factors shorting up freight rates in this field of shipping operations.

From shippers' point of view, tanker carriage appears to have numerous advantages. Tanker cargo can be loaded and unloaded far more quickly than one cargo which is unitized, thereby leading to great savings in time and money. However, there are a number of dangers in the carriage of bulk cargoes and the cargo handling operations which take place should be as much safer as this is possible. This is something that has to be taken under serious consideration by shipping companies that operate tanker carriers (Metaxas, B., 1998).

According to Alderton (1995), it has also been stated that as it has been estimated, more than 50% of cargoes in tankers transported by sea today can be regarded as dangerous or hazardous from a safety stand point or harmful to the environment, according to the criteria set by the International Maritime Organization (IMO) (Alderton P., M., 1995). Tanker cargoes have been mentioned to include commodities such as liquid chemicals and other materials, gases and products for and of the oil refinery industry and various wastes.

Tanker shipping is considered to be a wholesale operation. It sells its services in large quantities, by contract to a much smaller number of industrial customers at individually negotiated prices. The pricing system is crucial to the supply of transport. In the short run supply responds to prices as ships change their operation speed and move to and from debilitating, while liner operators adjust their services.

In the longer term, freight rates contribute to the investment decisions which result in scrapping and ordering of ships (Metaxas, B., 1998). Ship-owners who operate their ships inside the tanker sector, they need to be aware of the various statistical aspects that exist in such sector and appraise appropriately all the involved issues that can affect it accordingly. What ship-owners have to consider is the seasonality of goods which are carried worldwide. Seasonality has an uneven effect on the spot market and with effect to demand for sea transport. For this trade, special tanker ships are preferred. Moreover, long term trends in commodity trade are best identified by studying the economic characteristics of the tanker industry, which transport the traded commodities.

Tanker shipping companies should also know the physical and commercial properties of the cargo that will be carried, set a limit on the ship type of tanker that can potentially be employed in the transport operation. In a limited number of cases, such as liquid natural gas or nuclear waste, the cargo demands a specific type of ship, and ship owner's choice is limited to general design and operating features such as speed, crew, etc.

Ship-owners in tanker shipping, in order to appraise correctly the statistical market, they must know the precise type of cargo to be carried, but in practice the knowledge of both cargo and other physical operating constraints will depend upon the type of shipping operation for which the vessel is intended. There are several types of shipping operations in tanker, such as the long term charters where the ship-owner knows exactly the cargoes to be carried and the ports to be used.

Another type is the spot charter market operations where the owner has only a general idea of the type of cargo to be carried and no knowledge of the ports to be called. We could just mention that there are some basic factors which can affect the demand for sea transport with tanker carriers. Ship-owners should know that those factors are

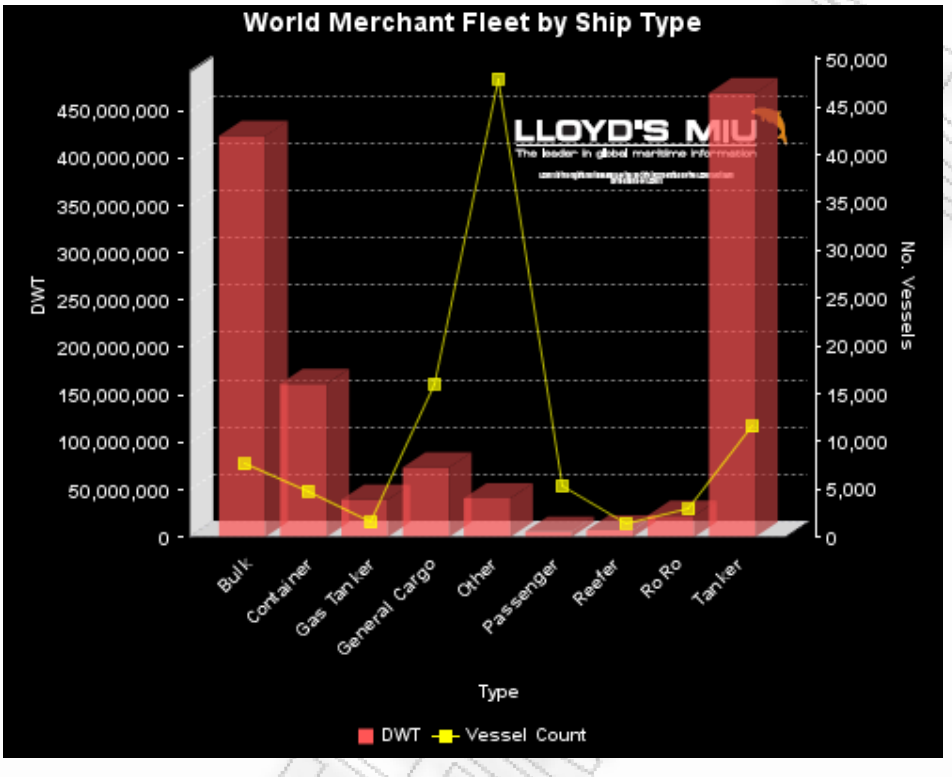
price, speed, reliability and world merchant fleet of the tanker carriers. The freight cost is always very important to the consignee, but the greater the proportion of it in the overall cost equation, the more emphasis shippers are likely to place on it. As a result, tanker companies devoted great effort to finding ways so as to reduce the cost of transport, minimizing by this way the amount of money that is demanded for a shipping investment. We mention indicatively as an example, that by 2003 the price of a tanker cargo had increased and the cost of transport had fallen to just 2,5 per cent of the CIF price, so transport cost became less important (Lorange, P., 2005).

Concerning the factor of speed in tanker carriers, we could say that time in transit incurs an inventory cost so shippers of high-value commodities value speed. Speed may also be important for commercial reasons and investment. A European manufacturer ordering spare parts from Far East may be happy to pay ten times the freight for delivery in three days by air if the alternative is to have machinery out of service for five or six weeks while the spares are delivered by sea.

Lastly we should mention that reliability upon the growing importance of "*just in time*" stock control systems has taken a new significance. Some shippers may be ready to pay more for a service provider which is guaranteed to operate on time and provides the service that he has promised. Moreover, the loss or damage in transport is an insurable risk, but raises many difficulties for the ship owner, who may well be prepared to pay more for secure transportation of his product without risk of damage.

Another basic factor that plays a very important role and can affect the demand for sea transport of tanker cargoes, is of course the world merchant fleet in tanker carriers (figure 12). This world merchant fleet grows up from day to day and in December 2003 the world fleet of self propelled sea going merchant ships over 200 gross tons stood at 195,890 vessels with a capacity of 786 gmt. Within this total, cargo moving vessels account for 97 per cent of the gross tonnage but only 56 per cent of the numbers (Lorange, P., 2005).

Figure 12 [12]



2.3 Characteristics of Shipping Companies Involved in Tanker Cargoes

Tankers are cargo ships which are used for the transport of fluids, such as crude oil, petroleum products, liquefied petroleum gas, liquefied natural gas and chemicals, as well as vegetable oils, wine and other food. The tanker sector comprises one third of the world tonnage.

The basic characteristics of the shipping companies which are involved in the operation of tankers, is the freight rate market and the demand of sea transport with oil tankers. As we know, the major task of the shipping industry of oil tankers is to transport oil cargo around the world and although this is the correct starting point for studying tanker's demand, as an economic definition is too narrow. If we take a customer's viewpoint, shipping with oil tankers is a service for covering the needs for transport of oil. But it is not as simple as the transport of cargo, as there will be an increase at the

[12] http://gcaptain.com/maritime/blog/wp-content/uploads/2008/11/world-merchant-navy-fleet-ship-type.png

freight rates for the specific commodity in periods where the demand for oil transport is in high levels.

Another aspect that tanker ship-owners should have in mind, is of course the world merchant fleet. This world merchant fleet grows up from day to day and the ship-owners are obliged to build oil tankers with double hull as the legislation imposes to them, after the Exxon Valdez oil spill disaster, when it grounded on Bligh Reef outside the port of Valdez in Alaska, since the US Government required all new oil tankers built for use between US ports to be equipped with a full double hull. Otherwise, their ships will not be able to call at the different ports around the world, having as a result their operation not to be profitable. Once again, the matter of safety is above all and the ship-owners will have to follow and comply with the rules, trying by this way to justify at the same time the high cost of double hull construction and the competition with other oil tanker shipping companies.

At this section of discussion, we could say that the supply of sea transport for oil can play an important role. At first sight, large tanker companies shipping substantial quantities of oil materials often run their own shipping fleets to handle a proportion of their transport requirements. If a shipper has a long term requirement for oil transport but does not wish to become actively involved as a ship-owner, he may charter tonnage on a long term basis from a ship-owner. Some capacities place charters for ten or fifteen years in order to provide a base load or shipping capacity to cover long term material supply contracts.

Another aspect in tanker shipping is the derived demand for such ships. Although those ships occupy the centre of the stage, the product in demand is not the oil tanker but transport. It is not the oil tanker that the customer wants but rather the transport of the oil products. Ship-owners can use the double hull oil tankers to provide the transport most profitably. If oil products could only be carried in double hull tankers, all the shipping economist would have to do is predict the trade in oil tankers, and the demand for oil tankers is determined. With several double hull oil tankers available to carry oil products, and different sizes to choose from, the calculation of demand involves two additional questions. First, what options are open to the ship-owner?

And, second, what economic criteria apply in choosing between those double hull oil tankers? (Ignary, 2001).

The charter rates are quoted on a competitive basis through brokers in various exchanges throughout the world. The major elements which influence the fixing of a specific rate and the way that the freight rates can be measured in the freight market, are the following:

- *ship specification in tankers*
- *trade and route*
- *general market conditions*
- *terms of charter party*
- *duration of charter*
- *the urgency of the charter*
- *convenience of the charter ship-owner.*

A special situation applies to tanker chartering. The majority of tanker contracts are arranged in accordance with the provisions of the specialized Worldwide Tanker Nominal Freight Scale. Several indices are available to keep track of rate fixing in the international dry bulk markets, such as the Baltic Freight Index (BFI) which is determined by an expert group and published daily by the London-based Baltic Exchange.

The objective of a shipping company involved in tankers is a consistent growth in terms of turnover and profit. The company is trying to be focused on the shipping transport through the design of new services and the establishment of the existing ones. This could be seen also through the rates and the campaign which was designed to promote sales and add excitement to its customers' experience during the past years.

Shipping companies operating tankers are trying to build strong relationships with their customers and focuses on customer retention. This strategy could be proved by the innovative idea of the optional services offered to its customers so as to keep contact with them. Encouraging feedback and educating customers about how to make imports with all kind of transports are excellent techniques that the company should use in

relationships with its customers. At last, the company offers some of the most competitive rates by trying to give the best service and cover through a large number of charter agreements of transport each year by competing on these bases.

However, during recent years the customers are becoming increasingly aware of oil products which can be carried. This had as a result the foundation of even more shipping companies involved with tankers, which opened the way to the emergence of shipping as an independent industry in the world trade of goods by sea.

Since the beginning of the shipping trade, the rates are considered to be the most important criteria for all customers who need to use a shipping company so as to transport their goods by sea. Especially for those who import oil products by China and Far East by tanker vessel and make a long term charter. These people are more aware that they have to search for that shipping company which will offer them low rates and at the same time will transport their oil products in a short time from one place to another. Generally speaking, customers at the market of the shipping and the chartering are always looking for lower rates and very good service so as to get their goods on time while at the same time will have not pay much money for the rates of transport (Stopord, M., 2000).

2.4 Factors Affecting Demand for Transport with Tanker Carriers

One of the most important influences in ship's demand and for a shipping investment in tanker carriers is definitely the world economy itself. There should be a close relationship between the similar timing of fluctuations in freight rates and cycles in the world economy and is only to be expected, since the world economy generates most of the demand for sea transport of tanker carriers, thus for shipping investment (Huges, L., 2002).

However, there is much more to analyze for the basic factors that can affect the demand for sea transport of tanker carriers and the supply of such ships. Since ships have a life of twenty or thirty years, the fleet trading as a meticulous point in time is a varied mixture of technology representing the increasing investment decisions of several generations of ship-owners. In recent years, the design of bulk ships has extremely advanced, as technology has been modified to improve the efficiency of vessels in these trades.

It is also important to mention that within the industry of tanker carriers, four aspects of this development merit special attention. Those are the shipbuilding technology, economies of scale, cargo specialization and cargo handling. Each of those has "played' an important part in the industry's respond to the challenge of investment of providing cheaper and better transport with bulk carriers, affective positively or negatively each time the commercial cycles of tanker shipping.

For a ship-owner who wants to make a shipping investment in a tanker carrier, the demand for sea transport can affect this investment, where he must consider and appraise some useful matters so as for him, those matters to operate as a good point of objectives for each of his futures procedures in the shipping industry. Long term trends in commodity trade are best identified by studying the economic characteristics of tanker industry carries the traded commodities (Mr. Linardis, Prodromos Shipping, 2010). Although every business is different, there are four types of change to look for: changes in the demand for this particular commodity, changes in the source from which supplies of the commodity are obtained, changes due to a relocation of processing plant which changes the trade pattern and finally changes in the shipper's transport policy (Isbester, J., 1993).

The design criteria can also affect the demand for sea transport of tanker carriers, as by the time that a ship-owner is choosing a vessel for a long term time charter it is likely to be quite different from those for the owner intending to trade on the spot market. For example, the former will be preoccupied with optimizing the ship to a specific operation, whereas the latter will be more concerned with such factors as the vessel's acceptability to charterers, and its short term resale value (Isbester, J., 1993). A shipping company involved in tanker shipping may prefer vessels that are more flexible, servicing a number of different markets and thereby reducing the risk.

Another ship-owner may follow a policy of specialization, preferring a vessel that is in every respect designed for the efficient carriage of a single cargo, offering greater efficiency or lower costs but at the price of lees flexibility. It follows that the shipping economists cannot forecast the demand for bulk shipping just by studying cargo movements. In the real world the choice of a particular ship type depends on all three factors – cargo type, shipping operation and commercial philosophy. This makes it

difficult to predict which factors will pre-dominate the final decision (Alderton, T. and Winchester, N., 2002).

Commercial cycles of operation of tanker carriers and existence of shipping risks, are considered to be two additional major factors that can affect the demand for sea transport of tanker carriers and include the evaluation of credit risk in that shipping market. The risk of an investment is usually measured by the standard deviation of the year on year return since this gives an indication of the variability of return. In these terms, shipping is a high risk industry with a standard deviation of bulk shipping roughly twice as high as the US stock market (Bloor, M., Thomas, M. and Lane, T., 2000).

A good starting point is to divide the risk faced by a tanker shipping company and its bankers into three parts. Economic risk occurs because shipping companies are exposed to a world economy which is by itself extremely volatile and risky. All industries face this risk to some extend but at the shipping market model, the ship demand is particularly closely linked to the world industrial economy.

The two deep recessions which hit the shipping market in the 1970s and 1980s were partly caused by recession in the world economy. Other capital goods industries encountered the same problems. Operating risk arises from the performance of the ship and the shipping company which manages it (Alison, H., 1997). Over ordering of bulk ships by ship-owners, over capacity in shipbuilding or any of the other factors which uniquely affect the bulk shipping industry, are risks which must be taken into account in the credit appraisal, but at the same time are factors which can affect the demand for sea transport services provided by bulk carriers. Commercial cycles in shipping have a specific purpose. Shipping market make use of those so as to control supply and demand in an impulsive world. In this perspective, the guiding light for financiers is "*know the enemy*".

3. Methodology for Collection of Data and Information

3.1 Research Design

Through this chapter, the author will try to provide an effective analysis of the methodology used for the application of all appropriate details and data for the completion of the dissertation. In the specific sub-chapters, the research design that was followed in connection with the approach made will be analyzed, which include among others the methods and techniques followed as to the details of operation and development of tanker ships during the last 20 years and how these facts had an emerge effect on the general operation of shipping industry since today.

3.2 Research Design

The collection of information and data as well as the analysis inside an academic paper, are considered to as very essential elements of the dissertation's "building" by providing the entire basis for author to consider any assumptions of planning. All collected data from a particular phase can inform the audience of the appropriate planning process by mentioning any strengths and weaknesses inside the project as well as the way that this could be applied worldwide. The research that the author made is considered to be relevant to the study of data and assisted him in order to receive the most appropriate decision making and similar recommendations for the particular dissertation. According to Jankowich (1995), people prefer to conduct a research so as to find a systematic way for the increase of their knowledge.

Any academic paper requires actually a methodology to exist so as to present and come to valuable conclusions. Those are also considered to be the means and ways for analyzing and producing concerned data in order for theories to be noticed and even accepted or rejected accordingly. For these reasons, a type of methodology can be connected by a detailed research where information and data are collected and some more general philosophies applied where the analysis and collection of information are placed (Saunders, 2000).

It should also be noticed that the form of qualitative research needed for particular case included also an element of exploration. Schindler and Cooper (1992) agree that when people decide to undertake a study of research or even a study that includes such

elements, it is more likely to conduct interviews in their approaches. For such reason they are used in research of qualitative manner so as to determine perceptions, manner of thinking and feelings of customers as to the various services offered (Saunders, (2000)). In addition, for the purpose of this study the quantitative research in specific case method of interview was used to collect data for exploratory research, establishing a cause and effect relationship, and descriptive research.

It should also be mentioned that there are even some philosophies of research which could be identified upon literature review which appraise to have some different views as to the kind of knowledge which is perceived to be developed accordingly, and those are phenomenology and positivism. In that particular point it should be noticed that the philosophy of research adopted for specific dissertation is actually a combination of phenomenology and positivism like we mentioned before. The characteristic of positivism is that it approaches various deals with quantitative data that is collected and analyzed. From the observations that were made, these are considered to be of a statistical nature. On the other side, phenomenology is considered to be a qualitative method which is also basic part of a particular research. This has as a purpose to make a deeper research than an approach of positivism and has as an objective to make a discovery in theories which are not seemed to be obvious.

3.3 Research Approach

There exists two basic approaches which could be applied within a study and those are the inductive and deductive one. The inductive approach is followed where someone could be able to collect appropriate data and therefore develop a theory as a basic result of someone's data analysis (Saunders, 2000). On the other hand the deductive approach is where someone would develop a theory and appropriate design and hypothesis so as to test those instead (Saunders et al, 2000).

Finally, this approach is perceived within the particular and considered to be inductive, as it formulates a basic theory which follows the collection of data and information that opposed to the examination of merits in already developed theory. This inductive approach is considered to be more suitable to the research due to the fact that it allows a flexible structure so as to allow for changes in the appropriate research process.

3.4 Data Collection

Author would like to mention that due to the nature of particular project and the kind of secondary and less primary research way of methodology which was followed in order to lead to the appropriate implementation of the triangulation within this kind of methodology, this offered the great chance of reliability increase instead (Saunders, 2000). It has to be noticed that a number of methods were considered in order to be able to gain a wider understanding of the way that tankers' operation and development has existed during the last 20 years and have actually affected the whole shipping industry.

Moreover, we would feel obliged to mention that the aspect of triangulation is being referred to the existence of various data methods of collection inside a research paper so as to ensure that all data and information is telling us what we should think that should be the right think (Saunders et al, 2000). This is considered to be extremely important within a study paper, as all the results could be obtained by a particular area to some more beneficial, if those will be combined with appropriate results from a different area as also of each method of data collection which appraise to have both advantages or disadvantages and by far a combination of some various types of information, as well as the different kinds of information that would assist researchers to minimize the provided disadvantages and offer me some more specific scope.

3.5 Secondary Data

The meaning of secondary data includes all the data and information collected and analyzed by a researcher prior to and for the actual purposes and present needs for appropriate research (Zikmund W.G., (2000)). All secondary details and data can provide background information as also the basis which will enable the researcher to have a clear understanding of his theme as also to offer some supporting information from books to the use of primary data.

All the sources for the use of secondary data were received from library of author's university and books from public sources and appropriate profiles and reports of organizations concerned with aspect of tanker ships' operation and development. The various sources for the secondary research could range and differ from any documentary data like the internet databases and the various journals. All the articles

which one could access therein can be accessible and covered by a wide literature field. In order for the author to achieve something like that, he was obliged to use wide range of information which could provide the chance to make the backbone of this study so as to choose the most recent one.

All textbooks could be useful for the collection of data and information as they have been written and published for the specific purpose of comprehensive view provision about a particular subject. According to Saunders, the materials in books is often being presented in a more adequate and ordered way than in articles and journals by pulling together a wide range of themes (Saunders, (2000)).

Moreover, it has to be noted that the collection of electronic information was also used as it has been proved to be a considerable valuable tool for appropriate research. Characteristic example from collection for electronic information is actually Google, as this includes scientific articles upon aspect of tanker ships' operation and development inside shipping industry during the recent years. This particular internet site could also provide researchers with a great access to some already published articles or books similar to the topic examined in dissertation. In conjunction with that, author looked at other websites so as to get the necessary information about the aspects and operation of tanker ships.

3.6 Primary Data

Primary data can be defined as the data that is collected and used specifically for a research paper so as to come into valuable conclusion (Zikmund W.G., (2000)). For this reason, primary data was also another valuable source of this dissertation. For the collection of important data and information there are also many strategies that could be adopted by researchers. Each of those options is considered to be an in depth research of viability and effectiveness of topic analyzed in dissertation. After serious consideration, the method of interview has been chosen for the collection of primary data.

Concerning to the design of sample, Hannagan (1992) has mentioned that sampling is considered to be a simple process of choosing those participants for the specific piece of research instead. When someone is conducting a primary research for a specific case, it is important to estimate exactly the target group. For our case, it is realistic to

conduct interviews with people on any shipping business or organization which is concerned with tanker ships' operation and development. Therefore and in order to carry out an effective research on specific dissertation, author had to make some appropriate interviews.

4. Trade Characteristics of Tanker Ships and Factors Affecting their Operation and Building Developments During the Last 20 Years

4.1 Aspects Which Should Be Noticed by Ship-owners In Tanker Shipping

Ship-owners who operate their ships inside the tanker ship sector, they need to be aware of the various statistical aspects that exist in such sector and appraise appropriately all the involved issues that can affect it accordingly (Stopord, M., 2000). What ship-owners have to consider is about is the seasonality of goods which are carried worldwide. Ship-owners should also know that the physical and commercial properties of the cargo (crude oil) that will be transported set a limit on the ship type that can potentially be employed in the transport operation.

In a limited number of cases, such as liquid natural gas or nuclear waste, the cargo demands a specific type of ship, and the ship owner's choice is limited to general design and operating features such as speed, crew, etc. For most cargoes, however, the ship-owner can choose from several types of ships. Crude oil can be carried in a specialist tanker or a combined carrier, dry bulk can be carried in a conventional bulk carrier, an open hold bulk carrier or a combined carrier, containers in containership, a tweendecker, a multipurpose vessel or a Ro-Ro.

We should also mention that shipping companies that are involved in tanker ship, they have to appraise accordingly the demand for sea transport services. This is not a direct one but actually we would say that is a derived demand. As we know, the major task of the shipping industry is to transport cargo around the world, although this is the correct starting point for studying ship's demand, as an economic definition is too narrow (Mr. Linardis, Prodromos Shipping, 2010). Therefore, we could just mention that there are some basic factors which can affect the demand for sea transport with ships.

Ship-owners should know that those factors are price, speed, reliability and world merchant fleet of the ships. This world merchant fleet grows up from day to day and in

December 2001 the world fleet of self propelled sea going merchant ships over 100 gross tons stood at 95,790 vessels with a capacity of 491 gmt. Within this total, cargo moving vessels account for 95 per cent of the gross tonnage but only 53 per cent of the numbers (Chrzanowski, I., 2002). The freight cost is always very important to the consignee, but the greater the proportion of in the overall cost equation, the more emphasis shippers are likely to place on it.

4.2 Factors Which Can Affect Chartering Contracts Inside Tanker Shipping

A factor that can definitely affect the demand for sea transport and by consequence the existence and nature of chartering contracts is the level of the freight rates inside the shipping industry. If we take a customer's viewpoint, shipping is a service for covering his needs for transport of different goods. We could say that the different shipping companies move cargo around the world, it is like to say that different restaurants cook different kinds of foods. All the shipping companies provide a variety of services so as to meet the specific needs of each customer.

Of course these needs may involve a whole range of factors where these factors can affect with their determination concerning the level of the freight rates at the different shipping cycles. Undoubtedly, the most important single influence in ship demand and for the level of the freight rates inside the freight market is the world economy of the future period. There should be a close relationship between the similar timing of fluctuations in freight rates and cycles in the world economy and this is only to be expected, since the world economy generates most of the demand for sea transport thus for shipping investment.

Nowadays most economists accept that there are different economic cycles which arise from a combination of external and internal factors. Those factors can also determine shipping cycles which are very important for the determination of the freight rates at the different period of sea trade. Two additional factors will complicate the measurement of shipping cycles for the next years. First, the factor of great technological advances and secondly, nominal freight rates will be of course affected by the long swings in the general price level. Both those complicate the task of separating the trend from the cycle movements of the series.

In addition, we could say the derived demand for ships will also determine the way and the level of the freight rates in applied chartering contracts. Although ships occupy the centre of the stage, the product in demand is not a ship, but transport. It is not the tankers that the customer wants, it is the transport of the tanker cargoes. Ship-owners can use whatever ships provide the transport most profitably (Ignary, 2001).

Therefore, we have to say that the freight rate mechanism at present time operates in a simple way. Ship-owners and shippers negotiate to establish a freight rate which reflects the balance of ships and cargoes available in the market. If there are too many ships the freight rate is low, while if there is too few the freight rates is high. Once this freight rate is established, shippers and ship-owners adjust to it and eventually this brings supply and demand into balance. The three economic concepts that can seriously affect the fluctuation of a shipping investment are the supply function, the demand function and the equilibrium price.

Lastly with respect to the factors that can affect the demand for sea transport and by far the existence of chartering contracts applicable to tanker carrier transport, we should say that one of these, is of course the supply of sea transport and ships. At first sight, we have to say that large companies shipping substantial quantities of cargo materials often run their own shipping fleets to handle a proportion of their transport requirements.

Ship-owners who operate their ships inside the tanker sector, they need to be aware of the various statistical aspects that exist in such sector and appraise appropriately all the involved issues that can affect it accordingly (Chrzanowski, I., 2002). What ship-owners have to consider is about is the way that shipping industry operates and if shipping is about to face a recession.

At first sight, we have to say that large companies shipping substantial quantities of tanker materials often run their own shipping fleets to handle a proportion of their transport requirements. If a shipper has a long term requirement for bulk transport but does not wish to become actively involved as a ship-owner, he may charter tonnage on a long term basis from a ship-owner. Some capacities will place charters for ten or fifteen years to provide a base load or shipping capacity so as to cover long term material supply contracts – particularly in the iron ore trade.

We have to keep in mind that the same ship-owners are trading in all four shipping markets at present times and their activities are closely correlated. When freight rates rise or fall, the changing sentiment ripples through into the sale and purchase market and from there into the new building market. The markets are also connected by cash. The main cash flow is freight revenue. This goes up and down with freight rates and is the primary mechanism leading the activities of shipping investors. The other cash inflow comes from the demolition market. Old or obsolete vessels will be sold to scrap dealers so as to provide a useful source of cash, especially during recessions (Peters, H., 2001).

4.3 Main Producers and Consumers of Oil and the Way that this Commodity is being Transported

We need to mention that the commodity of crude oil which is transported by tankers is the world's most commonly used raw material. It is used mostly in the various moving applications for maritime, air and land purposes and some general applications such as moving of vehicles, trains and motorcycles. The country of China is considered to be in our days the largest consumer of crude oil, meaning that is the world's largest oil producing country. China is followed by the countries of Japan and Korea, which also consume a significant amount of oil and similar raw materials. It is worth mentioning that in 2006, the country of China produced 622 million tons of crude oil with an annual growth of 42% ("Naftemporiki" Newspaper, 2008).

The commodity of crude oil can be produced by various methods and its use became more common after some efficient production methods which were devised in the 18th century. Today, the commodity of crude oil is one of the most common materials in the world and is a major substance for vehicles' moving and industries' operation. Due to the major role of crude oil in the infrastructural and overall economic development, the oil industry is considered to be an indicator of economic process (Stopord, M., 2000).

We should also say that the economic boom in China and India caused a massive increase in the demand for crude oil in recent years. Between 2001 and 2006 the world oil demand increased by 8%. Since 2001 the several Indian and the Chinese oil firms have risen a lot and consider to be in our days the world's largest consumers and

producers of crude oil ("Naftemporiki" Newspaper, 2008). The transport of crude oil commodities is being made by tankers under certain and detailed procedures, so as to ensure a safe transport and the safety of the vessel and the crew during the voyage.

We also need to mention that oil commodities pass through a treatment stage so as to increase their substances contents and decrease the content of some impurities. The grade of process depends on different deposit types and economic considerations. The high grades of crude oil are treated so as to obtain uniform sized products and to eliminate the fines. The low grades of crude oil are treated so as to obtain concentrates which can compete in the market with those of high grade.

The commodities of oil as to its trade have also produced positive rates in shipping. In 1998 a new record of 482 Mt of exported oil was achieved. After 1992 oil market crisis, the sea trade of that commodity achieved an increase for the next three years. The huge expansions in exports were caused by an increased oil demand in the largest importing markets of Japan, China and Korea and the European Union ("Naftemporiki" Newspaper, 2008).

In our days the countries of the European Union remain an important market of import for crude oil as the country of Germany leads the European Union imports and it is the second country of imports worldwide with crude oil. It is followed by the countries of China and Korea which are importing countries of high grade crude oil. For the future, the current oil market situation has to meet low prices over supply, reduction in demand and low crude oil production. As a consequence of this situation, measures have to be taken so as this market to remain competitive and the various tankers to continue to transport that commodity, as much safer as this is possible.

4.4 Demand and Supply for Crude Oil

All parties concerned with the world of shipping and transport, in 2006 they expressed the opinion that there would be a balanced supply and demand situation in the international oil market during 2007 and this would influence the price of this commodity and its negotiations accordingly (www.oecd.org). As an example, we would say that the China's domestic crude oil output grew up sharply in 2006, easing by this way the difficult market situation. Different official figures show that a large scale of Chinese mines produced 525 million tons in the first eleven months and

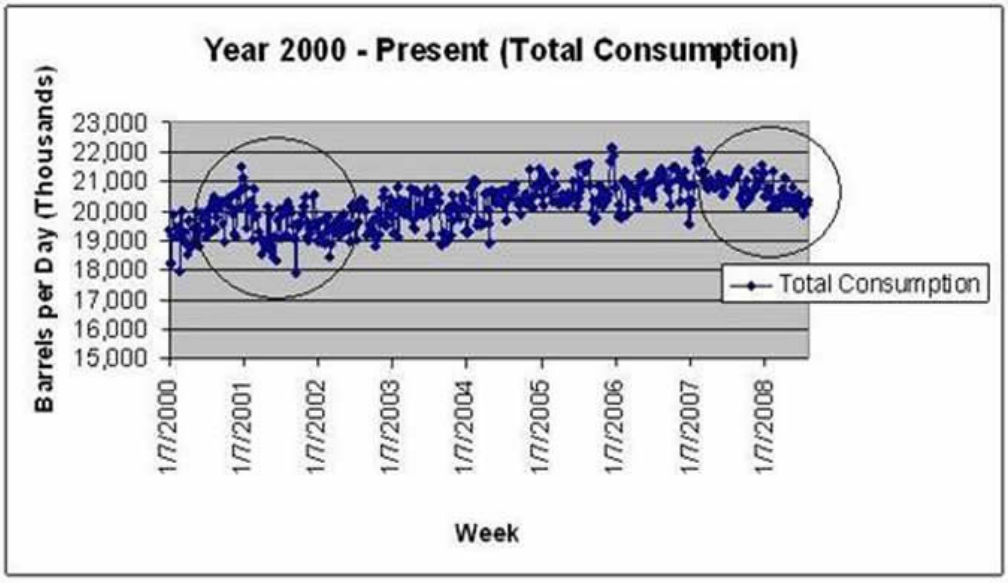
noticed an increase of 39.4% on the same period in year 2006 as the China's crude oil imports, which were rocketed in recent years, affected the international market ("Naftemporiki" Newspaper, 2008).

By this way we can understand that the current mechanism of supply and demand as to the commodity of crude oil should be adjusted so that a more reasonable price fixing system is set up for all the concerned parties. We could also mention that China's oil production and exports could cause different problems in the global markets and definitely affect the demand and supply, where excess in supply will continue to outpace the demand for such commodity.

The world's crude oil output is expected to increase dramatically during the year 2009, up 13 % to 15 % yearly in comparison with that of 2008. As an example we can mention that last year, the country of China produced five times as much oil as the United States, which has a population of about 300 million. During the past two years, China has produced huge quantities of crude oil but as it is not able to absorb all the oil production and cannot shuttered its excess capacity; the oil exports will continue to grow (www.oecd.org).

"Even though the oil consumption increased 23.1 % per year from 2001 to 2006 (figure 13), the domestic over capacity of the countries, is the largest problem. The exports of steel and iron ore are about to be increased on about 63 million metric tons in 2008 because of the over supply. Thus, export growth is expected to continue until supply and demand will be in agreement through an increased level of consumption" (www.oilmarketreport.org).

Figure 13[13]



It should also be noted that the past several years, the different governments have attempted to slow the fast growing supply, but these attempts mostly were followed by basic and capitalist driven economic growth and local entities. If the countries around the world could successfully close their inefficient and polluting capacity, the excess capacity problem of oil would be solved and countries like China would again become a major importer of oil, as many people of shipping consider. The question now is how long will it take for a government to accomplish this important goal and how the affecting countries will react.

The different countries which produce and consume crude oil, say that they will continue to subsidize the exceeded capacity as they don't have raw materials in large quantities and in advance they do not have good quality of oil in large quantities. According to a research which was made for the sea trade of crude oil, the different oil producers around the world pay more per ton to ship crude oil to the West Coast of the United States than the $132 per ton cost of the labor content in U.S. domestic oil or more than the entire processing costs of an oil work (www.oecd.org).

[13] http://www.marketoracle.co.uk/images/2008/crude-oil-demand-destruction-aug08_image004.jpg

4.5 Historical Review in Tankers' Development and Operation

It was actually in 1954 when Shell Oil developed the first average freight rate assessment (AFRA) system which classifies tankers of different sizes (Huges, L., 2002). In an attempt to make it an independent instrument, Shell consulted it to the London Tanker Brokers' Panel. At first, they divided the groups as *General Purpose* for tankers under 25,000 tons deadweight (DWT), *Medium Range* for ships between 25,000 and 45,000 DWT and *Large Range* for the then-enormous ships that were larger than 45,000 DWT. The ships became larger during the 1970s, which prompted rescaling (Huges, L., 2002).

The system was developed for tax reasons, as the tax authorities wanted evidence that the internal billing records were correct. Before the New York Mercantile Exchange started trading crude oil futures on about 1983, it was difficult to determine the exact price of oil which could change with every contract. Shell and BP, the first companies to use the system, abandoned the AFRA system in 1983 and where later followed by the US oil companies. However, the system is still used today. Besides that, there is the flexible market scale, which takes typical routes and lots of 500,000 barrels (Huges, L., 2002).

Merchant oil tankers carry a wide range of hydrocarbon liquids ranging from crude oil to refined petroleum products (Huges, L., 2002). Their size is measured in deadweight metric tons (DWT).Crude carriers are among the largest, ranging from 55,000 DWT Panamax sized vessels to ultra-large crude carriers (ULCCs) of over 440,000 DWT (Huges, L., 2002).

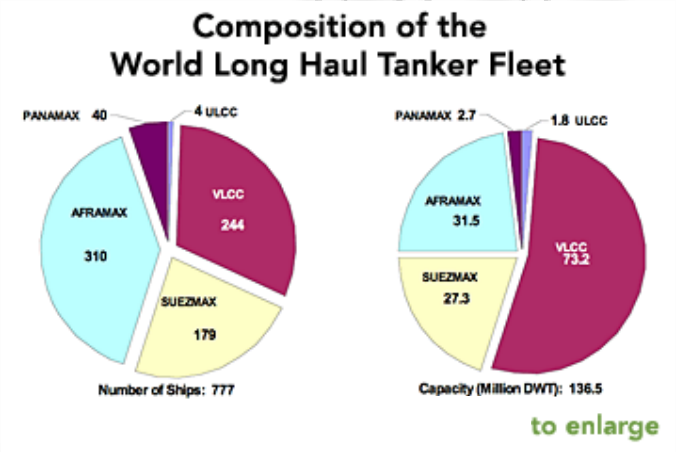
The category of "*Supertanker*" is perceived as an informal term used to describe the largest tankers. Currently, it is applied to very large crude carriers (VLCC) and ULCCs with capacity over 250,000 DWT. Those ships can transport two million barrels of oil (Kemp P., 2003). By way of comparison, the combined oil consumption of Spain and the United Kingdom in year 2002 and it was about 3.4 million barrels (540,000 m^3) of oil per day (Kemp P., 2003).

Due to their great size, supertankers often cannot enter port fully loaded. Those ships can take on their cargo at off-shore platforms and some single point moorings (Kemp P., 2003). On the other end of the journey, they often pump their cargo off to smaller

tankers at designated lightening points off-coast (Kemp P., 2003). A supertanker's routes are generally long, requiring it to stay at sea for extended periods, up to and beyond seventy days at a time (Kemp P., 2003).

The smaller tankers, ranging from well under 10,000 DWT to 80,000 DWT Panamax vessels, generally carry refined petroleum products, and are known as product tankers (Kemp P., 2003). The smallest tankers, with capacities under 10,000 DWT generally work near-coastal and inland waterways (Kemp P., 2003). Although they were in the past, ships of the smaller Aframax and Suezmax classes are no longer regarded as supertankers (Kemp P., 2003).

Figure 14[14]



In year 2005, oil tankers made up 36.9% of the world's fleet in terms of deadweight tonnage ("Naftemporiki" Newspaper, 2008) (figure 14). The world's total oil tankers deadweight tonnage has increased from 326.1 million DWT in 1970 to 960.0 million DWT in 2005. The combined deadweight tonnage of oil tankers and bulk carriers represents 72.9% of the world's fleet ("Naftemporiki" Newspaper, 2008).

4.5.1 Cargo Movement with Tanker Ships

It should be noticed that in 2005, 2.42 billion metric tons of oil were shipped by tanker. The percentage of 76.7% was crude oil and the rest consisted of refined petroleum products ("Naftemporiki" Newspaper, 2008). This amounted to a percentage of 34.1% of all seaborne trade for the year ("Naftemporiki" Newspaper, 2008). By combining

[14] http://www.pier400berth408.info/images/shipChart.gif

the amount carried with the distance it was carried, oil tankers moved 11,705 billion metric-ton-miles of oil in 2005 ("Naftemporiki" Newspaper, 2008).

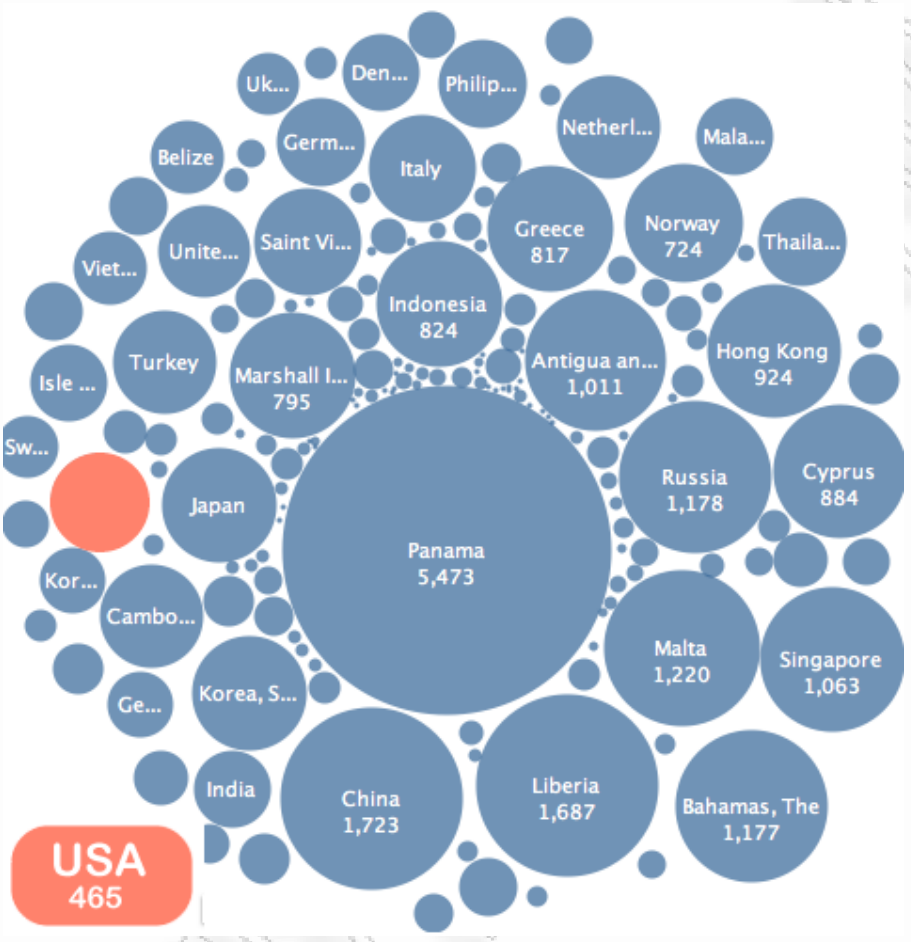
By comparison, on about 1970, 1.44 billion metric tons of oil was shipped by tanker ("Naftemporiki" Newspaper, 2008). This amounted actually to 34.1% of all seaborne trade for that specific year. In terms of amount carried and distance carried, oil tankers moved 6,487 billion metric-ton-miles of oil in 1970 ("Naftemporiki" Newspaper, 2008). The United Nations also keeps statistics about oil tanker productivity, stated in terms of metric tons carried per metric ton of deadweight as well as metric-ton-miles of carriage per metric ton of deadweight accordingly. On about 2005, for each 1 DWT of oil tankers, 6.7 metric tons of cargo was carried. Similarly, each 1 DWT of oil tankers was responsible for 32,400 metric-ton miles of carriage.

Lastly, the main loading ports in 2005 were located in Western Asia, Western Africa, North Africa, and the Caribbean, with 196.3, 196.3, 130.2 and 246.6 million metric tons of cargo loaded in these regions ("Naftemporiki" Newspaper, 2008). The main discharge ports were located in North America, Europe, and Japan with 537.7, 438.4, and 215.0 million metric tons of cargo discharged in these regions ("Naftemporiki" Newspaper, 2008).

4.5.2 Flag States and Flags of Convenience

As of year 2007, the United States Central Intelligence Agency statistics count of 4,295 oil tankers of 1,000 long tons deadweight (DWT) or greater worldwide ("Naftemporiki" Newspaper, 2008). Country of Panama was the world's largest flag state for oil tankers, with 528 of the vessels in its registry ("Naftemporiki" Newspaper, 2008). Six other flag states had more than 200 registered oil tankers such as Liberia (464), Singapore (355), China (252), Russia (250), the Marshal Islands (234) and the Bahamas (209) ("Naftemporiki" Newspaper, 2008). By way of comparison, the United States and the United Kingdom only had 59 and 27 registered oil tankers, respectively ("Naftemporiki" Newspaper, 2008) (figure 15).

Figure 15[15]



It is true that flags of convenience have lower standards for vessel, equipment as also crew than the traditional maritime countries and often have classification societies certify and inspect the vessels in their registry, instead of by their own shipping authority. This made it attractive for ship owners to change flag, whereby the ship lost the economic link and the country of registry.

On about 1978, a number of European countries agreed in The Hague on a memorandum that agreed to audit whether the labor conditions on board vessels were according the rules of the ILO. After the Amoco Cadiz sank that specific year sank that year, it was decided to also audit on safety and pollution. To this end, in year 1982 the Paris Memorandum of Understanding was agreed upon, establishing the Port State

[15] http://gcaptain.com/maritime/blog/wp-content/uploads/2007/06/bubble-chart-merchant-marine.png

Control, nowadays consisting of 24 European countries and Canada. In practice, this was also a reaction on the failure of the flag states especially flags of convenience that have delegated their task to classification societies so as to comply with their inspection duties ("Naftemporiki" Newspaper, 2008).

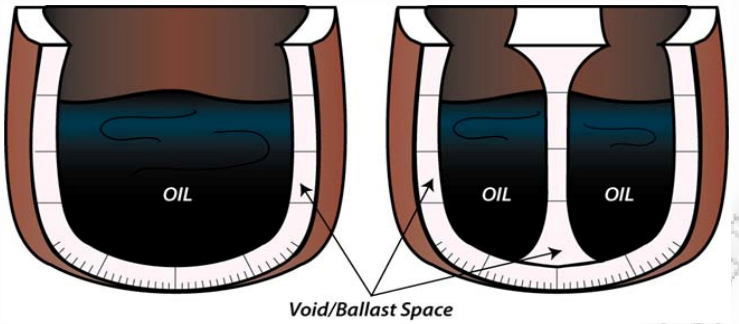
4.6 Legislation of Double Hull and Effect to Oil Freight Rates

We could say that Shipping is a global industry and its prospects are closely tied to the level of economic activity in the world. A higher level of economic growth would generally lead to higher demand for industrial raw materials, which in turn will boost imports and exports. The shipping market is cyclical in nature and freight rates generally tend to be highly volatile (Huges, L., 2002).

We have to know that the global shipping industry can be broadly classified into wet bulk like that of crude and petroleum products, dry bulk (like iron ore and coal) and liners. Under liners, it has containers, MPP and Ro-Ros types of vessels. Of course there are various benchmarks that determine freight rates for these segments. The prominent amongst them are Baltic Freight Index, Baltic Handymax Index for dry bulk segment and World Scale for tankers.

We have to mention that a double hull (figure 16) is a ship hull design and construction method where the bottom and sides of the ship have two complete layers of watertight hull surface. In other words, one outer layer forming the normal hull of the ship and a second inner hull which is somewhat further into the ship, perhaps a few feet, which forms a redundant barrier to seawater in case the outer hull is damaged and leaks (Huges, L., 2002). Of course the space in between the two hull layers is often used as storage tanks for fuel or ballast water.

Figure 16[16]

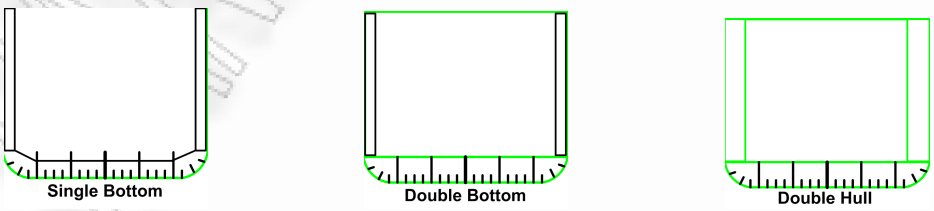


The double hulls are a more extensive safety measure than double bottoms, which have two hull layers only in the bottom of the ship and not the sides. The double hulls are significantly safer than single hulls. In case of grounding or other underwater damage, most of the time the damage is limited to flooding the bottom compartment, and the main occupied areas of the ship remain intact. In case of collision with another ship, most of the time the damage is limited to flooding the side compartment, and the main occupied compartments also remain intact (Huges, L., 2002).

For these reasons, we have to keep in mind that the double hulls or double bottoms have been required in all passenger ships for decades as part of the Safety Of Life At Sea or SOLAS Convention. Their ability to prevent or reduce oil spills led to their being standardized for other types of ships including oil tankers by the International Convention for the Prevention of Pollution from Ships or MARPOL Convention.

In order to understand exactly the above mentioned description, it would be useful to site (figure 17) the appropriate pictures of a double hull and a double bottom tanker and also of single bottom tanker as follows:

Figure 17[17]



16

http://www.pwsrcac.org/projects/MaritimeOps/TugEscorts/EscortBooklet/Images/Panacea2.jpg

17 http://reference.findtarget.com/search/oil%20tanker/

In addition, a double hull also conveniently forms a stiff and strong girder or beam structure with the two hull plating layers as upper and lower plates for a composite beam. This greatly strengthens the hull in secondary hull bending and strength, and to some degree in primary hull bending and strength. Some opposing viewpoints have argued that the double hull is actually more dangerous than a single hull. Most of the collisions that the double hull prevents are so minor that they would typically spill little to no oil on a single hull tanker. In addition, the double hull increases the risk of corrosion on the double hull, causing oil to spill into the ballast; not only defeating the purpose of the double hull, but in addition making it increasingly dangerous for the crew on a ship who must inspect those areas (Huges, L., 2002).

In addition to this, there is a much larger potential for explosive accidents happening due to the increased element of oil mixing with air during a high-energy grounding, as was the case with the Aegean Sea (oil spill). Possibly the most disturbing fact about the double hull is that it does not protect against major, high-energy collisions or groundings which is what causes the majority oil pollution, despite the fact this is why the double hull was put into United States Legislation.

One must bear in mind that the inland tanker shipping sector has seen a couple of excellent years and although this was also the case for the second half of 2006, the year on the whole did not really turn out that good. The first half-year was marked by such low freight rates that it was hardly worth the effort of taking to the Rhine in larger tankers. Cargo was in short supply and the waiting times at the terminals in the port areas of Rotterdam and Amsterdam were below par. There was a lot of dissatisfaction, more so because things are not looking particularly optimistic for the tanker shipping sector in the imminent future.

4.7 The Effects of Double Hull Tankers on Freight Rates Market

We could say that the image of safety that is associated with double-hull tankers came into being followed by some terrible incidents involving crude oil spills by breaking sea-going vessels such as the Prestige, the Erika and the Exxon Valdez. In the wake of these incidents, the usage of double-hull tankers was made compulsory for the transport of substances that were harmful to the environment, at least for some sections of the sea-going shipping sector.

The relationship between the use of double hulls and safety has however also trickled down to the inland shipping sector and a fleet of expensive double hull tankers was constructed. In the meantime, shippers and government bodies will however be drawing up rules that will make it necessary for most dangerous liquids to be transported in double-hull vessels in the near future. This is not as straightforward as it may initially seem.

On the other hand, we could say that the single-hull tankers are increasingly losing their value. Until some years ago, they could still be sold in order to generate capital for the investment in new ships. This market has however subsided and the future looks less optimistic for owners of single-hull tankers. The freight rates and the earnings of the different shipping companies around the world are primarily a function of demand and supply in the markets. While demand drivers are a function of trade growth and geographical balance of trade (which determines the length of haul required), the supply drivers are a function of new ship building orders as well as scrapping of existing tonnage (Huges, L., 2002).

Ship-owners can use the double hull oil tankers provide the transport most profitably. If oil products could only be carried in double hull tankers, all the shipping economist would have to do is predict the trade in oil tankers, and the demand for oil tankers is determined. With several double hull oil tankers available to carry oil products, and different sizes to choose from, the calculation of demand involves two additional questions. First, what options are open to the ship-owner? And, second, what economic criteria apply in choosing between those double hull oil tankers?

The answer depends on the type of the shipping venture for which the vessel is intended. Although there are many different influences to consider, the most important

can be the oil cargo, the type of shipping operation, the spot charter market operation and the liner operations. All four factors can play a very important role and affect freight rates market inside the shipping industry of the double hull oil tankers.

In addition, we have to keep in mind that the freight rate mechanism operates in a simple way. Oil tankers, ship-owners and shippers negotiate to establish a freight rate which reflects the balance of oil tankers and oil cargoes available in the market. If there are too many double hull oil tankers the freight rate is low while if there are too few the freight rate is high. Once this freight rate is established, shippers and oil tanker ship-owners adjust to it and eventually this brings supply and demand into balance (Mr. Linardis, Prodromos Shipping, 2010).

Furthermore, we could say that the new legislation on double hull tankers will affect the freight rates market in the Middle East where is the only export area where the share of double-hulls is lower than the average for the fleet. The avoidance by some large charterers of single-hull tankers probably contributes to a less efficient market, and a relatively tighter market, in particular in the VLCC spot market where less than 50 per cent of the tankers are double-hull. So it is obvious that the freight rates of oil products will follow an increased tendency (Kemp P., 2003).

On the demand side, we could say that the US is increasingly important to the tanker market. Crude oil imports to the US in 2006 were the highest ever, averaging some 3.4 million barrels a day 2005 levels. Imported crude oil has reached a record of 62.9%. Twenty years ago, foreign crude represented only 28% of oil used in the US. On the oil products front, gasoline imports increased by 5% to while distillate imports increased by 25% ("Naftemporiki", 2008).

All the above facts can just mention that although the legislation of double hull of oil tankers has been obligatory for the ship-owners who want to trade their tankers all over the world, the tendency of the freight rates market does not seem to be decreased. As the world demands for transport of oil products by oil tankers, the ship-owners will continue to build double hull oil tankers according the legislation and the rules of it and as a result their rates will continue to be increased. Increases which will be followed by the factors of the increased cost of building a double hull oil tanker and the high

demand of oil products while safety at seas will continue to be the primary concern of all the parties which are involved with the shipping industry.

4.8 Types of Engines Used in Tanker Ships in Recent Years

4.8.1 Propulsion Systems Used in Tanker Ships

Propulsion systems used for ships and boats could vary as from the simple paddle to the largest diesel engines observed in the world. Those systems may fall into three main categories. The first one is that of human propulsion, the second one of sailing and the third one of mechanical or electrical propulsion. That of human propulsion may include the pole and is still widely used in some marshy areas, rowing which was used even on the pedals and large galleys. Currently, human propulsion is mostly found on some small boats or as auxiliary propulsion on bigger sailboats.

Propulsion system by sail generally consists of a sail hoisted on a selected mast which is supported by various stays and spars and is controlled by different ropes. Sail systems were actually the dominant form of propulsion until the end of 19th century. Currently they are mostly used for purpose of recreation or racing, although some experimental sail systems like turbosails (figure 18), wingsails (figure 19), royals, and rotorsails systems are used in some larger and modern ships for purpose of fuel savings (Chrzanowski, I., 2002).

Figure 18 [18]

Figure 19 [19]

The third category which is that of mechanical or electrical propulsion systems in bigger or huge ships traveling around the world for trade, are generally consisted of a motor or engine turning of a propeller. It should also be said that steam engines (figure

[18] http://labspace.open.ac.uk/file.php/3391/T307_1_026i.jpg
[19] http://madmariner.com/files/images/WINGSAILS_060909_VX-P3.jpg

20) used for that purpose firstly. Those have been replaced by of two or four stroke, gas turbine and outboard motors on faster and bigger ships (Figure 21).

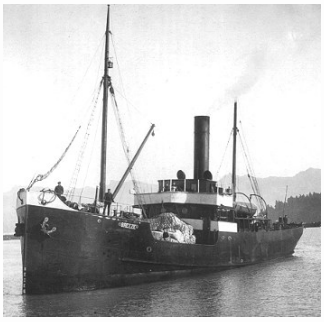


Figure 20 [20]

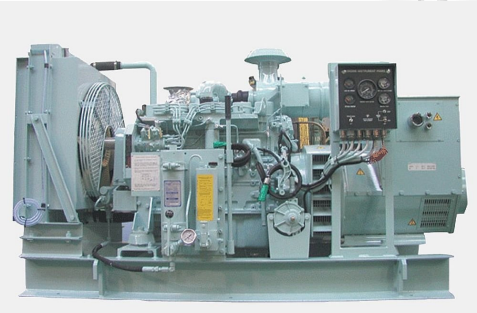


Figure 21 [21]

It should be stressed that in general there are a lot of variations concerning propeller systems and those include contra-rotating (figure 22), twin (figure 23), controllable-pitch (figure 24) or "*nozzle-style*" (figure 25) propellers. Some smaller ships tend to have also a single propeller system. Most of aircraft carriers use up to four (4) propellers which are supplemented upon bow and stern thrusters. The power they need is transmitted from the part of engine to the propeller in a way of a propeller shaft that may yew or not be connected to a specific gearbox.

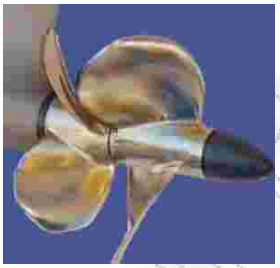


Figure 22[22]

Figure 23 [23]

Figure 24 [24]

Figure 25 [25]

As an example in that case, it should be told that are ships which use auxiliary systems which are characterized as steam powered, pneumatically or hydraulically powered. If someone tries to convert those systems to some electrical power and then combining

[20] http://www.nzmaritime.co.nz/images/breeze5.jpg
[21] http://img.nauticexpo.com/images_ne/photo-g/high-speed-auxiliary-diesel-engine-for-ships-4-stroke-in-line-type-196269.jpg
[22] http://www.btinternet.com/~jhpart/boata5bm.jpg
[23] http://www.marinetalk.com/Images/twin_propeller.jpg
[24] http://img.nauticexpo.com/images_ne/photo-g/pitch-propeller-for-ships-custom-made-controllable-193012.jpg
[25] http://img.nauticexpo.com/images_ne/photo-g/propeller-nozzle-for-ships-193782.jpg

those with electric drive propulsion, he would produce an "*all-electric*" ship. Various analysts have predicted that electric technology applied in ships, will offer those considerable benefits. It sis also true that electric drive offers considerable advantages for Tanker ships in terms of reducing their life-cycle costs, increase accordingly ship's stealthiness, survivability, payload and power.

Nowadays, most of the Tanker ships use mechanical drive. These systems are able to convert the engine's high speed revolutions per minute to low speed revolution per minute by using a set of gears. Ships upon mechanical drive systems like Tanker, actually appraise to have two sets of engines. One set is used for ship's propulsion and a second separate set is connected to generators and is used to create electricity for all of the electrically powered equipment on the ship (Master of Tanker Ship "Fereniki" –Prodromos Shipping, 2010).

Upon the existence of electric drive, generators can also convert the engine's high speed revolution per minute into electricity. Tanker ships upon such a system could be designed in order to have a single set of engines which would produce a common pool of electricity for use by the ship's propulsion and non-propulsion systems (Harrington R. L., 1992).

4.8.2 Redundancy - Electrical Propulsion System in Tanker Ships

It is true that electrical propulsion systems were extensively used during the days of World War II. Almost all of those ships were about to use steam turbines as prime movers with large gearboxes and electrical drives. Of course the things have changed and currently most of the electrical drives have medium or high speed diesel engines as also their prime movers. The only disadvantage that could be mentioned in that case is that of the electrical drive which is extremely expensive in the first cost and when this is compared to that of geared drive. This is happening due to the lower mechanical efficiency that leads to more fuel consumption and by consequence cost (Harrington R. L., 1992).

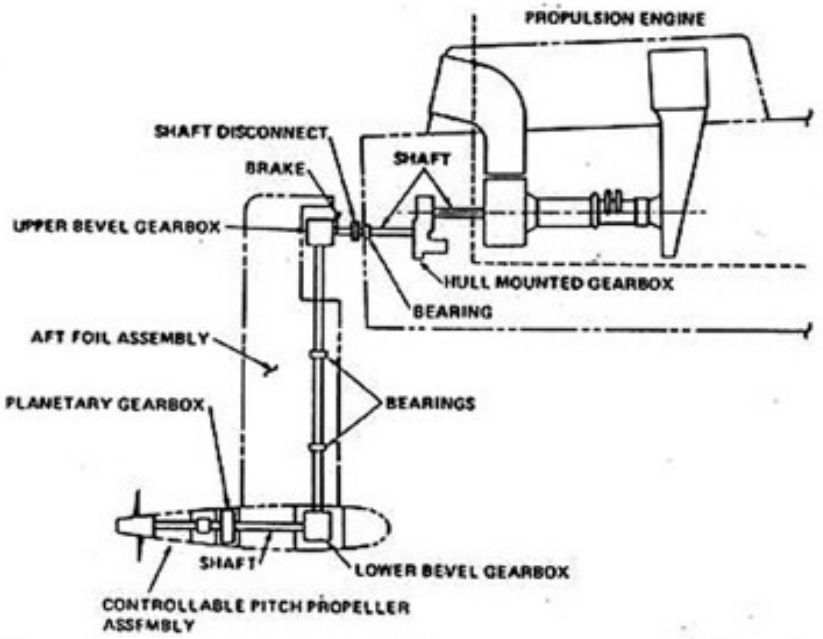


Figure 26 [26]

In previous years, ships and their motors were used with electrical drives and ships had completely separate electrical systems for propulsion and different purposes (figure 26). Although, after the invention of the so-called marine type thyristor converters, ships can also connect all of their machineries just to one single electrical system like that of power station. Therefore the power caused from the propulsion system, marine auxiliary machineries and ship's machinery load all is caused by a common energy "*pool*".

For that purpose generators in conjunction with the main engine are used, so as to get the close peak efficiency. As a result of combining the majority of electrical power sources into one system, this has assisted ship-owners to reduce all the extra costs and in ourdays is favored in almost all the ships. Particular system is considered to be suitable for all kind of ships upon high power requirements such as large cruise liners or Tanker and also specialist ships such as research vessels, fish factory ships, ice breakers, drilling vessel and oil production, etc.

Therefore it could be said that an electrical drive propulsion system is considered to be advantageous for ships which have large non propulsion electrical load or for a ship where there are number of propulsion devices which are installed throughout the ship

[26] http://www.foils.org/tutfig7.jpg

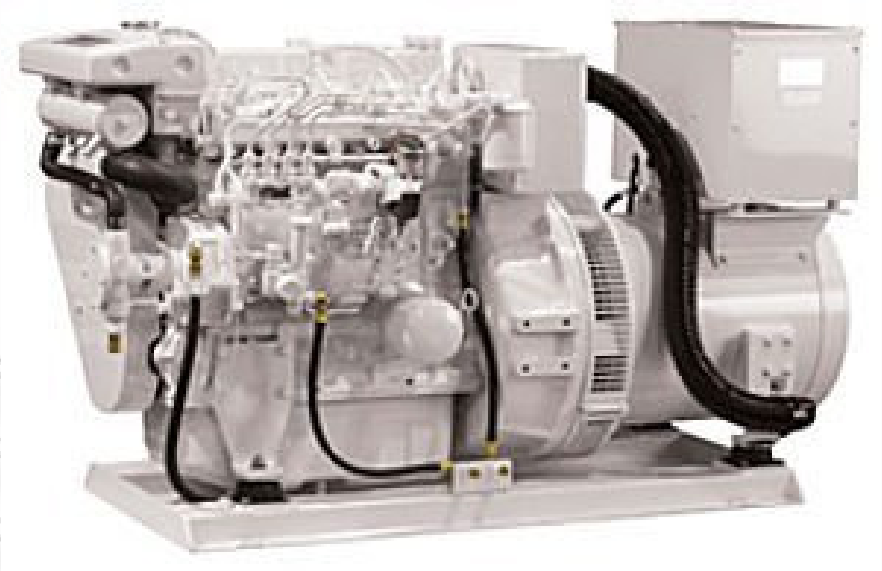
or dynamically positioned offshore vessel. Except from all the above, some other major advantages of electrical propulsion systems are those which drastically reduces the level of noise and vibration.

It can also provide power for the occasional use of bow thrusters without the assistance of any other power source. It can therefore operate on some low speeds and provide in advance a high level of reliability. Moreover, an electrical propulsion system can be easily maintained or repaired. Lastly it should be mentioned that it provides the facility for using all the machineries on one fuel where the requirement for spares is definitely low. It can therefore work on low grade fuels throughout the system, increasing by this way the cost efficiency of that system.

4.8.3 Diesel Mechanical Machinery in Tanker Ships

When somebody talks about diesel engine, he talks about an engine which is consisted by a parallel left and right engines mounted on a common bed plate having integral independent columns on which the cylinders of the engine are supported, the bed plate and columns forming the crank chambers of the engines (Bose B.K., 1997) (figure 27).

Figure 27 [27]



[27] http://img.nauticexpo.com/images_ne/photo-g/boat-diesel-generator-set-20-30-kva-204715.jpg

The parts of exhaust and scavenging pipes for the engines are being constructed like common parts, the scavenging pipe is being mounted between the engines and is flexibly connected to at least one of them in order to permit movement between the engine upper portions. Single propeller shaft is also driven at a desired low r.p.m. from the crank shafts of the engines through the gearing device which is consisting simply by a gear on the propeller shaft meshing upon a pair of pinions where each is connected to one of the engine crank shafts by an elastic coupling.

As this is being compared with a conventional single bank diesel engine, like a twin bank diesel engine that permits a ship of given dwt to be driven at the same speed with appreciable savings in fuel consumption and cost, in engine weight, and in engine room size with a corresponding increase in cargo carrying capacity also.

An internal combustion engine which is fitted on a ship is operating on a thermodynamic cycle in which the ratio of compression of the air charge is considered to be high so as to ignite the fuel that injected into the combustion chamber. Any true diesel engine, as represented in most low-speed engines, uses a fuel-injection system where the injection rate is delayed and controlled to maintain constant pressure during combustion (Bose B.K., 1997).

Such an adaptation of this injection principle to different higher speeds has necessitated departure from the constant-pressure specification, because the time available for fuel injection is so short. Nonvolatile fuels therefore are burned to advantage in these engines, which cannot be identified as true diesels but properly should be called commercial diesels. However, all those engines are primarily classified as diesel engines also fitted in ships. Diesel engines provide a high intrinsic and actual thermal efficiency by 20 to 40%.

The diesel engine in a ship is usually a four-stroke-cycle engine with indirect injection into an auxiliary combustion chamber. Most ships diesel engines use also a distributor-type injection pump for better results on propulsion systems. The fuel system most of the times includes a fuel-conditioner assembly that combines a water-in-fuel detector, water-fuel separator, fuel filter, fuel heater and hand-priming pump in a single unit.

4.8.4 Benefits from Redundant Machinery in Tanker Ships

All those specialists who are closely involved with the redundancy machinery in Tanker ships believe that when a Tanker ship is having a redundant power generation, propulsion and related systems, it can definitely minimize the risk of machinery related ship accidents. Various studies that have been conducted by the related organizations reveal that the ideal of a redundant configuration should consist of twin-screw, twin-rudder and twin medium-speed engines fitted with propellers and large primary shaft generators (Woodyard D., 1995).

The benefits which could arise in that case are major ones and most of those who are concerned with such matter; they also believe that true redundancy is not only about engines, computer systems and motors. It is also about the physical construction of a ship. There is absolutely no argument that by having redundancy machinery in ships this is extremely advantageous, if all the equipment is in one compartment**.** There should be twin compartments as a fire could make the redundancy (Master of Tanker Ship "Fereniki" –Prodromos Shipping, 2010).

Most of those specialists are convinced that electric propulsion in ships is perceived as an excellent opportunity for efficient operation and it is here to say that ship-owners should place considerable attention. According to DNV (Der Norske Veritas) redundancy is defined as the ability of a component or system to maintain or restore its function when one failure has occurred and that this can be achieved by component redundancy or system redundancy (Woodyard D., 1995).

Another major advantage of redundant machinery is that of weight economy. The shaft, propeller and gearing all represent the dead weight which is duplicated upon multi-shaft arrangements. Moreover, the curve of engine output power as compared to weight and size is not perceived to be linear and two smaller engines together can weigh substantially more than a single larger unit of the same output.

For such purpose it may be seen as an ideal arrangement which will involve keeping that particular duplication, i.e. the number of shafts, down to a bare minimum level. Provided the total power is below the maximum which can be absorbed by a single propeller, a single shaft arrangement would appear to be the most efficient. If the installed power is appeared to be greater than the maximum, this could be absorbed by

a propeller, then the most efficient arrangement would be that of involving the fewest number of shafts in most of the cases.

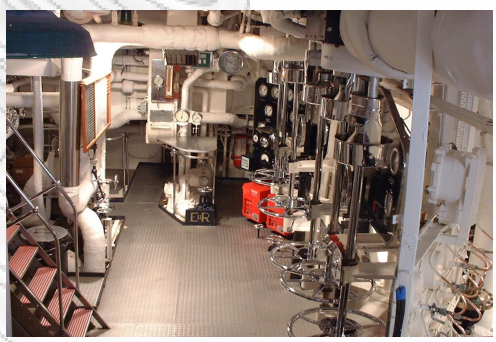
4.9 Shortening of Engine Room in Tanker Ships

In a tanker vessel like any other ship, an engine room is where the main engine, compressors, generators, pumps, fuel–lubrication oil purifiers and other major machinery are placed. Engine room is sometimes referred to as the "*machinery space*" of a ship.

Those are typically towards the stern, or some other times of the boat from the crew's living accommodations. On modern ships like tanker, a sound-proofed or air-conditioned engine control room is positioned just next to the engine room for the ship's machinery control systems.

Figure 28 [28]

Figure 29 [29]



The engine room of a tanker ship (figure 28, 29) typically contains several engines for various purposes. Main or propulsion engines are used to turn the ship's propeller and therefore move the ship through the water. They burn diesel oil or heavy fuel oil and might be able to switch between the two mentioned. There are many propulsion arrangements for tanker vessels, some including propellers, multiple engines and gearboxes.

There are also some large engines in those ships which are driving electrical generators that provide power for the ship's electrical systems. Large tanker ships typically have three or more synchronized generators so as to ensure a smooth operation. The

[28] http://www.yachtforums.com/forums/attachments/technical-discussion/20617-ship-engine-room-main-engine-1-.jpg
[29] http://image28.webshots.com/28/2/69/86/246226986JdINrb_fs.jpg

combined output of a tanker ship's generators is considered to be well above the actual power requirement so as to accommodate frequent planned maintenance or the loss of one generator.

On a tanker ship, power for both electricity and propulsion is provided by a large boiler. Superheated steam from the boiler is used so as to spin powerful turbines for propulsion and turbo generators for the electricity. A typical engine room in a tanker ship contains some smaller or redundant engines, including air compressors, generators, feed pumps and fuel pump. Nowadays, these machineries are usually powered by some small diesel engines or electric motors where may also use low-pressure steam (ABB Marine, 2000).

At this point it should be mentioned that the first major step to optimization is for specialists to recognize which type of vessel is to be optimized. Particularly for the case of tanker ships that we examine, it should be mentioned that the operability and performances of those ships must be considered in details, other points of intention are considered as ports of limitations, ship-owner requirements, slamming, or vibrations and structural requirements. Generally for such ships, it should be mentioned that the optimization is mostly focused on minimizing the resistance by mainly reducing the wave resistance.

In order for those ships with electric or diesel engine, is to meet the competition from new shipbuilding nations on this sector which is considered to be those more efficient ships which have to be produced in a shorter time. Today's ship design processes on tanker still follow a "trial and error" methodology unsuitable to cope with this market's growing demand (Master of Tanker Ship “Fereniki” –Prodromos Shipping, 2010).

Considering that this is a critical limitation to shipyards' competitiveness, major players of the European shipbuilding community contribute their expertise so as to significantly improve their design approach on which of those two types. Focusing on geometric modeling and hydrodynamic analysis on those engines, as the two decisive components, a new "functional design" process will be introduced which allows the efficient generation, systematic variation, effective flow analysis and rational evaluation of ship hull forms in tankers.

Aiming at hull form optimization at both the early and the refined design stage, some innovative parametric modeling techniques will be developed, established numerical simulation as methods will be enhanced and existing optimization procedures will be supplied. An open and modular system integrating all necessary tools will be implemented and applied at model basins and shipyards. Many design evaluation methods, like the resistance calculation techniques, use the major shape parameters of the hull to calculate their results.

Those parameters typically include the aspects of length, beam draft, prismatic coefficient (Cp), longitudinal center of buoyancy (lcb), and midship coefficient (Cm). It is therefore difficult to perform any parametric or sensitivity studies using these techniques due to the fact all of the variables are interrelated and may change at the same time for such ships. As an example, when a vessel's length is varied, it's "Cp", "Lcb" and displacement values all change at the same time. It would be also desirable to be able to change any one of these major design variables, while maintaining constant values for the rest parts of ships. Of course, this is impossible, due to the fact that appropriate variable changes, at least one other variable must change to compensate.

Previous work in the area of hull shape creation in the aspects of Ropax that approached the problem in three different ways. The series approach, hull variation or distortion from a parent hull and hull shape creation using form parameters. Many of those methods overlap, some are considered as automatic and some require users' intervention in tankers. The program which is described can also use specific hull variation or distortion techniques due to their generality and their fully automated approach applied to create the derivative hulls with the desired values of the major parameters.

An inspection routine is then used so as to extract all hull shape dimensions which are required by the evaluation routine or resistance calculation. This process of automatic hull variation and evaluation collects all input, intermediate, and final results for printing, plotting, and contouring.

It should be mentioned that the program starts upon a parent hull and then automatically varies the shape according to the designer's input, particular for such case

in tanker's design. In advance, each derivative hull shape is automatically evaluated, with the results printed, plotted, or contoured. Each box in the above diagram could explained in a way that the purpose of this program is to show the feasibility of carefully controlled hull variation for use by design optimization or evaluation methods in tanker ships also.

The overall design optimization is not considered to be fully automatic. It is actually under the control of the designers in shipyards who can carefully vary one or two major shape variables upon a time and then evaluate the results. By contouring and graphing these results, the designer could quickly study tradeoffs for a wide range of hull shapes and appropriate progress toward an optimal design shape.

4.10 Optimization of the Propeller in Tanker Ships

By continuing our analysis about the optimization of the propeller in Ropax ships, it should be mentioned that by taking as an example a tanker vessel, it should be said that this has a "CODED" machinery solution featuring a diesel mechanical part which is driving a conventional propeller and a diesel electric power plant powering both an electric pod and the hotel load. This machinery has the latest in environmentally friendly technology, such as "*EnviroEngines*" which is equipped with common rail and Compact SCR units. A ship like that appraise to have two large Wärtsilä 16V46 engines for the mechanical propulsion, two Wärtsilä 12V46 engines driving one generator each and one small Wärtsilä 6L32 generating set. The total installed power to that ship could be about 61.5 MW (Woodyard D., 1995).

The tanker vessel benefits from a novel propulsion solution with a contra-rotating fixed pitch propeller (FPP) mounted on the fact of the electrical pod located directly behind a conventional controllable pitch propeller (CPP) which is mounted on the centerline skeg (Master of Tanker Ship "Fereniki" –Prodromos Shipping, 2010). This configuration offers for sure better hydro dynamical efficiency, compared to any conventional vessel with twin screws on some long open shafts supported by brackets, for the reasons that the aft propeller takes advantage of the rotative energy left in the slipstream of the forward propeller when it turns in the opposite direction. This improves the rotative efficiency (R) of the propulsion (Woodyard D., 1995).

It should also be noticed that the single skeg hull form offers a more favorable wake than an open shaft line which is resulting in better hull efficiency (H). The resistance of the single skeg hull form with a single pod is considered to be lower than that of a twin screw hull with two open shaft lines, two rudders and many appendages.

It is true that this new concept can reduce the total delivered power known as "Pd" and demand the propeller by more than 10% to be compared with a conventional solution. Although, the delivered power is not the whole truth as it is the brake power demand at the diesel engine that determines the fuel consumption. The transmission efficiency must therefore also be taken into account when is about be decided accordingly. Those losses associated with electrical propulsion are about on 8%, compared to about 3 % for mechanical propulsion (Woodyard D., 1995).

When optimizing the machinery configuration for some overall economical performance, the investment cost must also be included as well. The best hydro dynamical efficiency is that of theoretically achieved with a power split of 50/50 between the pod and the mechanical propeller in Ropax ships. However, the higher transmission losses and much higher capital cost of the electrical propulsion part is important also as this means that more power should be on the mechanical propeller for the best economical performance of the ships. The pod power should not be so low though, due to the fact then that the full benefits of the "CRP" concept will not be achieved.

The power of the pod is under 40% of the total propulsion power in that position and in service conditions for the proposed tanker vessel. Since most of the power, more than 60%, is also on the mechanical propeller, the transmission losses and the capital costs are lower than in the case of a fully electrical propulsion system and only slightly higher than for a diesel-mechanical arrangement (Woodyard D., 1995).

However, due to its low fuel costs, the proposed machinery offers the lowest total annual costs for the intended service in tanker ships. In advance, the total installed power can be much lower. Although only part of the power is electrical the proposed "CODED" machinery still offers most of the benefits of a fully electrical power plant. Both the pod and the entire hotel load are supplied by the same power plant in that ship. The electrical capacity is also designed to cover the load at full speed at sea while

traveling. Since full pod power is not needed while maneuvering, no extra generator capacity needs to be installed for the bow thrusters in that propulsion system of tanker.

The large diesel generators with low fuel consumption supply most of the electrical power in tanker. The small generation set is intended also for use in port when the only electrical load consists of a 1.5-2.5 MW hotel load. This could give a very low engine load, if one of the large Wärtsilä 46 engines for example is used. Low engine load is not actually recommended for long periods of time in such ships. The type of "6L32" engine can also be used at full speed so as to reduce the load jump between the large engines at part load.

The pod is used for the steering of the vessel and can be turned till 360° while maneuvering. This also means that the maneuvering characteristics of the ship are about to be considered as excellent, which is most important for short turnaround time in port. No separate stern thrusters are needed in such case, which also avoids extra resistance and costs. The proposed machinery arrangement also offers a certain degree of redundancy since the machinery is being divided into two different separate compartments. If the mechanical engines are damaged in that type of ship, then the diesel electric power plant and the pod will automatically provide the hotel and propulsion power needed to operate the ship accordingly.

5. Conclusion

Nowadays, the most common ships which are used for the transport of goods from port to port, are those of bulk carriers and tankers. Of course there are also some ships that are characterised as special one, and those might include Ro-Ro passenger ships, liquefied natural gas carriers, liquefied petroleum gas, reefer, containerships, etc (Huges, L., 2002). Each of those ships demand for different operations of management and types of charter contracts, as they carry various commodities and their ship-owners need to employ experienced crew and managers ashore.

One of the most important single influences in ship's demand and for a shipping investment in tankers' carriers is definitely the world economy itself. There should be a close relationship between the similar timing of fluctuations in freight rates and cycles in the world economy and is only to be expected, since the world economy generates most of the demand for sea transport of bulk carriers, thus for shipping

investment. Though either the import of raw materials for manufacturing industry, or the trade in manufactured products (Huges, L., 2002).

Ship-owners who operate their ships inside the tanker sector, they need to be aware of the various statistical aspects that exist in such sector and appraise appropriately all the involved issues that can affect it accordingly (Stopord, M., 2000). What ship-owners have to consider is about is the seasonality of goods which are carried worldwide. Ship-owners should also know that the physical and commercial properties of the cargo that will be transported set a limit on the ship type that can potentially be employed in the transport operation.

The smaller tankers, ranging from well under 10,000 DWT to 80,000 DWT Panamax vessels, generally carry refined petroleum products, and are known as product tankers (Kemp P., 2003). The smallest tankers, with capacities under 10,000 DWT generally work near-coastal and inland waterways (Kemp P., 2003). Although they were in the past, ships of the smaller Aframax and Suezmax classes are no longer regarded as supertankers (Kemp P., 2003).

We must know and keep in mind that the inland tanker (figure 30) shipping sector has seen a couple of excellent years. The first half-year was marked by such low freight rates that it was hardly worth the effort of taking to the Rhine in larger tankers. Cargo was in short supply and the waiting times at the terminals in the port areas of Rotterdam and Amsterdam were below par. There was a lot of dissatisfaction, more so because things are not looking particularly optimistic for the tanker shipping sector in the imminent future.

Figure 30 [30]

[30] http://www.omccthailand.com/webboard/photo/32063206.jpg

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Appendix 1

Interview With Chief Engineer at Shore – Mr. Linardis in Prodromos Shipping Company

Question 1 : Which are the major steps that a shipping company has to proceed in order to operate efficiently its tankerships?

Any shipping company that operates bulk carriers has to use preventive to maximum practical extend. The recommendations and the instructions of the equipment suppliers in accordance with the experience of the company, the experience of the personnel and the class requirements of the vessel, they are very important because upon them is based the planning of the maintenance according to ISM Code.

Question 2 : Do you Believe that the Way that Tankerships Operate in Ourdays has Changed the Shape and Structure of Shipping Industry?

For a ship-owner who wants to make a shipping investment in a tanker carrier, the demand for sea transport can affect this investment where he must consider and appraise some useful matters so as for him, those matters to operate as a good point of objectives for each of his futures procedures in the shipping industry. Long term trends in commodity trade are best identified by studying the economic characteristics of tanker industry carries the traded commodities

Question 3 : Which are the Main Characteristics that Shipping Companies of Tankerships Should be Aware of as to the Demand of Sea Transport Services and Particular Shipping Investment

We have definitely to mention that shipping companies which are involved in tanker ship, they have to appraise accordingly the demand for sea transport services. This is not a direct one but actually we would say that is a derived demand. As we know, the major task of the shipping industry is to transport cargo around the world,

although this is the correct starting point for studying ship's demand, as an economic definition is too narrow

Question 4 : Do You Believe that the Freight Rate Mechanism Has Contributed to the Chance of Tankerships' Operation During the Last 20 Years?

We have to keep in kind that the freight rate mechanism operates in a simple way. Oil tankers' Ship-owners and shippers negotiate to establish a freight rate which reflects the balance of oil tankers and oil cargoes available in the market. If there are too many double hull oil tankers the freight rate is low while if there are too few the freight rate is high. Once this freight rate is established, shippers and oil tanker ship-owners adjust to it and eventually this brings supply and demand into balance.

Appendix 2

Interview With Master of Tanker Ship "Fereniki" of Prodromos Shipping Company

Question 1 : Which are the Types of Drive that Most of Tankers Use in Recent Years?

In ourdays, most of the Tanker ships use mechanical drive. These systems are able to convert the engine's high speed revolutions per minute to low speed revolution per minute by using a set of gears. Ships upon mechanical drive systems like Tanker, actually appraise to have two sets of engines. One set is used for ship's propulsion and a second separate set is connected to generators and is used to create electricity for all of the electrically powered equipment on the ship

Question 2 : Which are the Benefits that Could Arise from Machinery Redundancy?

The benefits which could arise in that case are major one and most of those who are concerned with such matter; they also believe that true redundancy is not only about engines, computer systems and motors. It is also about the physical construction of a ship. There is absolutely no argument that by having redundancy machinery in ships this is extremely advantageous, if all the equipment is in one compartment. There should be twin compartments as a fire could make the redundancy.

Question 3 : Do you Believe that Competition Has Contributed to the Development of Electric and Diesel Machinery for Tanker Ships?

In order for those ships with electric or diesel engine, is to meet the competition from new shipbuilding nations on this sector which is considered to be those more efficient ships which have to be produced in a shorter time. Today's ship design processes on tanker still follow a "trial and error" methodology unsuitable to cope with this market's growing demand

Question 4 : Finally from Where the Ship-owners Could Benefit as to Mechanical Machinery

The tanker vessel benefits from a novel propulsion solution with a contra-rotating fixed pitch propeller (FPP) mounted on the fact of the electrical pod located directly behind a conventional controllable pitch propeller (CPP) which is mounted on the centreline skeg