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Economics of Scrapping

by

Ekaterini Vlachopoulou

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Abstract

The decision to run a ship in a market depends upon the price offered by the charter market. Charter rates should be at least higher than the operational costs. If the charter prices are not good enough then the ship might be laid-up or even scrapped depending upon its age. The lay-up cost would depend upon whether it is a cold or a hot lay-up. If a decision is taken to scrap the ship then the ship-owner would have to take into consideration the market of second hand steel and the applicable environmental regulations. At the same time, the selling of the ship is also an option, but generally it is difficult in tough market conditions. The main inquiry of this thesis is to identify the factors which are affecting the decision of a ship manager whether to charter, sell, lay-up or scrap the ship. A literature review of the different environmental regulations related to scrapping will be part of the thesis. The reason is that environmental regulation will have a big impact on Ship demolition in the future due to the growing impact of environment globally. The required data will be second scrap value, charter rates, second hand ship sales figures, scrapped ships, laid up ships, scrap prices, lay-up cost, operations and capital cost of a ship for a particular time interval. At the same time all the environmental regulations should be taken into consideration. The Decision analysis has been used as a methodology to understand the various situations for the ship owners to operate or layup the ship. At the same time, data related to payoff of scrapping a ship and other demolition data have been used to analyze the important factors which lead to the scrapping of the ship.

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Chapter 1 Introduction to Thesis

1.1 Lay – up and scrap economics

The shipping industry is by nature a risky market. The dynamic and volatile nature of the shipping market makes the decision making of the ship owner or the ship manager a very difficult task. When the ship manager has to deal with low charter rates he tries to find ways to operate more efficiently through cost-cutting methods. In such difficult times the ship manager has two options. One option is to lay-up the ship and the other is to scrap the ship. The decision whether to scrap or lay up the ship depends upon various economic factors, which will be discussed in further sections.

When the ship is laid up, it's a cost for the shipping company. This cost will differ upon the kind of lay-up and the extent to which the ship will remain tied in a lay-up. Broadly dividing, the lay-up can be classified into hot and cold lay-up. Hot lay-up is short term and a minimal crew is maintained to run the required machinery. When a ship is in hot lay-up it can be easily re-employed when there are attractive charter rates in the market. Cold lay-up is relatively long term, all the machinery is shut down and the ship is moored with some minimal protection to avoid hull and other external parts from corrosion (UK P&I Club, 2009). If a ship has to be re-employed after a cold lay-up then the costs are very high since heavy maintenance is required. The ship might have to be sent to dry-dock after a cold lay-up, which would be a huge expense for the company. In hot lay-up the operational costs are higher due to more maintenance required and crew employment. Therefore, being able to predict the time duration of the lay-up is of high importance when deciding whether to do a hot or cold lay-up.

The ship owner might decide to scrap the ship instead of laying it up. In shipping, scrapping or dismantling of ship is considered to be a separate market (Stopford, 2009). The reason for this is its dependency on external market factors, such as second hand steel prices. Dismantling is giving the ship for break-up after running it for the required number of years. The ship manager gains revenue from this process from the scrap steel sold in the second hand steel market. So, the demand for second hand steel is a determining factor of the price of second hand steel. The price offered to the ship owners depends also upon other factors apart from steel prices. The labour costs in the dismantling facility, the capital invested, the taxes and the health and safety standards followed (European Commission Directorate General Environment, 2007) have an influence on the price as well. Generally, when the standards rise the costs also increase. If the manager chooses green recycling over traditional scrapping then the revenue earned from scrapping reduces due to the added cost of green re-cycling. The manager has to decide whether to go for the environmental friendly and costlier green recycling or traditional scrapping which is considered hazardous to the environment and dangerous for the labor involved especially in the developing countries. The new environmental regulations related to recycling of ship if ratified by IMO, will have a great impact on the scrapping market. Now the cost of green recycling is ignored by most of the companies, especially in tramp business. This extra cost might have an impact on the decision of a ship manager whether to go for lay-up or scrap the ship. Most of the

scrapping is nowadays done in the beaches of the Indian sub-continent in a hazardous environment; hence it is quite dangerous or even sometimes fatal for the labor involved.

To sum up, when the market is down, the manager has to decide whether he will lay-up or scrap the ship and accordingly which mode of lay-up and which type of scrapping he will choose. Time plays a crucial role upon these choices. The expectations of the manager on when the market will recover and what will eventually happen in reality will drive these decisions. If the manager feels that the charter rates are going to pick up soon then he might go for a hot lay-up, so that the ship is ready whenever there is business requirement. If a prolonged recession is expected then the manager might go for a cold lay-up. When the time period of the cold lay-up increases the manager would start thinking scrapping as an option. At this point of time the price of scrap steel in second hand steel market would have a definite impact on the decision of the manager. If the price of the scrap steel is high then the ship owner would have to calculate the revenue generated from scrapping of ship. This revenue has to be compared with any kind of charter prices in near future taking into consideration the cost of reemployment of a ship which has been in cold lay-up for a while. In this case, if the ship manager decides to scrap the ship, he has to make a choice between traditional scrapping and green recycling. As discussed before green recycling is an additional cost for the company. In that case the ship manager might decide to wait for the scrap steel price to go up even more than the optimal level to counter balance the extra cost of green recycling.

Sometimes, non-economic reasons are involved, but generally that is not the case since profit maximization is the ultimate goal. A company might choose to send her ship for scrap in a green recycling facility for marketing reasons, to promote her image as a follower of the green movement which is supported by corporatized shipping companies.

The critical decision of the ship owner of whether to lay up the ship or scrap the ship depends upon two different markets. One of them is the demand for cargo transport in the charter market which would determine the charter prices. If the charter prices would start to increase then the ship manager would be prompted to keep the ship in a lay-up for a slightly longer period. At the same time, if the second hand steel price of the scrap market is higher the manager would be prompted to scrap the vessel. So, the timing of the decision is very important here. A ship-manager might wait for the scrap steel prices to go up and keep the ship in a cold lay-up. Also, a ship manager might wait for the charter rates to go up and keep the ship in hot lay-up. At the same time a ship manager might keep both the options open since the market trend is not that clear.

1.2 Environmental issues

When a customer purchases a new product, he is concerned about the quality of the product. While selling a product, a vendor is also concerned about the quality since he will obtain a price for it. On the other hand, when we just have to throw or scrap something for which we get the nominal amount we are naturally least concerned about the method it will be used to scrap it or recycle it. In the case of shipping, most of the

scrapping takes place in the Indian sub-continent in an unregulated and uncontrolled manner. When compared to other major environmental issues related in shipping, like the Carbon-dioxide emissions, the problem of scrapping is given less importance. One of the reasons is that the Carbon-dioxide emission is a more serious issue and the consequences are more global in nature, in the form of the well known “greenhouse effect”. The impacts of scrapping are restrained in the area where the scrapping takes place, hence they are more localized, and have an effect on a limited number of local residents and labor working in the scrap yard. This problem is compounded by the fact that most of this scrapping is done in the Indian sub-continent where the scrapping has developed as an industry and there is a supply of cheap labor despite the hazardous conditions of working in the scrap yards. For these countries, ship breaking is a huge industry and a big scope of employment for low skilled workers.

The major issue with dismantling of ships in such a yard is the process in which these ships are being dismantled. The two primary points here are the safety of the workers working in such conditions and the pollution of the local environment due to the inappropriate handling of the wastage material. The safety of the workers is hampered not only due to the state in which the ship is delivered, but also due to their own negligence regarding standard safety guidelines. The whole process of dismantling the ship consists of dangerous jobs like gas cutting and physical breaking in hazardous conditions. This ideally requires huge investment in safety equipments for the labor to use. It also demands proper training of the work force for the safety procedures to be followed. In most of the cases, this is not seen to be practiced among the workers.

At the same time, the condition in which the ship is delivered to the scrap yard also plays an important role in the danger levels of the ship scrapping process. The tanks should be made ideally gas free and delivered for the scrapping to be continued. Some of the materials used during ship construction make the process of ship scrapping even more hazardous. Materials such as asbestos, ammonia, chlorofluorocarbons, oily residue and lead are used during ship construction. While dismantling the ship, the presence of such materials leads to serious health concern for the labor working in the scrap yard as they inhale gases coming out of these materials. During the operation of a vessel it has to undergo continuous maintenance. For example, the painting of the ship is a very important activity as a part of the operations. If the standard paints are not used then this might cause problems for the labor when the ship is being scrapped. Therefore, it can be seen that, the hazards the labor working face in the scrap yard are not only due to the ignorance in the scrap yard. It also depends on the materials used during ship construction, on whether the correct procedure is being followed during the ship operations, on whether standard materials are being used during the operations, and also on the condition of the ship when delivered for scrapping.

In order to improve the condition of the labor in the scrap yard especially in the Indian sub-continent, a four step regulatory process has to be set up. This would start from the design and construction phase of the vessel until the final scrapping of the vessel. Operations and the preparation for delivery to the scrap yard will also be important steps in between. The details of each of the step would be discussed in chapter 2.

Another major problem related to the scrapping of the ship is the pollution of the local environment due to improper handling of the wastage generated out of the scrapping process. Whenever scrapping is done in an open and unrestrained environment, the waste management or the byproduct management of all the activities during scrapping does not take place systematically. This might result in some of the unwanted elements such as asbestos, ammonia and lead to blend in the water supply of the local nearby population. This could lead to serious health issues for the local population when they consume this water for various purposes.

The IMO tried to deal with these problems and search for solutions with the Basel Convention in 1989 and the Hong Kong Convention in 2009. The seriousness of the issues related to the scrapping of a vessel under inappropriate conditions has come into the center of attention in recent times. This is due to the worldwide growing concern of the environment related issues. At the same time the shipping companies, especially of the liner industry, have been showing concern for the environment. Many of these liner companies have been trying to grow vertically and hence they have become more customers centric. So, the indirect pressure of the global concern for the environment has also affected the liner companies due to their more customer centric approach. The latest IMO Hong Kong Convention has been instrumental in highlighting the increasing importance which green recycling would hold in the future.

The primary objective of the Convention is to lay down the regulations for the design, construction, operation and preparation of the ship to facilitate the process of recycling in an environmental friendly way. The Convention is expected to take effect in 2015. All these regulations would take into account that the safety and operational efficiency of the ship are not compromised.

As explained, the most important problem with scrapping is related to the usage of the hazardous materials during the construction and operation of the ship. As per the Convention there will be some material which will be completely prohibited from usage in any phase. The ships will have to carry a list of hazardous material used while construction of the vessel. This will be done in collaboration with the ship-yard involved in ship design and ship construction. The ships also have to be carrying a list of hazardous materials being used during day to day operation. The survey to verify the inventory of the hazardous material will be done at three stages. One will be done at the initial phase, the second one will be done during the life of the ship and the third one will be done just before the ship is being given for recycling. Ships will be required to provide a ‘Ship Recycling plan’ in order to provide the process in which the ship has to be recycled, which in turn would depend on the particulars of the ship and the inventory of the hazardous material carried by the ship.

The guidelines of the ship recycling plans have been designed in such a way that the minimal materials are wasted and maximum are recycled. For example, the scrap steel can be reprocessed to make reinforcing rods used in the construction industry. If the generator of the ship is in working condition it can be used in industries ashore. Proper green recycling would not only help to solve environmental issues, but it would also help in the conservation of the resources and energy. If the industry of recycling is more organized then it would employ more trained and better skilled employees. As

discussed before, the whole process of implementing green recycling would be challenging and would take IMO longer time to implement due to the several stake holders involved in the whole process. As seen above, the whole process of recycling has to start from the design and construction phase. This would not be possible for an already built ship. There are many other issues which create a huge gap between the rules laid down by the Convention and its implementation which would be discussed in the second chapter of this thesis.

1.3 Data

The data requirement of the thesis is mostly historical data of a particular time period. Each of these data fields would correspond to a particular time period even though their source might be different. The data indicating the 'number of ships laid up' and the 'number of ships scrapped' is important for the thesis. The dataset above would be filtered on the basis of type of ship, age of ship and other sub categories. The 'second hand steel prices' which is expected to be the most important factor affecting the decision of a ship manager whether to lay-up or scrap the ship is an important data field. The charter rates of that time period are also an important field. Also, an attempt will be made to quantify other factors such as taxes, demands for other ship parts, labor and capital cost. All the variable factors like second hand scrap steel prices, taxes and other discussed above would be filtered on a basis of a country or region regarding the variance observed. In order to study the environmental impact data related to health hazard from traditional scrapping would be required. The data indicating the number of ships which have been scrapped through green recycling have to be used. The source of the data has been mentioned in the appendix.

1.4 Methodology

The methodology used in the thesis would help to answer the research question in a more holistic way. Decision Analysis would be used as tool or methodology in the thesis. It would provide scope to understand the various decision alternatives and the various approaches to reach the right decision. The different data obtained as discussed above would be grouped in a time series for a comparative analysis. For the decision to be taken by the ship owner the payoff has to be calculated in different market conditions. The time of ship, more importantly the probability of the right decision would be important. Also, a time series analysis would be done to analyze it through a time period. In order to narrow down the data usage the data would be mostly filtered on the basis of the type of ship. In this thesis due to consistent availability of data handy size vessel has been taken into usage in the data and methodology section of the thesis.

1.5 Research Objective and question

As discussed above this thesis would majorly focus on the decision making in the ship management taking into consideration the ship operations, layup and scrapping. In a few words, the various decisions the ship manager has to consider are the operations, layup and demolition of the ship. All these decisions have to be taken in the dynamic charter market and scrap value environment. The main research question and the sub-questions would be as followed.

How are the strategic decision making of the ship management with regard to ship operation, layup and dismantling affected by the charter market and scrap value market?

The sub-question would be as follows.

What are the problems with traditional scrapping and the environmental regulations which would have a major impact on the ship scrapping industry in the future?

What are the various regulations related to layup of a ship and the economic factors which have an impact on scrap market?

What kind of data and methodology has been used to analyze the decision making in the ship management?

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1.6 Structure

The structure of the thesis will be divided into the following manner. The first chapter will cover the introduction which will briefly describe the research background, objective and the method used to answer the questions. The second chapter will be related to a literature review of the environmental issues related to traditional scrapping and the new regulations which will encourage green recycling. It will first describe all the problems related to traditional recycling. Then it will describe the various regulations and conventions which have an impact on the ship recycling process. The chapter will end with a brief note on the practical problems related to green recycling along with some cost analysis. The third chapter will consist of a literature review related to the layup and scrap economics. It will also mention various regulations related to layup. It will also consist of literature review of the various market forces such as charter rates, scrap value and age of the ship. The fourth chapter will consist of all the data, which will be used to analyze the research question such as demolition data, charter rates and scrap value. It will also consist of the data related to the layup cost and operation cost. The fifth chapter will include the methodology in the form of a Decision analysis and pay-off calculations of the various decisions in different market conditions. It will also consist of some data analysis of important parameters in time series. At the end of the sixth chapter would be the conclusion in order to briefly summarize the findings of the whole thesis.

Chapter 2 Environmental Regulations

2.1 Ship breaking and ship scrapping operations

Ship breaking or demolition is another industry of its own. The major product of this industry is the scrap steel obtained out of the ships. This scrap steel is further used by the steel industries for reprocessing and subsequently making other new products sellable in the market. Initially, around 1970s this industry was more prevalent in US and Europe. Slowly it started shifting more towards Asia. Taiwan and South Korea were the first major players in this industry from Asia. But, during 1980s and 1990s the Indian sub-continent started to play a major part in the ship breaking industry. Today 80-90% of the ship demolition activities take place in India, Pakistan and Bangladesh. The two major factors which prompted the shift from the west to the Indian sub-continent is the increase in demand for scrap steel in the Indian sub-continent and the availability of cheap labor. In the Indian sub-continent this activity is carried out in a more labor intensive manner. Due to the abundant supply of cheap labor the investment done by the scrap yards on the infrastructure, safety and training of labor is very limited. As a result, ship breaking becomes even a more dangerous and hazardous job.

The focus of this chapter would be the environmental laws and regulations related to traditional scrapping and green recycling. The sources of these laws or the bodies which are making these laws are also important part of the review. Another important aspect would be the reason for making these regulations which means what are problems in the ship breaking industry which has prompted the formulation of such laws. The cost-benefit analysis of implementing these laws in practice and also the practical applicability of these laws is an important focus of this chapter. The following section would describe some of the problems and aftereffects related to traditional scrapping which are generally being practiced in the Indian sub-continent.

In addition to a reasonable demand for scrap steel and availability of cheap and abundant labor, the Indian sub-continent has some of other features which make her suitable for the ship demolition industry (Hossain & Islam, 2006). Most of the scrap yards like Alang in India, Chittagong in Bangladesh and Gaddani estate in Pakistan have a long uniform inter-tidal zone, stable weather conditions and certain level of infrastructure to promote ship breaking. These locations are also not very far from the major trade routes of the world. All these facilities are mostly labor intensive and they lack in use of technology. Moreover, they are mostly done in open and uncontrolled environment. These kind of traditional scrapping locations are also named as ‘non-facilitated beach’ or ‘first generation facility’. China has been trying to develop some of the modern ship breaking yards with the used of modern methodologies. The issue of ship breaking in these countries is due to negligence from three parties involved. The shipping company tries to increase its profit earned from scrap steel by using the cheapest ship scrapping yards. Hence, it chooses the scrap yards of the Indian sub-continent as they are more labor intensive. These scrap yard try use the advantage of cheap and abundant labor available for doing this dangerous work of scrapping. As the alternative sources of employment for the labor involved are very limited, the labor involved is voluntarily ready to do this dangerous and dirty job of ship scrapping in

adverse working conditions. So, it is a benefit in terms of cost for the shipping company as well as for the ship scrapping yard. The government has not been able to implement the environmental or health regulations effectively in these countries. It can be said that the labor, the scrap yards and the government have been trying to have a competitive advantage in terms of cost in this ship dismantling industry by neglecting the environment and safety requirement. In order to achieve optimal environmental and safety standards capital investment has to be done for which there has been no compulsive force.

In order to now understand the real issues related to traditional scrapping the operation of ship scrapping has to be understood.

- All the consumables, tank contents, loose equipments have to be removed. Vessel has to be made as light as possible to make it as high as possible. For this process to be carried out a proper reception facility should be available or else all the waste will get discharged into the sea and result in maritime pollution in the locality.
- The ship bow or stern are slowly opened in order to get access to the other internal valuable parts of the ship. This is done by the process of gas cutting. As a result, some of the antifouling agents, hydrocarbons, paint, heavy metal, dust and asbestos get deposited in the ground and mix with the water. Also, the vapors emitted out of this material and the emission out of the cutting process pollutes the environment.
- The next step is to accumulate all the valuable parts separately. At the same time reduce the size of huge chunks of scrap steel into smaller steel parts. This is done by using torch cutting. Due to uncontrolled nature of the operation, the same issue of leakage of unwanted material in air, water and ground happens. The emission from the cutting process leads to more air pollution. There is always a danger of burn, falls, overloading and explosion due to the simultaneous activity of cutting, sorting and transport in an unsystematic way.
- All the individual parts and components are sent to the nearby market for re-selling. Some parts are also sent for reprocessing and recycling. In this case, hazardous materials get exported from the breaking site. The process of transporting hazardous materials from the breaking sites to the reprocessing plants has to be done carefully.

The four steps above describe the process or the operation of the traditional scrapping in a simplified way along with the kind of threat they pose to the environment.
The process of disposal and recycling of the material extracted from the ship can be broadly classified into three categories. These are resale, remanufacturing/reprocessing and recycling material. Some of the products which were in working condition in a ship can be directly sold in the resale market. Products such as pumps, valves, motor, machines, navigational equipment, life-saving equipment, personal safety equipment, steel components, chemical and paints, sanitary equipment, furniture can be directly sold in the resale market. Some of the products which cannot be directly resold can be remanufactured and then sold. Products such as anchor chains and engine structure can be re-manufactured. Some of the oil products such as lubricating oil and some

mineral products such as asbestos can be reprocessed. The scrap steel can be passed through recycling process. The quality of the final product obtained out of the scrap steel is determined by the quality of the scrap steel, the sorting process and the recycling process. So, it can be observed that if the waste management is done in a proper way then it will go a long way in conservation of energy and resources.

2.2 Labour issues

The most important issue related to traditional scrapping is the problem of the working conditions of the workers. The safety and health of the workers working in the scrap yard is always under threat due to many factors which will be discussed in this section. The ship breaking operation is done under adverse conditions. The structures are huge and the area to work in is very congested. Over that, there are many simultaneous operations going on. These make the scrapping operation very challenging mechanically. In addition, the labor used are low skilled and untrained. These problems are compounded by lack of proper planning and management. The labor is not provided with proper and optimal safety equipments to use. Sometimes, even if the safety equipments are available, the labor is not trained in a proper way to use them or they are not aware of the negative implications of not using particular safety equipment. The platforms on which the labor stand and work are not stable and the tool used by them do not meet the required safety standards. Activities like gas cutting generate a threat of fire and explosion in such an environment. All the factors mentioned above impact the personal safety of the labor extremely. It results in death cases and serious injuries, which can make the labor handicapped for life. The accidental injuries can be broken limbs and burns due to fire or explosion. This problem is compounded by the almost non-existent insurance policy for the labor.

The other health issues which the labor has to bear are more of a long-term nature. This happens due to the unsafe working practices used by the labor and the hazardous materials used during the construction and operation of a ship. The operational activities such as torch cutting affect the eyes, heavy lifting leads to back injury like slip disc, and noise affects the ear drums in a negative way. The greater threat to health is posed by the exposure to hazardous material. The following points indicate the harmful effects of some of the hazardous material being used.

- Exposure PCB (polychlorinated biphenyl) can lead to cancer, liver damage, reproductive impairments and immune system ineffectiveness.
- When PCV (Polyvinyl chloride) undergoes combustion, it produces large quantity of Hydrochloric acid when its fumes mixes with water vapor present in the atmosphere. It results in ulceration of the respiratory tract. It also produces Carbon monoxide and dioxins which are highly toxic in nature.
- PAHs (polycyclic aromatic hydrocarbons) are produced by incomplete decomposition of hydrocarbons. They are one of the most known carcinogens.

- Asbestos is generally found in thermal insulated substance. When asbestos breaks down into fine particles they remain suspended in the air for a long period of time. When these particles are inhaled by the scrap yard workers, they lead to lung cancer, chest and abdominal lining cancer, and irreversible lung scarring. It is tough to detect these problems in the initial stages and generally they build up through a long period of time.

- Metals such as Lead, Mercury, Cadmium, Iron, Aluminum and Zinc are found in the ship breaking yards in some concentration in the air. Continuous exposure to such a metal environment may lead to serious health problems.

All the hazardous substances mentioned above pose serious threat not only to the workers working in the scrap yard, but also to the local environment. Due to improper waste management all these hazardous substances leech into the drinking water and the food chain of the whole community leaving nearby. This results in long term health problems for all the community surrounding the scrap yards. The presence of scrap yards also affects the local fishery industry in an adverse manner. Statistically it has been observed that there has been a decline in the fish stock in the presence of ship scrap yards, probably due to the marine pollution. TBT (Tributyltin) is one of the dominant anti-fouling agents used to reduce the resistance of the ship hull. It is primarily responsible for the heavy marine pollution in the water.

2.3 Laws and Regulations

2.3.1 Source of law

All the factors and concerns discussed in the sections above have led to formulation of laws and regulations to make the process of scrapping more organized and environmental friendly. In the section below all the law making body and stakeholders will be discussed. All these players have to play an important role in the formulation and subsequently in the implementation of these regulations. Moreover, all these stakeholders have to work very closely to make the regulations practically applicable in the changing times where the environmental concerns have reached their zenith.

- IMO (International Maritime Organization) – The IMO is the premier maritime organization. It has to take the responsibility of coordination between all the parties involved for the success of the whole effort to make the recycling more green and organized. It also has to monitor various laws which facilitate the recycling process from ship design, construction, and operational point of view. Also, the preparation of the ship for green recycling comes under the regulations formulated by the IMO.

- ILO (International labor organization) – The ILO is responsible for setting standards for the working conditions of the labor involved in the ship recycling

process once the ship has been beached. It would develop new standards for the safety of the labor over the already existing standards.

- The Basel Convention on the trans-boundary movements of hazardous wastes and their disposal. This convention is focused more on the safe handling of the hazardous materials and their disposal. It also aims at minimizing the use of such materials in the ship design, construction and operation stages.

- Shipping industry – The shipping industry is mostly responsible for the construction and design of the ship in a way so as to facilitate the green recycling process. All the laws and regulations formulated by the regulating authorities have to be finally implemented by the shipping industry. The final preparation of the ship for delivery to the scrap yard has to be done by the shipping company.

- Environmental groups – These groups input direct as well as indirect pressure on the regulatory authorities to regulate by addressing the issues related to the degrading environment. At the same time they also exert pressure on the shipping companies to implement these laws.

- National government – The role of the national government is most important here since it has to ratify the convention set by the regulatory authorities, such as IMO. Also, it will play a key role in setting of the work culture for the labor working in the scrap yard. They can also play a key role by helping to set up training institutes in order to facilitate safe working environment.

2.3.2 The regulations

The London convention 72
The London convention deals with the disposal of waste material from the ship in order to prevent marine pollution. It might be used as a guideline for the ship scrapping procedure but does not specifically state any clause related to the ship scrapping.

The Basel Convention
The primary objective of the Basel Convention was to prevent the dumping of waste in the developing countries by the OECD countries. The Convention was developed to regulate the trans-boundary movement of waste material, mostly from developed nations to developing nations. The ship when brought for scrapping can be considered to be waste hazardous material since it consists of hazardous materials. The ship scrapping being done as per the traditional ship scrapping method does not comply with the regulations of the Basel Convention. The Convention's goal was to prepare appropriate technical guidelines to facilitate the systematic recycling process. The Convention lays down a list of hazardous materials. Moreover, it states methods to

handle, dispose, and recycle the hazardous materials in an environmental friendly manner. The Convention was very much against the beaching method used for ship scrapping in the Indian sub-continent. The reason that the beaching method is not considered to be safe as it is dangerous for the workers and the local environment.

Hong Kong International convention for the safe and environmentally sound recycling

MEPC (Maritime environment protection committee),the senior technical body of the IMO, has played a major role in initiating the Hong Kong Convention which would facilitate green recycling. It would cover all the stages of the ship life which includes resources, production, use and recycling. The Hong Kong Convention has the following three major requirements

- The ships which are sent for recycling should carry a document consisting of inventory of the hazardous material. This list has to be maintained from the ship construction stage. It has to be passed to the ship owner from the construction yard and subsequently to any other ship owner if the ship is sold. The document has to be maintained in such a way that any subsequent changes to the materials or equipment can be recorded appropriately.
- A list of hazardous materials will be prevented from usage in the ship construction yard, ship repair yard and during the ship operations. This list of materials should not be used in any situation in any stage of the ship's life.
- In order to have a proper check on the inventory of hazardous materials the ship has to undergo surveys at three points in its life. The first survey is done after the construction is over. The second survey is done during the operational life of the ship and the third one done just prior to the recycling.

In the initial stage of the ship building the ship has to undergo the following procedure of compliance

- The usage of some of the hazardous material has to be completely prevented at any stage of ship construction.
- An initial inventory list of hazardous materials has to be prepared.
- An initial survey of the ship has to be done in order to check whether the ship is in compliance with the above two points.
- If the survey is completed successfully then a certificate of compliance will be issued.

There are two parties which play important roles here. One is the flag state of the ship, which has to oversee that ship is in compliance with the Hong Kong Convention during the construction and operation stage of the ship. The other is the recycling state, which has to check whether the recycling activities are being carried out as per the environmental regulations.

When it comes to the hazardous materials being used, there are two important points to be considered. One is the location of the hazardous materials on board and the other is the quantity of the hazardous materials on board keeping in mind their impact during the recycling stage. These materials can be subdivided into three kinds: the materials

present in the structure and equipments of the ship, the materials used during operations or generated as wastes during the operations stage, and the hazardous materials as a part of stores.

The ISO standards

The ISO standards are built in such a way that they support the goals and objective of the International Maritime Organization. The ISO tries to complement the already existing rules of the IMO. The IMO and the ISO work very closely so that there is no overlap of standards with their final objective as sustainable environmental regulation for the maritime sector. The ISO certification for ship recycling would provide audit and certification to increase the safety of workers and also to provide protection to the environment. It encourages companies to make their own standards to be more environmental friendly and socially conscious when it comes to recycling of ships. When it comes to standard the shipping company has to follow the normal good practices which would facilitate green recycling. The certification issued by the relevant ISO body would be internationally recognized. In order to increase confidence levels on the certification and auditing of ISO it would be carried out in a reliable and consistent way. The ISO 30000 will apply to all kind of ships, both type of ship and size of ship. These will apply to the ships which are in domestic as well as international routes. These rules would be developed in cooperation with the other international bodies such as International Maritime Organization (IMO) and World Trade Organization (WTO). The two main issues which the ISO 30000 would address will be how to scrap the hazardous material and the determining the optimal facilities in a green recycling facility. The major goals of the ISO 30000 would be as follows

- To guide the various bodies who are applying for ISO30000 certification in a systematic and harmonized manner.
- It defines the various specifications and checklist related to the audit and certification of the ship recycling procedure in order to achieve the required safety and environmental standards.
- The certification also provides the customers of the company with the confidence that the company is taking care of various environmental issues related to waste management and recycling.

All the points discussed above would help to standardize the process of green recycling and would provide the company a green certificate. The most important use of the ISO certification and auditing for a company is to use it for marketing purpose. The general customer of today has become very environment conscious. A shipping company might not be serving the general customer. For a shipping company a retail company like wall mart, or an electronic company like Sony, or a mining company might be its customer. For all these companies mentioned, the final or the end customer is the general public. So there is always an indirect pressure of the general public and subsequently a direct pressure of the clients of on the shipping company to follow environmental regulation. The ISO certification for ship recycling compliance is a very important tool for the

shipping company to show the customers about its growing concern for the environment.

A part of the ISO 30000, ISO 30003:2009 would be useful for the shipping company, the ship owners, the ship recycling yards, the government, the maritime research companies, the maritime institutes, the labor organization, the environmental organizations, the port authorities, the inspection authorities and the classification societies. It would help in promoting the safety of workers, the environmental conditions and recycling, reprocessing of steel and other equipment and material used in the ship. The ISO is still working in formulating other guidelines for ship recycling such as:

- The ideal process to be followed by ship recycling yards.
- Guidelines for the shipping companies in order to select the correct ship recyclers.
- Guidelines to practically implement ISO 30000.
- Adequate information availability of the hazardous material in ship designing, construction and operations.
- Guideline about how to conduct a survey on the hazardous material and the amount to be checked.
- To minimize the use of asbestos on ship.
- Make guidelines for yachts recycling.

The ISO along with IMO should provide adequate regulations for the recycling of ship to be carried out in the most environmental friendly way. At the same time it should ensure that the labor involved in such operations be safe and maximum recycling, re-usage and re-processing of the scrap metal and other equipments to conserve resources and energy.

2.4 Practical Problems with green recycling

- The first challenge for the ship yard is to determine each and every material being used in manufacturing of each part of the ship and also the various equipments being used in the manufacturing process. As many of the ship parts and equipments are assembled from various other vendors, it becomes very tough for the ship yard to determine and check the nature of various materials being used. So making an inventory list of each and every hazardous material being used in the ship construction would not be an easy job.
- Some of the materials have been completely barred from usage. It is very tough to follow this rule since traces of such substances can be found in some of the material being used in ship construction. For example, traces of PCB are always found in adhesive being used.
- It has been observed that the vendors generally provide 80% of the information related to the material so in order to provide a complete list of material, it would be very challenging.

- As the points above indicate that the complete inventory list is not available so it is very difficult to analyze the hazard the ship parts and equipments would pose during the recycling process.
- In terms of scrap yards the biggest challenge is that the country where recycling is happening should enforce all the regulations in order to facilitate green recycling. This would a tough job since it is very difficult to change the working culture of the labor involved. The scrap yards would need more capital investment to facilitate green recycling in terms of improving safety standards and better waste management. This extra cost might take away the competitive advantage of this scrap yards in terms of price.
- The regulations cannot be implemented in very strict way since that would result in moving the industry away completely from Indian sub-continent. This would have huge negative social implications on the labor involved in the traditional scrapping. As discussed before the alternative sources of employment for this low skilled labor is very limited so if they lose the scrapping industry then it would result in high rate of unemployment.

2.5 Cost-benefit analysis of green recycling

From a shipping company point of view the green recycling is always a cost. The cost would not only be limited to the higher cost at the re-cycling yard but also the cost incurred due to process changes required form the design, construction and operation stage. The maintenance of the inventory of the hazardous material would be a cost form ship yard initially which finally the ship owner has to bear. Also the various surveys to be done in different stages would be cost for the ship in terms of time spent in these surveys. The following calculation has been done for a particular ship which would indicate the reduction in revenues of a particular ship owner due to the green recycling.

Lightweight of ship = 19361 t
Green recycling cost = $ 15 per light weight ton
Total cost of green recycling = $ 290,415
Revenue earned from the scrap metal = $ 470 per ton
Total revenue earned from scrapping = $ 909967
Revenue earned while using green recycling = $ 619552

If a ship manager opts for green recycling the revenue of the company reduces by $290,415. Here the ship manager has to decide whether to take the extra cost of green recycling. If this green recycling becomes a mandatory regulation then it would be an extra cost for the ship owner.
As already discussed 90% of the recycling is being done in the beaches of the Indian sub-continent. In order to upgrade the facility to green recycling facilities the scrap yards of the sub-continent have to invest capital into the infrastructure. They would be reluctant to do that due to oversupply of cheap labor.

Chapter 3 Lay-up and scrap economics

3.1 Lay-up economics

When the charter rates do not cover the operational costs of a ship, then the ship manager might decide to lay-up the ship. Lay-up economically means that the ship is out of business and has to wait for the business to again pick in order to enter the market. During lay-up period, the ship is still at a lay-up harbor without any movement. But, even when the ship is laid up, there are some costs involved for the minimal maintenance to take place. These costs are incurred in order to maintain the security, safety and protection of the vessel, crew and the environment. Also, another source of costs during layup is the requirement to preserve and maintain the structure and machinery by providing protection against corrosion and static seizure (UK P&I Club, 2009).

The duration of a lay-up depends upon various factors. It depends upon the expected period of lay-up, the overhead running costs, and the time which the ship manager is anticipating to resume trading. Another important factor which affects the layup is the time and cost for reactivation. Age of the ship also plays a critical role in deciding the layup period of a ship.

Broadly, layup can be divided into two types. One is ‘hot layup’ and the other is ‘cold layup’. Hot layup is done for a short period of time. In the case of hot layup the minimal machinery is maintained. The crew is also reduced in size. The advantage of hot layup is that it can be reactivated very fast with reduced cost, time and effort. The disadvantage of hot layup is that, it has more operational costs due to higher level of maintenance and more crew involved compared to cold layup. Cold layup is done for a longer period of time (UK P & I, 2009). Most of the machinery in the case of cold layup is shut down. Only very minimal machinery maintenance is done so that it can be reactivated when required. Also, the hull structure requires maintenance in a way that it does not suffer from corrosion. A special layup crew can be employed consisting of a watchman who would be responsible for the security of the ship. The disadvantage of cold layup is that it takes more time and money to reactivate the ship. The machinery and hull undergoes more degradation in case of cold layup due to more time period during the layup and minimal maintenance work done. So, it might be required to send the ship for dry-dock. As a result, the cost of the reactivation might be very high. At the same time the risk of repairing the machinery after a cold layup is also high. During the repairs there may be problems which might result in permanent damage of the machinery for future use. In recent times the modern vessels are equipped with a higher level of computer technology and automation machines. All these modern vessels if laid up would be tough to again reactivate. It has still not been studied about how these modern vessels would react when they have to be put under cold layup. So, the risk of putting a modern vessel to a cold lay-up is still unknown. The only advantage of cold layup is that the operational costs are lower compared to hot lay-up. Therefore, if there is a certainty of a longer duration of layup then cold lay-up might be more cost effective.

The layup site has to be chosen in such a way so that it does not affect the ship in an adverse way. So a layup location has to be properly surveyed before it is set for a layup. In order to approve the lay-up location the following points are important (UK P&I, 2009).

- The amount of shelter provided form open sea, wind and other sea related natural factors which can cause damage to a static vessel.
- The method in which the ship is being moored meaning whether the ship is anchored or buoyed.
- The details of climatic condition and day to day weather condition to overcome any unprecedented situation like storm or hurricane.
- The local information about the tide, current and draught in order to prevent any damage to the ship.
- The location of any kind of obstruction or wreckage nearby which might affect the safety of the ship.
- Proper knowledge of the available facilities of fresh water and other amenities required for day to day running of the ship.

The lay-up arrangement can be approved if the following conditions are met

- The method in which the mooring of the ship has been done has to be checked.
- All the factors related to the safety of the crew and the vessel, have to be checked.
- All the steps related to the proper preservation of the hull and the machinery, have to be taken and this has to be checked before approval of the lay-up arrangement.
- The lay-up arrangement has to be approved by the surveyor of the classification society, the port state and the flag state. (UK P&I Club, 2009)

In order to maintain the security, safety and protection of the environment the following points have to be followed

- In order to maintain the ship in hot lay-up appropriate number of crew and officers has to be appointed to maintain the machinery, safety standards and mooring arrangement in an appropriate way as per the regulations. For the cold-layup sensors should be fitted at proper locations in the engine room and other operational parts of the ship to provide alarm signal whenever something goes out of order. A system of remote monitoring form a control room has to be maintained to have a continuous monitoring over the situation.
- The fire-fighting capability of the ship has to be maintained at an optimum level to fight fire if such a requirement arises.
- In order to minimize the risk of fire, any traces of flammable substances like oil vapors or other gases have to be removed from the tanks and enclosed spaces.
- The disposal of the garbage and sewage generated during the lay-up period has to be done in an environmental friendly way.
- All the safety equipments such as life-boat, life-raft, breathing apparatus should be maintained in such a way that they can be operated at any moment.
- The entire unused funnel for intake and outlet of gases or air has to be closed to prevent any safety issues.

- All the openings into the accommodation have to prevent any security threat. A remote monitoring system has to be installed through camera or any other means to monitor the security situation.
- All the oil tanks and pipelines have to be properly drained and cleaned before the layup. (UK P&I Club, 2009)

The following points have to be followed for proper preservation maintenance

- The engine room and the accommodation have to be sealed from the ambient atmospheric conditions to prevent the chances of corrosion due to high water vapor content in the air.
- A method of de-humidification has to be applied to prevent the corrosion happening due to the high humidity levels in the air.
- All rotary machinery equipment has to be turned at regular intervals to prevent permanent seizure.
- Appropriate lubricants and other chemicals to be applied to the machinery not within the de-humidification space to prevent corrosion and chances of seizure.
- Cathode protection to be used for hull protection in case of long term layup. Also, the ballast tanks have to be appropriately protected.

3.2 Scrap economics

The demolition market is dependent on several key factors. The major factors among them are the freight rates or the charter rates, the scrap steel market and the incremental age of the ship (Annex 1 - Economic Factors Impacting the Dismantling Market*,* 2007). There is no international standard which forces a company to scrap a ship meaning that there is no such rule which makes it compulsory for the company to dismantle the ship after a certain age. Only in the case of ship wrecks or groundings, maritime laws force ship to be dismantled in a proper way. So, the decision to demolish a ship is mostly an economic decision. If the benefits of scrapping a ship look very minimal then the ship-owner is encouraged to continue to operate and run a very old ship or in that case even obsolete ships. So, there is an increased risk of just abandoning a ship. A statistical study was done in 2006. In that study it was expected that 1500 ships should have been dismantled ideally. Total losses from sea related eventualities are estimated to be 300 (Annex 1 - Economic Factors Impacting the Dismantling Market*,* 2007). So, it can be calculated from the above statistics that around 900 ships were either kept in the sea despite their old age or were dismantled in unknown locations.
The decision whether to dismantle a ship or not is dependent on various factors as mentioned before.

- The sale value of the ship in the scrap market might be high due to the higher scrap steel demand. But at the same time the charter rates also might be attractive enough to run the ship.

- In a reverse of the scenario stated above the sale value of the ship in the scrap steel market might be low due to lower scrap steel demand. But, at the same time the charter rated also might be attractive enough to run the ship.

The ship passes through the following stages

- Initially a ship is ordered in the ship building yard. The purpose of building the ship is to use in a specific trade where there is demand in the market.
- A ship then after a few years of running moves from the ideal level of revenue from the specific trade it was purchased for. This can happen either due to the increase in the maintenance cost or due to the fact that the ship has become obsolete or due to the decrease in demand for sea transport in that specific trade.
- At this point the ship owner can either get rid of the ship for the specific reasons mentioned above or make huge profit by taking advantage of good market conditions.
- The new manager or the ship owner who purchases the ship will use the ship to his business for a specific period and will start using it for the existing trade. But gradually the same cycle as explained above would also repeat for the new ship-owner as well. (Annex 1 - Economic Factors Impacting the Dismantling Market*,* 2007*).*

3.2.1 Effect of freight market on the dismantling decision process

The freight market has in general an inverse effect when compared with the scrap market. The demand for maritime transport has been increasing due to more industrialization in the developing nations. The huge export of finished goods from China to the United States and the European Union has increased the demand for Maritime transport. So, the demand for ships to be used for cargo trading has increased. If the supply of ships does not meet the demand then there is a chance of increase in freight rates. If there is an increasing trend or stable freight rates then the ship owner will be tempted to run the ship for a longer period. Sometimes if the ships have passed their ideal age of operation, the ship owner still operates the ships even if this means compromising safety conditions to take advantage of the existing profitable freight rates.

3.2.2 Effect of scrap price on dismantling

Scrap steel can be used as a raw material for production of steel. In terms of more environmental friendly regulation there will always be an encouragement to use most energy efficient process of producing steel. There has been a huge increase in the world steel production. It increased from a 1 billion to 1.2 billion from the year 2000 to 2006. As a result of this there has been a constant increase in the demand for scrap steel and the scrap steel price increased from a value of $ 100 to $ 250. The prices were stable until about 2002 with the mean around $ 100 but then there was a rapid increase in the scrap steel prices due to an increase in demand from the Chinese market. This massive import of China in the steel sector was not predicted which led to

increase in scrap steel prices. The demand for steel followed quite well the scrap steel supply also. This possible due to new deposits found in countries like South Korea. Moreover, it was also helped by reduction in shipping cost of bulk steel scrap which also resulted in a fall in container costs, especially the empty ones returning from Europe to Asia. Europe has mostly high supply of scrap steel due to the increased number of motor vehicles and also household appliances. It is estimated that the scrap steel prices would stabilize around $ 250 with a slightly increasing trend. In the following table we can see the major importers of scrap steel.

Table 1: Major scrap steel importers

Turkey (12 MT)	South Korea (7 MT)	Italy (5MT)
China (10 MT)	Spain (6.4 MT)	United States (4 MT)
Belgium (8 MT)	Germany (5 MT)	France (3 MT)

(Source: Institute of Shipping Economics and Logistics)

The total scrap steel derived from the ship breaking industry is around 3-5%. This percentage level can vary depending on the supply of ships to be dismantled. Asia is the major market for ship dismantling. The scrap steel extracted out of the ships is used for re-rolling and subsequently production of long steel products such as concrete reinforcement rods and corner iron. The recovered ship machinery and equipment is also a major source of revenue especially in India, Pakistan and Bangladesh. The advantage of using scrap recycled steel is two folds that it is more viable economically, as well as environmentally. It helps in saving energy by about 40%. The major steel production countries are also in Asia so the transportation costs are also kept under limits.

3.2.3 Factor of age in the process of ship dismantling

The age of a ship is a very important factor when it comes to dismantling of ship. It would generally expect that the ships from the more industrialized world should have lower average age of phasing out, somewhere around 15 years. This mostly happens due to higher operational expenses of older ships. New Marine environment protection regulations also play important role in phasing out certain kind of ships. The regulation of double hull tanker is a classic example of such a regulation. In this case the owner of the oil tanker has the following options. He can either sell the tanker to another operator; convert the single hull tanker into a double hull tanker; scrap the vessel; use the tanker as storage tanker rather than a moving ship. The important decision the ship owner has to take here is whether the freight rates are attractive enough to convert the ship into a double hull tanker for further usage. At the same time the owner has to judge whether the scrap steel prices are relatively more attractive to scrap the ship.

The ship-owning sector can be broadly divided into Flags of Convenience countries, developing countries and OECD countries. The following table indicates the share of each category.

Table 2: Share of different categories of ship-owning countries

Flags of Convenience	60.9%
Developing Countries	27.4%
OECD Countries	11.8%

(Source: Institute of Shipping Economics and Logistics)

The OECD countries have the highest mean average age of 34.4 years. The following table shows the average age of dismantling of a few countries.

Table 3: Average age of dismantling in OECD countries

United States of America	42.8 years
European Union	33.9 years
Cyprus	32.7 years
Greece	34.7 years
Malta	28.6 years

(Source: Institute of Shipping Economics and Logistics)

Flags of Convenience countries have been found to have an average age of 29.4 years. The following table indicates few countries of such types

Table 4: Average age of dismantling in Flags of Convenience countries

Liberia	26.4 years
Dominican Republic	27.6 years
Saint Vincent	28.0 years
Panama	29.7 years
Bahamas	31.6 years

(Source: Institute of Shipping Economics and Logistics)

The developing countries show an average age of 32.9 %. The following table shows a list of such countries and their respective mean age.

Table 5: Average age of dismantling in developing countries

North Korea	35.0 years
China	32.8 years
Saudi Arabia	30.0 years
Singapore	28.0 years
India	26.7 years

(Source: Institute of Shipping Economics and Logistics)

The oldest ship which has been dismantled is 81 years old named Joseph H. Frantz.

3.2.4 Factor of type of ship and age of dismantling

The following graphs below show the trend of the age of ship in time series grouped in different types of ships.

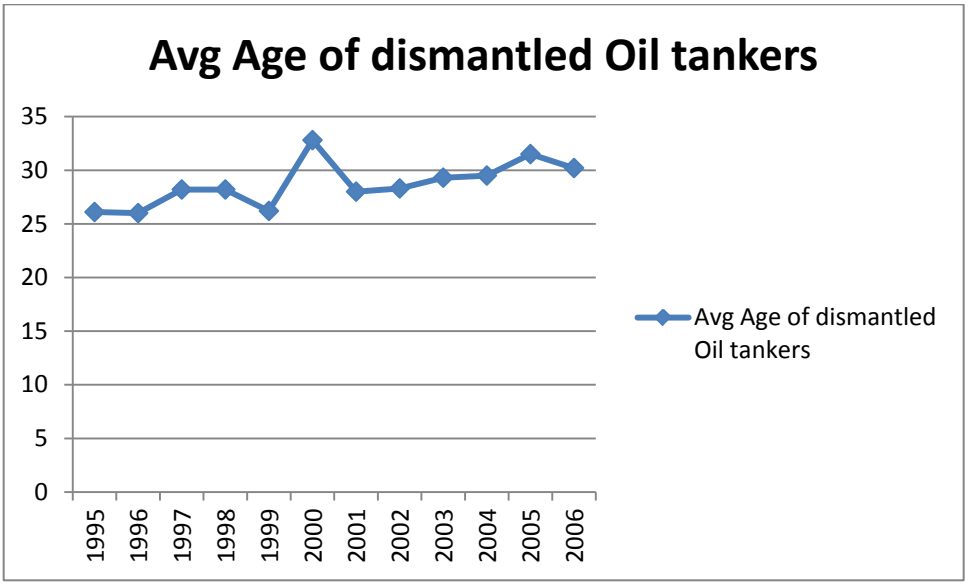

Figure 1: Average age of dismantled Oil tankers

(Source: Institute of Shipping Economics and Logistics)

As it can be seen from the graph above, the average age of dismantling an Oil tanker through the time series, from 1995-2006, shows a mixed trend. According to the graph the highest age is 32.8 years in the year 2000.

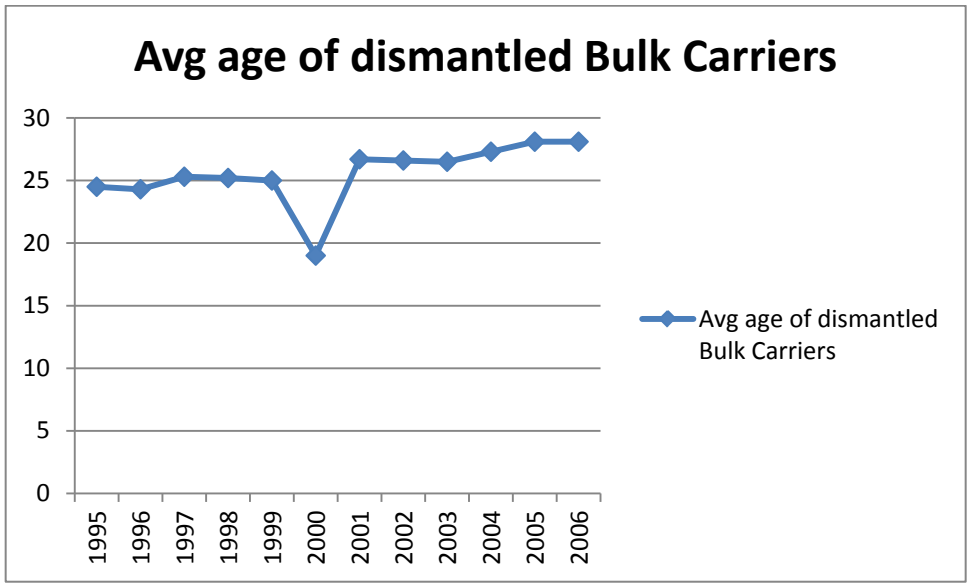

Figure 2: Average age of dismantled Bulk Carriers

(Source: Institute of Shipping Economics and Logistics)

In the case of bulk carriers, in the later years of the time series, there is a slight increase in trend. There was a dip in the year 2000 where the average age of dismantled bulk carriers is shown as 19.

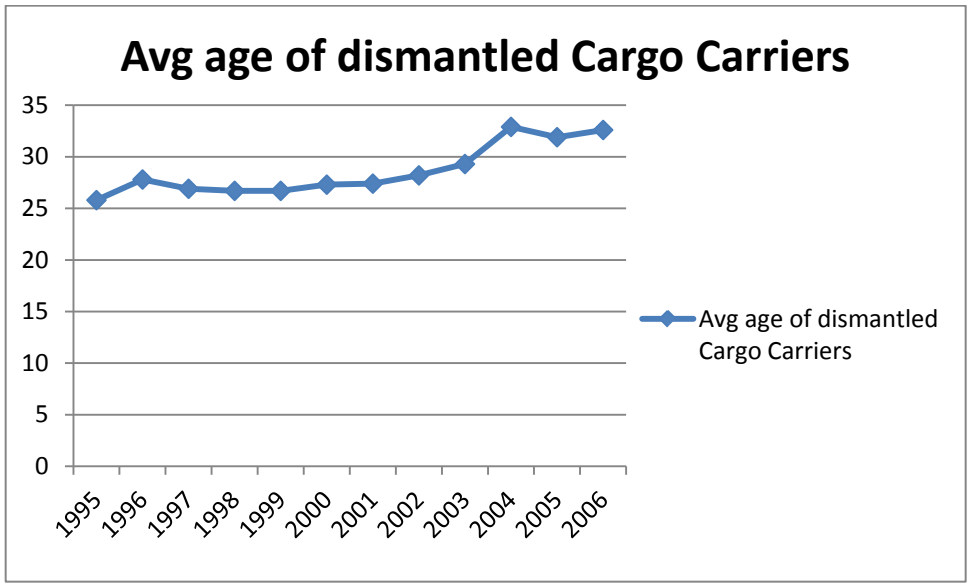

Figure 3: Average age of dismantled Cargo Carriers

(Source: Institute of Shipping Economics and Logistics)

In the graph above the average age of dismantled cargo carriers can be observed. This also shows an increasing trend in the average age of dismantled cargo carriers in the time series from 1995-2006.

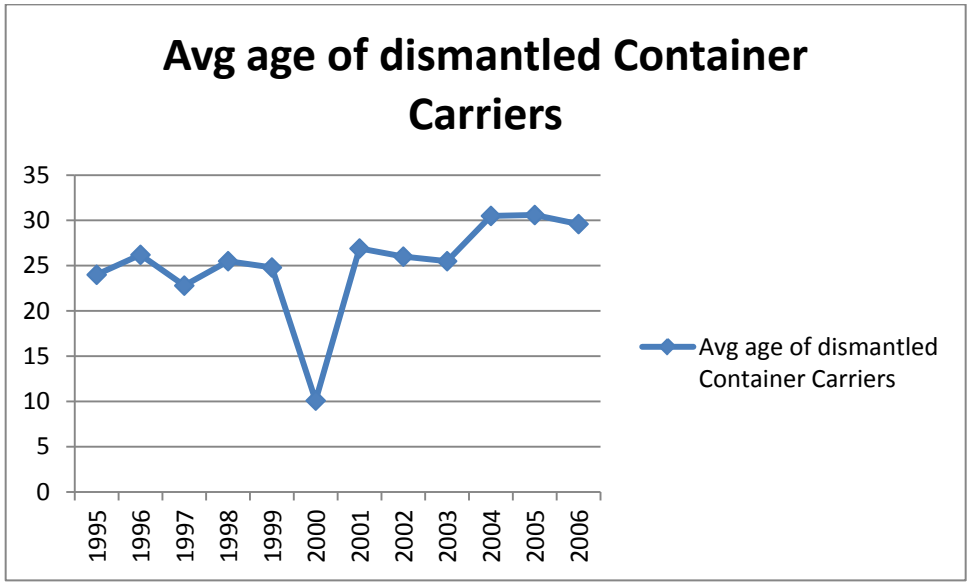

Figure 4: Average age of dismantled Container Carriers

(Source: Institute of Shipping Economics and Logistics)

As seen in the previous graph there is an increasing trend in the later years. In the year 2000 there is a huge dip of average age which is around 10.1 years.

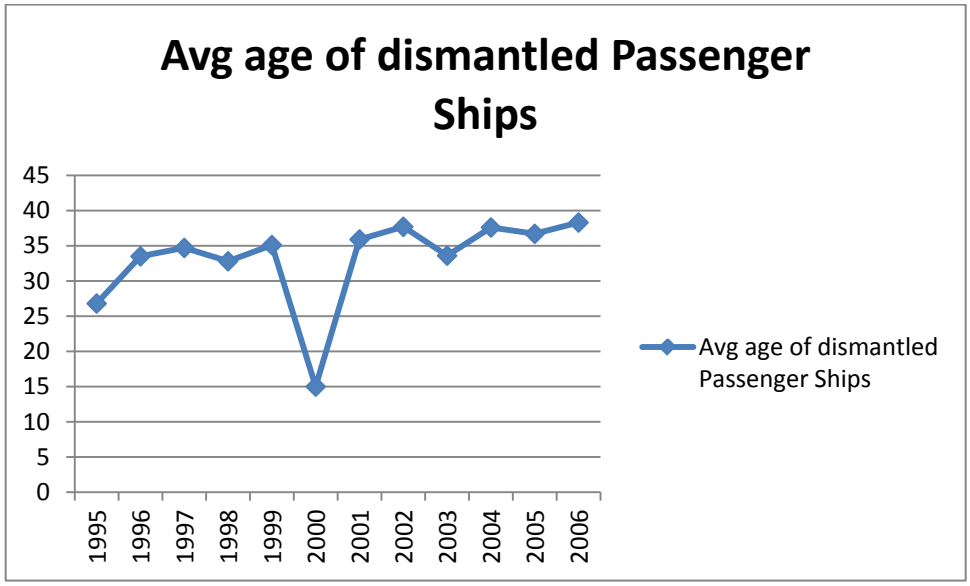

Figure 5: Average age of dismantled Passenger Ships

(Source: Institute of Shipping Economics and Logistics)

In the graph above it can be observed that the average age of the dismantled passenger ships has been quite high in recent years. In 2006 the mean age of dismantling a passenger ship was 38.3 years. A huge dip is seen in the year 2000, which shows the mean age of dismantled passenger ship as 15 years.

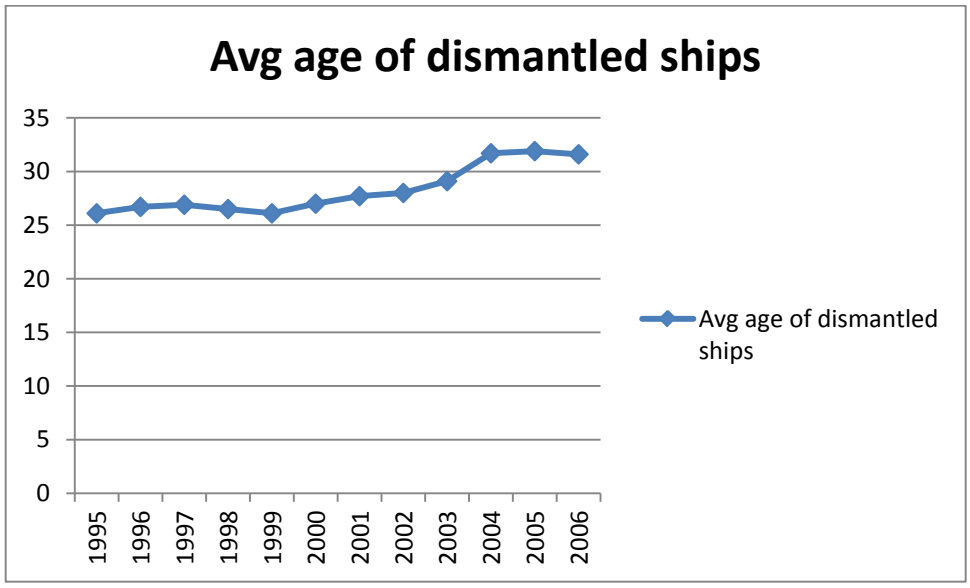

Figure 6: Average age of dismantled ships

(Source: Institute of Shipping Economics and Logistics)

In the graph above it can be observed that the mean age of the dismantled ship has been increasing in the time series from 1995-2006.

In all the previous graphs there is a general trend of increase in the mean of ship dismantling in the later years of the time series from 1995-2006. At the same time, in the case of Bulk Carriers, Container Carriers and Passenger ships, there is a huge dip of the mean age of dismantling in the year 2000. The similar kind of dip is not observed in the other type of ships.

Chapter 4 Data-Demolitions, Scrap value, Charter rates, Layup and Operations cost

As discussed in the previous chapters data would be required for the analysis of the thesis. This chapter in the following pages would show some data trends in time-series. The data would be related to scrapping of ships in different regions. At the same time there will be data related to scrap steel prices. In the latter half of this chapter there will be data related to the different cost involved in the decision making of the ship owner. The different cost has been calculated in order to calculate the revenue for the different decision involved. The data has been collected from various sources. All the sources are authentic data sources.

4.1 Demolition data

The demolition data consist of the data as per the time series. The time series is annual in nature and ranges from 1996 to 2011 until date. It consists of three columns. The first column is the date column which shows the annual time series. The second column is the total demolition done in terms of dead weight tonnage (DWT) annually. The third column is the total number of ships which have gone through the process of demolition annually. The aggregated data of the DWT and the number of ships is the aggregated data corresponding to that particular year. Both the columns, the DWT and the total number, are important data in the shipping industry to study any kind of trend related to the ship scrapping industry. The data are available for the countries where the majority of scrapping takes place. The countries are India, Pakistan, Bangladesh, China and others. A total figure of demolition is also available. The source of the data is Clarkson's database.

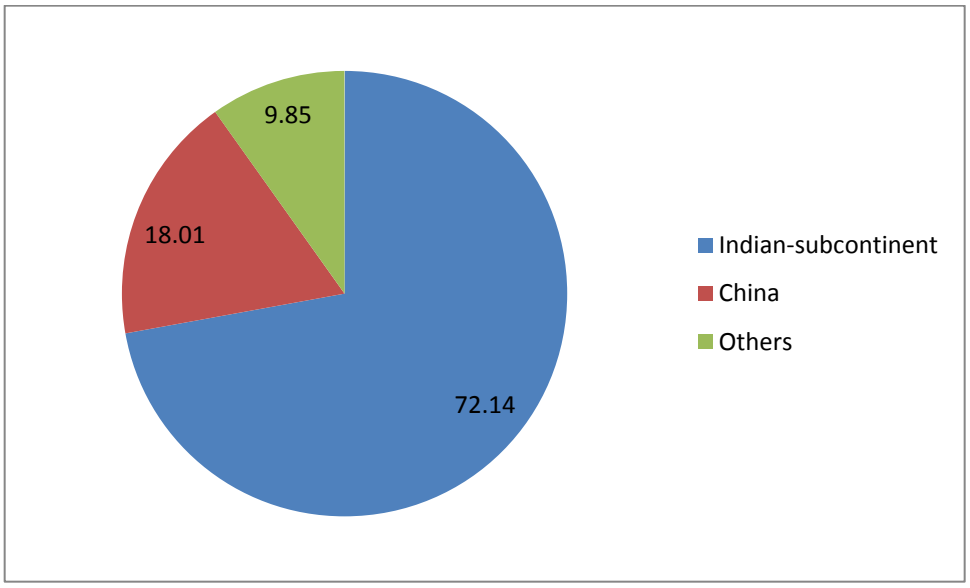

Figure 7: Distribution of ship demolition in DWT tonnage

(Source: Clarkson's Database)

The chart above shows the distribution of demolition of ships in terms of deadweight tonnage. It can be clearly seen that the Indian-subcontinent has the majority of demolitions. This data is the aggregated data of demolitions in terms of deadweight from 1996-2011 till date. The Indian sub-continent consists of India, Pakistan and Sri-Lanka. The others consist of countries of the European Union and the US. The distribution has been done in such a way so as to show the method in which recycling is done. In the sub-continent the recycling is done in a traditional manner. Therefore, it can be said from the chart above that most of the ship recycling done in the world is being done in traditional scrapping.

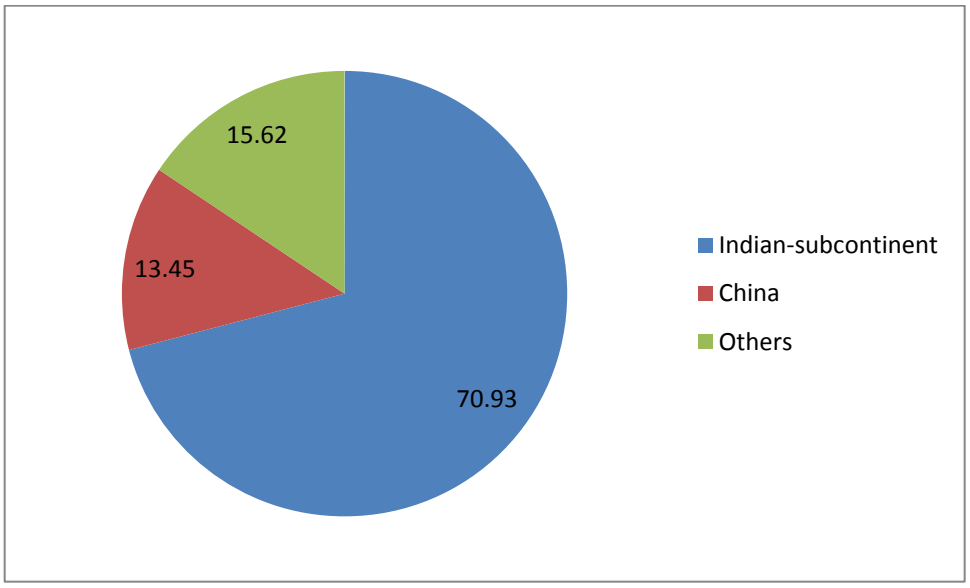

Figure 8: Percentage of demolished ships

(Source: Clarkson's Database)

The chart above also shows the percentage of ships demolished in the three divisions. In this case also it can be seen that the Indian - subcontinent shows the highest ratio as expected. The percentage of ships is higher here in the case of others which indicate demolition larger ships in this region.

Both the charts above show that most of the scrapping is being done in traditional scrapping methods in the beaches of the Indian sub-continent. In chapter 2 a complete literature review has been done in relation to the environmental effects of the traditional scrapping. This shows that the ship managers are still considering the economic factors to be the most important factors, which decide on the ways to do a recycling. The ship recycled in traditional way pose threat not only to the environment but also to the workers who are doing that. As seen from the charts above, a high percentage of the ships are being demolished under such conditions. If a regulation is enforced in the future, which would make it compulsory for the ship owners, as well as the traditional scrap yards to enforce green recycling then this can have huge impact on the demolition industry. It may require the ship owners to move their scrapping from the Indian sub-continent to China or other places where ship scrapping is done in a green way, if the scrap yards in Indian sub-continent do not change their traditional ways. This would be a very high cost for the ship owner at the end. But, in order to protect the image of the industry the IMO would want to implement such regulations seriously in the future. At the same time, the customers of the shipping industry are also becoming very environment conscious due to the general public opinion is going in favor of good environment. As a result, there is an indirect pressure on the shipping companies to focus on environmental issues, which is not only limited to Carbon-dioxide emissions,

but also to other issues like ship recycling. This might also impact the decision of a ship owner whether to scrap a ship or lay up a ship.

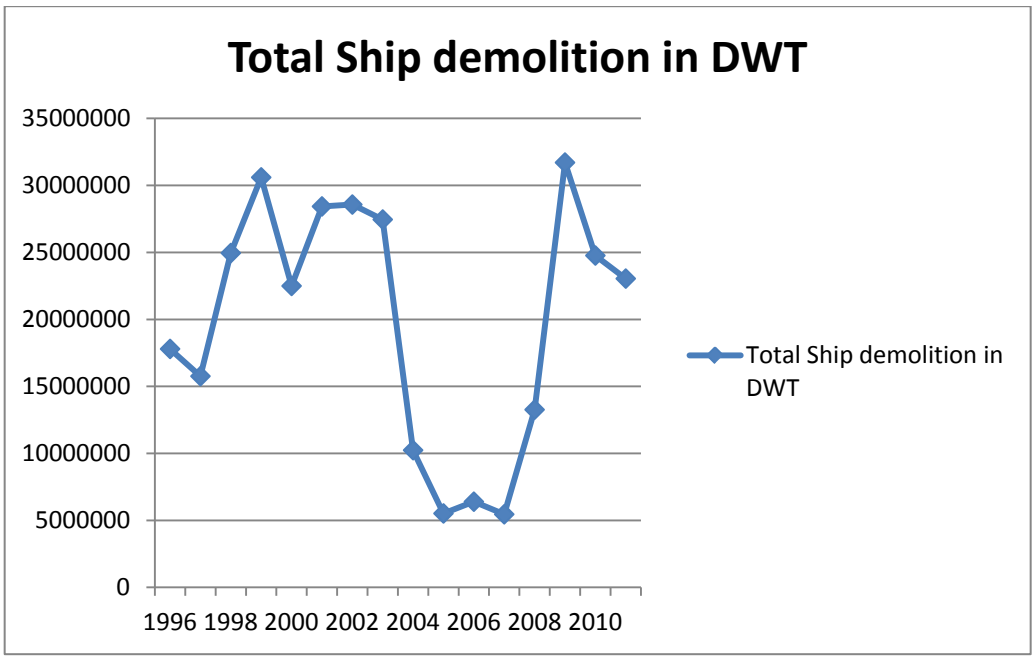

Figure 9: Total Ship demolition in DWT

(Source: Clarkson's Database)

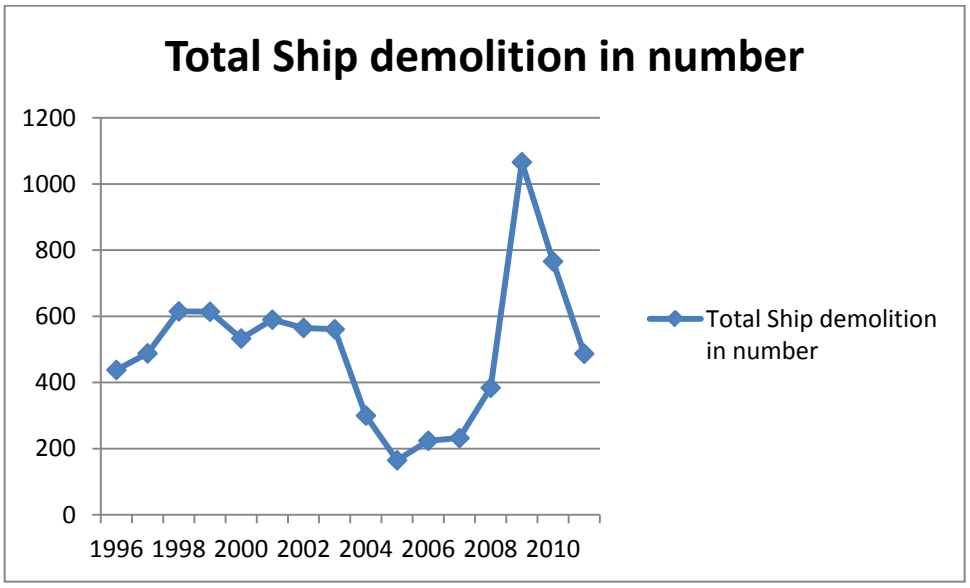

Figure 10: Total Ship demolition in number

(Source: Clarkson's Database)

The two previous graphs show the demolition of ship trend in DWT and also in numbers. This shows the total demolition of ships around the world. The source of the data is Clarkson database. In the trend line it can observed that there is a dip in the year 2005-2007. A sharp rise can be seen in the year 2009 in the number of ships which have been demolished. This may be due to the economic recession in the year 2009.

4.2 Scrap Value

The scrap value of a ship is a very important set of data for this thesis. The data have been gathered from the Clarkson database. The data vary in the manner they are calculated in two ways. One of the ways is depending on the location, the scrap value has been shown as $/ldt. The unit has been shown in such a way because the value of the scrap metal will change regarding the location where scrapping is done. The local demand for scrap steel will determine the scrap prices. The data have also been shown in terms of $ million in terms of the type and the size of the ships. Generally with the different type of ship, the size of the ship varies and hence the available scrap metal in the ship which can be extracted. At the same time, different kinds of ships have different structural requirements which means that the amount of metal required for different ships will be different and hence the amount of scrap metal extracted out of the ship. The data is available in time-series annually, quarterly and monthly. As a part of this thesis, the annual data have been taken into consideration, since most of the other data are also annual time series data.

In order to focus more on a particular type of ship, the thesis will focus more on a particular type of ship. This would not only provide more focus to the whole data analysis, but would also help to do any kind of comparative study. The kind of ship considered for this analysis is handy size ship. The Handy size bulker scrap value is available in $ million. The time-series starts from the year 1990-2010 for the handy size bulker scrap value. The unit for this is $ million. The data shows an average value of such ship has been $ 1.89 million in the time series 1990-2010 annually. The same data also show a maximum value of $ 3.76 million in the year 2007 and a minimum scrap value of $ 0.9 million in the year 1998. The standard deviation of the data set is found to be $ 0.87 million. The next set of data is the handy size demolition prices for the Indian sub-continent in terms of $/ldt. The data is available for the time period 1991-2010. The average or the mean value for this data series is 237.15 $/ldt for the time series 1991-2010. The maximum value of the data set is 470 $/ldt in the year 2007 and the minimum value is 110 $/ldt in the year 1998. The standard deviation for the data set is found to be 112.3 $/ldt. Another set of data is the handy size demolition prices for the Far East in $/ldt. The data available is for the time period 1995-2010. The average or the mean value of the data series is 208 $/ldt . The maximum value of the data set is is 420 $/ldt in the year 2010. The minimum value of the data set is 102 $/ldt in the year 1998. The standard deviation for the same data set is found to be 102 $/ldt.

From the data above it can be clearly seen that there is some kind of consistency in all the three different sets of data. In the year 1998, a real drop can be seen in the scrap value in the three sets of data. At the same time 2007 shows high scrap value in two of the cases. The difference between the maximum value and the minimum value of the scrap seems to be quite high in the time-series. The maximum value in most of the cases seems to be around 4 times higher than the minimum value. This shows that the ship scrap market can have extreme levels of fluctuation. Moreover the standard deviation of all the three data set is also quite high. This shows that the scrap value market also fluctuates quite regularly with a high deviation.

Table 6: Range and Standard deviation of scrap value of Handy-size vessels

Categories of data	Range	Standard Deviation
Handy size bulker 1990-2010	$ 2.86 million	$ 0.87 million
Handy size bulker in Indian sub-continent 1991-2010	360 $/ldt	112.3 $/ldt
Handy-size bulker in far-east 1995-2010	318 $/ldt	92.2 $/ldt

(Source: Clarkson's Database)

The data above for the different categories of Handy-size bulk carriers through different time-series show that the market is quite unpredictable. It would be a tough call for the ship manager to decide whether to scrap the ship or not. The data above would be also used in the next chapter of decision analysis.

4.3 Charter rates

The Charter rates are an important set of data for this analysis. It is the most important parameter for a ship manager to be taken into consideration while deciding whether to operate a ship or lay-up a ship. There are various kinds of chartering in the shipping market. It can be a time-charter, trip charter, spot rates. For the present analysis time charter has been taken into consideration. The reason for this is that all the other comparative parameters such us lay-up cost and operating cost are being measured in terms of $/day. The unit of calculation for any kind of time-charter is $/day. The time-charters vary as per the different ship size and the duration of the charter period. As the value of the time-charter is being calculated in terms of $/day, the value of the time-charter will change with the different type of ship which means whether it's a dry bulk carrier or oil tanker. If only a dry bulk carrier is taken into consideration, the charter rates will vary as per the different size of the ships because they can carry different volume and mass of cargo. The duration of the time-charter is also an important factor in determining the charter rate values. The reason is that higher the charter duration, the more secured is the business of the ship owner. So, the charter party can have more bargains on the charter rates during a long term charter contract. As per the requirement of the thesis, the data for the time-charter have been narrowed down to Handy-max vessels of size 45,000 DWT. Data for these ships have been taken for different time-charter durations. The duration is 6 months, 1 year, 3 years and 5 years. All the time charter data has been collected from the Clarkson database for the respective time-series.

The first data set is the 6 month time charter rates for handy size 45,000 DWT for the time period 1989-2011 annually. The average charter rates are found to be 14,807 $/day. The maximum charter rate value is found to be 43,439 $/day for the year 2007 and the minimum charter rates is 6,268 $/day in the year 1999. The standard deviation of the data set is 10,271 $/day.

The second data set is the 1 year time charter rates for the handy size 45,000 DWT for the time period 1989-2011 annually. The average or the mean value of the charter rates is found to be 14,030 $/day. The maximum value of the charter rates is found to be 39,870 $/day in the year 2007. The minimum value of the time charter is found to be 6,590 $/day in the year 1999. The standard deviation of the data set is found to be 9253 $/day.

The third data set is the 3 year charter rates for the handy size 45,000 DWT for the time period 1989-2011 annually. The average or mean value of the charter rates is found to be 12,147 $/day. The maximum value of the time charter is found to be 28,862 $/day in the year 2007. The minimum value of the time charter is found to be 7,043 $/day in the year 1999. The standard deviation of the data set is found to be 5,721 $/day.

The fourth and the final data set are the 5 year charter rates for the handy size 45,000 DWT for the time period 2008-2011 annually. The average or mean value of the charter rates is found to be 14,986 $/day. The maximum value of charter rates in data set is found to be 20,325 $/day in the year 2008. The minimum value of the data set is found to be 12,226 in the year 2009. The standard deviation of the data set is found to be 3705 $/day.

Table 7: Range and Standard deviation of the Charter rates

Categories of data	Range	Standard Deviation
6 months time charter 1989-2011	37,171 $/day	10,271 $/day
1 year time charter 1989-2011	33,280 $/day	9,253 $/day
3 years time charter 1989-2011	21,819 $/day	5,721 $/day
5 years time charter 2008-2011	8,099 $/day	3,705 $/day

(Source: Clarkson's Database)

From the data above it can be observed that, 2007 shows maximum value of charter rates and the year 1999 shows minimum value of charter rates. The difference between the maximum and minimum value is quite significant. From the table above the range has been found out. It can be seen the value of range decreases with the increase in the time period of the charter. The value of the standard deviation also seems to be quite high. A similar trend of decrease in the value of the standard deviation with increase in the time period of the charter can be observed. Therefore it can be said the charter rates in case of short term time charter rates fluctuate more and are more unpredictable compared to a long term time charter.

4.4 Lay-up cost

During a layup a ship manager has to very carefully plan the whole process. The following parameters are important to be considered in the layup planning. Initially, the layup time period has to be determined approximately which can be 1 month, 6 month or even 1 year based on the market forecast. The next important parameter is the reactivation time period. Depending on the time period of layup the reactivation period can vary between 24 hours, 1week and 3 weeks. The status of the class and insurance are important because their status changes depending on whether the vessel is under full trade or under layup. All the local requirement of the Port Authority has to be satisfied. The manning level of the ship would depend on the flag state requirement and the kind of manning.

The typical cost incurred during a layup is shown in the points below. The data has been collected from the Lloyd's Register from a November 2008 publication.

- The cost incurred by the shipping company for the ship to enter the layup is equivalent to $ 14,000.
- In order to layup a ship there are some preparatory work required to be done which costs somewhere around $ 16,000.
- Under water blanks have to be installed which costs around $ 10,000.
- Additional anodes have to be installed which costs around $ 10,000.
- A fixed cost has to be initially paid for the generator which costs around $ 6,000.
- A daily rental charges for the deck generator would cost around $ 200 per day.
- There are some charges related to layup services which would cost around $ 1,200 per day.
- The insurance charges for the layup would cost around 420 per day.

The following table is also some data collected from the Lloyd's Register. The publication is a dated in November 2008. The data give a comparison between hot layup and cold layup for a handy max bulk carrier of 45,000 DWT.

Table 8: Hot and cold lay-up costs of Handymax BC

Layup cost categories	Hot Layup costs	Cold Layup costs
Manning	$ 1,640	$ 300
Insurance	$ 835	$ 420
Repair and Maintenance	$ 230	$ 75
Stores Spares	$ 235	$ 80
Administration	$ 200	$ 100
Total	$ 3,440 /day	$1,275/day

(Source: Lloyd's Register)

In the table above it can be clearly observed that the cost layup is more than the cost of cold layup. It is obviously due to the higher time period of cold layup and less maintenance and manning requirement during a cold layup. Another important point to keep in mind is that, during a layup, the ship does not earn any kind of revenue.

4.5 Operational cost of a ship during full trade period

When the ship is under operation during the full trade period, various kinds of cost are incurred by the ship manager. These costs to some extent are dependent on fuel prices. The following table shows the cost of the ship incurred during full trade period. This data is relevant for a handy max bulk carrier 45,000 DWT.

Table 9: Operational cost of Handymax BC during full trade period

Category of ship	Manning	Insurance	Repair and Maintenance	Sores spares	Administration	Total
Handy max bulk carrier of 45,000 DWT	$ 2,145	$ 935	$ 855	$ 885	$ 645	$ 5,500 /day

(Source: Lloyd's Register)

The table above is an indicator of the cost incurred while operating a ship of the size 45,000 DWT. This cost of running a ship during full trade is much more than cost incurred during a layup which is due many obvious reasons. On an average the cost of layup is around 2000 $/day. There is a cost difference of around $ 3500 per day between the cost of running a ship in full trade and the cost of running the ship in a layup, for a handy max vessel of size 45,000 DWT. The above data only include the operational costs. But there is another aspect of the costs, which is the fuel cost. In total for the full running and the operation of the ship the cost is estimated to be somewhere around 9000 $/day. Including the capital cost it would come to somewhere around 11000 $/day.

Chapter 5 Decision Analysis and Methodology

5.1 Introduction

In chapter 4 the data available for the thesis has been shown. This chapter will be the main methodology of the thesis. Some data used in the previous chapter will be used in the calculation process of the methodology.

In this thesis the major focus is on the decision of the ship manager whether to operate the ship or to lay up the ship. In order to take this decision the ship manager is dependent on various market factors. This main factor to consider is the fluctuating Charter rates. Depending on whether the charter rates are high or low the ship manager has to decide whether to operate the ship or layup the ship. As seen from the data of the charter rates, all through the time series the charter rates fluctuate a lot due to high standard deviation. At the same time, the charter rates also have a high range in all cases, to be more specific the maximum value in the time series is almost four times that of the minimum value in the time series. The operation of a ship as well as the layup involves some form of cost.

5.2 Methodology

In this chapter Decision Analysis has been used as a methodology. This methodology was used in order to make a decision analysis model to be used by a ship owner to decide under various market conditions. In order to use this methodology the payoff for different decisions has to be calculated under different market condition. These payoffs have been calculated based on the data described in the previous chapter. In the next section below the various elements of the decision analysis tool has been described.

5.3 Decision Analysis

Decision Analysis can be used to decide or determine an optimal strategy when the decision makers have many different alternatives in his hands in an uncertain, unpredictable and risky environment in the future (Anderson et al, 2010).

5.3.1 Structuring of a Decision problem

- The most important feature is to exactly determine the most important decision which needs to be taken. These are the different decision alternatives which the decision maker has to strategically employ in order to find the correct decision alternative.

- The market condition or the uncertainty here is referred to as the States of nature. These are events which are expected to happen in the future and are mutually exclusive events.

- For each of the decision alternative and the corresponding state of nature there is a payoff. This payoff is the data based on which the decisions have to be taken.

5.3.2 Decision making under uncertainty

If the decision maker does not know about the predictability of the occurrence of an event then the decision have to be taken under uncertain condition. The following methods are used for decision making under uncertain condition when the probability of the occurrence of the event is unknown.

- Optimistic approach – As the word optimistic signifies its meaning, the maximum possible payoff is selected in this case. Hence the decision with the largest possible payoff has to be selected. If the values or the data is in terms of cost then the decision with the lowest cost is selected.

- Conservative approach – As the word conservative signifies a more conventional decision has to be taken in this case. In the first step, the minimum possible payoff for each decision is selected and then the maximum out of this minimum payoff is selected.

- Mini-max Regret approach – In this case the focus is to find out a decision in an indirect way. This is done by calculating a regret table or an opportunity lost table. In the first step, for each of the payoff, its difference with the largest possible payoff is calculated in terms of state of nature. In step 2, for each of the decision maximum value of the regret is noted. In step 3 the minimum value out of the maximum regret is noted and the decision corresponding to that value is considered.

5.3.3 Decision making under known probability

In this case there is some kind of certainty related to the decision. The probability of occurrence of each of the expected values is known. There two ways to determine the decision here.

- EV (Expected Value method) – The probability of the given state of nature and the corresponding Expected Value is multiplied. For each of the decision the summation of the Expected value is done. The decision with the maximum possible Expected value has to be the chosen decision.

5.3.4 Sensitivity of Probability

With the help of this tool a sensitivity analysis of the also can be done with regard to change in probability. Straight line equations are derived from the analysis with probability being the variable.

5.4 Decision Analysis with regard to operation or scrapping of ship with different charter rates

As described in the introduction section the ship owner has to decide whether to operate the ship or lay up the ship under different charter market condition. The above described method of decision analysis will be used to take a decision using different approaches as described in section 5.3.

5.4.1 Declaration of Decision alternatives and State of Nature

The two decision variables d1, d2 are as follows

Let d1 = Decision of the ship manager to operate the ship.

d2 = Decision of the ship manager to layup the ship.

The three states of nature are as follows

Let s1 = High Charter rates

s2 = Medium Charter rates

s3 = Low charter rates

5.4.2 Payoff calculation

The payoff for each of the decision with its respective state of nature has to be calculated based on the data of the previous chapter. As seen from section 5.4.2, there are two decisions and three states of nature. Hence the matrix will have 3*2 = 6 values of payoff.

In order to calculate the payoff for the operation of a vessel, the cost has to be subtracted from the revenue. The revenue is the data present in form of charter rates. Here time charter is taken into consideration and is calculated in $/day. The cost is in the form of operating and fuel cost as discussed in chapter 4.

In order to calculate the payoff of the vessel during a period of layup the method is slightly indirect. When the ship is in layup there is no revenue, since the ship is not providing any kind of services. The process of layup only involves cost. So any kind of charter rates will not have a direct effect on the layup cost. While calculating the payoff

the opportunity cost of the layup here has to consider in the form of the existing charter rates.

In the following calculation the data has been taken from chapter 4. The charter rate data is for 6 months time charter for a handy size vessel. The low charter rate is the minimum charter rate in the time series. Medium Charter rate is the average or mean charter rate in the time series. The high charter rate is the maximum charter rate in the time series.

The cost of operating a handy size vessel has been taken from chapter 4. It includes both the operating cost and the capital cost of the ship.

The cost of layup also has been taken from chapter 4. The value is based on the figure in between the cold and the hot layup.

Payoff for d1s1 = Low Charter rates – Total operating cost = 6268 – 9000 = - 2732.

Payoff for d1s2 = Medium Charter rates – Total operating cost = 14807 – 9000 = 5807

Payoff for d1s3 = High Charter rates – Total operating cost = 43439 – 9000 = 34439

Payoff for d2s1 = Profit/loss opportunity cost + layup cost = 2732 - 1500 = 1232

Payoff for d2s2 = Profit/loss opportunity cost + layup cost = - 5807 – 1500 = - 7307

Payoff for d2s3 = Profit/loss opportunity cost + layup cost = - 34439 – 1500 = -35939

5.4.3 Decision Analysis Payoff table

Table 10: Payoff table for Decision Analysis

Decision Alternatives/States of Nature	**s1(Low Charter rates)**	**s2 (Medium Charter rates)**	**s3 (High Charter rates)**
d1 (Operate Ship)	- 2732	5807	34439
d2 (Layup Ship)	1232	- 7307	-35939

The table above shows the payoff values for all the six conditions. In case of medium and high charter rates the operation of ship looks to be the best option. But, in the case of low charter rates, the ship manager would have to face considerable losses. As expected the layup of the ship results in losses during medium and high charter rates. When the states of nature are medium and high charter state the ship manager will not

even think about a layup since it would be completely uneconomic. On the other hand during the low charter rates the laid up ship shows a positive value. It is a positive value since the losses incurred by a ship in operation is much more than the cost of layup. There are many approaches which can be applied for a ship owner to come to some kind of decision which have been theoretically discussed in the sections above.

5.4.4 Results of the payoff table with different approaches

- Optimistic approach – If the ship manager is optimistic, he will choose the decision corresponding to the largest possible payoff

Table 11: Optimistic Approach of Decision Analysis

d1 (Operate Ship)	34439
d2 (Layup Ship)	1232

Since d1 has the largest possible payoff the ship manager would select d1 that is the decision to operate the ship in case he uses the optimistic approach to take the decision.

- Conservative approach – In this case first the minimum payoff of for each of the decision has to be listed first. Then out of these minimum values the maximum has to be selected.

Table 12: Conservative approach of Decision Analysis

d1 (Operate Ship)	- 2732
d2 (Layup Ship)	-35939

As seen from the table above the minimum possible payoff was listed for both the decision. Both the payoff values are negative which means that in worst case scenario both the decisions might result in loss for the ship manager. But, even in this case, the loss for the ship manager is less in case the ship manager chooses to decide to operate

the ship rather than layup the ship. So, a conservative ship manager will decide to operate the ship.

- Mini-max Regret approach – In this case initially a regret table has to be constructed. This regret table is constructed by subtracting each payoff value from the maximum possible payoff from that state of nature. For each of the decision the maximum possible regret value has to be listed. And the minimum out of the maximum regret has to be selected.

Table 13: Mini-max regret analysis of Decision Analysis

Decision Alternatives/States of Nature	**s1(Low Charter rates)**	**s2 (Medium Charter rates)**	**s3 (High Charter rates)**
d1 (Operate Ship)	3964	0	0
d2 (Layup Ship)	0	13114	70378

The table above shows us the regret table in this case. The table below would list the maximum regret values for each decision out of which the decision with the minimum regret has to be chosen.

Table 14: Mini-max Regret final values for Decision Analysis

d1 (Operate Ship)	3964
d2 (Layup Ship)	70378

As it can be seen that out of the maximum regret value for both the decisions, the minimum was chosen and in this case also the decision to operate the ship looks to be the more obvious choice.

- Decision making under known probability – In this case the value of probability for each of the states of nature has to be known. Here the probability of a particular charter rate has to be known. In this case if we assume the probability of all three cases to be 0.33, we can find out the expected values for both the decisions.

EV (d1) = 0.33 * -2732 + 0.33 * 5807 + 0.33 * 34439 = -902 + 1916 + 11365 = 12,379

EV (d1) = 0.33 * 1232 + 0.33 * -7307 + 0.33 * -35939 = 407 - 2411 - 11860 = -13,864

In the calculations above it can be clearly seen that if the probability of all the three events is assumed to be same, the decision to operate the ship shown far better results. At the same time in practical scenario the probabilities are generally unknown.

5.4.5 Sensitivity of Probability

It can be seen from the equations above the decision whether to operate the ship or layup the ship would depend largely on the probability of occurrence of the different states of nature. In case of high probability of medium charter rates or high charter rates, the ship manager has to go for d1 that is the decision to operate the ship. In case of only very high probability of low charter rates the ship manager has to go with the decision to layup the ship. Very high probability has been stressed here since the payoff in other cases that is medium and high probability is negative for a layup decision. At the same time only in case of low charter rate the payoff for decision to operate the ship is slightly negative. So a slightly more probability of medium and high charter rates would prompt the ship manager to go with decision 1. Therefore the sensitivity of probability here would be an important factor which would impact the decision of a ship manager.

5.5 Comparison between scrap rate pay off and layup cost

The revenue earned by the ship manager from scrapping of the ship is the payoff for the ship manager. The cost for the ship manager is that he is giving away an asset in the form of a vessel. At the same time he also losses a ship which was earning revenue for the ship owner in form of charter rates. So the payoff table for scrapping has been given below. The low scrap value is the minimum scrap value in the time series. The medium scrap value is the average or the mean of the scrap value in the time series. The high scrap value is the maximum scrap value in the series.

Table 15: Payoff for Scrapping in the different scrap market

Scrap Market	Low scrap value	Medium Scrap value	High Scrap Value
Handy size scrap value in $/ldt	110.00	237.00	470.00

The table above shows the different scrap market as per the data shown in chapter 4. It can be seen that the data vary a lot. It shows that the market fluctuates quite a lot. The decision whether to scrap the ship would depend on the value in the scrap steel market. High scrap values would prompt the ship manager to go for scrapping since the payoff would be greater in that case. If the scrap value is down and the charter market is down the ship manager might go for layup. In the case of layup, the layup cost has to be taken.

5.6 Comparison between scrap rates, charter rates, ship demolition numbers

Ship scrapping or dismantling is a different industry inside the shipping business. In chapter 3 the relation between dismantling and the age was shown. In chapter 4 the data related to number of ships dismantled and the tonnage of ships dismantled in terms of different countries was shown.

The following table shows the simultaneously the data of the dismantled ships, scrap rates and charter rates. The data has been taken from chapter 4. The base data source is the Clarkson data base.

Table 16: Ship demolition, Charter rates, Scrap rate comparison

Time Series	Ship demolition in numbers	Charter rates in $/day	Scrap rate in $/ltd
2000	533	8836	172
2001	590	8131	137
2002	565	7468	182
2003	561	14072	265
2004	300	26736	380
2005	165	19755	330
2006	224	21808	390
2007	232	43439	470
2008	384	41471	270
2009	1066	14889	330
2010	766	21172	435

(Source: Clarkson's Database)

In the table above there are three changing parameters in the time series. All the values mentioned above are taken from Clarkson database. The first one is the number of ship demolition in a year. Then is the Charter rates of handy size vessels and the third one is the scrap value. It can be said that both the charter rates as well as the scrap value are determinant factors which prompt a ship manager to decide whether to operate, layup or scrap the ship. The data above shows some kind of relationship between all the three parameter. When the charter rates are high, the number of ships to have undergone demolition seems to be lesser. In the data it can be seen when the charter rates took a dip from 41,471 $/day to 14,889 $/day, the number of ship demolition also increased from 384 demolitions to 1066 demolitions. It can be seen that the scrap value was also fairly good in that year. It was around 330 $/ldt. Interestingly, in the next year, that is 2010, there is an increase in charter rates to 21,172 $/day and simultaneously there is a drop in number of demolitions. There is also an increase in the scrap price but that does not necessarily dictate the number of demolitions.

Chapter 6 Conclusion

6.1 Conclusion

As discussed in chapter 1, the objective of the thesis was to analyze the various decision alternatives for the ship management with respect to operation, layup and scrapping of a ship. The decision making has to be done under a fluctuating charter market and also a dynamic scrap value. The thesis would also take into consideration the various problems posed by the traditional scrapping to the environment and the various regulations related to the layup.

In chapter 2 a literature review of the various environment regulations and problems were discussed. The various problems and issues related to traditional scrapping were studied. It was found that the problem is quite prevalent in the Indian sub-continent where the majority of scrapping is happening. The problems are not only limited to the localized environment but it is also very hazardous for the labor involved in the whole process. The root cause of this problem to the local environment was found to be the hazardous substance used whiles the construction and operations of the vessel. The problems related the labor is compounded by the improper safety standard practiced by the labor while handling the hazardous substance and working in such enclosed and heavy metal environment. The various regulations such as the London convention, Basel convention, Hong Kong convention and the ISO standards were studied. The Basel convention was not absolutely focused in shipping. The Honk Kong convention brought more focus to the green recycling process in shipping. It laid down that in all the stages of the ship life such as ship construction, operations and dismantling there should be minimal usage of hazardous material and if something of such nature is used, it should be handled properly. More importantly it laid down the various levels of survey which have to be conducted before the ship is sent for recycling as per the Hong Kong convention. At the same time the ISO has laid down importance on standardization and certification. This even allows companies to develop their best practices which are practically more feasible for shipping companies and it would help to develop trend towards good practices. The practical problems related to these regulations were discussed. At micro level, the all the regulations related to the hazardous material would be difficult to implement since it is very tough to find ways to inspect all the material of such heterogeneous nature. At the same time it would be really hard to avoid all the hazardous material listed during construction as well as operation of a vessel. At a broader level, implementing all the regulations in the biggest scrap market in the Indian sub-continent would be a huge challenge. At the same time it would have huge social impact in terms of cost if the industry is completely removed from the sub-continent. So a very balanced approach has to be followed in order to solve this issue. Moreover a cost analysis was done which showed lower revenues for the company which follows green recycling. Even though there has been growing environment concern in the shipping industry due to the indirect pressure from their customers, still economically the ship managers would want to follow the traditional scrapping. On a long term basis however environmental regulations will have an impact and the ship managers have to find out ways to make it beneficial in form of the revenue earned from optimum recycling.

In chapter 3 the layup and scrap economics were reviewed. The regulations and the cost involved in the ship layup were discussed. Charter rates, Scrap value and the age of the ship were found to be the most important factors which would impact the decision of a ship manager as per the literature available. The Flag of convenience countries were found to have lower average age of the ships compared to the OECD countries. Some trends related to mean age of dismantling of ships were studied through a time-series from 1995-2006 based on different ship types. It showed a general increase in trend through the time except a dip in the year 2000 due to other reasons.

In chapter 4 initially the demolition data has been shown as per the Clarkson database. It shows the maximum demolitions in the Indian sub-continent in terms of numbers as well as DWT. A trend in the ship demolition from 1996 to 2010 shows a dip in 2006 and 2007 and another sharp rise in the year 2009. The scrap value data was narrowed down to handy-size bulk carrier. It showed a high standard deviation and a range which shows high fluctuation in the scrap value market. The charter rates were also narrowed down handy size ships in form of time charter for 6 months, 1 year, 3 years and 5 years contracts. All the four types of time charter showed high standard deviation and range which again confirms that charter market are highly volatile in nature. At same time it was observed that with increase in the duration of the charter contract the volatility reduces. Then the layup cost was taken into consideration with broken up cost. Finally and value of 1500 $/day was taken considering an in between both kinds of layup and the long time series. The cost of operating and running the ship was around 9000$/day. All these costs were only considered for handy size vessels.

In Chapter 5 the methodology of Decision and payoff analysis was used to analyze the decision making process. As seen in chapter 4, charter market is highly volatile so it was considered to be the state of nature for the decision alternatives of ship operation and layup. All the decision approach showed the decision to operate to be the right one. Only in case of low charter rate the decision to layup gave positive payoff. This shows that the probability of occurrence of a low charter market is a determining factor in the decision of the ship owner whether to operate or layup the ship. From the analysis it was found that if the probability of low charter rates is very high the ship manager should think in terms of layup as the layup would lead to a positive payoff compared to the operation of the ship. If there probability of medium or high charter rate exists, the ship manager should go for the operation of the ship since it shows high profitability. At the same time medium and high charter rate shows highly negative payoff during a layup. So, the decision to layup the ship should only be taken if there is a high probability of occurrence of low charter rates. Similarly, the scrap value market was also found to be highly volatile. In this case, the ship manager has first to decide whether to layup or scrap the ship. If the scrap value is high, the charter rates are low and the ship is old, the ship manager should go for scrapping of the ship. In demolition market also the as per the data analysis in chapter 5, it was seen that the ship manager is more sensitive to charter rates than the scrap value when it comes to decide whether to scrap the ship. In case of a high duration of low charter rates and high scrap value the ship manager might go for a scrap. The layup is a good option when the charter rates are expected to be low for a lesser duration and the scrap value is also low.

At the end it can be said that the expected state of the charter market is the most important factor which should influence the decision making of the ship manager with respect to the operation, layup and scrapping of the ship. Scrap value is an important factor which affects the decision of the ship manager whether to layup or scraps the ship. In future the environmental regulation which would be an added cost to the ship scrapping would have a more impact on the ship manager's decision making.

6.2 Further research

This thesis also gives scope to raise more questions for future. One important question to be asked here is how the duration of the low charter rates can be determined so as to decide on whether to lay-up or scrap the ship. Another important aspect would be the quantification of the environmental impact due to the development of so many regulations related to green recycling.

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Appendices

Year	Avg age of Dismantled Oil Tankers	Avg age of Bulk Carriers	Avg age of cargo carriers	Avg age of dismantled Container Carriers	Average age of Passenger ships	Avg age of all vessels
1995	26,1	24,5	25,8	24	26,8	26,1
1996	26	24,3	27,8	26,2	33,5	26,7
1997	28,2	25,3	26,9	22,8	34,7	26,9
1998	28,2	25,2	26,7	25,5	32,8	26,5
1999	26,2	25	26,7	24,8	35,1	26,1
2000	32,8	19	27,3	10,1	15	27
2001	28	26,7	27,4	26,9	35,9	27,7
2002	28,3	26,6	28,2	26	37,7	28
2003	29,3	26,5	29,3	25,5	33,6	29,1
2004	29,5	27,3	32,9	30,5	37,6	31,7
2005	31,5	28,1	31,9	30,6	36,7	31,9
2006	30,2	28,1	32,6	29,6	38,3	31,6

Year	demolition % in DWT in the indian sub-continent	demolition % in DWT in PRC	Demolition % in DWT in other countries
1996	15120179	293913	2381655
1997	11995368	117973	3647773
1998	19224647	2283701	3443808
1999	21826582	5396960	3375404
2000	14067981	5681582	2746180
2001	21297495	5784409	1348893
2002	21334011	6037560	1198875
2003	14311795	11083227	2057938
2004	7897214	1782128	558761
2005	4762586	425271	330570
2006	5799231	250018	345679
2007	4513025	311225	630112
2008	11161430	1279967	820982
2009	21972734	6105950	3626173
2010	17739326	4327527	2699388
2011	15258158	5829042	1957134
Total	228281762	56990503	31169425

Demolition percentage in DWT

	India	PRC	Others
	338	13	87
	387	7	94
	459	49	107
	429	72	113
	360	86	87
	437	81	72
	390	96	79
	347	131	83
	207	49	44
	116	16	33
	181	10	33
	179	11	42
	323	30	31
	671	214	181
	516	126	124
	354	89	44
Total	5694	1080	1254

Total ship demolition trends

Year	Total Demolition in DWT	Total Demolition in Numbers
1996	17795747	438
1997	15761114	488
1998	24952156	615
1999	30598946	614
2000	22495743	533
2001	28430797	590
2002	28570446	565
2003	27453010	561
2004	10238103	300
2005	5518427	165
2006	6394928	224
2007	5454462	232
2008	13262379	384
2009	31704857	1066
2010	24766241	766
2011	23044334	487

Handysize scrap value			
Year	Handy Size ship in $ million	Indian demolition prices in $/ldt	Far east demolition prices $/ldt
1990	1,52		
1991	1,28	160,00	
1992	1,20	150,00	
1993	1,28	160,00	
1994	1,48	185,00	
1995	1,48	165,00	145,00
1996	1,30	152,00	125,00
1997	1,14	155,00	130,00
1998	0,90	110,00	102,00
1999	1,16	145,00	120,00
2000	1,38	172,00	171,00
2001	1,10	137,00	112,00
2002	1,46	182,00	165,00
2003	2,12	265,00	288,00
2004	3,04	380,00	330,00
2005	2,64	330,00	260,00
2006	3,12	390,00	225,00
2007	3,76	470,00	230,00
2008	2,16	270,00	200,00
2009	2,64	330,00	305,00
2010	3,48	435,00	420,00

Handymax charter rates				
Year	6 months time charter in $/day	1 year time charter in $/day	3 years time charter in $/day	5 years time charter in $/day
1989	10186	10351	9679	
1990	8623	8782	8992	
1991	9293	9403	9640	
1992	8333	8566	9386	
1993	9837	9677	10290	
1994	9835	9812	10383	
1995	12468	11766	11238	
1996	8497	8702	9344	
1997	8433	8346	9077	
1998	7189	6964	7801	
1999	6268	6590	7043	
2000	8836	8759	8480	
2001	8131	8141	8411	
2002	7468	7536	7938	
2003	14072	12815	9948	
2004	26736	25269	15242	
2005	19755	19111	14430	
2006	21808	19432	14772	
2007	43439	39870	28862	
2008	41471	38673	28231	20325
2009	14889	12827	12089	12226
2010	21172	18330	15368	14627
2011	13819	12966	12735	12767