NTNU – Trondheim
Norwegian University of
Science and Technology

Driving Sustainable Ship Recycling

A Case Study of the Container Shipping
Industry

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Project Management
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Preface

This master thesis is written during the spring of 2012 and constitutes the final work of the two year Master of Science education program at the Norwegian University of Science and Technology (NTNU). The master thesis is written at the Department of Industrial Economics and Technology Management. This thesis is connected to the Knowledge Building Project, 'Innovation in Global Maritime Production 2020' (IGLO MP), funded by the Norwegian Research Council. The work has been both challenging and rewarding; the author has explored and gained insight to the different aspects of the ship recycling industry, international regulations, corporate social responsibility and project management in the context of the shipping industry. The author will continue to keep an eye on the further developments in this topic area in the coming years.

The author would like to thank his supervisor, Professor Annik Magerholm Fet, at the Department of Industrial Economics and Technology Management for guidance, constructive advice and feedback. Cecilia Müller at the container shipping company, Maersk Line also deserves the author's gratitude for valuable and inspirational input and taking out time to answer and review in detail all questions that the author put to Maersk Line, which is the case company for this thesis. The author would also like to thank Tom Peter Blankestijn from the ship recycling consultant firm, Sea2Cradle for taking out time to talk in detail to the author about different aspects of the ship recycling business. Further, the author is thankful for the benevolence shown by the other experts that the author has been in contact with and the extensive amount of knowledge that they shared with the author.

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Madhur Ahuja

Abstract

The main target of this thesis is to develop knowledge about the different drivers that can facilitate the widespread adoption of sustainable ship recycling by ship owners. This thesis also aims to look at the advantages a ship owner can gain by effective communication of its ship recycling policy, the impact of such a ship recycling policy on a ship owner and also the opportunity to feedback information from the end-of-life phase of a ship to the Project Management of a new ship.

The Systems Engineering process with a lifecycle perspective is applied to study the problem. The problem is also analysed from the perspective of Corporate Social Responsibility for ship owners. A case study based on a ship owner from the container shipping industry is carried out in order to determine the current state-of-the-art of the ship recycling activity and also to investigate further the measures that can drive sustainable ship recycling by ship owners.

It was determined that even though in the current scenario the issue of ship recycling is at a nascent stage of development with not much attention paid to this issue by the different stakeholders, ship recycling is bound to gain importance in the coming years due to international regulations, the potential for ship owners to gain competitive advantage based on their activities in ship recycling and also because of the tremendous amount of raw materials like steel that can be derived from end-of-life ships.

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1 Problem Formulation

This chapter defines the problem studied in this thesis including the background behind the issue being studied, the goal and structure of this report.

1.1 Background

Worldwide, between 200 and 600 large end-of-life ships are dismantled every year (Commission, 2008). Due to the recent economic crisis, this number has further increased to between 800 and 1500 ships per year as per the estimates by some of the experts this author contacted during this research. The steel, other scrap metal and equipment obtained from recycling ships constitute valuable raw materials. Most of the ship dismantling now-a-days takes place in South Asia, on tidal beaches and under unacceptable conditions from the point of view of safety and environmental protection. The rate of accidents is high, many workers contract lethal diseases, and water, soil and coastal habitats are heavily polluted by hazardous materials from ships (Commission, 2008).

Ship recycling is a fully globalised market driven by factors like freight rates, the price of steel scrap and the costs of maintaining an ageing fleet, which decide at what point a ship will be scrapped. The choice of dismantling location is influenced in particular by the metal price a facility can offer to the ship owner. The price in turn depends on the demand for recycled steel in the area concerned and on the costs of the recycling operations. The costs of ship recycling differ considerably according to the price of labour and the costs of infrastructure for worker's safety and environmental protection (Commission, 2008).

Considering this background, the serious nature and complexity of the problem at hand, this thesis looks at the possibility for promoting sustainable ship recycling, looking first at the principles of systems engineering and life cycle thinking in order to look at the issue of ship recycling in a lifecycle perspective. This thesis then goes on to look at the issue of ship recycling as a CSR issue for ship owners and the different perspectives available on recycling. Further, this thesis looks at the current state-of-the-art in ship recycling and dominant methods for ship recycling in order to determine the method of ship recycling that is most sustainable. Then, this thesis looks at the legal requirements currently in place for ship recycling going on to describe the research methodology used for this work, the findings and results of this research and finally ends by giving the conclusions of this work. This study

places focus on the issue of ship recycling as seen from the perspective of ship owners, the way in which ship recycling impacts ship owners and the ways in which ship owners can help to improve the industry practice with respect to end-of-life treatment of ships especially looking at ship recycling as a part of Corporate Social Responsibility (CSR).

This thesis looks at ship recycling practices in the container shipping industry as a case. The container shipping industry is an international industry by nature. Container shipping companies' services are produced to satisfy the derived demand for the transport of container cargoes. Container shipping mainly involves carrying containerised cargo on regularly scheduled service routes. Considering the importance and scale of the container shipping industry, this thesis focuses especially on this sector of the shipping industry and the case company for this thesis, Maersk Line is also from the container shipping business.

1.2 Problem Statement

The work of this thesis is formulated around the following problem statement:

"How can different measures lead to widespread adoption of sustainable ship recycling for end-of-life ships by ship owners, specifically considering the case of Container Shipping companies?"

1.3 Goal

The main goal of this master thesis is to "identify measures that will facilitate the adoption of sustainable ship recycling by ship owners". This was accomplished by establishing secondary objectives that build the necessary knowledge in a stepwise progression.

Secondary targets:

1. To study development of ship recycling from a historical perspective, identify market drivers and present an overview of the state of the art in ship recycling.

2. To study the drivers of sustainable ship recycling; legal requirement, value chain impacts, Corporate Social Responsibility.

3. Explore ways on how communicating a responsible ship recycling policy can benefit a ship owner?

4. Evaluating the impacts of pursuing a ship recycling policy on a ship owner

5. Contribute to a more active usage of the current ship recycling policy of the case company.

6. Discuss how to integrate information from the end-of-life phase with the Project Management for a new ship.

7. Identify the implications on decision making at a strategic level due to the end of life phase.

1.4 IGLO-MP 2020 Project

This report is written under the Innovation in Global Maritime Production 2020 (IGLO-MP 2020) project, which is a knowledge-building project with collaboration between the Norwegian University of Science and Technology (NTNU), Marintek, Norwegian Center of Expertise Maritime (NCE Maritime) and industrial partners like Ulstein International AS, Pon Power AS, Siemens AS etc.

The recycling phase or the end-of-life phase is important in any industry and for any product that is produced but, since the author was working under the IGLO-MP 2020 project, which is specifically related to the maritime sector, this report looks at the issue of recycling of ships as a case study on the maritime industry, specifically considering the container shipping industry sector.

1.5 Structure

The structure of this report follows a linear-analytic structure as proposed by Yin (2009), starting with a description of the issue being studied and a review of the relevant prior literature, proceeding to the methods used, findings from the data collected and analysed, conclusions and implications from the study.

Accordingly, this report is divided into the following chapters:

Chapter 1 describes the background behind the problem which this thesis is based on. It further defines the problem studied in this thesis including the goal and the structure of this report.

Chapter 2 goes on to describe the theoretical background including the concepts of sustainability, systems engineering, lifecycle thinking and principles of Corporate Social Responsibility. This chapter then describes the current state-of-the-art of ship recycling.

Finally, this chapter gives a short overview of the project management of a new ship viewed in light of the problem being discussed in this thesis.

Chapter 3 presents the research methodology used in this work also giving arguments behind why this specific methodology was chosen.

Chapter 4 presents the main results and findings of this research.

Chapter 5 presents a discussion of the findings of this thesis discussed from various different perspectives including a discussion with reference to the theoretical frameworks presented in this report and also with reference to the achievements of the stated goals of this thesis.

Chapter 6 presents the final conclusion to this thesis.

Finally, the list of references used and appendices to this report have been listed in the end.

2 Theoretical Background

Theory means different things to different people. One way of defining theory is that any conceptualization, as opposed to observation, is theory. Other social scientists equate theory with the "history of ideas" (Nachmias et al., 1981). Others view theory in a narrow sense: a logical deductive system consisting of a set of interrelated concepts from which testable propositions can be deductively derived (Nachmias et al., 1981).

This chapter describes the theoretical frameworks on which the problem formulation for this work is based and also the theoretical background on which the conclusions of this report have been derived. This work uses theoretical frameworks as a history of ideas consisting of a set of interrelated concepts based on which the problem at hand has been discussed and further new knowledge and propositions have been derived.

2.1 Systems engineering and life cycle thinking

Systems engineering is a management technology to assist and support policy making, planning, decision making and associated resource allocation or action deployment (Sage, 1992). It may be thought of as consisting of formulation, analysis and interpretation of the various elements at phases in the life cycle of a system.

The Systems Engineering process involves a series of steps accomplished in a logical manner and directed toward the development of a product or production system (Fet, 1997). The six step methodology can be depicted in the flowchart depicted in figure 1.

The first step in the Systems Engineering process is *Needs identification* from the consumers. This can be defined as an answer to the following questions: "What is needed?", "Why is it needed?" and "How the need can be satisfied?" The second step in this process refers to *defining requirements* that aim to meet the needs as described in *step 1*. These can be further broken down into defining functional, physical and operational performance requirements. These refer to the what, how and why questions respectively asked in the needs specification in step 1 above. The next step is to *specify performances* i.e. to define measurable performance criteria for the total system and subsystems. The fourth step is to *analyse and optimize* as an iterative process until a design or description/solution to the problem is accepted. The next step in the Systems Engineering Process is to *design and solve* i.e., to provide a system design that will satisfy the identified needs. The final step in this process is to *verify and test* i.e. the system concept should be verified by simulation or prototyping to

validate that the system satisfies the required performance and functional characteristics determined initially (Fet, 1997).

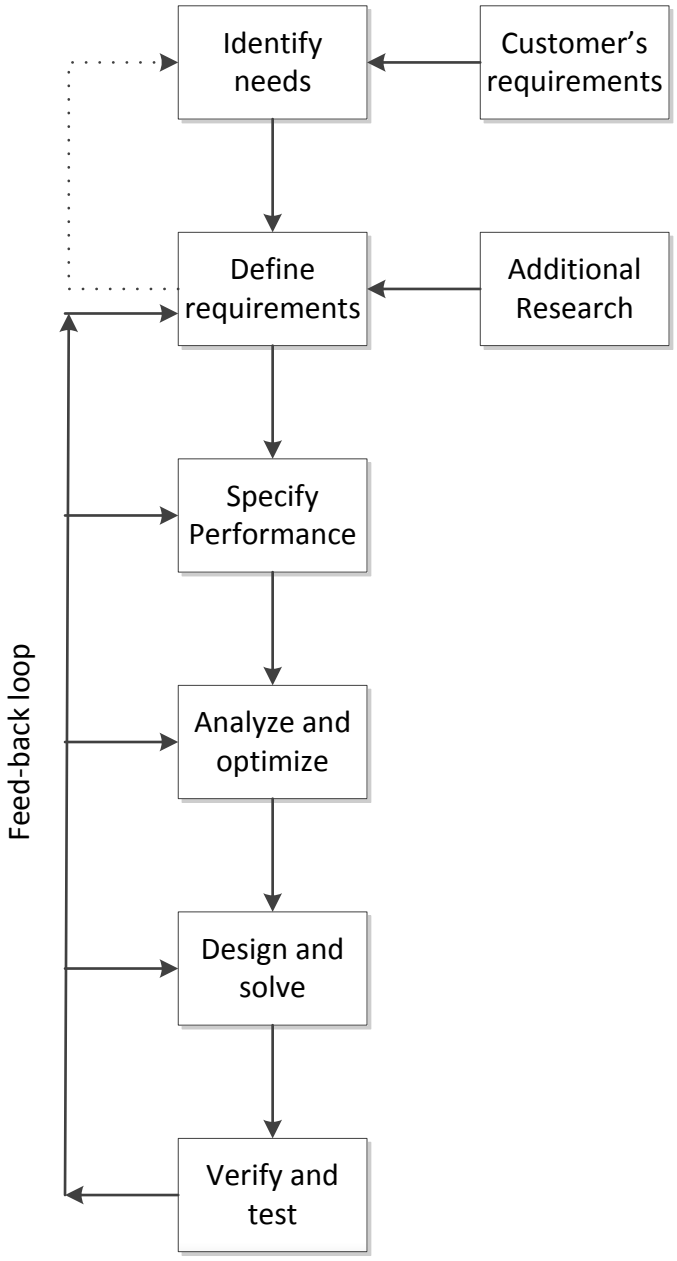

Figure 1: The Systems Engineering Process (Fet, 1997)

An important part of this approach is to conduct the steps in an iterative manner. For each new phase, a check with the previous step has to be done in order to ensure that the system that is being developed is internally consistent.

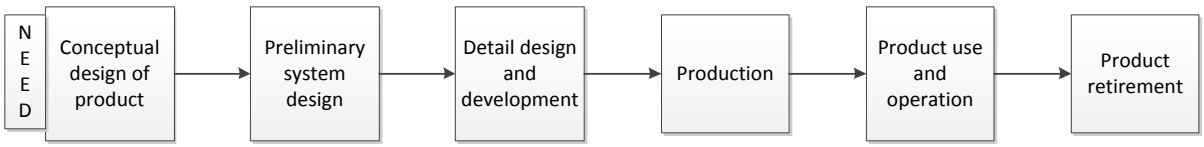

Figure 2: The life cycle of a product considered as a system (Fet, 1997)

The System Life Cycle is one of the backbones in Systems Engineering. It constitutes a total time pattern of events or a series of activities starting with the initial identification of a consumer need and continuing through project planning, design and development; production or construction, maintenance and support; and ultimately system retirement, reuse, recycling and scrapping (Fet, 1997). The main phases in the life cycle of a system can be defined as in the figure below:

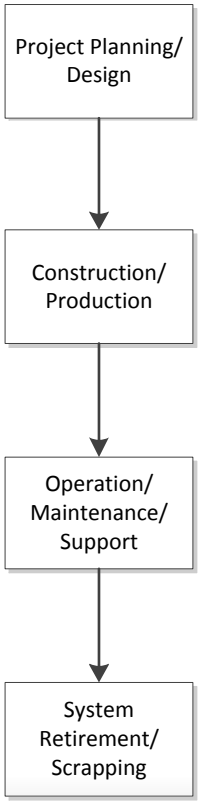

Figure 3: Main phases in the life cycle of a system (Fet, 1997)

Out of the different life cycle phases of a product, this work focuses on the end-of-life or the product retirement phase. More specifically, this study considers the maritime industry and specifically the container shipping business as a case, i.e., the scrapping or recycling of container vessels.

2.2 Sustainability Principles and Recycling

The Brundtland report "Our Common future" published in 1987 defined Sustainable Development as "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs."(Brundtland, 1987). In order to meet this objective, economic, environmental and social concerns, known as the three pillars of sustainability must be considered in economic activity. Sustainable development embraces social, economic and ecological issues in a long term perspective, where, sustainability in economic terms is described as maintenance of capital, social sustainability includes human rights, moral and social justice and ecological sustainability refers to natural capital, environment (Fet, 1997).

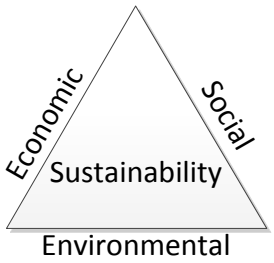

Figure 4: Three pillars of sustainability

The question for businesses is that whether environmental measures will benefit them or not. It is seen that businesses have a more reactive approach rather than proactive approach towards environmental issues especially if the higher costs related to dealing with environmental issues cannot be justified from a cash flow point of view (Fet, 1997). Moreover, most companies have a strategic planning perspective of not more than 3-5 years and hence their attitude in environmental issues tend to have a limited scope of time. What happens 20-30 years ahead in time has little or no influence on their decisions today unless indisputable consequences can be demonstrated (Fet, 1997). This type of short sightedness for environmental aspects from the end-of-life phase is typical because the end-of-life phase occurs a long time after the product has been manufactured and then used for a long time. In the case of ships, this period is typically 25-30 years after the ship has been manufactured. Thus, waste can be said to be "out of sight and out of mind"!

2.3 Corporate Social Responsibility (CSR) and Ship Recycling

This section begins by providing an analysis of the literature review about definitions of CSR and the benefits that a company can gain by practicing CSR. Further, this section looks at the different ways of communicating CSR by companies to their stakeholders. Finally, this section describes the state of the art of CSR communication with a focus on ship recycling in the container shipping business and then, ends by suggesting ways of improvement so that companies can benefit more from their CSR initiatives on ship recycling.

2.3.1 Definitions of CSR

There have been many attempts to derive an appropriate definition of CSR which may cause confusion as to how CSR is to be understood (Dahlsrud, 2009). Dahlsrud (2008) identifies the following five dimensions of CSR, based on a content analysis of 37 definitions of CSR:

- The social dimension
- The economic dimension
- The environmental dimension
- The stakeholder dimension
- The voluntary dimension

The social, economic and environmental dimensions correspond to the triple bottom line concept, and firmly link CSR to sustainable development, as discussed in section 2.2 of this report. The stakeholder dimension emphasizes the importance of stakeholders in CSR. Some definitions suggest CSR is about recognizing stakeholders, while other definitions suggest it is about including stakeholders at some level in corporate decision making. These five dimensions of CSR are illustrated in figure 5.

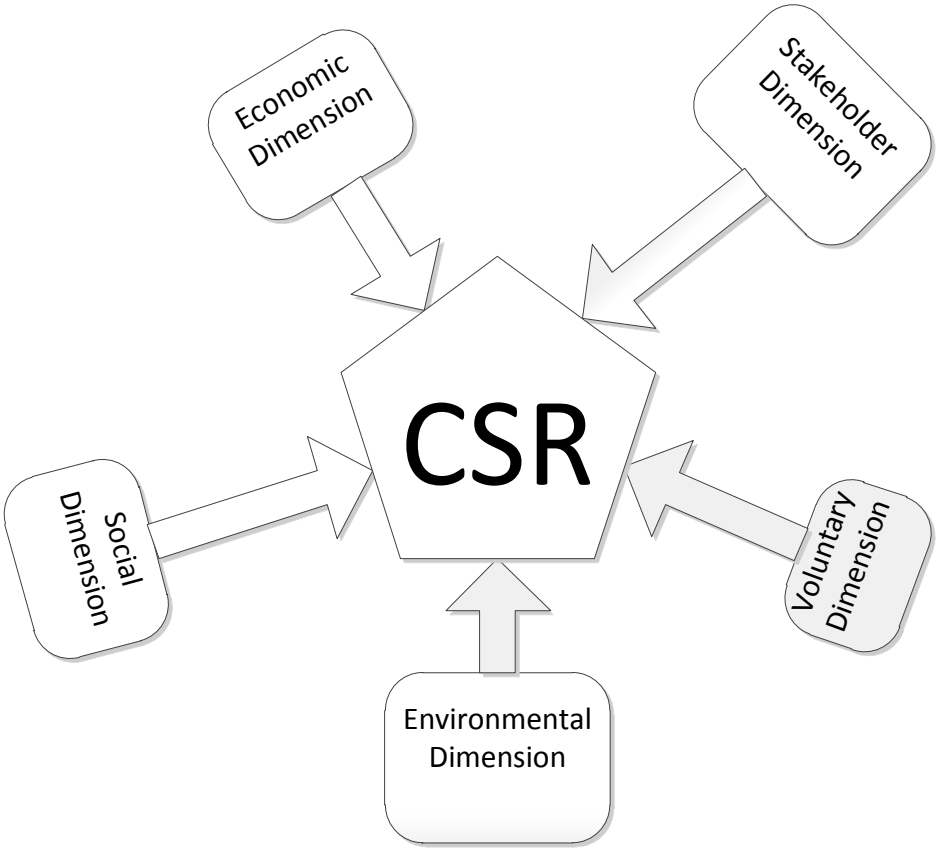

Figure 5: The five dimensions of CSR (based on Dahlsrud (2008))

The voluntary dimension indicates that CSR is limited to the efforts a business is making to manage their social, economic and environmental impacts beyond regulatory requirements.

Dahlsrud (2008) further shows that all of the five identified dimensions are significant in order to understand how CSR is defined. Further, Dahlsrud (2009) argues that if CSR is to contribute to sustainable development, it will have to be reflected in the operational practices of a corporation. This will take the form of CSR practices that improve the social, economic and environmental impacts of business beyond regulatory requirements. It is these practices that are described in the definitions of CSR.

Dahlsrud (2009) identifies three different perspectives on corporate social responsibility (CSR):

1. **The CSR Champions**

The CSR champions view CSR as business' contribution to sustainable development. Central in their rhetoric is the *win-win theory*, also known as the *business case* for CSR. According to this theory, both society and business will profit from CSR; a situation they dub as "win-

win". Thus, since CSR is profitable, adopting CSR is the only rational choice for business managers (D., 2002, Nourick, 2001, Dahlsrud, 2009). Some claim that CSR is even a prerequisite for long term survival of corporations ((Bonini et al., 2006, Sethi, 2005, Kemp, 2001) as cited in (Dahlsrud, 2009)).

The argument of the CSR champions is based on one general assumption; that CSR can be used to build a positive reputation for the company. This in turn, according to CSR champions, may result in a number of profitable effects related to a range of stakeholder groups, e.g. investors, consumers, employees etc. Thus, CSR is providing companies with tangible benefits and should be adopted as a pursuit of enlightened self-interest (Dahlsrud, 2009).

2. The Free Market Advocates

The position of the free market advocates is summed up by Milton Friedman, the Nobel laureate, as "there is one and only one social responsibility of business – to use its resources and engage in activities designed to increase its profits so long as it stays within the rules of the game, which is to say, engages in open and free competition, without deception or fraud".

They agree that as long as CSR is profitable, companies should implement it as a part of their profit maximising strategy, although they refuse to label those initiatives as CSR; it is simply good management (Crook (2005) as cited in Dahlsrud (2009)). They argue that if corporate managers were to comply with unprofitable demands that are put on business in the name of CSR, they will consequently be giving away someone else's money, namely that of the stakeholders ((Crook, 2005, Friedman, 2007) as cited in Dahlsrud (2009)). In their view, this is neither ethical, legal nor will it increase public welfare. In other words, unless CSR is profitable, it cannot contribute to sustainable development. Another argument against CSR frequently used by free market advocates, is that investments in countries with poor labour standards may be discouraged in the name of CSR (Henderson (2001) as cited in Dahlsrud (2009)).

3. The CSR sceptics

According to the CSR sceptics, corporations will only be socially responsible if this is rewarded by the market. This they claim the market does not (Doane (2002) as cited in Dahlsrud (2009)). To support their claim they point to the *attitude-behaviour gap*. This gap denotes the situation when consumers express a preference for products from socially

responsible corporations, but do not transcend this attitude into actual buying behaviour (Dahlsrud, 2009).

Further, the CSR sceptics stress that even if consumers were to use their buying power to favour socially responsible corporations, this would constitute a limited pressure on corporations to actually change their behaviours. The argument for this is that whether or not a corporation is perceived to be socially responsible is more dependent on how successful a corporation is to project that image to their consumers, than their actual behaviours.

Based on these arguments, CSR sceptics promote the idea that international binding regulations for corporations is the only means to secure that business makes genuine contributions to sustainable development (Dahlsrud, 2009).

Based on the analysis of the opposing views on CSR described above, Dahlsrud (2009) concludes that all the three different perspectives on CSR seem to hold one common position: CSR, when it is profitable, should be implemented by businesses and will be a genuine contribution to sustainable development.

Moreover, sustainable development, triple bottom line and corporate social responsibility are related concepts, but could be differentiated by their scopes. The scope in sustainable development is all sectors in society, while triple bottom line refers to how business may contribute socially, economically and environmentally to sustainable development. CSR has an even narrower scope and refers to when this contribution is beyond regulatory requirements and stakeholders are involved (Dahlsrud, 2009).

2.3.2 **Strategic CSR**

The classic literature in business and society asserted that while CSR might entail short-term costs, it paid off for the firm in the long run (Davis, 1973). A strategic reorientation of the firm's CSR philosophy can support its financial interests as well as other stakeholders' interests in the firm (Burke and Logsdon, 1996). CSR is *strategic* when it yields substantial business related benefits to the firm, in particular by supporting core business activities and thus contributing to the firm's effectiveness in accomplishing its mission. Value creation is commonly viewed as the most critical objective for the firm and its strategic decision making process. In assessing the probable contributions of CSR activities to value creation, the five dimensions of strategic CSR are: centrality, specificity, proactivity, voluntarism and visibility (Burke and Logsdon, 1996). These dimensions of strategic CSR are explained below:

Centrality

This refers to the fit between a CSR policy and the firm's mission or objectives ((Ansoff and Management, 1975) as cited in Burke and Logsdon (1996)). Programmes or policies which are related closely to the organization's mission or tightly linked to its accomplishment have much higher centrality and are therefore expected to receive priority within the organization and to yield future benefits, ultimately translated into profits for the organization (Burke and Logsdon, 1996).

Specificity

This refers to the firm's ability to capture or internalize the benefits of a CSR programme, rather than simply creating collective goods which can be shared by others in the industry, community or society at large. For example, philanthropic contributions create public goods that are broadly available to a local or national community (Burke and Logsdon, 1996).

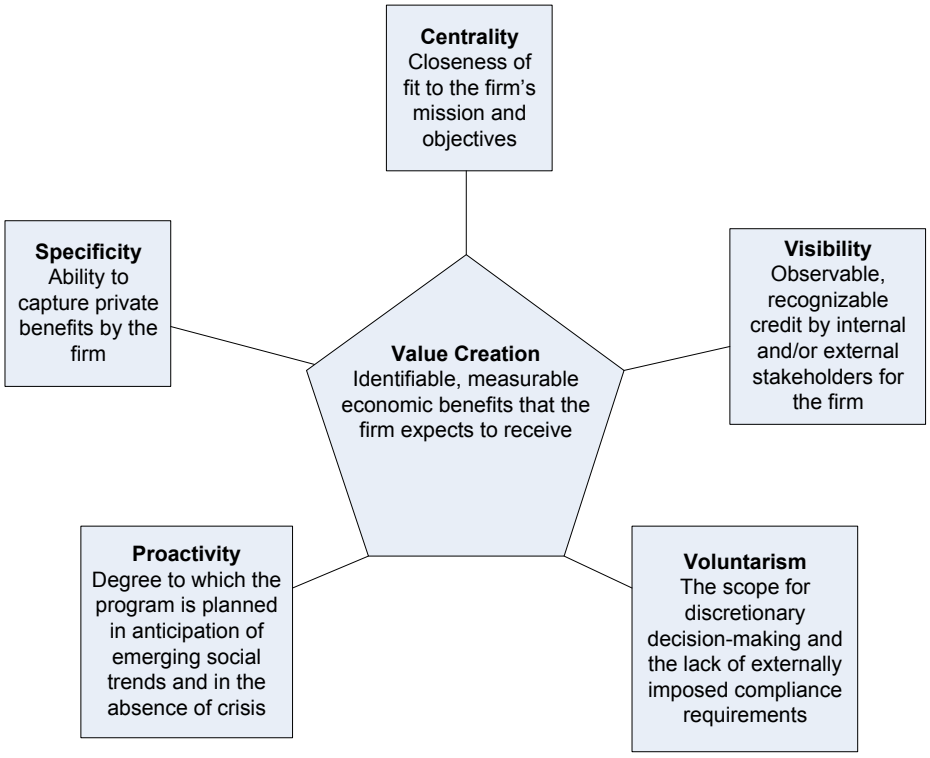

Figure 6: Different strategic dimensions contributing to strategic outcome of value creation (Burke and Logsdon, 1996)

Proactivity

This reflects the degree to which the behaviour is planned in anticipation of emerging economic, technological, social or political trends and in the absence of crisis conditions. The firm that recognises critical changes early will be better positioned to take advantage of opportunities or to counter threats (Burke and Logsdon, 1996).

Voluntarism

This indicates the scope of discretionary decision-making by the firm and the absence of externally imposed compliance requirements (Burke and Logsdon, 1996).

Visibility

This denotes both the observability of a business activity and the firm's ability to gain recognition from internal and external stakeholders (Burke and Logsdon, 1996).

2.3.3 Effective communication of CSR activities

This section explores ways on how communicating a responsible Ship Recycling Policy can benefit a ship owner.

In its conceptualization as "the stated commitments of an organization" to go beyond economic priorities, to foster relationships with stakeholders, and to maintain transparency and ethical behaviour, communication is central to the practice of CSR (Capriotti and Moreno, 2007). *CSR communication* can be differentiated from *social reporting* as using a range of communication tools instead of the mandatory nature of social reporting and disclosure (Chaudhri and Wang, 2007).

The container shipping industry is an international industry by nature. Container shipping companies' services are produced to satisfy the derived demand for the transport of container cargoes. Container shipping mainly involves carrying containerised cargo on regularly scheduled service routes. This activity means that container shipping is an activity conducted on a business to business basis. Hence, traditionally there was no reason for companies to invest in advertising or in any other activities that could improve their image. What was always crucial for the survival of the companies in the highly volatile and competitive environment of shipping markets was their ability to produce at low cost and with good

service quality. Moreover, shipping is a responsive industry, not a proactive one (Lu et al., 2009).

2.3.4 Improvements in CSR communication

This section describes improvements in communication in corporate social responsibility. While addressing the important question of CSR communication, companies should focus on finding answers to questions surrounding *how to communicate* their CSR activities to their stakeholders. When dealing with the question of CSR communication, they should also focus on *what to communicate* (i.e. message content), *where to communicate* (i.e., message channel), as well as an understanding of the company and stakeholder- specific factors that impact the effectiveness of CSR communication (Du et al., 2010). The following paragraphs try to answer these questions in more detail.

2.3.4.1 How to communicate?

The findings from a study conducted by Morsing et al. (2008) on CSR communication in the Danish context suggest the following two models on how companies can best communicate their CSR activities to the different stakeholders:

1. The 'inside-out approach': This means that first companies should base their CSR communication on ensuring employee commitment before they start communicating about their CSR activities to external stakeholders. This will help to build a strong organizational commitment to the corporate CSR agenda, thus encouraging employees to contribute to the further development and support of the corporate CSR activities and policies.

2. Two processes for CSR communication are described in the following paragraphs and also depicted in figure 7 below:

    a. The expert CSR communication process

        This process is meant for highly involved stakeholders, with a high level of interest and knowledge about CSR e.g., local decision makers and the media. This communication style of CSR messages expresses a scientific discourse, which uses facts, figures, statistics and curves, and yet remains rather congenial (Morsing et al., 2008).

b. The endorsed CSR communication process

This implies communicating CSR through third party experts for the general public and customers. This strategy is perceived as key to avoid appearing as a self-complacent and self-serving organization in the eyes of the general public and customers (Morsing et al., 2008).

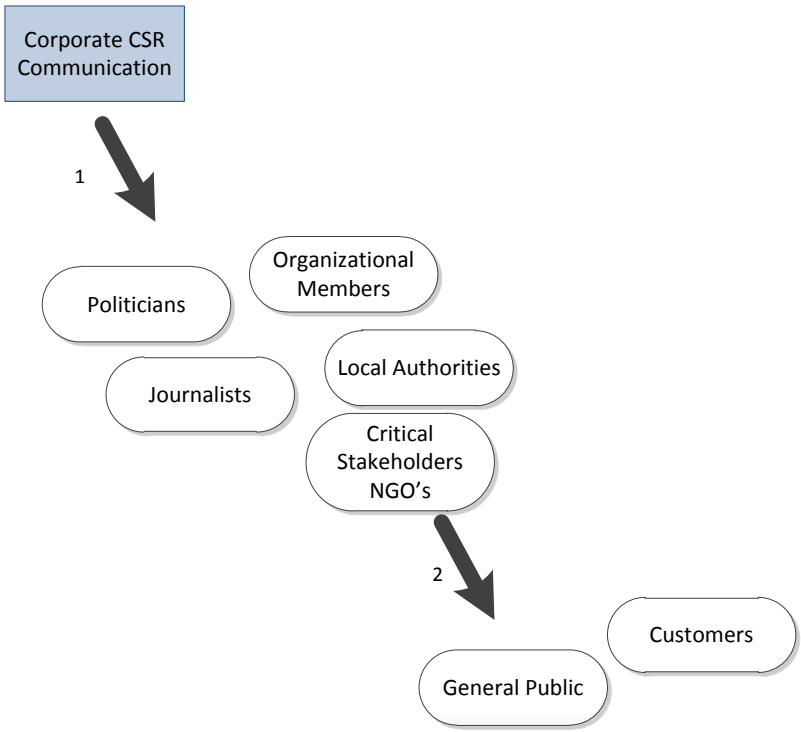

Figure 7: A model of CSR communication (Morsing et al., 2008)
(1. Expert CSR communication process, 2. Endorsed CSR communication process)

2.3.4.2 What to communicate?

A company's CSR message can pertain largely to a social cause itself or to a company's specific involvement in a social cause. Most CSR communication typically focuses on a company's involvement in various social causes, rather than on the social causes themselves. In this context, there are several factors that a company can emphasize in its CSR communication, such as its commitment to a cause, the impact it has on the cause, why it engages in a particular social initiative (i.e., CSR motives), and the congruity between the cause and the company's business (i.e., CSR fit) (Du et al., 2010). These factors are explained below:

1. CSR commitment

   A company can focus on its commitment to a social cause in various ways, including donating funds, in-kind contributions or providing other corporate resources such as marketing expertise, human capital and R&D capability dedicated to a cause. There are several aspects of commitment: the amount of input, the durability of the association and consistency of the input (Dwyer et al. (1987) as cited in Du et al. (2010)).

2. CSR impact

   Instead of focussing on the input side of its involvement in a social cause, a company can focus on the output side of its CSR endeavour, that is, the societal impact, or the actual benefits that have accrued. CSR communication should be factual and avoid the impression of 'bragging' (Du et al., 2010). Webb and Mohr (1998) as cited by Du et al. (2010), found that the durability of support for a cause was used as a cue for judging a firm's motives: longer-term commitments were more likely to be seen as driven by a genuine concern for increasing societal/community welfare, while shorter-term campaigns were more likely to be viewed as a way of exploiting the cause for the sake of profit.

3. CSR motives

   According to Foreh and Grier (2003) as cited in Du et al. (2010), acknowledgement of extrinsic, firm-serving motives in its CSR message will actually enhance the credibility of a company's CSR communication and inhibit stakeholder scepticism, which underlies the potential boomerang effect of CSR communication. Therefore, a company should emphasize the convergence of social and business interests, and frankly acknowledge that its CSR endeavours are beneficial to both society and itself (Porter and Kramer (2006) as cited by Du et al. (2010)).

4. CSR fit

   This refers to the perceived congruence between a social issue and a company's business.

According to the two stage model of attributions, consumers will first attribute CSR activities to dispositional motives (i.e., intrinsic motives), and then 'correct' this inference, if they allocate sufficient processing capabilities and engage in more effortful elaboration by considering alternative, contextual factors (Du et al., 2010). Therefore, a company should highlight the CSR fit of its social initiative if there is congruence between the social issue and its business. When a company does not have a good natural fit with the social cause it supports, it should elaborate on the rationale for its social initiative to increase the perceived fit.

2.3.4.3 Where to communicate?

The next question that a company needs an answer to when dealing with the issue of CSR communication is about the message channels i.e., *where to communicate?* There are several communication channels through which information about a company's CSR activities can be disseminated, which include official documents, such as annual CSR report or press releases, a dedicated section of the official corporate website to CSR, advertisements etc. These channels can be divided into two major groups, *company controlled channels* and *external channels* that are not entirely controlled by the company. The company controlled channels are official documents and information on company website for example. While, external channels include information covered by the company's CSR activities in the media. Similarly, the company can exert greater control over the content of CSR communication by members of its value chain. Since individuals are often more critical of messages from sources they perceive to be biased or self-interested (Wiener et al. (1990) as cited by Du et al. (2010)) , CSR communication via internal sources will create more scepticism and have less credibility than external sources. Companies should therefore try hard to get positive media coverage from independent, unbiased sources, such as editorial coverage on television or in the press. Since employees often have a wide reach among other stakeholder groups through their social ties and are considered a source of credible information, companies should 'tune-up' their internal CSR communication strategy and find ways to engage employees and convert them to companies' CSR advocates (Du et al., 2010).

2.3.5 Factors affecting effectiveness of CSR communication

Next, we define factors affecting effectiveness of CSR communication. These factors can be further divided into two categories: *company specific factors* and *stakeholder specific factors* (Du et al., 2010).

2.3.5.1 Company specific factors

These factors have a greater influence on CSR communication from company related communication channels than for third party communication channels. The following two factors can be identified under this category:

1. Corporate reputation

   Corporate reputation is conceptualized as 'a collective representation of a firm's past actions and results that describes the firm's ability to deliver valued outcomes to multiple stakeholders' (Gardberg and Fombrun (2002) as cited by Du et al. (2010)). Companies with good reputations, perceived to have high source credibility, will probably find the positive effects of their CSR communications to be amplified, whereas the effects of CSR communication in the case of companies with poor reputations will be dampened or even backfire (Yoon et al. (2006) as cited by Du et al. (2010)).

2. CSR positioning

   Corporate Social Responsibility positioning refers to 'the extent to which a company relies on its CSR activities to position itself, relative to the competition, in the minds of the consumers' (Du et al. (2007) as cited by Du et al. (2010)). This can be used by a company to position itself as the socially responsibly brand in a category. A company's CSR positioning is likely to amplify the effectiveness of CSR communication because, given that the company has taken the relatively uncommon and perhaps risky stance of positioning itself on CSR rather than superficially engaging in such activities, stakeholders are likely not only to pay more attention to its CSR message, but also to believe in the authenticity of its CSR endeavours, resulting in greater persuasion in favour of the company (Du et al. (2007) as cited by Du et al. (2010)).

2.3.5.2 Stakeholder specific factors

Some characteristics of stakeholders, as the recipients of CSR communication also affect the effectiveness of CSR communication the following factors can be identified under this category:

1. Stakeholder type

   One unique characteristic of CSR communication is that it often has many potential audiences, ranging from legislators, business press, investors and non-governmental organizations (NGOs) to local communities, consumers and employees (Dawkins, 2005).

   Furthermore, these different audiences vary in terms of their expectations of businesses, and in information needs, and may thus respond differently to the various communication channels of CSR. Accordingly, it is imperative for a company to tailor its CSR communication to the specific needs of different stakeholder groups. For example, the general public such as consumers or the local communities often do not proactively seek CSR information about a company, even with regards to issues they consider particularly important (Dawkins, 2005). The general public often become aware of a company's CSR activities through independent channels, such as editorial coverage on TV and in the press, stakeholder word-of-mouth or corporate communication channels.

   Stakeholders' attribution of a company's CSR motives may be of two kinds: *extrinsic*, in which the company is seen as attempting to increase its profits; or *intrinsic*, in which it is viewed as acting out of a genuine concern for the focal issue (Du et al., 2010). Ellen et al. (2006) concluded that stakeholders are often tolerant of extrinsic motives as long as CSR initiatives are attributed to intrinsic motives as well. Therefore, the company should emphasize the importance of the social issue and communicate a lack of vested self-interest by choosing issues that are not logically related to the company's businesses, to allay consumers' concern about ulterior motives and to enhance the credibility of advertising (Menon and Kahn, 2003).

2. Issue support

CSR information on initiatives that stakeholders deem important or personally relevant is likely to be more effective. Individuals' awareness and knowledge of a social issue will often lead to greater support for that particular issue (Sen (2004) as cited in (Dawkins, 2005)). Therefore, companies need to explain and communicate the importance of the focal issues of their social initiatives so as to increase the stakeholders' issue support.

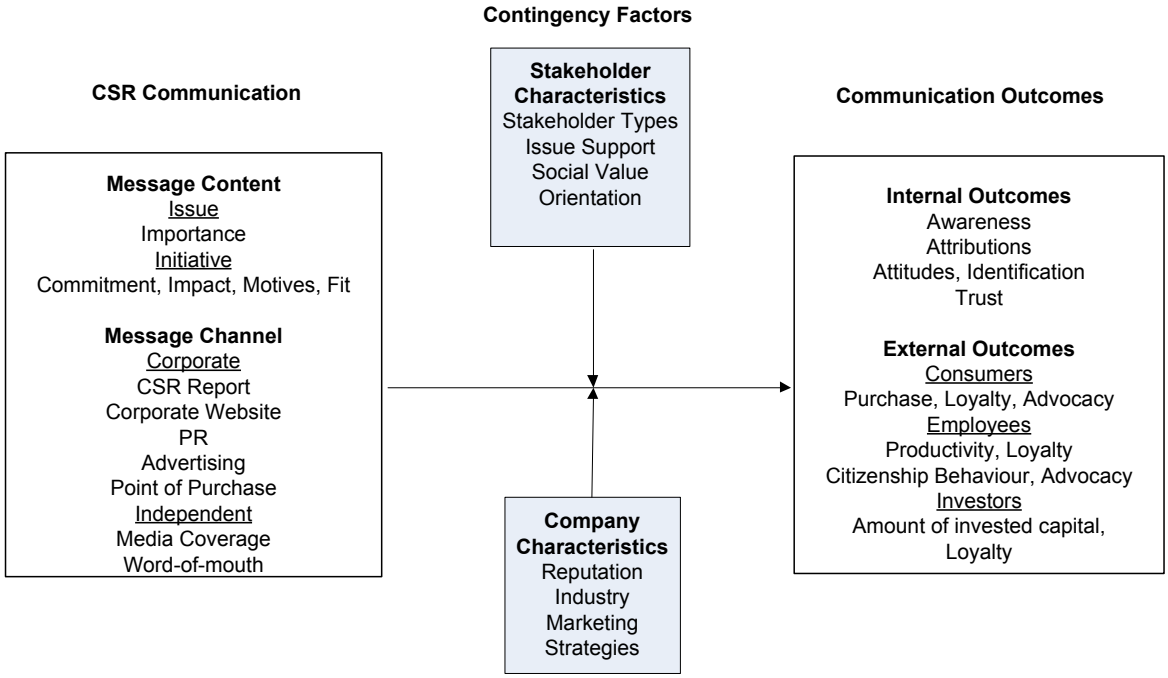

Figure 8: A framework of CSR communication (Du et al., 2010)

Figure 8 presents a conceptual framework of CSR communication. The different factors mentioned under different blocks in the figure above have been described in detail in the preceding sections while this figure in addition also lists the outcomes that an effective communication of CSR activities as per the factors mentioned in the figure can lead to.

2.4 Design for recycling

In current practice, products are usually designed for ease of production, delivery and maintenance. The disposal is usually excluded from the optimization because it is usually paid for by somebody else, e.g. by the customer. With companies having to organise and pay for recycling, they will put the same emphasis on designing their products for the ease of recycling (Seliger et al., 1994).

2.4.1 Rules for design for recycling

This section deals with design-for-recycling at the conceptual design stage, as depicted in figure 9. The input to this stage includes the clarified design task comprising functional product requirements as well as the necessary information about relevant processes, tools and optimization goals. One of the optimization goals is the ease of recycling. When designing products for recycling, a designer has to take into account several areas that influence the optimal choice for design for recycling (Seliger et al., 1994):

- Future ways of collecting, transporting and storing the products after usage
- Current and future developments of recycling methods
- Possibilities to reuse components in future products
- Existence of technologies to reprocess the materials
- Existence or future development of markets for the recycled materials

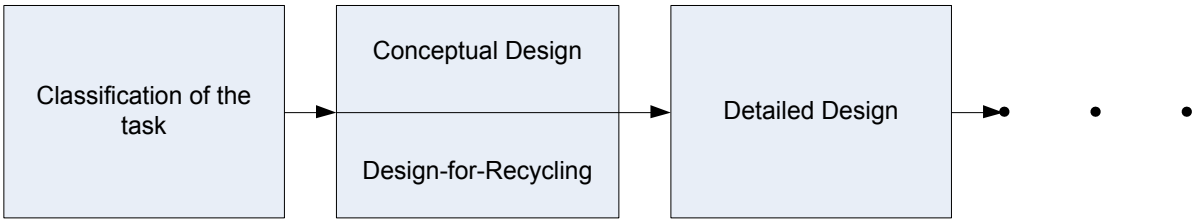

Figure 9: Design for recycling at the conceptual design stage (Seliger et al., 1994)

1. Product recycling

   The first priority for recycling is extending the products lifespan by recycling during usage. It aims that the product can fulfil its function for a longer period using minimal resources (Seliger et al., 1994). This can be achieved by the following aims (Seliger et al., 1994):

- A modular structure of the product allows to modernize components that are outdated without having to change the whole product
- To design those sections of a product which are subject to heavy wear and tear as separate elements so as to allow their exchange easily and thus extend the product's life

Further, Chen et al. (1993) list the following steps for designing a product for recyclability and design for ease of disassembly:

a. Structural design: This determines the layout of the parts and complexity of the product, as well as the paths and difficulty in reaching a particular part or subassembly. These aspects directly affect disassembly time and cost.
b. Joint types: This increases the disassembly cost by increasing the time and tools required for disassembly.
c. Operating methods for disassembly can be dictated by the nature of the design.

2. Ease of disassembly

   The disassembly process allows regaining components intact and materials of higher purity than the alternative shredding process. Design for disassembly can also be of advantage for other stages of the product lifecycle, namely (Seliger et al., 1994):
   - Easier packaging and transportation during the distribution phase
   - For repair and maintenance during usage phase
   - During the recycling phase

3. Choice of material

   If recycling of the whole product or product components is impossible, the combination of materials has to be separated and regained. Rules regarding this aspect are (Seliger et al., 1994):
   - Selecting environmentally compatible and recyclable materials for components
   - Reducing the volume of plastic and component materials used
   - Avoid secondary finishing operations such as painting. Dissimilar materials must be identified and separated.
   - Avoid using non shreddable materials.

Further, Chen et al. (1993) list the following steps for selection of suitable material for ease of recycling:

a. Materials mix: The larger the variety of materials used, the harder the separation task will be.
b. Toxicity of materials: The use of toxic materials will cause environmental problems during manufacturing, separation, material recovery and disposal.
c. Materials recyclability: Materials that are hard to recycle are often not recycled because the cost of recycling outweighs the cost of purchasing virgin material.
d. Recycled materials: To keep the recycling market alive, a green designer should not only design for recyclability but also try to design with recycled material.
e. Materials compatibility: If compatible materials are used for subassemblies, and easily separable joints are used between groups, then we can reduce the time spent and the cost of disassembly.

4. Design for logistics

Besides designing the product for ease of recycling, an important factor is to make sure that the product is actually fed back to the recycling process by the last user. This can be achieved by the following rules (Seliger et al., 1994):

- Design the product so that it can be transported easily after usage
- Develop a simple and efficient system support approach which will encourage the consumers to start the recycling process, and will be cost effective

2.4.2 **Extended producer responsibility legislation**

Governments have recently introduced new types of regulations, called extended producer responsibility, which makes firms and producers responsible for waste disposal costs. When firms internalize the cost of eco-friendly waste disposal, they tend to reduce the use of hazardous material and improve the reusability of their products (Bernard, 2010).

Applying the "polluter pays principle" that calls on governments to "take those actions necessary to ensure that polluters and users of natural resources bear the full environmental

and social costs of their activities" (Hunter, Salzman, and Zaelke, 2002, as cited in Toffel et al. (2008)), take-back regulations impose part or all of the recycling and disposal costs on manufacturers.

Imposing part or all of the costs of recovering and recycling EOL (End-Of-Life) products on their producers is meant to create incentives for producers to modify product designs in ways that minimize such costs, such as by facilitating the reuse and recycling of components and materials. Policies could, for example, require producers to make toxic components easily visible and removable, direct producers to label the material content of plastics and other difficult to identify materials, and encourage or require the use of materials that can be recycled multiple times and for which recycling markets exist (Toffel et al., 2008).

Policies can also require producers to incorporate minimum thresholds of recycled content or recyclable content in their products, which could simultaneously increase the demand for recycled materials, reduce the flow of recovered materials to landfills or incineration, and reduce demand for virgin materials (Toffel et al., 2008).

Moreover, recycling of materials obtained from a ship will help to (Bennett and Sorensen, 2012):

1. Keep the quality of materials
2. Reduce mining of new materials to a minimum
3. Making capital out of materials

In an effort to reduce material waste, conserve resources, and prevent hazardous disposal, several countries have enacted the principle of extended producer responsibility (EPR) within statutory frameworks. EPR directives place financial responsibility for the collection and disposal of products at the end of their useful life on manufacturers, thereby aiming to create incentive to redesign products for reuse and recycling. EPR legislation, also referred to as "take-back," is attractive to policy-makers because it is a market-oriented instrument for environmental improvement (Paquette, 2006).

End-of-life value can be realized by two means: Improvement of recycling processes by developing more sophisticated recycling technologies, and improvement of product design in a recycling friendly manner. Only 10-20% of recycling costs and benefits depend on recycling processes optimization. The remainder is already determined at the design stage (Kriwet et al., 1995). It is therefore necessary that ship designers also consider the end-of-life

phase of the ship in mind while designing new ships so that it is easier to derive the maximum end-of-life value from ships at the end of their operational lives.

2.4.3 End-of-life treatment options

Recycling aims at "closing the loop" of materials and components after usage by (re)using/utilizing them for new products. "(Re)using" can be defined as keeping the shape of the original product for future use, while "utilization" can be defined as making use of the material after dissolving the original shape (Kriwet et al., 1995). If the function of the recycled product is the same as the one of the original product, we call it "reusing", otherwise, we call it "using on" (Schmidt et al., 2011). Figure 10 below describes the product lifecycle with environmental impacts from the various phases and also showing feedback loops from the different end-of-life options back to the other phases of the product lifecycle.

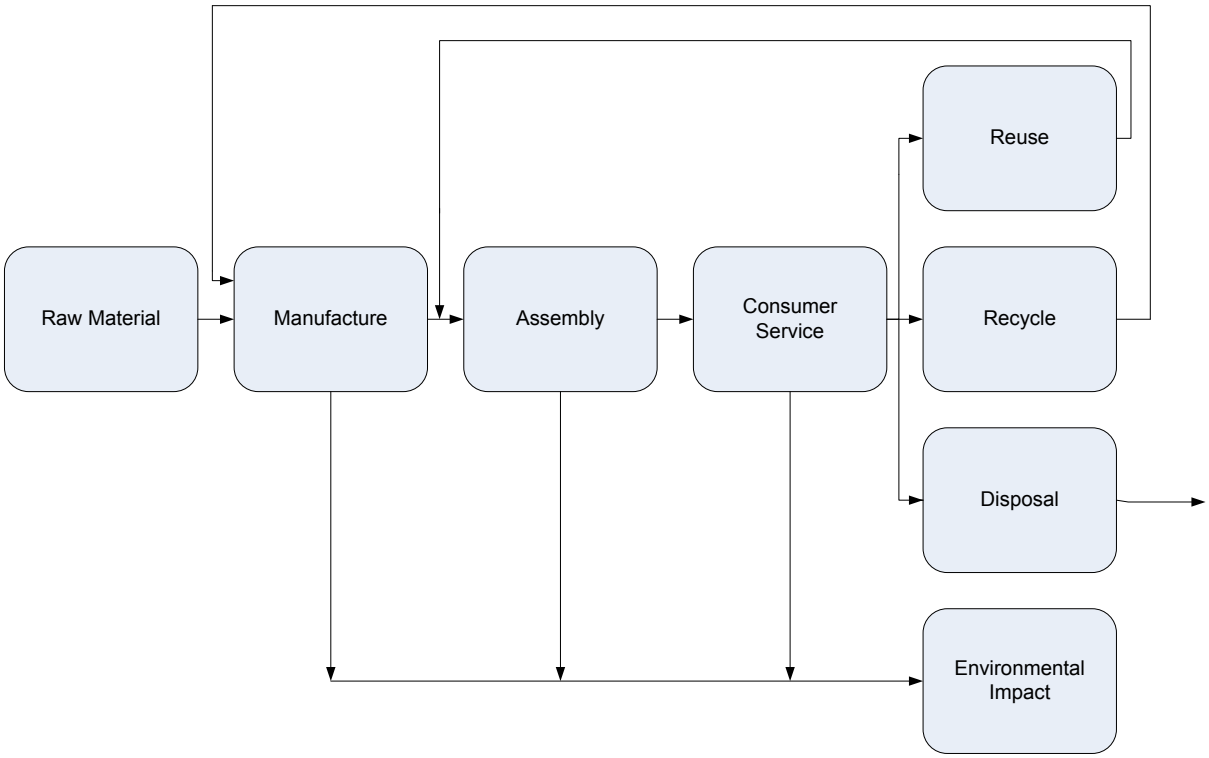

Figure 10: Product life-cycle (Ishii et al., 1994)

Recycling is the process of collecting used products, components, and/or materials from the field, disassembling them (when necessary), separating them into categories of like materials (e.g., specific plastic types, glass, etc.), and processing into recycled products, components, and/or materials. In this case, the identity and functionality of the original materials are lost. The success of recycling depends on whether or not there is a market for the recycled

materials, and on the quality of the recycled materials (since most recycling processes actually reduce the value of the material from its original value, as the material itself has degraded). Re-use is the process of collecting used materials, products, or components from the field, and distributing or selling them as used. Thus, although the ultimate value of the product is also reduced from its original value, no additional processing is required (Beamon, 1999).

The process of remanufacturing consists of collecting a used product or component from the field, assessing its condition, and replacing worn, broken, or obsolete parts with new or refurbished parts. In this case, the identity and functionality of the original product is retained. The resulting (remanufactured) product is then inspected and tested, with the goal of meeting or exceeding the quality standards of brand new products. Thus, in some cases, the remanufactured product can exceed the original product in quality and/or function. This is due to the fact that during the remanufacturing process, the design of the replaced parts and/or components may have been improved since the original product was manufactured. The unique advantage of remanufacturing is that, unlike recycling and re-use, the process of remanufacturing does not degrade the overall value of the materials used (Beamon, 1999).

Further, Paquette (2006) defines remanufacturing as a process to clean, repair, and restore used durable products to good condition for resale. Remanufacturing is typically integrated with reverse logistics processes because valuable products and components must be appropriately transferred from the consumer to the manufacturer.

When service, refurbishment, and remanufacturing are not possible, returned products enter recycling channels. When a product is disassembled before recycling, components salvaged from the product can be sent back to different tiers of the forward supply chain and reused, thus creating a closed-loop. Standard components and certain materials (e.g., silver, copper) can also be sold in secondary markets. Recycling without disassembly often takes a rather primitive “grind and sort” approach. This option is less desirable because it recovers less value. The worst case scenario involves certain materials (plastics, rubber) being incinerated as fuel or being sent to a landfill.

Decisions regarding recycling processes come down to two main decision criteria: whether or not the products are disassembled before being recycled and who performs the recycling processes. There are two main recycling options available:

1. Recycling without disassembly

   This type of recycling process is often carried out through a grind and sort process, in which collected products are first crushed or shredded, then ground into materials that are sorted by type (e.g., ferrous, polymer, glass) (Pagell et al., 2007).

   This EOL strategy requires little change in the design of the product. Designers can focus on maximizing functionality and reducing costs without having to devote concern to matters regarding EOL strategy.

   The downsides of this method are, lower recovery rates, less chance for learning and the fact that little to no change in design is needed means that many members of the supply chain can remain ignorant of EOL management and the associated issues (Pagell et al., 2007).

2. Recycling with disassembly

   Through hands-on disassembly activities, managers can understand the disassembly process and provide feedback to the product design engineers. Product design that integrates disassembly process needs will ultimately lead to higher disassembly efficiency.

   Moreover, the process of redesigning products to consider not just their initial production, but also their eventual disassembly and recycling can be a path to innovation and unique competitive advantage.

When forced to engage in an activity they see as having no obvious economic benefit, managers are likely to look for a low cost option to perform the recycling process. Often, *outsourcing* provides just such a low cost option, especially when the process is one the firm has never before performed. Therefore, it seems likely that many firms faced with EOL product management will look to outsource the recycling task. The decision to outsource recycling, however, has major strategic implications beyond cost that the focal firm must consider. Rather than merely looking at who performs them, it is more meaningful to examine the *level of involvement* of the focal firm in recycling activities.

Direct involvement in recycling operations can create unique knowledge of products, processes, and even customers. Studies find that less than 30% of all products are designed

with disassembly and recycling processes in mind (McDonough & Braungart, 2002, as cited in Pagell et al. (2007)). Once managers begin to understand the relationship between product creation and product take-back, they start to consider environmental impacts in their day-to-day decision making, reducing the likelihood of having to make major changes later (Pagell et al., 2007). Over time, it allows environmental management to become an integral part of business decision-making, rather than something one has to do in reaction to regulatory or customer pressure.

In the long term, controlling product take-back may be a *hedge against uncertain or constrained supply*. Companies that employ a recycling strategy that maintains control of plastics and other hard-to-get commodities may well hold a competitive advantage, as they will have a certain and somewhat steady supply of materials at their command.

In-house recycling is also beneficial when it comes to keeping product out of other channels. Many companies face competition from third parties who remanufacture their products (Rossetti & Choi, 2005 as cited in (Pagell et al., 2007)). By taking products back and recycling them, the supply chain effectively keeps them away from the competition.

By carrying out recycling processes internally the firm gains the potential to create a new business and enter into new markets as a provider of recycling services to others.

When the recycling task is outsourced to a third party, it is critical to consider the need to protect intellectual property. When a third party agrees to carry out disassembly, however, it may rightfully expect early access to designs, product material manifests, and prototypes in order to build an efficient disassembly system. This necessary disclosure automatically puts the intellectual property at greater risk

Being the first in an industry to deal with EOL issues may have other benefits as well. In industries in which recycling is not yet the norm, being able to show customers that one firm has moved ahead of the pack can put competitive (sometimes even regulatory) pressure on competitors, who will be forced to react. The low price reaction may well be to outsource recycling to the first mover. In this scenario, the first mover creates a viable business that generates cash and scarce raw materials from their competitors, who are forced into a reactive mode.

2.4.4 **The effect of recycling on the Supply Chain**

In order to comply with EPR requirements, companies must design, implement, and possibly operate comprehensive reverse supply chains. Reverse supply chains may involve collection facilities, reverse logistics, partnerships with disassembly and recycling providers, integrated remanufacturing and reuse plans, and marketing initiatives to encourage consumer participation. Altogether, "take back" requires considerable organizational, technical, and financial commitment from industry (Paquette, 2006).

Supply chains have traditionally been conceptualized as flowing from raw materials to an end customer. A supply chain that includes EOL product management will have flows back from the customer toward raw materials (Pagell et al., 2007).

Figure 11 below offers a pictorial illustration of a closed loop supply chain. The top part of figure 11 represents the traditional forward supply chain. Materials, components, and subassemblies move from upstream suppliers and contract manufacturers to downstream OEMs and vendors (e.g., distributors, retailers). The bottom part of figure 11 is often referred to as the reserve supply chain. It begins with the used products being taken back through various channels.

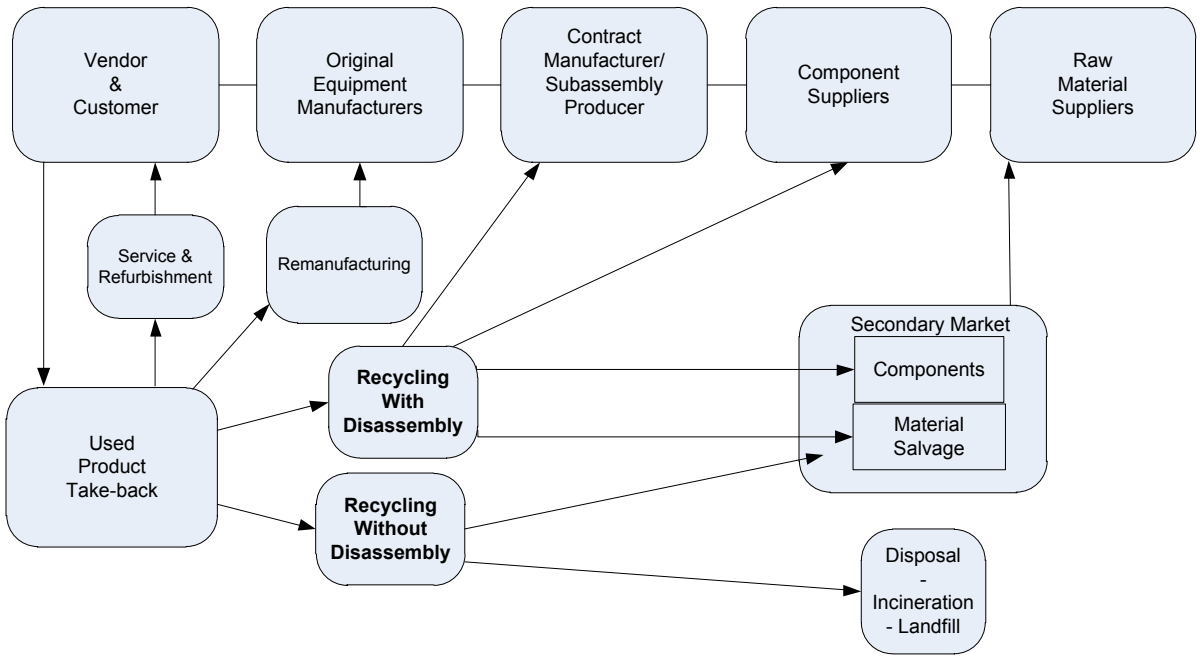

Figure 11: A Supply Chain that accounts for reverse flows (Pagell et al., 2007)

In the current scenario, the responsibility of ship recycling lies more on the last ship owner, which is the *focal firm*, defined by Pagell et al. (2007) as the company with the name on the

end product. Instead of laying the responsibility for recycling on the focal firm, the responsibility of recycling can also be laid on the Original Equipment Manufacturer (OEM), which is the ship building yard in the case of ships.

Based on an analogy from the automotive industry, as analysed by Schmidt et al. (2011), one should bear in mind that while the OEM bears responsibility for the end-of-life phase, his influence is often limited. In current practice, design processes are distributed over various companies. Hence, all the subsystems of a ship are not designed centrally at the, OEM but, at a variety of specialized suppliers. For this reason, the efficiency of recycling depends on the specifications of each subsystem of the ship and thus on the design effort of the suppliers. Thus, the contracts between subsystem suppliers and the ship building yard must be based on contracts that include recycling relevant specifications of the components that the sub-suppliers develop.

2.5 State-of-the-art of the Ship Recycling industry

This section describes the most recent assessment of the global ship recycling industry at the time of writing this report.

2.5.1 Ship Recycling industry in Asia

Explaining the current industry situation with regards to ship recycling, Mikelis (2012) states that five countries recycle 97% to 98% of all the tonnage recycled in the world. In four of these countries, namely Bangladesh, India, Pakistan and Turkey, all recycling is concentrated within a single area, while in the fifth recycling country, China, recycling is spread in numerous locations from the south to the north of the country.

The five recycling countries share a common characteristic in having a large appetite for scrap steel. Bangladesh, Pakistan and to a large extent India use the steel from recycled ships in mills where steel is “cold” rerolled so that it can be used directly, for example in urban construction. It is understood that China and Turkey mostly melt the ship scrap. The expert from the ship recycling consulting firm Sea2Cradle whom the author interviewed during this research highlighted the fact that in China it is a legal requirement to melt the steel scrap that is obtained as a result of recycling of ships. It is notable that Turkey, which is alleged to be the largest importer of scrap steel in the world, satisfies just 2% of its needs with scrap steel from its ship recycling industry. Equivalent figures for the contribution of steel from ship recycling to the steel production of the country, according to the World Bank, is 50% for

Bangladesh and 15% for Pakistan, while the figure for India is understood to be between 5% and 6% (Mikelis, 2012, Commission, 2008).

India's recycling industry prefers to recycle smaller ships compared to Bangladesh. These two countries have generally offered similar prices for ships, except in the last two years (before 2012), when the Bangladeshi recycling industry had to withdraw repeatedly and for long spells from buying ships following High Court litigation by a local environmental NGO. Pakistan, after being almost absent from the market from 2004 to 2008, returned to ship recycling and is offering prices that follow those offered by India. China, who also was almost absent from the market from 2005 to 2007, is now a very active buyer, generally paying prices which are around $50 to $70 per light ton less than those paid in South Asia, that is Bangladesh, India and Pakistan. Turkey tends to pay around $150 per light ton less than the prices paid in South Asia and specializes in recycling mainly Mediterranean trading ships and European government-owned ships. China and India each command around 30% of the world's recycling capacity, while Bangladesh's capacity is around 25%. Pakistan and Turkey each command 9% and 2%, respectively (Mikelis, 2012).

Mikelis (2012) explains that the international perception of safety and environmental standards in the five recycling countries is that China and Turkey now offer safe and environmentally sound ship recycling, while India has progressively improved its standards, especially after the decision of its Supreme Court in 2007 which instigated important requirements for the industry. It is also widely considered that the ship recycling industries in Pakistan and Bangladesh are in need of making significant improvements in safety and in the responsible treatment and disposal of hazardous waste streams. Table 1 summarises the current waste treatment practices within three major ship recycling countries, India, Pakistan and Bangladesh based on information obtained from COWI (2010).

Table 1: Overview of the current waste treatment practices in India, Pakistan and Bangladesh and their compliance with EU requirements (COWI, 2010)

	India	**Bangladesh**	**Pakistan**
Asbestos	Partly landfilling (EU Compliant) Partly burial (non EU Compliant)	Burial (non EU Compliant)	Burial (non EU Compliant)
PCB	Either sold for reuse as part of its host equipment (non EU Compliant) or disposed off uncontrolled. In a few cases stored.	Either sold for reuse as part of its host equipment (non EU Compliant) or disposed off uncontrolled.	Either sold for reuse as part of its host equipment (non EU Compliant) or disposed off uncontrolled.
Heavy Metals	In larger components like batteries: reused (EU Compliant) In paints: follows the steel plates to the steel plants (partly EU Compliant and partly non-compliant)	In larger components like batteries: reused (EU Compliant) In paints: follows the steel plates to the steel plants (partly EU Compliant and partly non-compliant)	In larger components like batteries: reused (EU Compliant) In paints: follows the steel plates to the steel plants (partly EU Compliant and partly non-compliant)
Oil	Reuse (EU Compliant)	Reuse (EU Compliant)	Reuse (EU Compliant)
Oil Sludge	Partly collected and reused for energy production(EUCompliant) Partly dumped/washed out to the sea	Partly collected and reused for energy production(EUCompliant) Partly dumped/washed out to the sea	Partly collected and reused for energy production(EUCompliant) Partly dumped/washed out to the sea
Mercury	Reuse (non EU Compliant)	Reuse (non EU Compliant)	Reuse (non EU Compliant)

The author would like to highlight the fact that as per information received from the expert at the ship recycling consulting firm, Sea2Cradle, who was interviewed by this author during the course of this research, most of the batteries recovered from a ship during the process of recycling are empty and they are therefore not reused. The expert further explained that in the case of India, Pakistan and Bangladesh, these batteries are simply placed in a waste pile which is not treated afterwards. This is in contrast to the information mentioned in the table above that is based on information gathered from COWI (2010). Further, the expert based on

his experience also suspects that mercury removed from ships is not reused as mentioned in the table above, based on COWI (2010), but it mostly goes into the marine environment.

2.5.2 Ship Recycling industry in Europe

The fact that there is very little ship recycling activity in Europe is often explained in terms of the inability of Europe to compete with the low labour costs and low compliance costs of South Asia. Another reason that can be attributed to the little ship recycling activity that exists in Europe can be attributed to the fact that whereas the Asian countries utilize scrap steel in their domestic economies, Europe is an exporter of scrap steel. Therefore, the idea of setting up a ship recycling industry in Europe to break ships – with more expensive European labour – in order to export the scrap to Bangladesh or India is simply not realistic (Mikelis, 2012). Further, Commission (2008) explains that in case of Europe, due to stricter product regulations and less demand, the machinery from old ships is rarely re-used, and the scrap steel will have to be recycled "hot" via furnaces.

2.6 Major types of Ship Recycling methods

Ship recycling has always operated on the basic principle that the value of the scrap and reusable materials extracted from an unneeded ship will exceed the cost of purchasing the ship and dismantling it. In this section, we consider the major types of ship recycling methods, beaching, dry dock and green recycling as described in the literature on ship recycling. The other ways in which an end-of-life ship can be treated, for example, by sinking in military exercises or making artificial reefs etc. have been left out of this report as they do not relate to the *cradle-to-cradle* approach to recover raw materials for reuse from an end-of-life ship. It is important to consider the different methods of ship recycling in order to determine the best and most sustainable method of ship recycling.

2.6.1 Beaching

A few areas in the world provide natural conditions that make them ideal for the ship breaking process, taking advantage of the high tidal variation. They include the Chittagong area in Bangladesh, Alang in India and Gadani in Pakistan. The key element is a long uniform intertidal zone that makes beaching vessels of different sizes possible. The ship is run on to the beach using own propulsion at full speed and as little ballast as possible. The flat bottom of the ship and the uniform beaches allow the ships to sit steadily on the beach sand. The workers drill holes into the beached ship through which sea water enters, washing

the oil-contaminated tanks at high tides. The primary breaking takes place in the inter-tidal zone, where the bow is cut open to access objects of value. Thereafter, the hull plating, large segments of the ship's structure are opened and sequentially extracted and are either winched or towed ashore. Oils, gaseous wastes, asbestos, etc., are removed. The ship is manually torn down by the ship breaker. It is estimated that nearly four to five months are required to scrap a ship of an average size. Once on the beach, the recovered scrap is cut to size by using gas torches. The scrap steel and other objects of value are loaded on to trucks by the workers who usually carry it on their heads or shoulders, to be transported to the re-rolling mills. The ship breakers generally do not have any protective gear, or when provided, the scope is substandard. Most work is done with bare hands, sledgehammers, crowbars, flashlights, and gas torches (Puthucherril, 2010). Figure 12 below shows a picture from a ship recycling facility at Alang in India where the ship is being broken by the process of *beaching*.

Figure 12: Ship Beaching at a ship breaking yard in Alang (http://www.independent.co.uk/news/world/asia/alang-the-place-where-ships-go-to-die-1779656.html, dated 31.08.09)

2.6.2 **Dry Dock Recycling**

This method involves docking the ship at shore, where water can be pumped out in order to dismantle parts before the waterline. Often the ship is broken into large pieces which are carried to other areas for dismantling into smaller parts. It is claimed that the dry-dock method meets the requirements of the Environmentally Sound Management (ESM) guidelines of the Basel Convention, which requires an "impermeable surface" during dismantling. Dry docking has been acknowledged as a more environmentally friendly method of ship dismantling (Mudgal et al., 2010). This has been practised at the Harland and Wolff yard in the UK as an example (Blankestijn, 2012).

Organization for Economic Co-operation and Development (OECD) member states such as Belgium, Netherlands, the United Kingdom, Italy, Denmark, Spain, Canada, and the United States also have green recycling capacity, but to a limited extent (Mer., 2007). Figure 13 below shows a picture from a ship recycling facility in Denmark.

Figure 13: Ship Recycling at Fornaes Ship Breaking Yard, Denmark (http://fladen.posterous.com/?tag=shipbreaking, dated 11.05.2011)

2.6.3 **Alongside**

China is the only Asian developing country where ships are not beached. Ship breaking in China takes place mainly in the 90 breaking yards situated on the deltas and the lower reaches of the Pearl and Yangtze rivers. The major ship breaking yards are in Zhang Jiagang in Jiangsu province. These facilities have capacity to recycle large vessels and are pioneers in the industry of green ship dismantling and founding members of International Ship Recycling Association (ISRA). Larger shipping companies such as the case company of this thesis, Maersk Line, are sending their ships to be dismantled in an environmentally sound way to facilities such as Chang Jiang in China (Mudgal et al., 2010). The method of ship recycling in China is called the *alongside* method (Blankestijn, 2012), which is also referred to as green recycling.

In literature, *green recycling* in this context is described as a method of recycling ships where the processing of steel plates takes place on concrete surfaces rather than in the vicinity of intertidal zones (Puthucherril, 2010). The workforce is also better trained, afforded greater protection and there is a higher degree of mechanization in the processes in comparison to the practices being followed in ship breaking yards in the Indian subcontinent. For example, these recyclers use oxy-acetylene torches and nearly all lifting is done by crane or fork lift. Whereas, the standard for Indian recyclers is the lower-temperature and slower cutting liquefied natural gas (LNG) or liquefied petroleum gas-oxygen (LPG oxygen) torches. Additionally, Indian recyclers cut ships into pieces weighing no more than about 400 pounds

so that a gang of men can lift the pieces by hand and load them into trucks for transport to steel mills (Hess, 2001).

2.7 The journey of a ship to a Recycling Yard

This section analyses the transactions that an end-of-life ship goes through from the hands of its last owner before reaching its final destination at the recycling yard.

The transaction to sell a ship for scrap is unique and involves a discrete and predictable number and class of actors. The basic business model for ship recycling is as follows: Once a ship owner makes the decision to dispose of a ship, a middleman called as the *Ship Broker* is normally employed to either sell the vessel for further trading, or if it is not economically viable for re-use, to sell it onto a *Cash Buyer* intermediary. These intermediaries know the scrapping market very well. They would in turn source and sell the vessel onto a *ship recycler*, who then becomes the legal owner of the vessel. The price is determined by the weight of the ship, measured in light-ship displacement tonnes (LDT), the prevailing cost for recycling labour and materials and the anticipated revenues for scrap metal and reusable equipment (Ahuja, 2011b).

The website of a prominent cash buyer GMS, states that the business functions performed by a cash buyer include sales (selling), financing (taking title of the vessel against payment), market evaluation (forecasting future prices, demand/supply factors and other relevant business-specific issues) and risk management (underwriting market, operational, currency, demand/supply, and other risks). They are able to identify the most competitive recycling country (e.g., China, Indian, Bangladesh, Pakistan, etc.) and then can market the vessel to the most competitive performing buyers.

Figure 14 shows the related transactions and associated costs incurred and revenues earned by the different actors as described above. As can be seen from the figure, the ship-owner is liable to pay the ship storage costs, towing costs and pre cleaning costs if he decides to scrap the ship himself whereas, he has the option to sell the ship to an intermediary in which case, all these costs are included in the price of the ship and the responsibility is transferred to the intermediary who is the new owner of the ship. This “cash-buyer” intermediary then sells this ship further to the recycling yard and earns a profit on the price.

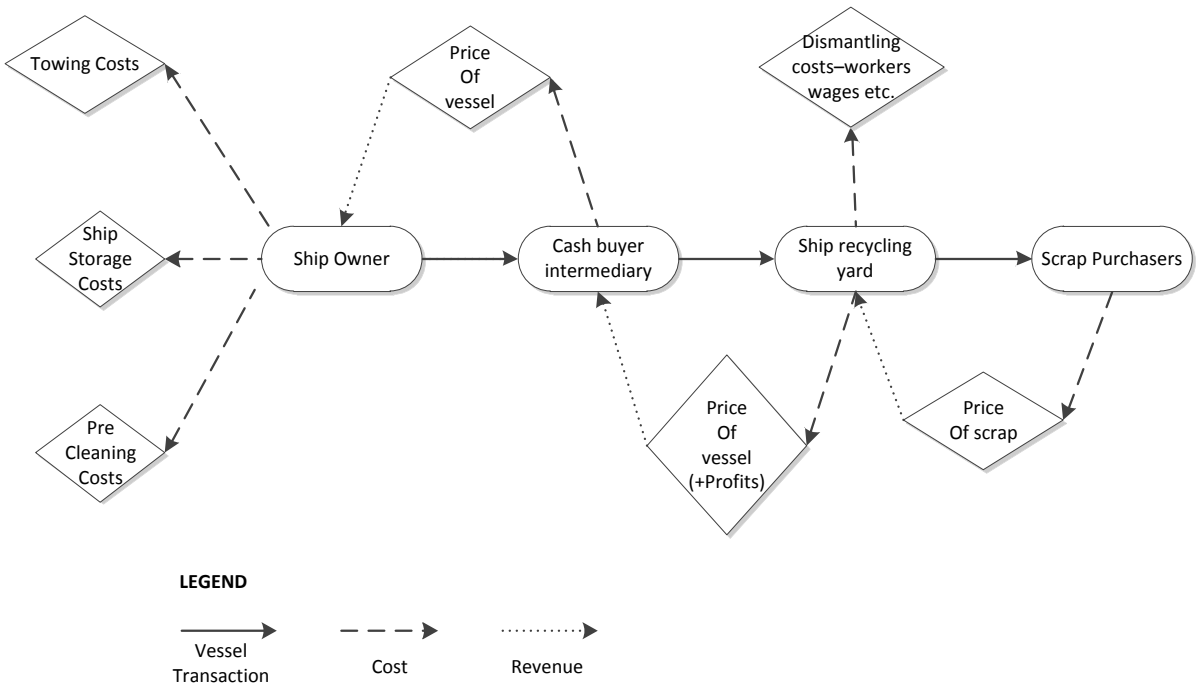

Figure 14: Different transactions and cash flows from the ship owner to the ship recycling yard

There are several important reasons for using the cash buyer intermediary by the ship owners instead of dealing with the recycling yards directly. One of the reasons is the Basel Ban imposed by the Basel Convention which prohibits the transboundary movement of hazardous wastes from an OECD (Organisation for Economic Co-operation and Development) to a non OECD country. Considering that majority of ship owners are in the OECD countries and the ship recycling yards are in non OECD countries, it will be impossible for a ship owner in an OECD country to sell his ship to a recycling yard in a non OECD country. It is apparent that in order to get around this regulation, the ship owners and the cash buyer intermediaries utilise what is called in the literature as the *flag of convenience*. Even though flag states also apply international standards pursuant to IMO conventions, enforcement is generally lax as these countries generally have "insufficiently developed maritime administration". Taking advantage of this situation, many ship owners register their ships under such open registers as ships approach the end-of-life stage. As such ships might also have changed hands; it becomes difficult to pinpoint responsibility for ensuring responsible ship recycling (Ahuja, 2011b).

Apart from the reasons mentioned before, another reason for ship owners to use cash buyer intermediaries is that the financing of ships is done at a national level and because the ship

owner, cash buyer intermediary and recycling yard are all located in different countries, the ship owners want to transfer the financial risks of the transactions involved in this process to the cash buyer intermediaries (Ahuja, 2011a).

Another factor that plays a role in utilising the services of cash buyers instead of dealing with the recycling yards directly is that the volume of ships sent for scrapping is not very high. Ship owners on an average have 10-15 vessels and they sell ships only 3-4 times in a 10 year period. This implies that the ship owners usually do not have the necessary expertise of the recycling market themselves. Therefore, they use the expertise of the cash buyer intermediaries who are specialists in the ship recycling market (Ahuja, 2011a).

Another important consideration in the regard is that only a few scrapping yards buy their ships directly from ship owners. This makes the role of intermediaries more significant (Ahuja, 2011a).

The "cash-buyer" intermediary will know exactly which ships are to be sold for breaking, and what their timeline is for their voyage to the ship breaking yards. The shipbroker is a difficult category of persons to regulate given the specialized nature of their work and the international scope of their transactions, as they are neither implicated in the enforcement jurisdictions of either the port State or the flag State (Ahuja, 2011a).

2.8 Legal Requirements

This section is meant to describe the current set of legal requirements that influence the ship recycling industry worldwide. Since there are many International Regulations that have an impact on Ship Recycling but are not directly drafted in order to regulate the ship recycling industry, these are mentioned in brief in this section whereas the latest International Convention from the International Maritime Organisation (IMO), the Hong Kong Convention is described in some detail.

2.8.1 The Basel Convention

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, sponsored by the United Nations Environment Programme, the convention entered into force in 1992 and the subsequent Ban Amendment was adopted in 1995. The Basel Convention prohibits parties from exporting or importing hazardous or other wastes to or from non-party states. Exports of hazardous wastes are permitted only in cases where the

exporting state lacks the technical expertise and capacity for sound disposal or in situations where the waste is required as a raw material for recycling or for recovery in the state of import. In all cases, the duty to ensure Environmentally Sound Management (ESM) of the hazardous waste lies solely on the state of export and cannot be transferred to the importing or transit state (Convention).

2.8.2 ILO guidelines

In 2003, as part of its "Safe Work" agenda, the International Labour Organisation (ILO) established the Safety and Health in Ship breaking: Guidelines for Asian Countries and Turkey (ILO Guidelines). The ILO Guidelines provide direction to those who have the responsibility to ensure occupational safety and health in the ship breaking yards (Office, 2004).

2.8.3 The Hong Kong Convention – IMO

Following acceptance of the IMO Guidelines on Ship Recycling, the IMO turned to developing a binding legal regime, the recently adopted Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009 (Hong Kong Convention). This Convention is the most recent step taken towards forming legislation with regards to ship recycling. It should be noted that this Convention has not come into force yet due to the fact that the entry into force conditions have not been met. The expert from the ship recycling consulting firm, Sea2Cradle, who was interviewed by this author estimates that this Convention is not likely to come into force before the year 2020.

The Ship Recycling Convention incorporates control and enforcement measures from two perspectives: the first set of controls apply to ships during their life cycle, and the second details standards in relation to the operation of ship recycling facilities. It identifies two major actors in ship recycling: the "*Administration*", which is the government of the state whose flag the ship is entitled to fly or under whose authority the ship operates, and the state where the recycling facilities are situated. In addition, port states, the recycling company, the ship-owner, and workers also have obligations under the Ship Recycling Convention (Organization, 2011).

Upon entry into force of the Hong Kong Convention, ships to be sent for recycling will be required to carry an *inventory of hazardous materials (IHM)*, which will be specific to each ship. The IHM is comprised of three parts. Part I requires listing of the hazardous materials in

the ship's structure or equipment in accordance with appendices 1 and 2 of the Ship Recycling Convention, their location, and the approximate quantity. Part II (operationally generated wastes) and Part III (stores) of the IHM are only relevant if they are still present on the ship at the time of its recycling, these listings need only be developed prior to the recycling (Organization, 2011).

Under the Ship Recycling Convention, ships are subject to a series of *surveys and certifications*, for the purpose of enforcement of the provisions of the Convention. It is the responsibility of the administration to ensure the completeness and efficiency of these surveys (Organization, 2011).

The authorized ship recycling facilities also have some responsibilities. Firstly, they can only accept ships that comply with the terms of the Ship Recycling Convention. Secondly, they can only accept ships which they are authorised to recycle. Finally, they are to make available documentation relating to its authorisation to a ship-owner who is considering recycling his/her ship at this recycling facility (Organization, 2011).

Port state control extends to verifying whether the condition of foreign ships and their equipment, when in their ports, are in compliance with international maritime conventions.

Cooperation and technology transfer is fortified by the provision that empowers parties to directly request technical assistance from other parties or through the IMO and other international bodies. Such assistance can take the form of personnel training, technology facilities and equipment transfer, or programmes for joint research and development.

Although this Convention has been appreciated by many countries, there are several criticisms that have been voiced against the Ship Recycling Convention. By placing an inequitable burden on the states, which are also in the least advantageous position to ensure compliance, the Convention drafters seem to have ignored the *polluter pays principle*. The Ship Recycling Convention exonerates the ship owner from any responsibilities (Puthucherril, 2010).

Another significant drawback of the Ship Recycling Convention is that it evades the most contentious issue in ship breaking, i.e., the prior removal of hazardous wastes before the ship is sent for recycling. The Ship Recycling Convention, while adopting measures to control environmental dangers during ship recycling, ignores the need to phase out the practice of breaking ships on beachheads, i.e. the process of 'beaching' (Puthucherril, 2010).

It is certainly true that the Hong Kong Convention imposes heavier demands on the recycling yards and a lighter load on the ship owner. Whereas the ship owner bears the costs of compiling the compulsory Inventory of Hazardous Materials and of complying with the required surveys, the recycler needs to train all his workforce and management; to prepare for any kind of accidental eventuality; to ensure the environmentally sound management of hazardous waste during removal, storage, transport and disposal; to maintain safety systems; to keep records; to provide personal protective equipment to all employees; and generally to establish and maintain more costly procedures for safer ship breaking (Mikelis, 2012).

The Hong Kong Convention obliges the ship owner of a ship flying the flag of a state that is Party to the Convention (Party State) to recycle that ship in an authorized yard that is located in a Party State. The ship owner who does not change flag to a non-Party flag, so as to avoid the obligation of recycling in a Party to the Convention, will have to accept his fair market share of the costs of compliance incurred by the yard in the Party State (Mikelis, 2012).

2.9 Flags of Convenience

Every ship has to be registered under a certain flag. The flag state, as defined by the United Nations Convention on the Law of the Sea (UNCLOS), has overall responsibility for the implementation and enforcement of international maritime regulations for all ships granted the right to fly its flag. Changing flag allows the ship owners to change the legal regime for the ship (Commission, 2012). There are different reasons because of which ship owners change the flag of their ships:

1. When a ship is sold to a foreign owner, it is often associated with a change of flag
2. The option chosen by the ship owner to sell its ships also has an impact on the flag at the time of dismantling in case the ship is sold on a "*delivery*" basis i.e., once the vessel changes hands from the owner at the recycling yard, it must be deregistered. Short-term registration comes into play when the ships are sold on an "*as-is*" basis.
3. Certain ship owners choose to change the flag of their vessels when they reach a certain age for economic reasons – maintenance costs, surveys etc.
4. To evade certain legal obligations that certain flag states may fall under, e.g. the Waste Shipment Regulation (Commission, 2012)

Change of flags just before recycling of vessels to evade certain legal regimes and obligations (reflagging) is a well-known situation today. Furthermore, reflagging to non-party

substandard flags for the oldest part of the fleet is a reality for many IMO Conventions (COWI, 2010).

The NGO Shipbreaking Platform, a Brussels-based coalition of environmental, labour rights and human rights organisations describes the problem of Flags of Convenience (FOC) in a press release dated 16 January, 2012 (Delphine, 2012): " Unscrupulous ship owners have long used FOCs to evade tax rules, license regulations, safety standards and social requirements for the treatment of crew. Backed by shell companies, joint-ventures and hidden owners, FOCs are also considerable constrains to combating illegal toxic waste dumping as they make it extremely difficult to locate and penalise the real owners of vessels. In 2011, the top five flags used by European companies were so-called "flags of convenience" as listed by the International Transport Workers Federation, and accounted for 64% of the total of flags. These are:

1. Panama
2. Liberia
3. Bahamas, St. Kitts & Nevis
4. Comoros
5. Marshall islands, St. Vincent and Grenadines

2.10 Project Management for a new ship

The system "ship" in Systems Engineering represents the ship during its different stages in the lifetime. This system can be divided into subsystems and system elements that can also be used for Project Management of a new ship. In systems engineering the ship is divided into four subsections describing the main activities planning, construction, operation/maintenance and scrapping as shown in figure 15 (Fet, 1995). Each of these subsystems can be decomposed into system elements as shown in the figure 15 below:

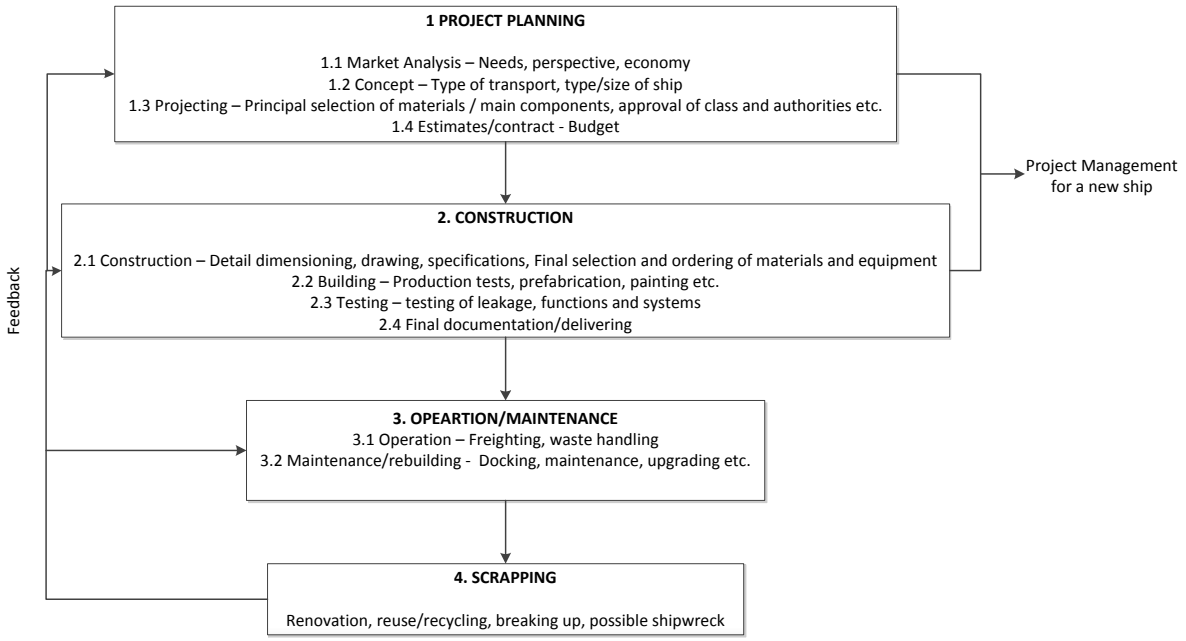

Figure 15 : The system "Ship" with subsystems and system elements showing possible feedback from the end-of-life phase to other phases of the lifecycle (Fet, 1995)

The purpose of system decomposition is to make each element easy to handle in terms of size and complexity (Fet, 1995).

The Project Management phase for a new ship can be said to include the Project Planning and Construction phases of the life cycle as depicted in figure 15 above. One of the goals of this thesis is to determine feedback relationships between the scrapping/retirement phase of the lifecycle to the Project Planning and Construction phases of the life cycle of a ship in order to make the ship easy to recycle during the end-of-life phase. This feedback from the end-of-life phase can also be used during the operation phase of the ship so that the maintenance and modifications done on the ship during the operation phase are done with the end-of-life phase in mind.

One of the methods used for Project Management for a new ship is to decompose a ship into several components. A relevant method for decomposing, grouping different parts of the ship into a group system is by using the SFI group system. This system is distributed by Norwegian Shipping and Offshore services AS and is the most frequently used system in Norway (Fet, 1995).

A group system is a grouping of a great number of parts. In shipbuilding it is useful with groupings for the product specification, accounting, logistics and production control. There are different ways of grouping depending on purpose. This will depend on (Fet, 1995):

1. Geographical location of the details in the ship.
2. The type of disciplines involved, e.g. mechanical work, joiners work, plumbers work etc.
3. Functionality of different parts, e.g. hull, machinery, navigation etc.
4. Parts with similar geometrical shapes.

Types 1 and 2 are applicable for production control, type 3 is applicable for cost control and technical specifications. Type 4 is applied for planning the production in the plants/shipyard. SFI's group system is of type 3 and describes a technical chart of account.

3 Methodology

This chapter begins by providing a theoretical background based on which the research methodology for this work was chosen. This chapter goes on to describe the different sources of information used in this work, including literature review and telephonic interviews. Finally, this chapter describes the tests used for case study research and a description of the qualitative research method as applied to this work.

Yin (2009) describes that case study evidence may come from six sources: documents, archival records, interviews, direct observation, participant observation, and physical artefacts. He also states that an essential tactic is to use multiple source of evidence with data needing to converge in a triangulating fashion.

This study uses documents, including newspaper reports, literature from previous research, reports from organizations like IMO and other relevant documents. Further, this report uses two telephonic interviews and databases for gathering data. The feedback from industry participants received to the presentations by the author to his work was also used as a source of data collection used in this report. The different sources used for data collection are depicted in figure 16 below:

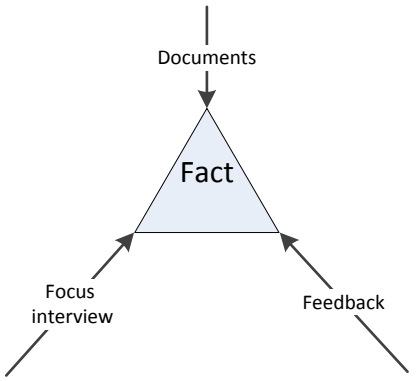

Figure 16: Different data sources used in this research (Adapted from Yin (2009))

Yin (2009) further defines the following overriding principles that are important to any data collection effort in case studies:

a) Multiple sources of evidence – data triangulation
b) A case study database
c) A chain of evidence

All the different sources of empirical data have been used for *data triangulation* i.e. to confirm the conclusions from the different sources for increasing reliability. Further, the author maintains a *case study database*, with all the different documents used for this report and also a record of the transcripts of the telephonic interview along with the audio recordings of the original interviews. Moreover, the different sources of information used by the author also work as a *chain of reference*, with one reference leading to another with information about the research.

3.1 Literature Review

A fundamental part of any study is a thorough knowledge of the area in which the research is to be carried out and a familiarity with other research on the same or related topics (McQueen and Knussen, 2002). This information is important to know important things like whether the project we work on has already been published in the past or if the articles on which we base our research were later refuted by its own authors (McQueen and Knussen, 2002).

Moreover, the essential, reasoned justification for our work would be impossible unless we are able to provide a balanced review of previous research in the area (McQueen and Knussen, 2002).

This might involve tracking down back copies of newspapers or relevant material that might be available through library sources or a computerised system. While referring to the newspaper articles, it is necessary to bear in mind that they might have been written for some specific purpose and some specific audience. In this sense, the author must act as a vicarious observer, and the documentary evidence reflects a communication among other parties attempting to achieve some other objectives, Yin (2009). Textbooks also provide a useful source of background information, but of a general nature. It should be kept in mind that books provide a source of secondary data as it is not always the case that their interpretations of primary work reflect the intentions of the original authors (McQueen and Knussen, 2002).

For research in the social sciences, journals form the main source of background and reference material. Journals are regular publications closely attached to a particular scientific domain and comprising a collection of articles, reports and research papers reflecting current work in particular fields. Moreover, before any material is accepted for inclusion in a journal, it is subjected to a process of peer review, in which other researchers and academics have the

opportunity to comment, evaluate and comments for improvement (McQueen and Knussen, 2002).

An abstract describes in concise terms the research issue addressed by a study, the research design implemented, key procedural elements and a summary of the findings. This is usually enough to inform a judgement about whether or not that research is of relevance to the current topic. Electronic search facilities available through libraries and the internet also serves as a vast resource for the researcher (McQueen and Knussen, 2002).

3.2 Case Study Research

According to Yin (2009), case studies will be the preferred method for a study when it satisfies the following criteria: it asks "how" questions, the investigator has little control over events and the focus is on a contemporary phenomenon within a real life context. This work fulfils these criteria and thus case study would be the best possible way to go about this study. This study also fulfils the definition of a case study as cited in Yin (2009), that "it tries to illuminate a decision or a set of decisions: why they were taken, how they were implemented, and with what result".

This study also utilises the other recommendations made by Yin (2009) in order to utilise the unique strength of a case study investigation to deal with a full variety of evidence-documents, artefacts, interviews and observations. Yin (2009) states that theory development prior to the collection of any case study data is an essential step in doing case studies. As Yin (2009) describes the mode of generalization used is *analytic* generalization, in which a previously developed theory is used as a template with which to compare the empirical results of the case study. The emphasis (of a case) tends to be upon an intensive examination of the setting (Bryman and Bell, 2007). Accordingly, this study treats the practice of ship recycling in the container shipping industry as a case and carries out an extensive examination of the setting.

Empirical research suggests new problems for theory, calls for new theoretical formulations, leads to the refinement of existing theories, and serves the function of verification (Frankfort-Nachmias and Nachmias, 1992).

Further, Yin (2009) gives the following guidelines for the "cut-off" point for data collection for case study investigation:

a) When there is confirmatory evidence
b) The evidence includes attempts to investigate major rival hypotheses or explanations

3.3 Telephonic Interview

The type of interview used can be described as a *focussed interview*, defined by Yin (2009) as an interview in which a person is interviewed for a short period of time. The interview may still remain open ended and assume a conversational manner, but more likely following a certain set of questions.

The focussed interview is described by four characteristics (Frankfort-Nachmias and Nachmias, 1992):

1. It takes place with respondents known to have been involved in a particular experience.
2. It refers to situations that have been analysed prior to the interview.
3. It proceeds on the basis of an interview guide specifying topics related to research hypotheses.
4. It is focussed on the subjects' experiences regarding the situations under study.

The advantages of an interview can be described as (Frankfort-Nachmias and Nachmias, 1992):

1. Flexibility: This allows to clarify the questions and to have a less structured interview
2. Control of the interview situation: It is possible to control the sequence of questions asked and also to control the interview environment
3. Collection of supplementary information: This may include information about the respondent's personal characteristics etc.

The main disadvantage of the interview is the interviewer bias. Although interviewers are instructed to remain objective and to avoid communicating personal views, they nevertheless often give cues that may influence respondent's answers (Frankfort-Nachmias and Nachmias, 1992).

The main critique regarding telephone interviews is that they produce less information; interviewers cannot describe the respondents' characteristics or their environment in detail (Frankfort-Nachmias and Nachmias, 1992).

3.4 Tests for case study research

Yin (2009) proposes the following tests for case study research, in order to further describe the methodology used in this study:

a) Construct validity – identifying correct operational measures for the concepts being studied, multiple sources of evidence, whether interviewees understand what is being asked of them
b) Internal validity – establish a causal relationship, pattern matching (for explanatory or causal studies only)
c) External validity – defining the domain to which a study's findings can be generalized, analytic generalization
d) Reliability – demonstrating that the operations of a study can be repeated with the same results, document the results

3.5 Qualitative Research

Qualitative research can be construed as a research strategy that usually emphasises words rather than quantification in the collection and analysis of data (Bryman and Bell, 2007).

The research methodology is based on interviewing the Corporate Responsibility Manager of one of the world's biggest container shipping companies, Maersk Line and a top manager of a leading consultant firm, Sea2Cradle, which deals with ship recycling. The author also sent email inquiries to the other major container shipping companies operating in the world and used two prominent industry databases, Sea-Web and Equasis, to gain further information about the current practice and a historical overview of the way ship recycling has been carried out globally. The author's understanding is based on the views and interpretation of the industry situation from these sources. The author's understanding and results are also based on the extensive literature study done during the course of this thesis.

Having identified this research as mainly qualitative, Bryman and Bell (2007) identify six main steps for this type of research which are summed up in table 2:

Table 2: Steps of qualitative research (adapted from Bryman and Bell (2007))

Steps of qualitative research	Translated to this work
1. General research questions	Identified in the beginning of this study based on knowledge from the literature review done by the author on the topic of ship recycling and further modified based on feedback received from the case company
2. Selection of relevant sites and subjects	One of the biggest container shipping company in the world, Maersk Line which is also considered to be at the forefront of innovation and CSR was chosen as the case company
3. Collection of relevant data	Data was collected from different sources including literature, databases and interviews
4. Interpretation of data	Interpretation of data was carried out objectively based on literature reviews and interviews
5. Conceptual and theoretical work a) Tighter specification of research questions b) Collection of further data	Defining the research question was an iterative process that was initially based on the author's literature review and then modified according to the inputs from the case company
6. Writing up findings and conclusions	Based on the literature review and knowledge gained during the course of this research, the conclusions have been summarised in chapter 6 of this report

4 Results

This chapter describes the main findings and results of this research. These results are further discussed in greater detail in chapter 5 of this report. These points taken together can be seen as the measures identified to drive sustainable ship recycling as per the aims and objectives of this report.

4.1 Sustainable ship recycling method

In order to gain first-hand knowledge about the differences between the different methods of ship recycling, the author conducted an interview with a top management representative of the ship recycling consulting firm Sea2Cradle that was earlier a part of the case company, Maersk Line, but is now an independent consultant providing consultancy on ship recycling to different ship owners. The transcripts of this interview can be found in the Appendix to this report.

The author asked the respondent about the differences in the different methods of ship recycling in order to determine the most sustainable method of ship recycling. The results obtained as an answer to this question can be summarised in the table below:

Table 3: Differences between Beaching and Alongside methods of ship recycling

Beaching	Green Recycling (Alongside)
Average size of plot 30m wide and 100m long	Larger plots
Fixed cranes used	Portable cranes are used alongside the vessel
Uncontrolled breaking process	The most controlled recycling process available at present
Break 3-4 ships in an year on average	Break 100 ships in an year on average
Practiced in India, Pakistan and Bangladesh	Practised mainly in China
Highest point of the vessel cannot be reached by cranes – offloading difficult	It is easier to reach the highest point of the vessel by portable cranes – offloading is easy
Difficult to put escape routes	Easier to put escape routes
Disposal and waste handling facilities are mostly handled by small unorganised traders	Disposal and waste handling facilities are controlled and organised

The other methods of recycling like the dry-dock method and the slipway method were also discussed in the interview. But this report focuses mainly on *beaching*, which is the most popular method of ship recycling and the *alongside* method, which is considered to be the

'green recycling method' and is becoming more popular as an alternative to the beaching method. Further, since this report focuses on the recycling of container ships, the beaching and alongside methods are the only two practical methods of ship recycling for large container ships.

A European Union report which rated shipyards globally on disposal methods found that China's shipyards scored well, whereas some shipyards in South Asia averaged a death per week and experienced daily injuries (Marusiak, 2012).

The author would suggest comparing the beaching, alongside and slipway methods as alternatives for sustainable ship recycling in future studies. Based on the research conducted during this study, the author can conclude that the *alongside* method appears to be the most advanced and sustainable method of ship recycling available at present.

4.2 Effective communication of activities relating to ship recycling

During this research the author observed that even though many ship owners take some steps regarding ship recycling, they are not able to take full advantage of the resources that they spend on responsible ship recycling because they don't communicate their activities on ship recycling well enough to stakeholders to gain positive recognition. The case company, Maersk Line said that they do not run active campaigns to educate their employees about ship recycling although they have had some internal articles about this issue, when required.

It emerges that most ship owners take steps for proper ship recycling mainly for two reasons, firstly, to get prepared for the upcoming international legislation i.e. the Hong Kong Convention and secondly, in order to prevent the image of their company being damaged by the fact that the company uses the method of *beaching* for recycling its ships that is widely considered to be not the best method for recycling ships.

Ship owners have considerable potential to gain competitive advantage by widely reporting their activities about sustainable ship recycling to different stakeholders, starting internally by making their employees aware about the problem of ship recycling and the steps that their company takes about this problem and then making other stakeholders like customers, media and NGOs aware about their company's efforts towards ship recycling. The questions of what to communicate, how to communicate, where to communicate and communicating in different ways to different stakeholders has been dealt with in detail in the next chapter of this report.

4.3 Value chain impacts from ship recycling

In case of the container shipping industry as studied in this research, responsible ship recycling is clearly not the norm. In the present scenario, the task of recycling a ship is completely outsourced to third party ship recycling yards that typically have no other relation with any other actor in the supply chain of a ship. These ship recycling yards recycle ships by disassembly and then further sell the materials obtained as a result from recycling. The transaction between a ship owner and a ship recycling yard is mostly on contract basis for every ship that has to be recycled, based on the best price that a ship owner can receive from a ship recycling yard for his ship.

When a ship owner adopts the cradle-to-cradle concept, he needs information about hazardous materials and other support from the various sub-suppliers and contractors in the supply chain and also, in order to get feedback of knowledge and information from the ship recycling yards to other phases of a ship's lifecycle including the design and construction phase, it is important that the various actors in the value chain act in unison and collaborate with each other. This will involve ship designers, ship building yards, system suppliers, ship owners and the ship recycling yards. The author would propose such cooperation between the different actors in the value chain so as to gain maximum benefits from the sustainable recycling of ships for all actors in the value chain.

4.4 End-of-life phase and Project Management of a new ship

During the course of this research, especially by the information gained by the author from the interview with Sea2Cradle, it can be concluded that there exists a lot of information with the workers in the ship recycling yards that can be fed-back to the Project Management of a new ship, especially to the ship design and ship building phases. This information, if properly extracted from the workers working at the ship recycling yards and then properly used by the ship building yards and ship designers can lead not only to building of new ships that are easy to recycle but also drive innovation for search of better materials to replace the materials that are being used in existing ships but are considered to be either difficult to recycle or considered to be an environmental hazard. This can also lead to development of newer and better methods of ship design and ship building at the same time. This can further be a source of unique competitive advantage for the different actors in the value chain including ship designers, ship building yards and sub-system suppliers.

Responsible ship recycling, as shown in the previous section, needs closer cooperation between the different actors in the supply chain. This is also a challenge to the project management of a new ship because even at the design and construction phase of a new ship, needs to build up closer cooperation between the designers, sub-system suppliers, ship owners and the ship recycling yards so as to effective utilize information from the end-of-life phase and also in order to prepare the IHM that will be required by legislation.

4.5 Impact of ship recycling on decision making at a strategic level

In an interview to the author, the case company for this thesis, Maersk Line highlighted the fact that they are a container shipping company and not a ship broker or a ship recycler. Further, since they have a relatively young fleet, ship recycling is not likely to play a major role in strategic decisions in the current scenario. This also partially explains the fact as to why the dedicated ship recycling unit of the A.P. Moller-Maersk group became a separate independent consultant company outside of the A.P. Moller-Maersk group.

But, as described in section 4.6 of this report, there are several positive impacts that sustainable ship recycling can have on a ship owner. Also, the case company for this thesis, Maersk Line is also looking at the cradle-to-cradle concept in their new built *Triple-E class* vessels highlighting the importance that the company places on responsible ship recycling and the end-of-life phase. This clearly indicates that ship recycling will increasing play an important role in the strategic decision making of ship owners in the coming years.

4.6 Impacts of pursuing a ship recycling policy on ship owners

The author aimed to establish the financial impact of following a ship recycling policy on the case company as they are the first container shipping company to actually follow and publish a ship recycling policy. This would help in determining a benchmark for other ship owners to follow. It was however not possible to get such *'numbers'* from the case company as they said that they don't have such targets. They evaluate the positive impacts from their ship recycling policy in terms of other indirect positive impacts, some of which are explained below.

Following a ship recycling policy towards sustainable ship recycling can have several positive impacts for a ship owner. Firstly, it will make the ship owner ready for the upcoming legislation on ship recycling, the Hong Kong Convention. Secondly, it will lead to a positive recognition from various stakeholders which can potentially lead to competitive advantage,

especially if the ship owner is able to demonstrate effectively to its customers the advantages that they will gain by selecting this particular ship owner over other ship owners who might not have well defined ship recycling policies that could lead to their ships being recycled in an improper manner. This will also lead to a positive improvement in the image of the company as other stakeholders like communities, media and NGOs become aware of the steps that a ship owner takes regarding sustainable ship recycling. Thirdly, sustainable ship recycling gives a ship owner guaranteed access to different raw materials like different grades of steel, copper etc. which can potentially become a scarce commodity in future. These raw materials are very important for the construction of new vessels and containers, both of which are critical assets for a container shipping company. Fourthly, sustainable ship recycling has the potential of contributing to improvements in ship design and ship building if the feedback from the ship recycling yards is incorporated into the ship design and ship building process. This can be seen as a kind of challenge for ship designers and ship building yards for innovation and product improvement. This can also lead to improvements in other phases of a ship's lifecycle, for example, it can lead to advantages during operation and maintenance of a ship and it can lead to unique competitive advantage for ship owners. Finally, sustainable ship recycling can be identified as a part of corporate social responsibility for ship owners as they gain considerable profits from the ship during the 25-30 years of the lifetime of the ship, it is their responsibility to ensure proper recycling of their assets in the end-of-life phase.

4.7 Improvements in the current ship recycling policy and its active usage

The case company for this thesis, Maersk Line told the author in an interview that they have a relatively young fleet and therefore the issue of ship recycling is not of immediate and pressing importance to them. In such a scenario, it was difficult to obtain information about the loopholes and negative aspects of the company's ship recycling policy in order to suggest improvements. But, based on the information gathered from other sources, especially based on the upcoming Hong Kong Convention, the author proposes the decision making model that a ship owner including the case company can use for recycling their ships. This model is described in detail in section 5.2.5 of this report. Further, communicating the efforts towards ship recycling to different stakeholders in a better way will lead to a more active usage of the ship recycling policy of a ship owner. This will also involve the entire value chain from ship designers to the recycling facilities, seen in a lifecycle perspective, as described in this report.

4.8 Current state-of-the-art in ship recycling

This section focuses on the state of the art in ship recycling activities undertaken by companies in the container shipping business. This specific business sector has been chosen for study because of the relevance to Maersk Line, the primary case company for this Master Thesis.

4.8.1 Analysis of container ships recycled in the past

Table 5 in Appendix 3 of this report represents the details of the different container ships that were recycled in the recent past, specifically between 1997-2012, that were managed, operated or owned by some of the biggest container shipping companies in the world. The category of container ships was chosen as this research is limited to a study of ship recycling in the container shipping business. All the data presented in the following table was gathered from a database called *Sea-Web* (Fairplay, 2012) and is therefore limited to the details of ships that could be gathered from that database and cannot assumed to be exhaustive. Another database called Equasis was also used for cross checking the data in some of the data fields as obtained from the Sea-Web database as mentioned earlier. Although the author took all possible care to ensure the validity and correctness of the data presented hereunder, the author cannot take legal responsibility for this data as it was collected from external databases.

The author would like to emphasise the fact that in the comments received by the author from the respondent interviewed from the ship recycling consulting firm Sea2Web, the question of validity of the data presented hereunder was raised by the respondent. Whereas the respondent claimed that from 1997-2012, 716 container ships have been scrapped according to the data available with him, the author clarified that the data presented in this report is non-exhaustive and is based on two different databases as mentioned above. Though the source of the respondent's data was a different database which was not accessible to this author, the respondent was in any case not confident about the validity of his data either and he believed that it might be incorrect too.

Since ships may be sold several times during the working life of a vessel, the column in the table below which mentions ship owner/manager/operator of a vessel refers to the *beneficial owner* of the ship, assuming that the major container shipping company studied during data collection for this research would have obtained some benefit from the ship at some point in

time before that ship was sold on to another owner. As defined by the Lloyd's register, the *beneficial owner* of a vessel "*may be the vessel's management company or the trading name of a group, both of which are generally perceived to represent the ultimate owners of the vessel*" (Delphine, 2012).

The respondent from Sea2Web also highlighted the fact that some ship owners use small ownership companies that are hard to trace and that the ship owners/operators/managers as mentioned in this report might not have anything to do with the recycling. The author would like to emphasise for the reader that one of the purposes of this report is to highlight such loopholes and transparency in the ownership of a vessel as it could turn out to be an important measure to drive sustainable ship recycling. The data presented in table 5 therefore mentions the names of those prominent ship owners that at some point in a ship's lifetime derived benefits from the ship as per the data gathered from the Sea-Web database.

It can be seen from the data presented in the table that the average number of years after which a container ship is recycled is about 27 years. Further, the average price for recycling container ships over the years as per the data available in the table is USD 3,384,337. From this data, it is easy to conclude that the ship recycling yards in India are the world leaders for recycling container ships. Chinese recycling yards come at the second position.

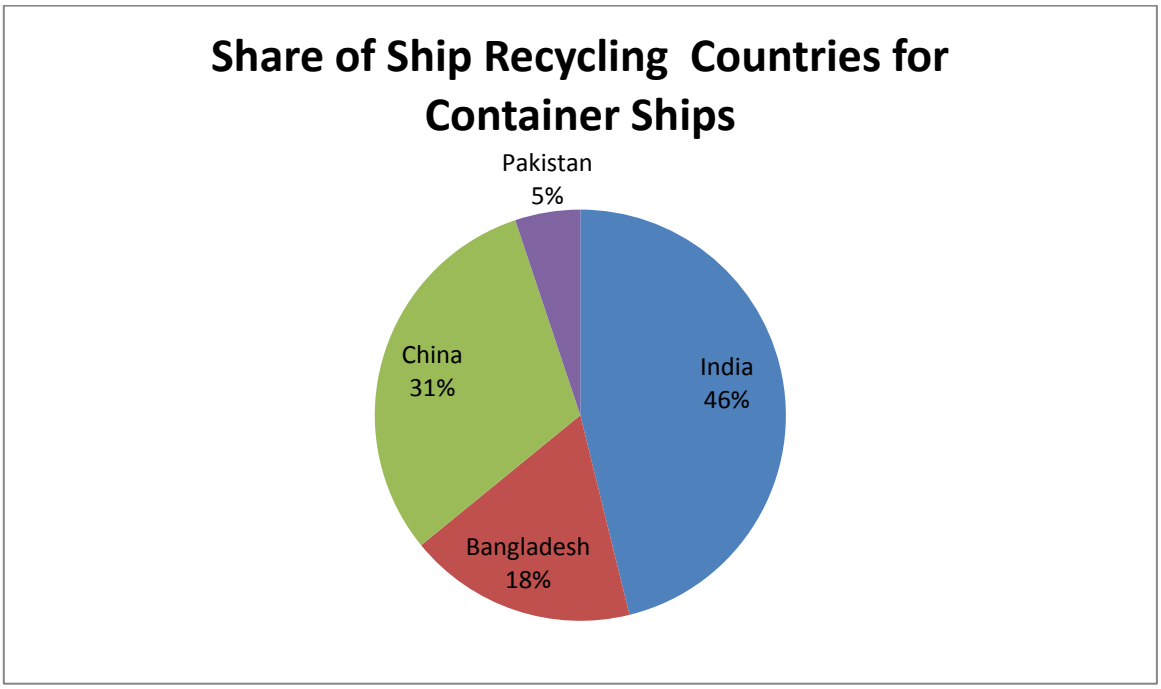

Figure 17: Share of the different recycling countries for number of recycled Container Ships (based on Table 5)

Figure 17 above shows the share of the four prominent ship recycling countries when considering container ships. Turkey has been left out of this analyses as it apparently does not recycle a large volume of large container ships which are the focus of this research. From this figure it is clear that India has had a majority share of recycled ships over the years.

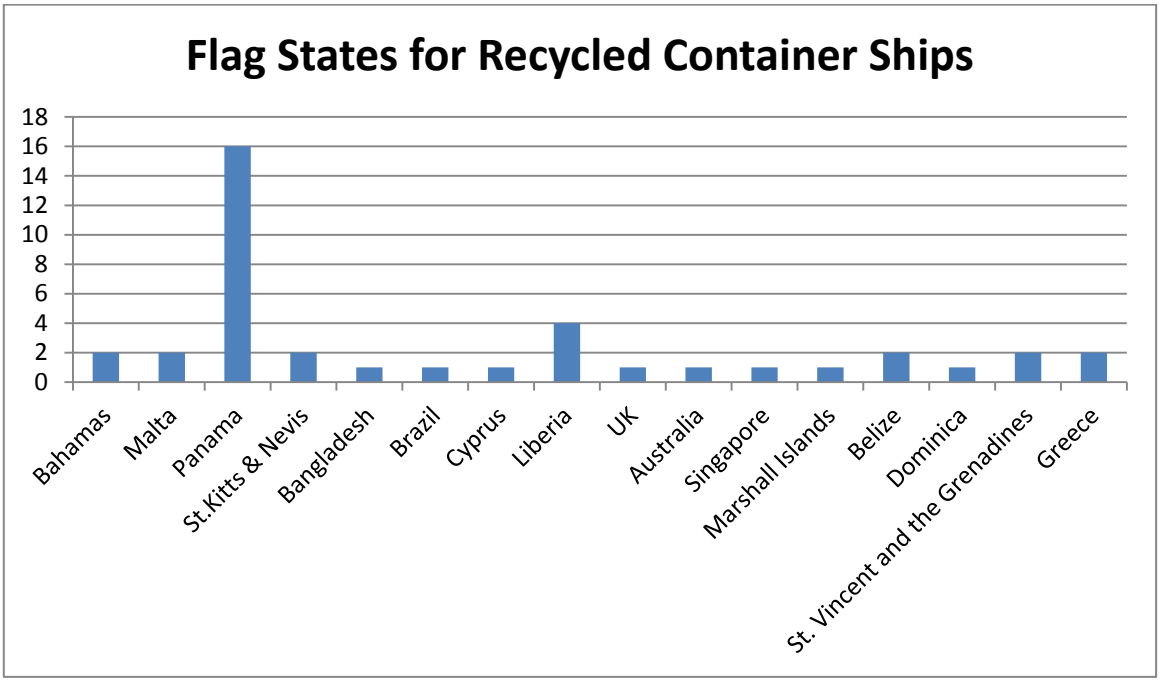

Figure 18: Frequency of different Flag States for recycled Container Ships (based on Table 5)

As can be seen from the figure 18 above, based on data obtained from the table 5, Panama is the country that is chosen as flag state by majority of the ship owners. Panama is closely followed by Liberia as a popular flag state. It can be seen that the majority of the countries chosen as flag states for ships which are in their end-of-life phase are countries that have been described as *flags of convenience* in literature. Mikelis (2012) states that usually the ship will be flagged with a flag that is advantageous in terms of the flexibility it allows in operations, chartering, taxation and crewing.

On being asked about the reason for choosing Panama as a flag state for their ships instead of Japan itself, a Japanese container shipping company replied that they choose Panama because of the economic benefits achieved. This clearly indicates a problem as the majority of the ship owners, managers and operators of container ships as per the data presented in table 5 belong to relatively developed countries including Denmark, Germany, France, Switzerland, Japan and China but the ships that they manage, operate or own are flagged in some smaller countries for economic benefits. A very important step in driving sustainable ship recycling is

to increase transparency and responsibility of ship owners so that the ships are flagged in the same country where the company operating, owning or managing the ship is located. This will ensure that the countries where the ship owners are located can get their fair share of taxes from the profits that these companies earn and also the ship owners and their ships are then forced to comply with stricter regulations from their own countries. Since the issue of flag states applies to all ship owners, it would be appropriate to have steps regarding transparency and responsible flagging of ships as a part of future international regulations.

The recent data about ship recycling obtained from a report by a shipbroker, N. Cotzias Shipping Group (N. Cotzias, 2011), dated January 2011, can be summarised in the table below:

Table 4: Maximum and Average scrapping prices offered by major ship recycling nations (N. Cotzias, 2011)

Ship Recycling Country	**High Scrap Price (per LDT)**	**Average Scrap Price (per LDT)**
China	$ 495	$ 454
India	$ 780	$ 501
Bangladesh	$ 502	$ 464
Pakistan	$ 500	$ 485
Turkey	$ 280	$ 274

The data from the above table about the average scrap prices per Light-Ship displacement Tonnes (LDT) given by the different countries involved in the business of ship recycling is depicted in figure 19 below:

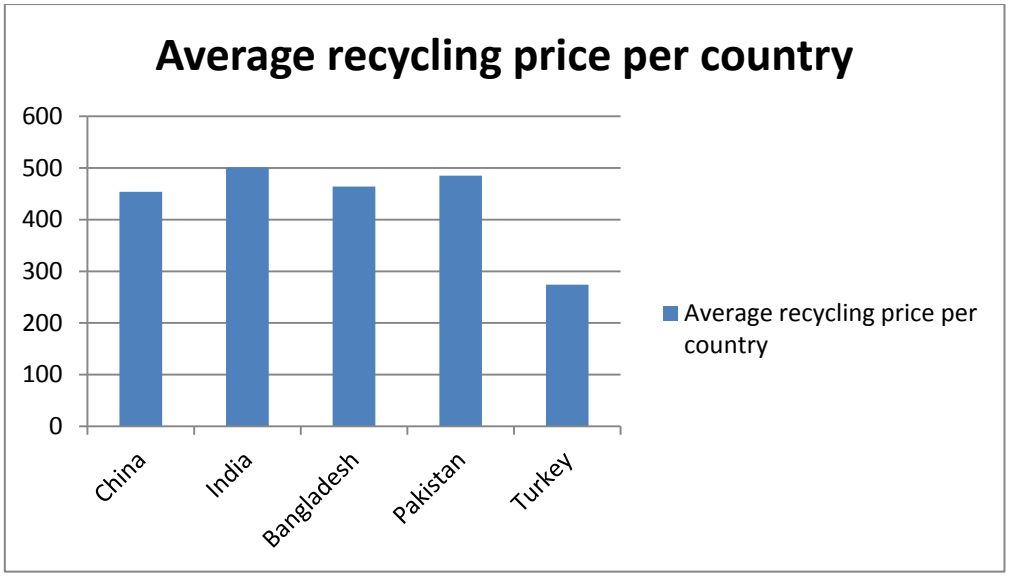

Figure 19: Average price (per LDT) paid for recycling ships by different countries (N. Cotzias, 2011)

As can be seen from figure 19 above, India emerges as the leader in the ship recycling because it offers the highest price for scrap ships in relation to all the other ship recycling nations. It can also be inferred from the data presented above that the world ship recycling industry is mainly concentrated in the three countries from the Indian subcontinent – India, Bangladesh and Pakistan. China comes a close second while offering competitive prices for ships.

The author would like to highlight that the respondent from Sea2Cradle who was interviewed by the author explained that the prices mentioned above are only advertised prices and these prices are often renegotiated when the ship reaches the beach and then the prices are further lowered by 25 USD to 30 USD per LDT.

4.9 Sustainable ship recycling as a part of CSR

The case company for this thesis, Maersk Line in an interview to the author said that is a difficult question to answer as to whether or not their efforts on sustainable ship recycling forms a part of Corporate Social Responsibility (CSR) for that company. This was because of the fact that the company separates CSR and environmental issues and sustainable ship recycling can be classified into both topics, as a CSR activity and also as an activity that has environmental impacts. But, the company also said that they think that their efforts towards sustainable ship recycling form a part of CSR as well. The company also mentioned that they have other programs like a *Responsible Procurement* program that also indirectly relates to ship recycling as it covers sub-suppliers.

In order to study the current state of the art of CSR communication on ship recycling in the container shipping industry, a study of eight different companies from this industry was carried out, primarily by analysing data on their websites. The author also wrote to these companies to find out in more detail if they have any activities towards ship recycling. It must be emphasised that even though all the companies studied have a section devoted to sustainability and environment on their websites, information on their activities on ship recycling was in most cases not available or it was not displayed very prominently and it was not easy to locate. This is despite the fact that most of these companies do take some steps on ship recycling.

Apart from the case company, the author got replies from three other container shipping companies when asked about their activities on ship recycling. This gives a response rate of 50%, as four of the eight companies contacted provided information about their activities on ship recycling. The four companies that replied are leading container shipping companies from four different countries, namely, Denmark, Germany, Hong Kong and Japan. Therefore, their replies taken together can be said to provide a good overview of the current state of the art in ship recycling prevalent in the container shipping industry. From their replies, it can be concluded that all these companies are aware about the recent Hong Kong Convention and are therefore taking steps to get in line with the requirements of this Convention well ahead of time before this legally binding Convention comes into force. Two of the companies which replied to the author's questions mentioned that they are committed to having the Inventory of Hazardous Materials (IHM) for all their new built ships and maintaining the IHM during the operational life of the ship. One of these companies mentioned that they use the cradle-to-grave concept for better environment protection and to minimise pollutants produced in the ship's disassembling and recycling. The third company said that their scrapping policy is according to the Hong Kong Convention. They said that they have already chosen a scrapping yard which conducts environment friendly ship recycling and that they inspect the yard regularly.

The issue of CSR in the context of a shipping company is further analysed in more detail in chapter 5 of this report.

4.10 Flags of Convenience

The issue about *Flags of Convenience* has been highlighted as an important factor in the literature about ship recycling as shown in section 2.9 of this report. Research done by the

author presented in section 4.8 of this report shows that countries in Central America like Panama and Liberia, for example, are the most popular flag state countries used by container shipping companies. When being asked about which flag states Maersk Line uses for its vessels, the company declined to reveal this information but the case company said that they were aware of the problem of flags of convenience. Mikelis (2012) states that when a ship is in service, the owner will choose the destinations where to trade so as to obtain the best financial returns. The case company further stressed that though some of the popular flag states used have improved their regulations, it is also important to consider what kind of regulations and checks the flag states themselves impose on ship owners for changing flags, for example, do they need to have a facility in that country, should there be real owners behind a vessel or just a *cash buyer* is enough? In case of Mongolia, for example, the manager from Maersk Line said that it is possible to change the flag on the internet, which then obviously requires no checks and controls.

4.11 Other drivers of sustainable ship recycling

Other steps that have been proposed by various stakeholders in order to drive sustainable ship recycling include (Mudgal et al., 2010):

- Technical assistance and support to developing countries for safety training programmes and basic infrastructure for environmental and health protection

  Two Member States of IMO are establishing technical cooperation with two recycling States in South Asia, while the IMO Secretariat, in collaboration with the Secretariat of the Basel Convention and the International Labour Office, is already carrying out technical co-operation activities in the ship recycling sector (Mikelis, 2012).

- Encouraging voluntary industry action through measures such as awards for exemplary green recycling; publication of guidance, such as a list of “clean” ship dismantling facilities

These and other important drivers for sustainable ship recycling are discussed in the following paragraphs.

4.11.1 **Extended producer responsibility for ships**

The author observed during this research that vessels change hand several times during their operational lifetime. From the time when they are built to the time they reach the recycling yard, the vessels can have several owners, operators or managers. The owner is free to change the name of his ship, to change its flag, or to sell it, at any time, in his efforts to navigate through the vagaries of the market. The ship owner would normally select to send his ship to the yard that gives him the best returns, bearing in mind the relative costs of repositioning the ship from the place where it discharged its last cargo, and also bearing in mind the different rates paid by recycling facilities in different locations (Mikelis, 2012).

When the author asked Maersk Line about this, they said that they do the same i.e. they do sell a lot of vessels when they have quite a number of years left to operate. In the author's opinion, this would make it difficult to fix responsibility for ship recycling on a particular owner as the ship would have had several owners by the time it reaches the recycling yard. On being asked whether Maersk Line sees itself as being responsible for ship recycling as one of the ship owners, Maersk Line said that they don't see themselves responsible in such a scenario. The corporate responsibility manager at Maersk Line who was interviewed by this author said that there has been a lot of discussion in the ship recycling business on how to ensure responsibility of future owners but there is a difficulty in implementing such a contract clause because if the current owner puts requirements on the new owner for ship recycling, he would get a lower price for the ship because it reduces flexibility for the new owner to recycle their ships. But, when the new owner resells his ship, it is not necessary that he retains the clause about ship recycling and so, he might resell the ship at a higher price after removing that particular clause from the contract. In such a scenario, the current owner of the vessel stands to lose.

Considering this scenario, the author tried to draw an analogy with other industries, for example, the mobile phone industry where the original equipment manufacturer normally takes back the product for recycling after its useful lifetime. This could also work for the shipping industry as it is not the ship owners who can directly use the steel and other raw materials that can be derived from a ship and it appears logical that it would instead be the ship building yard who would be in a position to make proper use of the raw materials obtained from the ship after recycling. So, it could be a possibility to make the ship yard which is the original equipment manufacturer of the ship in this case, responsible for ship

recycling. To this suggestion, Maersk Line replied that the way in which the industry talks and thinks as of now and the way the current legislation is framed, it does not look possible that the ship building yards can take care of the recycling business. With regard to a ship owner, the maximum they can do is to provide a transparent list of the different materials present on board the ship so as to make it easier to recycle. And if every subsequent owner updates this list, the ship would be easier to recycle in the end.

A unique problem that can arise when thinking about extending producer responsibility in the shipping industry is that since the lifecycle of a ship on average is fairly long, 25-30 years, there is a possibility that by the time the ship reaches its end-of-life phase, for the ship building yards as the producers of ships to take responsibility for recycling, it is possible that the original ship building yard does not exist anymore. The author would suggest that the recycling of a ship built by a shipyard should be put as a liability on the shipyard that must be transferred to the new owner of the shipyard along with the required documentation for the ship. In case the ship building yard is sold in such a way that the new owner of the yard is not another ship building yard, the responsibility of proper recycling of ships for which the ship building yard in question holds liability should be sold either by the old or by the new owners to some other shipyards. Extended producer responsibility is important in the case of shipping because as shown in section 2.7 of this report, it is an established fact that ships change hands several times from the time that they are built in a shipyard till the time they reach the end-of-life phase in the ship recycling facility. It is because of this that it is difficult to pinpoint responsibility for ship recycling on one owner. But, since the producer of the ship, that is the ship building yard, remains the same, it is easier to pin point responsibility on the original producer that is the ship building yard.

4.11.2 **Mandatory funding mechanism**

Another important proposal for driving the adoption of sustainable ship recycling, especially among ship owners is to ensure sustainable funding in order to support activities for sustainable ship recycling. It is believed that this is important to provide proper incentives to ensure that ships are dismantled in a safe and environmentally sound/certified facility. Without a funding mechanism there is a real risk of circumvention given that there is very little incentive for a shipowner, from an economic point of view, to choose green recycling in Europe or elsewhere compared to standard ship breaking (*beaching*) in Asia due to the fact that it is more costly. Green recycling facilities are thus not able to pay as high a price for the

scrapped ships as the conventional (Asian) recycling facilities. A fund is therefore required for closing the financial gap between the conventional and green dismantling facilities to provide proper incentive for ship owners to choose a green ship recycling facility (COWI and milieu, 2009).

In the author's opinion, creating this kind of so-called '*Ship Recycling Fund*' from tax-payer's money in order to support ship owners who have used the ship for their entire lifetime, for 25-30 years, gaining significant profits from the ships, is against the polluter pays principle. The ship owners must take more responsibility and should be voluntarily willing to ensure safe and environmentally sound recycling of their own ships.

4.11.3 **EU member states taking responsibility for end-of-life ships**

Another option that has been proposed in literature is that the EU or its member states buy end-of-life ships from ship owners at market price and then tender the dismantling of the vessels to the most competitive environmentally sound facility in the EU/OECD.

In the author's opinion, any step/measure towards driving sustainable ship recycling should be in line with the polluter pays principle. The measures taken in case of end-of-life ships can be based on the established legislation on waste (end-of-life vehicles, waste electrical and electronic equipment, batteries) where extended producer responsibilities have been established as also discussed in section 4.11.1 of this report. It is suggested that in case of ships, due to their long lifetime, a system of shared responsibility for shipyards and ship owners must be set up (Commission, 2008).

5 Discussion

This chapter discusses the results obtained in this research in greater detail according to different criteria. It starts by discussing the results according to the research methodology used, then it discusses the results with reference to theoretical background, followed by a discussion based on the current state-of-the art of ship recycling and CSR of ship owners with a focus on ship recycling. Finally, this chapter provides a discussion based on the stated goals and objectives of this work followed by the applicability of the results.

5.1 Discussion based on research methodology

With reference to the research methodology presented in chapter 3 of this report, this thesis utilises the case study method as it satisfies the defined criteria when case studies would be the preferred method for a study. This thesis asks 'how' questions, mainly as to *how* different measures can be taken for widespread adoption of sustainable ship recycling and *how* would adoption of sustainable ship recycling affect a ship owner, for example.

The focus of this study is on a real life phenomenon and this phenomenon is at such a large, international scale that the author has absolutely no control whatsoever over the events related to the phenomenon of ship recycling.

The author tried to gather data from different sources like literature, documents, interviews and databases in order to *triangulate* the results. The author used two *focussed* interviews as described in section 3.3 of this report. These interviews were conducted with people who can be considered experts in the field of ship recycling. The interviews were '*semi structured*' as a pre-defined interview guide was sent to the respondents in advance. The author tried to follow the interview guide during the interview but also came up with new follow up questions based on the respondent's replies to the author's questions in order to clarify and further investigate the issue at hand. The interviews focussed on the experience of the experts on the topic of ship recycling.

To avoid inaccuracies due to poor recall, the conversations were recorded and notes were taken during the meetings. Further, to eliminate any possible ambiguities from the telephonic interview, the transcripts of the conversations were written down in the exact question-answer format in which the telephonic interview was conducted. These transcripts were then sent to the respondents for review who then commented on the transcripts of the telephonic

interview in order to give further clarifications. Transcripts of the interview with Maersk Line could not be published in this report due to reservations expressed by the company but the transcripts of the interview with Sea2Cradle are available in the appendix to this report.

Further, the applicability of the different tests for case study research as described in section 3.4 of this report as applied to this research are presented below:

1. Construct Validity: The operational measures for the concepts being studied in terms of the research question were based on the literature study and were then modified according to feedback received from the case company. Since the interviews were semi-structured, the author had opportunities to explain the questions to the respondents and ensure that they correctly understood the questions being asked.

2. Internal validity: The author tried to establish causal relationships like the causes that make ship recycling important for ship owners. The author also tried to match patters in the knowledge gained from the literature review and from the two interviews conducted by the author.

3. External validity: The focus of this study is on the container shipping industry but the results of this study can be generalised to ship owners of other types of vessels as well.

4. Reliability: Since this study looks at the contemporary situation of ship recycling, the results of this thesis can be said to be reliable as they have been *triangulated* from different sources including literature, documents and interviews with experts.

5.2 Discussion based on Theory

This section presents a discussion of the results derived in this work based on the theoretical frameworks described earlier in chapter 2 of this report.

5.2.1 Systems engineering and ship recycling

The issue of sustainability is important for all industries and all products. This report aimed at studying the sustainability aspects of the end-of-life phase of the life cycle.

The author proposes a decision making model (Ahuja, 2011a) for ship owners to deal with end-of-life ships in section 5.2.5 of this report. This model is based on the six-step Systems

Engineering process described earlier. The *needs requirement* for end-of-life ships have been defined as per the Ship Recycling Convention, which answers the question "What is needed?" The next question, "Why is it needed?" is also answered by the fact that the Ship Recycling Convention because will be a legally binding instrument which will place requirements relating to ship recycling on ship owners and make the ship owners more responsible with regards to the end-of-life ships. There will also be pressure from actors down the value chain for ship owners because there will be other ship owners in the competition who will highlight the steps that they take regarding ship recycling in order to gain a competitive advantage and it is therefore necessary for ship owners to follow the proposed model in order to have a well-defined Ship Recycling Policy. For the next step, *requirements specification*, functional performance requirements can be defined as the safe and environmentally sound recycling of ships. The operational functional requirements have been defined by the Ship Recycling Convention for ship owners in terms of preparation of the IHM, IRRC, survey requirements etc. The Physical requirements defining how the system fits into the environment can be specified as the interaction between ship owners, recycling yards, certification authorities set up by the flag states and the recycling states. The next step in the System Engineering process is to *specify performances*. If the process of ship recycling is considered with the definition of the system limited to requirements from the Convention, the requirements are very straight forward and measureable e.g. the Ship Recycling Facility Plan (SRFP), Inventory of Hazardous Materials (IHM), International Ready to Recycle Certificate (IRRC) etc. to be established by the ship owners, recycling yards etc. But, if the overall picture of ship recycling is taken into consideration, taking the total system and its subsystems, the performance requirements are can be vaguely defined as *safe and environmentally sound* recycling of ships. The performance requirements in this case can be made more specific and measurable e.g. having zero casualties. The *analyse and optimize* step of the Systems Engineering process has been implemented in the model by having different decision nodes and then having feedback to the previous nodes in case the decision making process cannot go ahead. *Design and solve* step of the Systems Engineering process has been implemented by designing the model described here. The last step, *verify and test* by using prototypes or simulations has not been performed yet due to the limitations in testing such a practical, real life model by the recommended prototypes or simulations.

We can therefore conclude that the proposed model is in accordance with the theoretical framework about the Systems Engineering process proposed earlier. The lifecycle approach

has been used as the foundation of this research specifically analysing the end-of-life phase and also trying to determine feedback relationships from the end-of-life phase to the other phases of the lifecycle.

5.2.2 Sustainable ship recycling method

As described in section 4.1 of this report, the author concluded that the *alongside* method of ship recycling is the most advanced and sustainable method of ship recycling available at present.

It should be further emphasised that while choosing a ship recycling method, it is also important to look at the processing of materials that are removed from the ship as a result of the process of recycling. In order to ascertain the differences between the treatment of materials, the author posed this question to the respondent. The author found that in case of India, a large landfill has been created a few years ago to put in all hazardous materials in the landfill. Most of the other material removed from a ship is passed on directly to small handlers outside the gate of the recycling facility. It can be said that the situation is almost the same in case of ship recycling facilities in Pakistan and Bangladesh. So, it can be seen that the treatment of materials obtained from the breaking of ships is not very organised at the ship recycling facilities in India, Pakistan and Bangladesh.

But, in the case of ship recycling facilities in China, the disposal and waste handling facilities are much more organised and controlled. It is possible to get direct contracts with facilities that deal with batteries and mercury etc. which are controlled at a higher level, by the State Environment Protection Agency in China and this kind of guarantee is not available in the case of India, Pakistan or Bangladesh.

The author next asked the respondent from Sea2Cradle about the current status of documentation required by the Hong Kong Convention like the Ship Recycling Facility Plan. The author found out that since the Hong Kong Convention has not come into force yet, most of the times recycling yards comply with documentation required by the local authorities to operate or on a voluntary basis. Further, not many ship recycling facilities have a Ship Recycling Facility Plan but they might have information that can be used to make such a Ship Recycling Facility Plan. It should be noted that even the ship recycling facility that the case company, Maersk Line uses in China does not at present have a Ship Recycling facility Plan which is in the process of being prepared by the consultant interviewed by this author.

5.2.3 Effective communication of activities relating to ship recycling

This section presents a discussion of the results based on theoretical frameworks on CSR communication presented in sections 2.3.3 and 2.3.4 of this report.

As discussed in section 2.3.4 of this report, a container shipping company should first make its own employees aware about the steps that it takes regarding sustainable ship recycling and why this is important. This will help to build a strong organizational commitment to the corporate CSR agenda on ship recycling, thus encouraging employees to contribute to the further development and support of the corporate CSR activities and policies on ship recycling. Secondly, the company must develop a detailed case with statistics and facts about the issues associated with ship recycling, for example, about the upcoming legally binding Hong Kong Convention and demonstrate how steps taken by this particular container shipping company can benefit its potential customers from utilising the services of this particular company instead of the other competitors. This information can also be provided to the media. A simplified form of this information can then be passed on to the public and affected communities in the recycling countries. These and other factors are discussed in more detail in the following paragraphs.

5.2.3.1 How to communicate?

1. The *'inside-out'* approach to communicating CSR says that companies should base their CSR communication on employee commitment before they communicate their CSR activities to other stakeholders. When asked about the steps that the case company, Maersk Line takes to educate its employees about the specific issue of ship recycling, they replied that the company has had some internal articles on ship recycling but they do not run active campaigns to make their employees aware of this issue. It can therefore be concluded that in the case of Maersk Line, the inside out approach model to CSR communication is not being applied.

2. The expert CSR communication process

   Since this method of CSR communication using facts, figures, statistics etc. is meant for highly involved stakeholders, in the case of ship recycling, this method can be applied to the media, NGOs, international organizations like IMO, customers and local authorities.

3. The endorsed CSR communication process

   Since this method is meant for the general public, the company can use third party experts like the media to present the steps taken by the ship owner towards ship recycling in a simple and easy to understand manner.

5.2.3.2 What to communicate?

1. CSR commitment: A ship owner can display its commitment towards ship recycling by first having a ship recycling policy that displays action from a ship owner towards sustainable ship recycling. Further, a ship owner could also develop a long term working relationship with the recycling yard in order to help to feedback information from the end-of-life phase to the other phases of the lifecycle of a ship, especially the design and ship building phase. A ship owner can in this way and in other ways, including financial and technological support help a recycling yard to improve their recycling process.

2. CSR impact: A ship owner can also highlight the positive impacts on communities and labourers working in ship recycling facilities by means of following a sustainable ship recycling process. The positive impact from sustainable ship recycling also includes a better usage of raw materials like steel that will have a positive impact on the entire shipping industry and also reduce the environmental impacts caused by mining fresh virgin raw materials. The advantages in terms of reduced pollution due to better handling of hazardous materials during the recycling process is also a positive that ship owners can highlight as an impact of their activities on CSR.

3. CSR motives: In order to gain better acceptance among stakeholders to which the message of CSR is being directed towards, a ship owner can easily highlight the convergence of social and business interests as adopting a sustainable method of ship recycling will lead to social benefits for workers working in the ship recycling yards, reduced pollution and at the same time it will benefit the ship owner by securing access to potentially scarce raw materials and in addition gives positive publicity to the ship owner among stakeholders, thus giving it a competitive advantage in the market among customers.

4. CSR fit: Since ship recycling forms a natural fit between a ship owner's business objectives and also brings benefits to society simultaneously as shown above, ship recycling is a perfect case of CSR fit.

5.2.3.3 Where to communicate?

1. Company controlled channels: A ship owner should communicate its activities relating to sustainable ship recycling in internal documents like CSR reports. This should also be communicated to the employees of a ship owner by means of internal communication such information should also be displayed prominently on a company's website.

   A ship owner can also ask members of its value chain, for example, the ship building yards and system suppliers to further promote the message of sustainable ship recycling.

2. External channels: The media, press and NGOs form important external channels that can potentially drive the message of a ship owner's policy towards sustainable ship recycling. Getting positive media coverage in place of negative media coverage regarding irresponsible ship recycling, for example, can have serious consequences for a ship owner's business.

5.2.3.4 Factors affecting effectiveness of CSR communication

5.2.3.4.1 Company specific factors:

1. Corporate reputation: How much people believe in a ship owner's message about the steps that a ship owner takes about sustainable ship recycling is based on the past history of the actions that a ship owner has taken towards various social issues and the credibility and reputation of a ship owner's name in the eyes of the stakeholders to which the message about sustainable ship recycling is directed. This will also play a role in forming the company's reputation for the future.

2. CSR positioning: From the interview with Maersk Line, it is clear that the topic of ship recycling is not a priority among customers of ship owners. Therefore, CSR communication about a ship owner's initiatives towards suitable ship recycling

directed towards its customers can definitely be used by a ship owner to position his company based on sustainable ship recycling relative to competition.

5.2.3.4.2 Stakeholder specific factors

1. Stakeholder type: As explained in the section titled *'How to communicate'*, a ship owner should customize his message about his activities on ship recycling for different audiences based on the expectations of the targeted audience and their level of expertise in understanding the issue of sustainable ship recycling and its impacts. It is important that a ship owner sufficiently highlights its intrinsic motives towards the issue of ship recycling, whether it be better working conditions for workers working in ship recycling facilities or a reduced environmental impact due to better handling of the waste and hazardous materials obtained as a result of breaking ships. This should be in addition to the extrinsic motives of the company in getting an assured supply of scarce raw materials for their ships and containers in future and getting a better price for their old ships.

2. Issue support: The issue of ship recycling is considered important especially by certain NGOs and also international organizations like the IMO. A ship owner can get favourable support from such stakeholders who consider ship recycling to be especially important.

5.2.3.5 Ship recycling and definitions of CSR

Analysis of the problem based on the five dimensions of CSR presented in section 2.3.1 of this report is presented in this section.

1. The social dimension: The problem of ship recycling is an important social issue for the labourers working on the ship recycling facilities as they are exposed to health and safety hazards. It is also a social problem for the communities that stay in regions surrounding the ship recycling facilities because ship recycling is a large source of employment in that area while at the same time it causes a great amount of pollution in those areas. Thus ship recycling has grave social implications.

2. The economic dimension: Maintaining profitability is one of the primary requirements of an organization for it to remain sustainable in its operations. The costs of recycling ships in a green recycling facility in comparison with recycling in a relatively

uncontrolled manner by the process of beaching can vary from being the same for both methods to being as large as between 1 million to 2 million USD, as estimated by the two different experts from Maersk Line and Sea2Cradle who were interviewed by this author. The ship recycling expert from Sea2Cradle further explains that this price difference depends on various factors including the time of the year, second hand steel prices and supply and demand factors. Thus, the issue of ship recycling therefore clearly has an economic dimension attached to it.

3. The environmental dimension: It is clear that there are several hazardous substances that are released to the environment during the recycling process of ships. Ship owners taking responsibility of the environmental impact from the purchase and operation of a ship should also take responsibility of the environmental impact and pollution caused during the end-of-life phase of their ships.

4. The stakeholder dimension: With reference to ship recycling, the stakeholders that can have a special interest in this activity from a ship-owner's perspective are the media which can highlight the responsibility of ship owners towards responsible ship recycling and the impacts that the process of ship recycling has on the environment and communities where this activity takes place. The other relevant stakeholders can be the communities involved in the physical activity of ship recycling itself. Also, international organizations like the IMO can be stakeholders as they make regulations that can impact a ship owner. Finally, the customers of a ship owner can be termed as stakeholders as they might not want to be associated with irresponsible recycling of ships that they use. It is therefore clear that due to the presence of so many critical stakeholders, ship recycling is an important issue for ship owners.

5. The voluntary dimension: Since the Hong Kong Convention has not come into force yet, whatever steps a ship owner takes regarding ship recycling are completely voluntary, over and above existing regulation. This can have several positive impacts on ship owners including positive recognition from stakeholders and better preparedness with regards to the Hong Kong Convention when it comes into force.

Analysis of ship recycling with reference to the three different perspectives on CSR identified by (Dahlsrud, 2009) is presented below:

1. The CSR champions: Ship recycling can be presented as a *'win-win'* situation for both the ship owners as well as for the society. From a business perspective, the ship owners benefit by sustainable ship recycling as they get better and positive recognition from various stakeholders that can give them a competitive advantage with respect to their competitors. Moreover, by using the cradle-to-cradle concept for ships and ensuring sustainable ship recycling, they can get a better price for their ships and most importantly, ship owners can get access to different raw materials obtained from the recycling of their old ships.

2. The free market advocates: Given the positive impacts that sustainable ship recycling can have on a ship owner, these impacts can also lead to profits for the ship owners, directly in terms of access to raw materials for their ships as well as indirectly in terms of gaining a competitive advantage in the market due to a positive recognition from stakeholders. Sustainable ship recycling can therefore also be justified from Milton Friedman's view on business as presented in section 2.3.1 of this report.

3. The CSR sceptics: The respondent from Sea2Cradle in the interview conducted by the author refers to the *'attitude-behaviour'* gap as presented in section 2.3.1 of this report. He mentions that the websites of all ship owners mentions about CSR and also have social responsibility reports but it is still a fact that many of the ships owned by these ship owners pollute the beaches in South Asia. This clearly shows an attitude-behaviour gap on part of the ship owners as they show an attitude of social and environmental responsibility but when it comes to the topic of ship recycling, their words do not translate into tangible actions in most cases. Even if sustainable ship recycling is not rewarded by the ship owner's customers, they will definitely benefit from the access to scarce raw materials from their old ships that will reduce the cost of new built ships and increase the price that they get for their old ships.

When we consider CSR practices with reference to the shipping industry in particular, referring to a study conducted by on 112 Norwegian shipping companies, it was found that only 9 of these companies reported such practices in order to improve their social, economic and environmental impacts. Further, the practices reported were primarily related to environmental impacts and only about 10% of the reported practices were above regulatory requirements and can therefore be classified as CSR practices (Dahlsrud, 2009). Based on this analysis of the Norwegian shipping industry, Dahlsrud

(2009) concludes that CSR should be viewed to be a limited supplement to regulatory requirements instead of being viewed as business' contribution to sustainable development.

5.2.3.6 Ship recycling and Strategic CSR

Ship recycling can also be seen to be a part of strategic CSR because it yields substantial business related benefits to ship owners in terms to access to raw materials in the future which will reduce the cost of new building vessels and increase the price that a ship owner gets for his old ships. The point about raw materials also gives a sort of insurance to the ship owners regarding access to raw materials that can potentially get scarce in the future.

In this section, we analyse the relevance for a container shipping company of the different factors about CSR communication described in the previous section. We begin by analysing the factors defining *strategic CSR*:

1. Centrality: A container shipping firm transports goods around the world using ships throughout the firms' life. Ships are therefore central in the container shipping business. Thus, it can be argued that the end-of-life phase and the CSR activities relating to sustainable ship recycling are closely linked with a container shipping company's business.

2. Specificity: The development and use of a Ship Recycling Policy by a container shipping company will be specific to that particular company. This applies to the management structure put in place for handling the end-of-life phase and the collaboration with the chosen specific ship recycling yard.

3. Proactivity: Since the topic of sustainable ship recycling is gaining importance in different media and also keeping in mind the recent Ship Recycling Convention by the IMO which will be a legally binding regulation when it comes into force, any steps that a container shipping company takes towards sustainable ship recycling will help it to adapt early to the future changes in the legal regime.

4. Voluntarism: In preparation for the entry into force of the Hong Kong Convention from the IMO, the Industry Working Group on Ship Recycling (IWGSR, 2009) has issued guidelines for ship owners describing steps that ship owners can take voluntarily in order to become compliant with the Hong Kong Convention when it

comes into force in a few years' time. This includes steps like the ship owners begin making IHM for their existing and new ships, identify ship recycling facilities that meet IMO standards and which have been approved by the flag state and the authorities in the ship recycling state, using the intermediary cash buyer only as a facilitator between the ship owner and the recycling facility and finally ship owners requesting classification societies to confirm that they have taken steps in accordance with the Hong Kong Convention. These steps are also applicable to container shipping companies and should be taken voluntarily. In the current scenario, however, it is a fact that not many ship owners follow this, as highlighted by the expert from Sea2Cradle who was interviewed by this author.

5. Visibility: As per the responses received from some of the container shipping companies that were contacted by the author to inquire about the activities on ship recycling, they are aware of the upcoming Hong Kong Convention and do take some steps towards promoting sustainable ship recycling, but, they do not appear to take advantage of the resources that they spend on this CSR activity. It is therefore important to gain recognition from internal and external stakeholders by effective communication of CSR activities.

5.2.3.7 State of the art in CSR communication

As described in Chapter 4 of this report, ship owners are generally not very active in prominently communicating their CSR activities to the different stakeholders, especially activities related to ship recycling.

Further, Fafaliou et al. (2006) based on their study of Greek short sea shipping companies identified three approaches that shipping companies have employed in terms of their social responsible behaviour. The first approach is implemented by a minor group of companies, those called "*substandard operators*". Competitiveness is a goal of primary importance for them, even if its achievement means decreasing the operating cost by lowering safety and quality standards. This gives a cost advantage of 13% to 15%. The second approach, the so-called *typical*, is implemented by the majority of companies and can be described as an attempt to simply stay within the "rules of the game". These companies apply a standard level of operation and conform to requirements of regulations and conventions that constitute the regulatory framework of world shipping, no matter what the cost of conformance is. In

addition, such companies implement fair and commonly accepted commercial practices in their operation. Finally, the *supportive* approach is implemented by a group of companies that move beyond the compliance to the rules, comply with non-obligatory standards or even set their own standards regarding their operation. According to Fafaliou et al. (2006), companies which are always eager to undertake the cost of implementing non-obligatory rules, and standards that help them behave in accordance with the society's expectations should be considered as socially responsible. According to this definition of CSR and in the context of this study, *container shipping companies that voluntarily and proactively take steps to promote sustainable ship recycling can be called as socially responsible*.

Based on a survey of 25 short sea shipping companies from Greece, Fafaliou et al. (2006) managers of the companies that participated in the survey reported the following benefits of pursuing CSR activities in the order of importance from highest to lowest:

- Improvement of employees' job satisfaction. It has also been shown in a study by Turban and Greening (1997), that employees prefer to be employed by companies with a good CSR rating. In addition, Koh and Boo (2001) showed that there was a positive correlation between CSR and job satisfaction.
- Better relations with community and public authorities
- Improvement of customer loyalty. Several other studies have shown that consumers express a preference for brands with a reputation of being socially responsible (Anselmsson and Johansson, 2007, Pivato et al., 2008)
- Relations with partners and investors
- Expected total economic performance

Further, according to Co-operation and Development (2001), enterprises which are involved in CSR initiatives, may derive benefits such as the following:

- Reduced risks of costly criminal prosecutions, litigation and damage to reputation
- Help for firms to manage relations with shareholders and with actors in the societies in which they operate
- To create a "culture of integrity" within a company
- Improved enterprise image and reputation (Fafaliou et al., 2002)

5.2.3.8 Challenges to CSR in the context of a shipping company

In a study, Hargett and Williams (2009) identified challenges to CSR at the Wilh. Wilhemsen group, which is a Norwegian based leading global provider of maritime services. It should be noted in the context of the present research, that the study about the Wilh. Wilhemsen group by Hargett and Williams (2009) referred to above was not in relation to container ships. However, some of the challenges identified to CSR in Hargett and Williams (2009) were:

- Communicating CSR efforts and activities
- Finding appropriate ways to measure impact of CSR and quantify it
- Establishing consistent CSR accountability processes
- Integrating traditional maritime culture with culture of innovation

Analysing further based on the other points mentioned in the previous section, in the case of a container shipping company communicating about its activities on ship recycling, it seems reasonable that the company communicates about the cause itself along with its own commitments towards this cause. This is important because ship recycling is not a very well-known issue among the public in general and also presumably among the other stakeholders of a container shipping company. The various stakeholders should therefore be made aware of this problem first and the container shipping company can then communicate about the steps that it takes to tackle the problem. This will help to improve the perception of commitment of the container shipping company towards the social cause of ship recycling. It is also important to communicate about the societal impact from the steps that the company takes on ship recycling. For example, by complying with the provision of the Hong Kong Convention and choosing a ship recycling yard which complies with IMO standards, a container shipping company influences the lives of the people who stay near the ship recycling yards as they get better working conditions and less pollution in their immediate environments.

The container shipping company can also demonstrate a long term commitment to the cause of ship recycling by working together with the ship recycling yard, trying to improve the recycling process by providing information about the ship-to-be-recycled, that the ship owner has acquired over time during use of the ship and also using the information from the end-of-life phase of the ship during ship design and manufacture so as to make the ship easier to recycle at the end of its working life.

Further, in order to communicate how its efforts towards ship recycling benefits its own business interests, a container shipping company can also communicate that the steps that it takes with regards to ship recycling makes them compliant with international laws and regulations regarding ship recycling and therefore saves the company from penalization due to non-compliance with the law.

5.2.4 **Design for recycling**

This section discusses the problem of sustainable ship recycling from the perspective of the theoretical frameworks on this topic presented in section 2.4 of this report.

1. Product recycling: As Maersk Line stated during the interview (Appendix 1) that they design their ships so that the ships have a long life. This aspect can also be adopted by all ship designers and ship building yards so that the ships that they design and build have a long life.

   Regarding modularisation, ship designers can adopt the SFI system being used in Norway, as described in section 2.10 of this report, for dividing the system 'ship' into smaller subsystems so that it is easier to manage the smaller subsystems during the design and project management of a new ship and these modules can then also be replaced or modernised without a need to scrap the entire system of a 'ship'.

2. Ease of disassembly: This deals with practical issues in the ship design process that can be changed in order to make the ship easier to disassemble. This can be things like using pins instead of glue for fastening or letting cables be in one long stretch rather than cutting cables into smaller pieces which makes it even more difficult to extract metal from smaller pieces or positioning of other subsystems so that it is easier to reach them while disassembly.

3. Choice of material: Ship designers can choose environmentally friendly materials instead of hazardous alternatives like asbestos, for example, which can cause health hazards during all phases of a ship's lifecycle, during the construction, operation and recycling phases. Similarly use of plastics and paint can be avoided. There can be many such alternatives that can make the ship not only easy and safer to recycle but also to construct and operate.

4. Design for logistics: After the different components from a ship have been removed, they are transported and handed over to different facilities that deal with different kinds of materials like steel which are recovered from the vessel. If the different parts of a vessel are designed for logistics, it would make it easier to transport the different subsystems removed from the ship during recycling. This would help not only in the recycling phase but also in the other phases like in the construction and operation phases of the lifecycle of a ship.

5.2.4.1 Options for recycling

Since a ship has a relatively long operational life, extending from 25-30 years, it is reasonable to expect that by the time a ship reaches its end-of-life phase, most of the systems and technology used in the ship would be obsolete for considering remanufacturing of the ship. So, this option as suggested in theory for treatment of end-of-life products can therefore be eliminated in case of ships.

Moreover, as a ship is a large system with many valuable smaller subsystems, recycling with disassembly appears to be the most practical option to treat end-of-life ships. As discussed in this report, knowledge from the end-of-life phase can be used in the designing phase in order to redesign new ships in a way that it is easier to recycle and that will also have positive impacts on other phases of the lifecycle, including construction and operation phases. This can also act as a hedge against uncertain or constrained supply of raw materials like steel which can be a scarce commodity in future. This knowledge can be derived from a end-of-life ship only if the ship is recycled by disassembly.

5.2.5 **Discussion based on Legal Requirements**

This section describes two models developed by the author about the current state of the art in ship recycling with reference to the legal requirements towards ship recycling. The first model describes how the issue of ship recycling is being dealt with by ship owners in the current context and the second model builds up on the first model to propose a decision making tool for a ship owner that can be used for dealing with end-of-life treatment of ships by a ship owner.

5.2.5.1 Contemporary decision making model for end-of-life ships

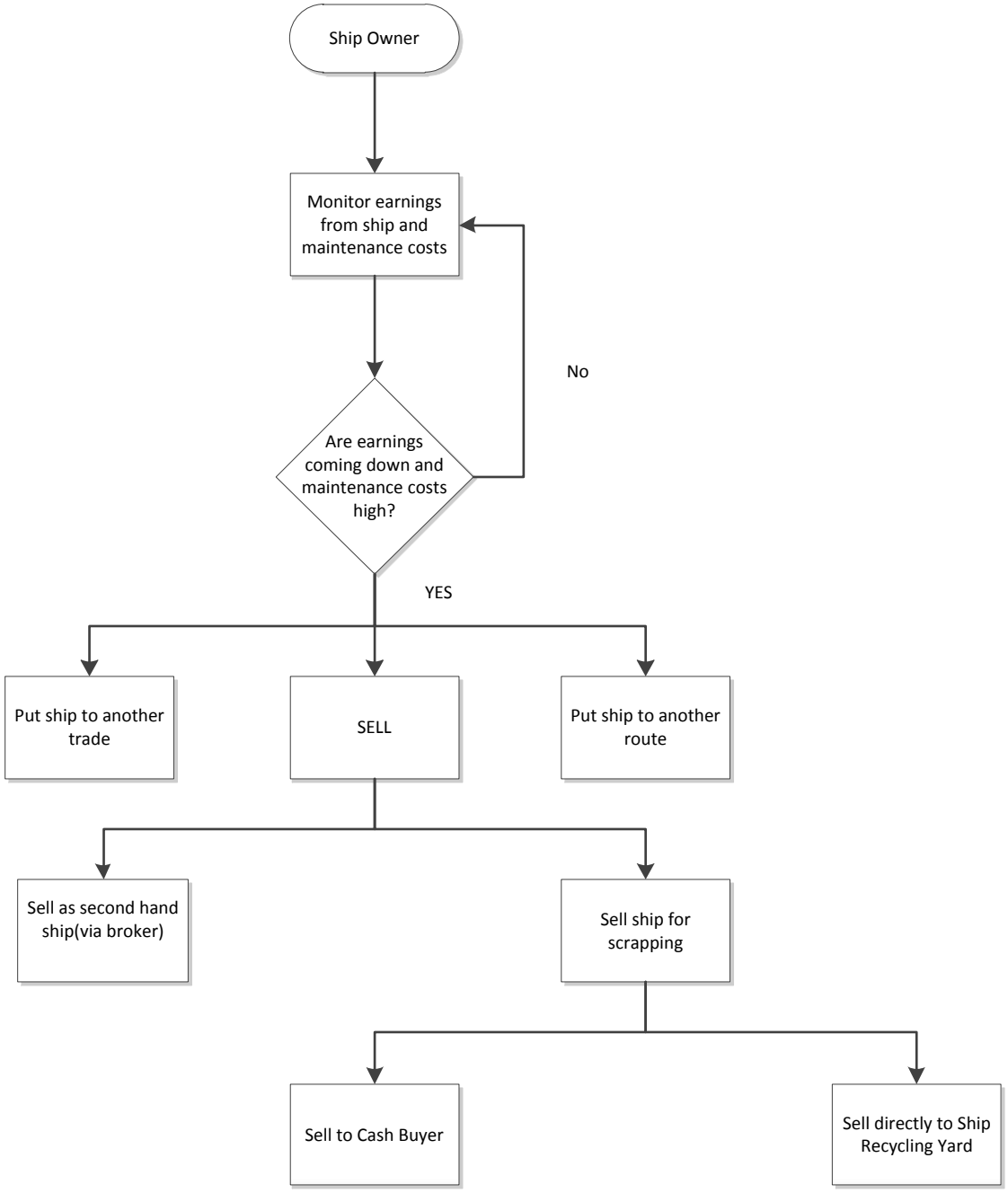

Figure 20: Model for decision making criteria used by ship owners for end-of-life ships (Ahuja (2011a))

The above model for the decision making criteria used by ship owners with regards to end-of-life treatment of ships was developed during the previous work of this author on ship recycling (Ahuja, 2011a) .

This model describes the decision making process followed by the ship owners from when they start thinking about the end-of-life ships. The ship owner starts considering about the

end-of-life treatment of ships when the earnings from the ship start decreasing. This is related to the freight prices for that particular type of ship. The earnings are then compared to other costs to the owner e.g. maintenance costs or costs for conducting a survey for certification etc. If the earnings from the ship are going down and the costs are high, the owner has the following three options (Ahuja, 2011b):

a) Put the ship on a different route – This could involve putting the ship between a route that involves countries with a relatively higher volume and/or value of trade between them so that the ship owner has an opportunity of getting better returns from his ship
b) Put the ship to another trade – This could involve using the ship for another purpose than what the ship is currently being used for with minimal modifications required in the ship. The new 'trade' that the ship works in could have a higher volume/value and therefore be more profitable for the ship owner.
c) Sell the ship

Selling the ship is often the last option utilized by the ship owners, after evaluating the possibility of putting the ship on another more profitable route and putting the ship to another trade if possible, in order to increase the earnings from the ship. In case the ship owner has no other possibility, but to sell his ship, the owner has further two more options:

i. Sell the ship as a second hand ship
ii. Sell the ship for scrap

Out of these two alternatives, the ship owner prefers to sell the ship as a second hand ship and selling the ship for recycling is the last possible option executed by the ship owner. As described before, the ship is sold to the recycling yard through an intermediary called as the cash buyer intermediary or a broker (Ahuja, 2011b).

Apart from the reasons mentioned before, another reason for ship owners to use cash buyer intermediaries is that the financing of ships is done at a national level and because the ship owner, cash buyer intermediary and recycling yard are all located in different countries, the ship owners want to transfer the financial risks of the transactions involved in this process to the cash buyer intermediaries (Ahuja, 2011b).

Another factor that plays a role in utilising the services of cash buyers instead of dealing with the recycling yards directly is that the volume of ships sent for scrapping is not very high.

Ship owners on an average have 10-15 vessels and they sell ships only 3-4 times in a 10 year period. This implies that the ship owners usually do not have the necessary expertise of the recycling market themselves. Therefore, they use the expertise of the cash buyer intermediaries who are specialists in the ship recycling market (Ahuja, 2011b).

Another important consideration in the regard is that only a few scrapping yards buy their ships directly from ship owners. This makes the role of intermediaries more significant (Ahuja, 2011b).

The "cash-buyer" intermediary (or a broker) will know exactly which ships are to be sold for breaking, and what their timeline is for their voyage to the ship breaking yards. The shipbroker is a difficult category of persons to regulate given the specialized nature of their work and the international scope of their transactions, as they are neither implicated in the enforcement jurisdictions of either the port State or the flag State (Moen, 2008).

A program for recycling a fleet of ships has the following discrete cost elements (adapted from Hess (2001)):

1. The cost for ship owner to store ships while they wait to be sold or recycled.
2. The commission paid to the "cash-buyer" intermediary by the ship owner.
3. Payment received from the "cash-buyer" intermediary (or ship recycling yard).
4. The cost for ship owner to prepare ships for towing, e.g. removing expensive machinery, preparing inventory of hazardous materials on board a ship etc.
5. Costs to tow the ship from their storage sites to the dismantling site – for ship owner or recycling yard, depending on the specific contract.
6. The cost to dismantle ships, i.e., the cost of all the work done at the recycling shipyard or facility. This includes all costs to cut a ship apart, sell what can be sold, dispose of wastes that cannot be sold, and comply with all state and local rules while performing this work. Other costs here include labour, the recycler's management and overhead expenses, the cost of subcontracts (such as for equipment rental and waste management), marketing costs for selling scrap and reusable equipment, and the recycler's profit.
7. The revenue (or negative cost) from selling the scrap metal and reusable equipment from the ship.

5.2.5.2 Proposed decision making model for end-of-life ships for ship owners

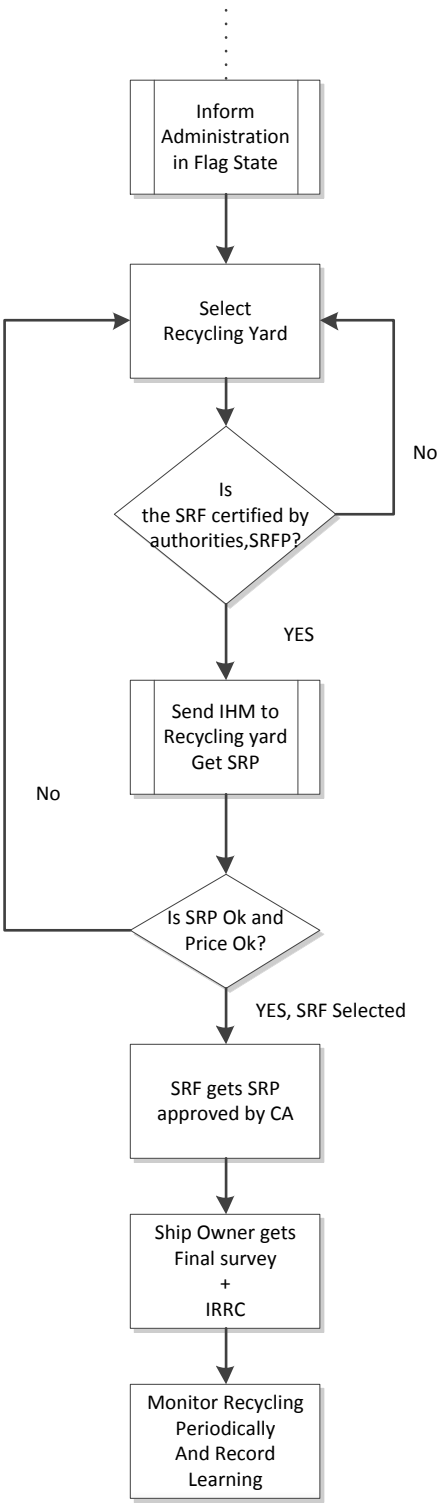

Figure 21: Proposed decision making model for ship owner for end-of-life ships (Ahuja, 2011a)

The author proposes the following model (Ahuja, 2011a), which is an extension of the model presented earlier in this report in figure 20. This study uses the analytic approach of "Pattern

Matching", described by Yin (2009) as a logic which compares an empirically based pattern with a predicted one. The model presented earlier in figure 20 describes the current state of the decision making practice of the ship owners when it comes to the end-of-life ships. The proposed model bases itself on the model proposed earlier and it describes the process after the decision to sell the ship for scrapping has been taken by the ship owner at the end of the model proposed earlier in figure 20. The proposed model describes the decision flows that the ship owners must take into consideration when the new Ship Recycling Convention comes into force. It is recommended that the ship owners consider this model even in the transient phase from now until the new Convention comes into force so as to better adapt to the provisions of the new Convention. It should be noted that the certification authorities proposed by the Ship Recycling Convention will be set up by the governments of the signatory countries to the Convention once the Convention comes into force. Therefore, the step of informing the authorities and getting the final inspection and the International Ready for Recycling Certificate (IIRC) can only be done once these authorities are set up. This model is also in accordance with the Guidelines for transitional measures for ship owners selling ships for recycling adopted by the Industry Working Group on ship recycling (Recycling, 2009).

It can be argued that the role of the cash buyer intermediary should still remain strong primarily because of the limited expertise that ship owners possess with regards to the ship recycling business. According to Yin (2009), "specifying important rival explanations is a part of a case study's research design work".

As described earlier in this report, the author found that the ship owner starts considering about the end-of-life treatment of ships when the earnings from the ship start decreasing. This is related to the freight prices for that particular type of ship. The earnings are then compared to other costs to the owner e.g. maintenance costs or costs for conducting a survey for certification etc. If the earnings from the ship are going down and the costs are high, the owner has the following three options:

a) Put the ship on a different route – This could involve putting the ship between a route that involves countries with a relatively higher volume and/or value of trade between them so that the ship owner has an opportunity of getting better returns from his ship
b) Put the ship to another trade – This could involve using the ship for another purpose than what the ship is currently being used for with minimal modifications required in

the ship. The new 'trade' that the ship works in could have a higher volume/value and therefore be more profitable for the ship owner.

c) Sell the ship

Selling the ship is often the last option utilized by the ship owners, after evaluating the possibility of putting the ship on another more profitable route and putting the ship to another trade if possible, in order to increase the earnings from the ship. In case the ship owner has no other possibility, but to sell his ship, the owner has further two more options:

i. Sell the ship as a second hand ship
ii. Sell the ship for scrap

Out of these two alternatives, the ship owner prefers to sell the ship as a second hand ship and selling the ship for recycling is the last possible option executed by the ship owner. Referring to the earlier model, even if the ship owner sells the ship to a cash buyer intermediary, this intermediary becomes the new ship owner and the steps described in the proposed model are applicable to all types of ship owners. If the ship owner finally decides to sell the ship for scrap, the ship owner as a first step must inform the administration in the flag state about their decision to scrap the ship.

Once this is done, the ship owners must start searching for the suitable Ship Recycling Facility (SRF). The first step in this process is to look at the certification papers of the recycling yard, including Ship Recycling Facility Plan (SRFP), that covers worker safety and training, protection of human health and environment, roles and responsibilities of personnel, emergency preparedness and response and systems for monitoring, reporting and record keeping. It should be checked whether this recycling yard has been certified by the authorities in the recycling state or not and that this recycling yard is in conformance with provisions of the Ship Recycling Convention. Once this has been established, the next step is to send the IHM of the ship to the recycling yard and then to ask the recycling yard about the ship specific Ship Recycling Plan (SRP). Once the ship recycling yard provides the SRP, the ship owner must compare the IHM with the SRP to decide whether or not the ship owner is capable of recycling all the hazardous materials listed in the IHM and what provisions has the recycling yard made to deal with the hazardous materials that the recycling yard is unable to recycle. Based on these facilities, the price for the recycling is decided and the ship recycling yard is chosen.

A SRF preparing to receive a ship shall notify its Certification Authority (CA) of the intent and the SRP shall be approved by the CA and then be sent to the ship owner for the final survey.

The ship owner must then arrange for the final survey to verify the IHM and to verify that the SRP reflects correctly the IHM and that it contains the required information. After this, as specified by the Ship Recycling Convention after which the ship will obtain the IRRC (International Ready for Recycling Certificate) from the authorities in the flag state. When the ship has acquired the IRRC, the SRF shall report to its CA the planned start of recycling. Once the recycling yard is chosen, the ship owner must ideally take steps to monitor the recycling process periodically in order to ensure that the recycling takes place in accordance with the agreed terms and also to ensure organisational learning for future ship recycling projects. The above model is based on the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009 (Hong Kong Convention).

5.3 Discussion based on goals and objectives

This section discusses the results of this thesis based on the goals and objectives defined at the beginning of this research in Chapter 1 in order to appraise the reader about the attainment of goals that this research aimed to achieve. This section should be read also taking into account the results presented in Chapter 4 of this report.

5.3.1 Impact on decision making at a strategic level for a ship owner

Johnson et al. (2008) define strategy as "Strategy is the direction and scope of an organisation over the *long-term*: which achieves advantage for the organisation through its configuration of resources within a challenging environment, to meet the needs of markets and to fulfil stakeholder expectations." As discussed in the following paragraphs, there are several decisions that the case company took with regards to long-term direction and scope of the organisation, specifically as an impact of the end-of-life phase of ships. This clearly shows that the end-of-life phase has impacts on decision making at a strategic level for a ship owner.

From the interview with the case company, it was found that the company earlier used to have an entity called A.P. Moller-Maersk Ship Recycling which was dedicated to ship recycling activities. But, later this entity became an independent consultant. The author perceived this to be an important event, signifying that the case company had decreased its efforts towards ship recycling. On asking about this issue during the interview with the case

company, the company representative clarified that they are a container shipping company which is their primary business activity and not ship recycling or acting as a ship broker. Also the fact that the AP Moller Maersk group has a relatively new fleet, the issue of ship recycling will not be a primary business activity for the group. That is the reason why A.P. Moller-Maersk Ship Recycling was discontinued and made as a separate activity to the A.P. Moller-Maersk group, in order to streamline the case companies' business activities. The company also stressed that A.P. Moller-Maersk Ship Recycling used to provide consultancy to external ship owners, outside the A.P. Moller-Maersk group as well even when it was a part of the A.P. Moller-Maersk group.

This clearly signifies that, the ship owner did not consider ship recycling to be a part of *their core business*, even though they stressed that they have not reduced their efforts towards ship recycling. This can be described as one of the conclusions with respect to implications on decision making at a strategic level, as in the opinion of the author, the ship owner in this particular case did not consider ship recycling to be of long term strategic interest to the company and so, A.P. Moller-Maersk Ship Recycling was allowed to become an independent and external consultant, as a result of a decision made at a strategic level about the way in which ship recycling impacts the core business activity of the A.P. Moller-Maersk group. By using an external consultant, it could be difficult for a ship owner to utilise information gained from the end-of-life phase of a ship as described in this report.

The author came across a new perspective on ship recycling originating from the case company. The case company looks at responsible recycling today as a loss of high value materials (Line, 2012b). They highlight the fact that shipping and other industries are heavily dependent on steel. In the interview that the author did with the case company, they explained this point by stating that in the current scenario, all equipment and furniture etc. removed from a ship is sold to farmers or to homes, for example. Moreover, in a business as usual scenario, according to estimates, we might run out of steel in the next 60 years (Line, 2012b). Therefore, in order to sustain their business long term, recycling and reuse of steel is key (Line, 2012b). Maersk Line is looking at a scenario in future when it could be possible that a ship owner comes up with an old vessel to be recycled and in return gets a new vessel built from the raw materials recovered from the old vessel.

The company has thus started using the cradle-to-cradle concept for reducing resource use and pollution by eliminating waste. The idea of the cradle-to-cradle concept is that materials

should either be biodegradable or be "food" for new products (Line, 2012b). As defined by Line (2012a) "*The term cradle-to-cradle refers to the optimal lifecycle of the materials in a product: specifically that they should either biodegrade and be absorbed back into nature or be recycled. Not wasted.*"

The Cradle to Cradle concept used by Maersk Line can be illustrated in figure 22 below:

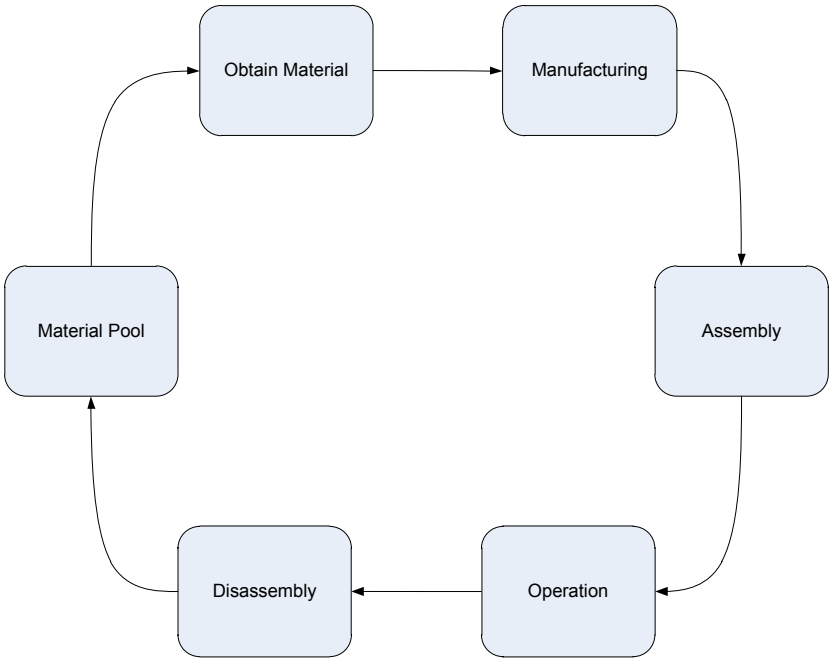

Figure 22: The Cradle to Cradle concept (Line, 2012b)

The efforts by Maersk Line towards sustainable ship recycling are further described in Line (2012a) by highlighting that in order to eliminate waste and ensure the safest and most efficient handling of the ship's materials once it is removed from service, each of their new built *Triple-E vessel*s will come with a 'cradle-to-cradle passport'. This will be a living document, describing the material composition of every piece of the ship.

Maersk Line worked with the Environmental Protection Encouragement Agency (EPEA), a German organisation that specialises in the cradle-to-cradle concept, to develop the idea for its passport (Line, 2012a).

Pursuing a policy on ship recycling is important for Maersk Line not only because of the potential scarcity in the availability of steel in future, but also because they state their aim to be that they want to be the shipping line with the best environmental performance (Line, 2012b). This can be seen as an impact on decision making at a strategic level due to the end-of-life phase.

Regarding the recycling yard that Maersk Line uses in China, the company said that they use a yard that has been assessed by the former A.P. Moller-Maersk Ship Recycling as the yard that has the best capacity to recycle ships in the right way in the present market situation. The case company works on a contract basis with the recycling yard for every ship that they recycle. But, Maersk Line also has a long term relationship with the yard. Further, the case company said that since there is a lot of activity going on in China with respect to ship recycling and that they are open to working with other recycling yards in the future.

All the steps described above can be said to be related to strategic decision making at the ship owner company due to the impact of ship recycling.

5.3.2 Impact of ship recycling on Project Management of a new ship

This section further describes the impact of ship recycling on the Project Management of a new ship where Project Management is limited to the design and construction phase of a new ship. It should be noted that this research focuses on ship owners and the author did not have the opportunity to work in detail with a ship building yard and ship designers who primarily carry out Project Management of a new ship. The conclusions presented in this section are based on literature and information gathered from experts on ship recycling as a part of this research. It is proposed to further study the impact of ship recycling on Project Management of a new ship from the perspective of ship building yards and ship designers as a part of future research.

As Nøsted (2010) notes in the documentation of the *customized design* process of a major Norwegian ship building yard, the *Ulstein Group*, the concept of disposal, as defined by the Systems Engineering concept, described in previous sections, is normally not documented in the ship's documentation. It is done only on customer request. But, the *Ulstein Group* officials also maintain in an interview given to Nøsted (2010) that they have seen an increasing interest in lifecycle considerations for scrapping/disposal with society's increased focus on environmental concerns. This clearly shows that in current practice, the end-of-life phase of a ship does not play a very important role in the ship design process but focus on the end-of-life phase of ships is increasing as customers are increasingly showing interest in that phase of a ship.

The type of decomposition of the system into parts and subparts by the SFI system, as described earlier in this report in section 2.10 can help in creating a system that is easy to

recycle as this will help in making the system more modular and so, it becomes easier to remove the complete modules while recycling. Such modularisation can also be based on the composition of materials, for example, the components and systems made of different grades of steel can be grouped together and then disassembled and recycled/reused.

Further, the workers working on the recycling yards who have first-hand experience of recycling ships should be able to give feedback on the problems they face while disassembling such modules when the ship eventually goes for recycling. This feedback from the recycling yards can then be used by system designers and shipyards and incorporated into the design for new ships so as to make new ships progressively easy to recycle. Such feedback can also be obtained from facilities that process and recycle different raw materials obtained from the ships about ways in which extraction of different types of raw materials from ships can be made easier.

In order to investigate the ways of integrating information from the end-of-life phase of a ship with the project management of a new ship, the author asked the case company about how the case company designs and builds its ships and whether there is any consideration given to the end-of-life phase of the ship during the project front end or the ship-design phase. The company replied that they always ensure that they build vessels with lifecycle consideration in mind and therefore ensure that the vessels have a long operating life. They also stated that they are for the first time looking at *how a vessel will be recycled* in the ship design phase itself, by designing a *cradle to cradle* passport in the new *Triple-E* class container ships, where Triple-E (EEE) stands for **E**conomy of scale, **E**nergy efficient and **E**nvironmentally improved vessel. The cradle-to-cradle passport offers a tool that makes recycling of ships easier by identifying the different raw materials and hazardous materials and their location on board a ship. This can help to locate and separate high grade steel, low grade steel and copper, for example, instead of mixing material which may have a higher value if reused separately. This way, the steel and other raw materials that have been recovered from a ship can be reused in building a new ship so that the raw materials that are currently in use in the shipping industry continue to remain in the shipping industry. On further investigation about *Triple-E* class vessels, the author found that Maersk Line has placed an order for 20 Triple-E class vessels to South Korea's Daewoo Shipbuilding & Marine Engineering, which will be delivered between 2013-2015. These vessels have been reported to be the most efficient container ships in the world, with lower fuel consumption,

lower CO_2 emissions and a waste heat recovery system (Line, 2012b). The new *Triple-E* design also made Maersk Line win the "Sustainable Ship Operator of the year award, 2011".

The shipping industry estimates that shipyards can recover an additional 10 per cent in the value of scrap materials through improved disposal methods (Marusiak, 2012).

Though the author could not get much information about how the information from the end-of-life phase or from the ship recyclers is being actually used in the ship design process, this does seem to be the roots of the first beginnings towards the use of *design for recycling*, in the Project Management of a new ship building project.

5.3.3 Impact of following a Ship Recycling Policy on Ship Owners

The author wanted to identify the gains that a ship owner gets from following a ship recycling policy because the case company is a pioneer in the container shipping industry in having a well defined ship recycling policy. Though it was not possible to get the gains as a monetary value, the author found the various advantages that a ship owner can gain indirectly from a ship recycling policy and subsequent responsible recycling of their ships.

Finding appropriate ways to measure impact of CSR and quantify it emerged as an established challenge to the CSR practice for shipping companies in the study conducted by Hargett and Williams (2009). Based on this, the author asked the case company about the ways in which they evaluate their activities on CSR. In response to this question, the author was told that Maersk Line does not have targets in percentages on ship recycling as such but they do have other programs under CSR, that relate to ship recycling for which they have targets, for example, the Responsible Procurement program. This program looks at suppliers to ensure that they act responsibly in terms of health and safety, corruption, environment etc. It was a difficult question to answer because returns from practising CSR, for example, responsible ship recycling, can come to the company in several ways, including that the customers select Maersk Line because of more efficient vessels, that they get more money when they sell their vessels for recycling because they are easy to recycle and more valuable to the recycler because of the cradle-to-cradle passport etc. It was therefore not possible to quantify the impacts that following a ship recycling policy has on a ship owner.

As the corporate responsibility manager from Maersk Line had stated in the beginning of the interview that A.P. Moller-Maersk Ship Recycling was allowed to become an external consultant outside the company because ship recycling was not a part of the primary business

activity of Maersk Line, the author wanted to know as to why Maersk Line is so much interested in the steel that can be obtained from a ship. To this, the company replied by saying that it has indirect impacts on the company as in case steel becomes a scarce commodity, the prices of new ships will go up and so, it will be difficult to buy new vessels. It also influences the price that they get for recycling their ships. For example, in 2010, the company got USD 1-2 million less for recycling at a yard in China instead of recycling the ship by the method of beaching at a recycling yard on the Indian subcontinent. Steel is also important for the container shipping industry as it is used to make containers and therefore sustainable ship recycling is in the interest of the container shipping industry to have enough steel in future to build new vessels and containers. Further, Mikelis (2012) explains that the price a ship is sold for recycling represents a significant residual value, which today stands between 17% and 23% of the replacement new building price. The scrap price is therefore important in the ship owner's long term calculations (Mikelis, 2012). There are also political factors and national demand/supply factors with regards to the usage of steel that the company has to look into.

It can therefore be concluded that with the cradle-to-cradle passport, Maersk Line is dramatically expanding the scope of its effort from safe and effective recycling of only hazardous materials on board a ship towards a new approach of recycling and reuse of all materials that a ship is made of. The total weight of a *Triple-E* vessel is 60,000 ton, out of which, 98% is steel. The graphic below shows the practical implications of using the cradle-to-cradle passport in the new *Triple-E* vessels from Maersk Line.

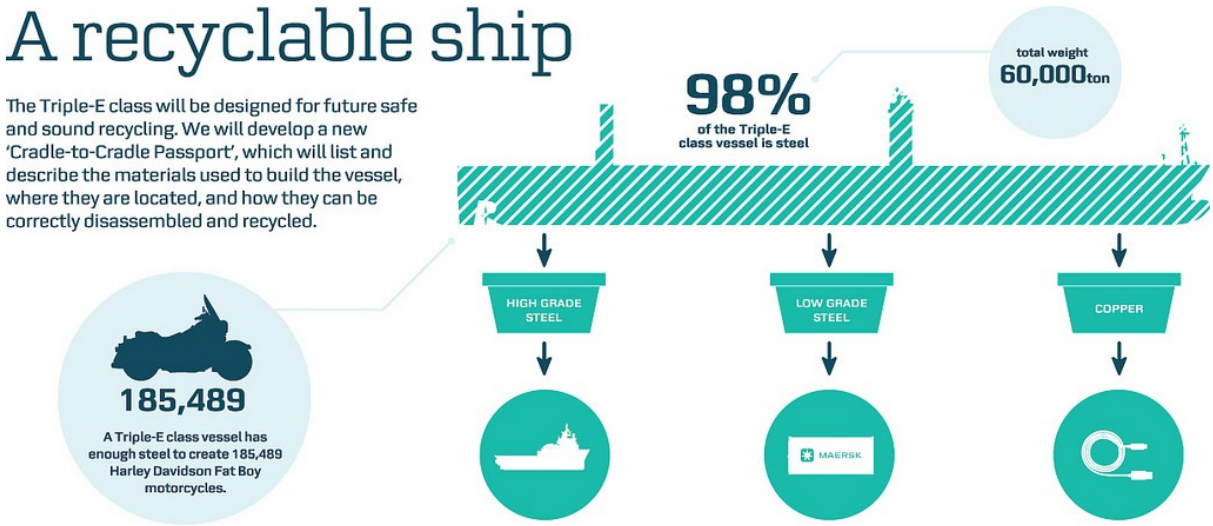

Figure 23: Maersk Line *Triple-E* vessels (Line, 2012a)

Maersk Line has also identified the benefits and challenges associated with the cradle-to-cradle passport. These are summarised below (Line, 2012b) :

The expected benefits

- Reduced lifecycle environmental impact

  This is due to the proper recycling of materials from the ship in the end-of-life phase of the lifecycle

- Higher resource availability in the long term

  This is because of the increased availability of different grades of steel and other raw materials like copper etc. in future due to their proper identification and reuse from a ship during recycling.

- Higher recycle price for vessels (estimated 10% higher)

  This should be because of the fact that the *Triple-E* vessels will deliver more value to the recyclers as they will be easy to recycle and will give the recyclers an option to sell the different types of raw materials at better prices in the market.

- Easier to ensure compliance with regulation

The current international regulation on ship recycling, the Hong Kong Convention requires the ship owners to have an Inventory of Hazardous Materials (IHM). This will therefore make it easier to comply with regulations.

- An incentive to ensure responsible recycling

  Considering all the advantages mentioned above, it creates an incentive to ensure responsible recycling.

The challenges going forward

- To develop an industry standard, effectively changing global steel resource management beyond shipping

  Since the focus of Maersk Line is on reuse of steel as it is likely to become a scarce commodity in future and because 98% of a vessel is steel, it makes sense for Maersk Line to pursue this objective. During the interview with the author, the company representative also explained that to develop an industry standard is also important for Maersk Line in order to have the necessary capacity in terms of recycling yards so that they can effectively recycle ships with the kind of documentation and the cradle-to-cradle passport that the new Triple-E class vessels from Maersk Line will have. There must be a large volume of recyclable ships with that kind of documentation from different owners in the industry in order to build the necessary capacity in the recycling yards.

- Supplier and sub-suppliers need to share information sensitive on material composition in a global database

  This is important to identify the location of different types of raw materials on a vessel, in order to facilitate their effective recycling and reuse.

- Effectively integrate cradle-to-cradle thinking in the design phase for ships

The author also wanted to investigate the fact that whether a ship owner is concerned about a recycling yard copying the ship designs and then reusing them while recycling the ship by disassembly. In the interview with the case company, when asked about possible issues with

intellectual rights when they sell their ships for recycling, the company said that they have not yet thought that far and that they do not see that as being an issue.

In order to investigate how a ship recycling policy can benefit a ship owner in terms of impacts on different stakeholders, the author asked the case company during the interview about the requirements that Maersk Line's customers have while hiring Maersk Line ships. The author was told that on a larger scale, the customers of Maersk Line do not think about how their cargo can be on board a vessel that can eventually not be recycled properly. But, the company sometimes gets questions about ship recycling. On further investigation, the author found that good environmental performance is increasingly becoming important to the customers of Maersk Line. Moreover, they want to help their customers reduce their environmental impacts and they also want to compete on environmental performance (Line, 2012b). This clearly shows that Maersk Line wants to use its efforts on sustainable ship recycling to create competitive advantage vis-à-vis its competitors.

5.3.4 Improvements in Ship Recycling Policy

The decision making model proposed by the author in figure 21 in this report is a proposal towards improvement of the Ship Recycling Policy of ship owners. It should be noted that out of the ship owners from the container shipping industry that the author investigated for this study, Maersk Line is the only company that has a published ship recycling policy. Some of the other ship owners said that they were aware of the Hong Kong Convention and they take precautions while selecting the proper yard for recycling their ships, but, none of the other ship owners had a published ship recycling policy.

From the interview with Sea2Cradle, there emerged several examples that can be used to improve the ship design process in order to make the new build ships easier to recycle – for example, insulation material that is glued to the hull of the vessel or on piping that needs to be scraped and has the potential of causing health hazards if inhaled or if it catches fire. It was also found that in the current practice of ship recycling, different steel types are mixed together, for example, mild steel with high tensile steel. Also, different materials like copper and steel are mixed together. Further, there exist design issues which make recycling impossible, like spray insulation that is impossible to remove (Bennett and Sorensen, 2012). This knowledge from the workers working on the end-of-life ships can be easily fed-back to the ship designers and ship building yards. The author found out that though such information

on improving the design process exists, it is not being transmitted back to the design phase from the end-of-life phase of the product life-cycle, as described in section 2.10 of this report.

The respondent from Sea2Cradle suggested that this proposal should be brought to the IMO in order to make a legislation regarding this, but the author believes that this can be directly done between the ship designers or ship building yards and the ship recycling yards; not only taking into account the principle of extended producer responsibility but also due to the fact that as it has been shown in this report that such a step can also potentially benefit the ship designers, ship building yards and the shipping industry in general by driving innovation about how ships can be designed in a better way, using better materials, considering the entire lifecycle of the ships. In order to get an idea about the industry perspective in general as seen from the point of view of ship owners, the author asked the respondent from Sea2Cradle about the steps that the other ship owners apart from Maersk Line take regarding ship recycling. The respondent replied that as per his knowledge, just two ship owners, Maersk Line and another Hong Kong based ship owner think about ship recycling from the cradle-to-cradle perspective, looking at ship recycling in a more active way, trying to bring ship recycling into the ship building and design process. Whereas, the other ship owners view the 'beaching' method of ship recycling as something that is not good for their company's image and so, they bring their ships to facilities where they can be recycled in a more controlled way, for example, in recycling facilities that are a member of the International Ship Recycling Association (ISRA).

Another issue that relates to the fact that shipbuilding is not a mass production industry, like cars, for example, is that it would be easier to prepare the Inventory of Hazardous Materials (IHM) for cars because the same type of car is built in large numbers and will have the same IHM while, in most cases, very few ships of the same design are built and even if they have the same design, it could be possible that the ships have components and subsystems from different suppliers. This makes it difficult to get a declaration of hazardous materials from the suppliers for every case as also shown in theory in section 2.4 of this report.

5.3.5 Better Communication of Ship Recycling policy

Many ship owners do take some steps regarding responsible ship recycling but they are not able to gain much advantage from such efforts. The author found that an important reason for this is the fact that not many stakeholders are aware of the issue of ship recycling and the steps container shipping companies take in this regard. It is therefore important to make

stakeholders, including customers, NGOs, suppliers and also employees aware of the end-of-life phase of ships so as to gain more recognition, to improve the end-of-life treatment of ships and thereby gain advantage from the efforts towards ship recycling.

On being asked about whether ship recycling forms a part of CSR for the company, the answer received was that it is a difficult question because it depends on how CSR is defined. In case of Maersk Line, they have separated social responsibility from the environmental performance and ship recycling can be seen in terms of both, the social dimension and its environmental impact. For example, Maersk Line has a social responsibility in that it would not want the use of child labour during recycling and to ensure the safety of its employees even when the ship is in the recycling phase. So, it can be concluded that ship recycling is a part of CSR for Maersk Line.

When asked about communicating their CSR practices to the different stakeholders, the company acknowledged that there is a possibility of gaining more recognition and that they are currently working on this aspect. When asked about the different stakeholders that they were looking at for recognition regarding ship recycling, the company replied that the primary recognition should be from their customers. The corporate responsibility manager at Maersk Line that the author interviewed felt that the customers of Maersk Line are still not very well aware about the topic of ship recycling. Although it has gained some space in the media, the topic of ship recycling is still very anonymous for the customers of Maersk Line. The company also said that they would like to gain recognition from some active NGOs working on a broad range of issues apart from just ship recycling as there is not so much media attention devoted to the topic of ship recycling yet. The respondent further explained that gaining recognition from one key stakeholder can easily spin off to recognition from other stakeholders as well. Keeping this in mind, it could be worthwhile to gain recognition from bodies like the IMO or the EU as this might spin off to commercial benefits as the customers might start asking about ship recycling.

6 Conclusion

This thesis was written with an aim to determine different measures that can drive sustainable ship recycling. The conclusions of this work are based on the literature, documents studied by the author and two interviews conducted by the author as presented in this report. The case company for this thesis is a large ship owner from the container shipping business and this thesis considers the problem of ship recycling mainly from the perspective of ship owners, specifically in the container shipping business.

In order to determine the 'sustainable' method of ship recycling, the author studied the different methods of ship recycling available in the context of container vessels and found that the *alongside* method is the most organised and controlled method of ship recycling currently available. This method of recycling is mainly practiced in China and is described as the green recycling method. The author would suggest further research carrying out detailed analyses of the different recycling methods available in order to certify which method is the most sustainable.

Further, this thesis studied the impacts that a ship recycling policy has on a ship owner. During this research, the author found that not many container shipping companies have a published ship recycling policy though they do take some steps in this direction. Moreover, it was found that this topic is not considered very important in the media and also by the customers of container shipping companies. Since some ship owners are already taking steps towards proper ship recycling of their vessels, this thesis proposed ways in which a ship owner can benefit from the proper communication of their ship recycling policy to different stakeholders which can also eventually lead to competitive advantage for ship owners. It was found that like in the case of other CSR activities, it is important that ship owners make their employees aware of the issue of ship recycling and the steps that they take towards responsible ship recycling. Moreover, it was found that ship recycling is important for ship owners in order to secure raw materials like steel that can become scarce in future. This thesis also proposed a decision making model for ship owners that they can use to manage their end-of-life ships.

This thesis looked at the problem of sustainable ship recycling from the systems engineering and lifecycle perspective. This work proposed ways in which valuable knowledge from the

end-of-life phase of ships can be fed-back to the design and construction phase of the ship in order to help Project Management of a new ship to make the ship easier to recycle.

Further, this thesis studied the principle of extended producer responsibility as applied to ships and the challenges associated with this approach. It was found that the current regulation and market scenario puts a greater responsibility for ship recycling on ship owners rather than the producers which in this case would be the ship building yards. Finally, this thesis looked at the other drivers of sustainable ship recycling as proposed by different stakeholders.

It can be concluded from this research that that the topic of ship recycling has started gaining attention of different stakeholders including ship owners, especially after the Hong Kong Convention was adopted in 2009. In the period until this convention comes into force, there will be heightened activity in the field of ship recycling. This thesis provides a positive basis for ship owners to act proactively and take up more responsibility for their end-of-life ships and start collaborating with the entire supply chain from the designers and ship building yards to the ship recycling facilities in order to make ships easier to recycle. This will prepare the ship owners for the Hong Kong Convention and also give them a competitive advantage if they can communicate this specific activity well to their customers. Most importantly, this will lead to an assured supply of raw materials like steel that can become a scarce commodity in future which is in the long term strategic interests of ship owners.

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Appendix

Appendix 1: Transcript of interview with the case company, 11.00-11.50hrs, 13.04.2012

Representative from the case company who was interviewed: *Cecilia Müller, Corporate Responsibility Manager, Maersk Line*

Interviewer: *Madhur Ahuja, Masters Student, NTNU*

Also present during the interview: *Professor Annik Magerholm Fet, IØT, NTNU*

Transcripts of the interview with Maersk Line could not be published in this report due to reservations expressed by the company.

Appendix 2: Transcript of interview with Sea2Cradle, 12.45-13.30hrs, 08.05.2012

Representative from the company who was interviewed: *Tom Peter Blankestijn, Managing Director, Sea2Cradle*

Interviewer: *Madhur Ahuja, Masters Student, NTNU*

Also present during the interview: *Professor Annik Magerholm Fet, IØT, NTNU*

This appendix presents the transcripts of the telephonic interview conducted as per details mentioned above. The telephonic interview was recorded and the transcripts were then sent to the respondent for review. This transcript presents the questions asked and answers given during the telephonic interview in the exact order in which the interview was conducted.

This version of the interview transcripts includes the clarifications given by the case company after the first version of the interview transcripts were sent to the case company for review and comment.

Question 1

What can you tell about the differences between beaching and the other methods of ship recycling, e.g. the alongside method, dry dock?

Answer

On the beach you have a plot and the recycling facility is not bigger than about 30m wide and 100m long. There are no fixed cranes on the beach and normally everything that they cut loose drops and it falls by gravity and so it is a rather uncontrolled breaking process also to get hazardous materials offloaded by not having cranes high enough to offload it, which means that it finds its way down in another way.

The alongside method in facilities in China have more port infrastructure. Here facilities can be as as big as 1 sq mile where they can recycle more than a 100 ships in a year v/s in India where they can do 3-4 ships a year. So, the infrastructure is such that if you are alongside the key, you can use portable cranes to move alongside the vessel which are high enough to reach the highest point of the vessel which also means that you can offload more easily. If the ship is still in water and you want to reach the highest point and you are on the key side, you have already bridged a part of the height of the vessel because the vessel is to drop within the alongside which is about 5-7 mts, we have the key side and then the rest of the vessel. So, to

bridge the height, it is easier to get the hazardous materials and potentially hazardous materials offloaded and all kinds of other materials as well. In addition, it is easier to put escape routes on and off the vessel alongside the key than if you start cutting the vessel on the beach, the vessel will not move anymore. It is stuck firmly on the ground. If you have it floating alongside, you can cut the vessel in such a way that the vessel is trimmed in a way that it will be its own containment so no loose materials will fall out because it will fall inside the vessel which you can easily clean. If you cut the vessel completely open on the beach, the tidal zone is washing the water in and out which takes a lot of loose material with it as well. Those are the main differences in the breaking methods.

Question 2

Are the dry dock and alongside methods the same?

Answer

No, they are different as well. In a dry dock you have a similar kind of problem as beaching because you cannot trim the vessel. I have seen the MSC Napoli been broken up in the Harland and Wolff yard (by the way, that's the same yard where the Titanic was built). When they broke or cut the front of the vessel inside the dock, but, as it was completely open on one side, a lot of dirt and other materials that were there in the double bottom continuously polluted the dock and so they were cleaning the dock more than they were cleaning the vessel. So, overall it was a very lengthy process to do it in a dock and thus leaving the alongside method as the most flexible in operation and the biggest control that we can get.

What we do in China with the last double bottoms is that we put it in a dry dock, but small floating dry docks which means that you only have to submerge it slightly in order to insert the double section in and then you can cut that on the dry dock as well.

Question 3

Have there been any studies to find out which method is the best because the alongside method is claimed to be the 'green recycling method'?

Answer

The other alternative is the '*slipway*' (which you haven't mentioned) where it should not be in a tidal zone like in Aliaga in Turkey where the difference between the high and low tides is

maybe 4cm, so you don't even notice it. And there you can make the infrastructure as such that you always work on a concrete area with enough drainage to capture all kind of spillage.

Studies have been performed on some locations but the Bangladeshi, Pakistani and Indian governments have not been willing to say cooperate in seeking the pollution in the area and in the surroundings including the coral reefs outside the beaches.

Comment (from the interviewer) 4

The slipway method was not considered because China and countries in the Indian subcontinent are major players in the ship recycling industry and Turkey does not have such a big share.

Answer

Turkey recycles quite a large number of ships which are not that big but, say for regional and domestic breaking capacity, the slipway could be an alternative.

Comment (from the interviewer) 5

But it can be done only in that area of Turkey because of the tidal difference.

Answer

Correct. Belgium is doing the same.

Question 6

What about the differences in processing of materials after they have been removed from the ship - between the alongside and the beaching method?

Answer

So far what I have seen in Alang and Chittagong is that they sell it immediately from the yards to small handlers outside of the gate, except for the steel, but the other loose materials immediately go to handlers. In India, a couple of years ago they made one big landfill in which they put all hazardous materials. They put in a liner but they forgot to put in a drainage system to deal with rainwater.

If I look at the disposal and waste handling facilities in China, you can get direct contracts with facilities that deal with batteries and mercury etc. So that it is far more controlled at a

higher level, directly procured and under control of the State Environment Protection Agency and that guarantee I do not get in Pakistan, India or Bangladesh. Pakistan even admitted that they did not have any decent disposal/waste handling facilities. In Bangladesh we know that they are not available. There are some in India but not handling all hazardous materials.

Question 7

Talking about documentation like the Ship recycling Plan (SRP), Ship Recycling Facility Plan (SRFP) that the Hong Kong Convention (HKC) talks about, what is the current scenario regarding this comparing China against India, Pakistan and Bangladesh?

Answer

The HKC has not come into force yet so most of the times it is on a voluntary basis or based on local requirements to get permits to operate. Not all facilities have the SRFP ready. They might have some documentation that if you add all of them together, they will fill up the SRFP but not many have those, not even in China. I just finished writing the SRFP for the facility that we use in China. They had all the information there. We just had to put it in paper so that it follows the right order.

Question 8

I am also looking at ways in which ships can be designed to be 'easy for recycling'. Is there a way to feedback information from the recycling yards to the ship designers and ship building yards?

Answer

When ships are built, they are built normally for the safety and health on board and for operation of the vessel which is not the same as the health and safety of the people who break the ships. An example is that sometimes you see insulation material which is glued to the hull of the vessel. So, you have to scrape materials like glue apart in order to start cutting the steel or hot cutting the steel with torches. If you leave material still on there (like glue) that can start melting and if you then inhale that, it can cause a hazard for the workers or it catches fire and fire is a drastic thing because it is an uncontrolled situation. So, anything that is glued and that you can pin it instead, that would be the safe way. Another example is that a lot of piping is covered with insulation material and materials that you cannot easily reach that makes it cumbersome. Also, some piping is put so high up in the engine room that you have

to use torches high up to cut them. So, there are quite a number of design issues which we should bring back probably to the table of IMO to change present legislation and to bring recycling also into legislation to allow for design and building of new ships with a vision for the complete cradle-to-cradle concept. I am working on a project with the University of Tianjin and the University of Delft to bring recycling into the design process.

Question 9

What are the other ship owners apart from Maersk doing about ship recycling?

Answer

There are quite a number, some Norwegian owners are active, the Japanese carriers are very active although the government sometimes wants something else, there are many examples like NYK, Wilh. Wilhemsen, Willenius, Fugro, oil companies like Shell, Total. I know that Swire from Hong Kong are looking at recycling in a more active way, also to bring it in the building process. Maersk and Swire are the only two companies that look at the cradle-to-cradle concept. The other companies just look at the fact that it is very bad for their image to put the ship on the beach and that is why they have a policy not to beach the vessel but bring it to a place where recycling is more controlled. There are owners that deliberately look for recycling facilities that are a member of the International Ship Recycling Association (ISRA).

Question 10

Because a ship can have many different owners during its lifetime and so, it can be difficult to pinpoint responsibility; can it be possible to make the ship building yards responsible for ship recycling?

Answer

Yes it can. In the (end-of-life) phase the owner(s) have the legal obligation to maintain the Green Passport. Discrepancies need to be sorted out responsibility, but, it is the last owner who will need to make the IHM complete for recycling.

If you look at the future, all legislation on recycling is being brought back to producer responsibility. Eventually, I am convinced that it will happen for ship building as well but we have a lot of catching up to do and if we start doing that now, a lot of ships that are 25-30

years old, it is possible that those new building facilities do not exist anymore. So, you will have to find an interim regime to deal with that.

It is true that a lot of ships pass ownership and that's why in the HKC we brought in the aspect of IHM of existing ships. We call it the Green Passport but that's more of a commercial term than anything else. Passport just because it travels with the ship and green just to give the image of green but it is nothing more than an inventory. IMO made a limitation of that of only 4 commodities that were already banned for being on ships. But we know that we still find them there. Even on new built ships, we find a lot of asbestos still put in the structure of the vessel. So, there is a need to follow that but there is also a discussion of hazardous materials which you should identify because radioactive materials or mercury, in my perspective are equally bad for the environment and human health as PCB, asbestos and ozone depleting substances.

Question 11

What advice would you give to the ship owners for ship recycling? What can they do better in the current scenario?

Answer

All the shipowners have CSR and environmental statements on their websites as being a part of their corporate policy. But then how is it that so many ships still pollute the Indian subcontinent and other places where there is no control? So, putting the activity of recycling v/s diplomacy is already the first step that they can take and take responsibility for the waste generated from the end-of-life ships. To accept that principle is the first big step in dealing with recycling and then if they accept that, they can go one step further in accepting responsibility of the waste management.

Most ships today are sold on the basis of Light Weight Tonnes but ship owners can get a higher value of their second hand ships if they can identify raw materials and they have a better knowledge about their ships. But, this doesn't dismiss the owner from taking responsibility.

The maritime sector is quite conservative. If you compare the IHM of ships v/s cars, it is easier to make an IHM for cars as the same type of car is manufactured in large numbers and in the case of ships, every ship is unique.

Another point to consider is that even if we consider say, 20 ships of the same kind, there might be different suppliers for different systems in different ships. That makes it difficult to get a proper declaration of materials from the different suppliers. And even for new built ships, they claim zero asbestos, for example, but we have still found asbestos on board ships in packing etc.

Question 12

What more can the ship owners do?

Answer

The ship owners can raise awareness about hazardous materials on board existing ships, for example asbestos, as it has related hazards from the ship building phase, during operation and during the end-of-life phase. So, the ship owners can suggest precautions.

They can also contribute towards making IHM for existing ships.

It is about the difference in taking your responsibility for proper waste management or letting someone else pay for it and for the related pollution.

It is also possible to do a proper planning in the design phase for example, instead of cutting cables into smaller pieces, let the cables be in one long piece so that it is possible to draw one large piece of clean copper or aluminium from the cables.

Appendix 3: Sample data about Container Ships scrapped in the past (Fairplay, 2012)

Table 5: Sample data about Container Ships scrapped in the past

Ship Name	Flag State	Owner/ Operator /Manager	Built Year	Year of recycling	Years in operation	Recycling Country, Price (USD)
Ankara	Bahamas	AP Moller (Denmark)	1976	2009	33	Pakistan 4,145,580
Aphrodite I	Malta	Evergreen Marine Corp. (EMC) (Chinese Taipei)	1984	2011	27	China
Apollon I	Panama	EMC (Chinese Taipei)	1980	2009	29	China
Aramis	Panama	EMC (Chinese Taipei)	1984	2012	28	China 6,095,350
Aris I	Panama	EMC (Chinese Taipei)	1983	2009	26	Pakistan
Artemi	St. Kitts & Nevis	EMC (Chinese Taipei)	1987	2010	23	India 3,135,160
Athena I	Panama	EMC (Chinese Taipei)	1980	2010	30	China 5,188,050
Athos I	Panama	EMC (Chinese Taipei)	1983	2010	27	China 5,378,250
BangaBorak	Bangladesh	EMC (Chinese Taipei)	1984	2012	28	Bangladesh
Alianca Urca	Brazil	Hamburg Süd (Germany)	1981	2008	27	India 2,088,000
Cap Blanco	Malta	Hamburg Süd (Germany)	1984	2009	25	India 4,100,865
Cap Brett	Cyprus	Hamburg Süd (Germany)	1979	2006	27	Bangladesh 4,074,840
Cap Domingo	Liberia	Hamburg Süd (Germany)	1984	2009	25	India 4,239,314
Heron	St. Kitts & Nevis	Hapag-Lloyd (Germany)	1986	2011	25	India
Anl Explorer	UK	CMA CGM (France)	1985	2009	24	China 3,309,055
Australian Endeavour	Australia	CMA CGM (France)	1969	1985	16	China 1,700,000
Bergen	Panama	CMA CGM (France)	1979	2006	27	Bangladesh
Chicago Express	Bahamas	CMA CGM (France)	1972	2001	29	India 2,640,000
ACX Apricot	Singapore	NYK Line (Japan)	1974	1997	23	Bangladesh 2,856,000
ACX Lotus	Panama	NYK Line (Japan)	1973	1998	25	India 2,095,000
ACX Ruby	Panama	NYK Line (Japan)	1975	1999	24	India
ACX Tsubaki	Panama	NYK Line (Japan)	1980	2009	29	China
Andalucia I	Panama	Mediterranean	1978	2009	31	India

		Shipping Co. (MSC)(Switzerland)				2,822,960
Ansovy	Panama	MSC (Switzerland)	1972	2007	35	India
Baleares	Marshall Islands	MSC (Switzerland)	1978	2009	31	India 2,364,922
Barbarossa	Liberia	MSC (Switzerland)	1981	2009	28	India 1,704,720
Cape Race	Liberia	MSC (Switzerland)	1993	2012	19	Not Available
MSC Shaula	Panama	MSC (Switzerland)	1977	2011	34	India 4,438,640
MSC Carole	Panama	MSC (Switzerland)	1980	2011	31	Bangladesh
MSC Alpana	Panama	MSC (Switzerland)	1978	2011	33	Bangladesh
MSC Paola	Panama	MSC (Switzerland)	1978	2011	33	India 5,165,320
MSC Aurelie	Panama	MSC (Switzerland)	1979	2011	32	India 9,101,160
Da Li	Belize	Orient Overseas Container Line(OOCL) (Hong Kong)	1977	2002	25	China 1,120,000
Da Sheng	Belize	OOCL (Hong Kong)	1977	2002	25	China 1,132,847
Faith	Dominica	OOCL (Hong Kong)	1987	2009	22	China 3,609,095
Franconia	Liberia	OOCL (Hong Kong)	1979	2009	30	China 2,153,320
Award I	St. Vincent & the Grenadines	OOCL (Hong Kong)	1974	1997	23	Bangladesh 801,000
Fame	Greece	OOCL (Hong Kong)	1972	1998	26	India 3,666,000
Frontier	Greece	OOCL (Hong Kong)	1972	1998	26	India 3,666,000
Irenes Symphony	St. Vincent & the Grenadines	OOCL (Hong Kong)	1972	1997	25	India 1,970,000