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PRACTICES TOWARDS CLEANER SHIPS AND SUSTAINABLE SOCIAL DEVELOPMENT

By

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DECLARATION

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the university.

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ABSTRACT

Title of Dissertation: Practices towards Cleaner Ships and Sustainable social Development.

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This dissertation studies the need of developing a life cycle approach in shipping to achieve sustainable development goals. It focuses on the End-of-the-life management practices currently prevalent in the shipping industry and examines the possibility of emulating systems that have been developed by the automobile industry.

It delves into the development of pollution prevention policies from the polluter pays principle to the current emphasis on Cleaner Production techniques. Extensive resource utilisation and waste generation arising from a product-based society has led to the search of new environmental strategies. One such strategy detailed in this study is Extended Producer Responsibility (EPR) where the producer takes upon a degree of responsibility for managing environmental impacts throughout the lifecycle of his product. EPR forms the basis of “Take back” legislations enforced by governments for several products. The EU end-of-the-life vehicle Directive is one such legislation from where initiatives can be drawn in shipping. Existing guidelines on ship recycling are looked into and the need for mandatory international legislation is emphasised. The research studies the applicability of the tools of EPR such as life cycle assessment and recycling funds.

Collection of materials necessary for the research has been primarily through literature reviews. A questionnaire constituted to solicit opinion on the topic received low return rates. Therefore conclusions have been drawn by comparative analysis of relevant topics from the referred texts. The research contends that the shipping industry should assimilate several good points that have been successfully applied to the end-of the life management of cars. The study brings out recommendations for implementation and identifies challenges for further research.

Key words: Cleaner production, extended producer responsibility, end-of–the-life management, recycling funds, sustainable development, life cycle assessment.

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List of Abbreviations

ARN	Auto Recycling Nederland
CFC	Chlorofluorocarbons
CP	Cleaner Production
CO2	Carbon-di-oxide
DSD	Duales System Deutschland AG
DWT	Deadweight
EEA	European Environment Agency
EPR	Extended Producer Responsibility
EU	European Union
EAC	Ecotoxicological Assessment Criteria
ELV	End-of-the-life vehicle
ESM	Environmentally Sound Management
HCFC	Hydro chlorofluorocarbons
GT	Gross Tonnage
GWP	Global Warming Potential
IOPC	International Oil Pollution Compensation
IDIS	International Dismantling Information System
IMO	International Maritime Organisation
ILO	International Labour Organisation
ISO	International Standards Organisation
LCA	Life cycle assessment
LDT	Lightship deadweight tonnes
mg	Milligram
mT	Million tonnes
MEPC	Marine Environmental and Protection Committee
NOx	Nitrous Oxides
NH_3	Ammonia
OSH	Occupational Safety and Health
OSPAR	Oslo-Paris Convention
OECD	Organisation for Co-operation and Development
PPP	Polluter Pays Principle
PCB	Polychlorinated biphenyls

PAH	Polycyclic Aromatic Hydrocarbons
PVC	Poly-Vinyl Chloride
P&I	Protection and Indemnity
R&D	Research and Development
SO2	Sulphur-di-oxide
TBT	Tributyl Tin
TBTO	Tributyl Tin Oxide
TBCL	Tributyl Tin Chloride
UNEP	United Nations Environment Programme
UNEP/ IE PAC	UNEPs Industry and Environment Programme Activity Centre
μg	Microgram

CHAPTER 1
INTRODUCTION

1.1 Background

The slow but rising awareness to move away from "growth at all costs" policies has led to sustainable development gaining centre-stage in the development approaches at the national and international scene. It requires among other things, an emphasis on eco-efficiency i.e the efficiency with which we use energy and a wide range of materials from nature and how we minimise waste (European Environment Agency [EEA], 1997, p.9).

Focus on minimisation of waste led to a departure from the end-of-the pipe solutions offered by the "polluter pays" principle to "cleaner production" techniques (Kryger, 1992, p.6) accompanied with further demands on increasing the eco-efficiency of products through out their life cycle (EEA, 1997, p.9). The lifecycle of a product involves an entire range of activities encompassing extraction of raw materials, design and formulation, processing, manufacturing, use, collection, reuse, recycling and ultimately waste disposal.

Such an integrated life cycle management has given rise to the Extended Producer Responsibility (EPR) approach, where the producer takes responsibility for managing the lifecycle environmental impact of products ranging from upstream impacts arising from the selection of raw materials to the downstream impacts that can be attributed to the recycling or disposal of the product (Davis, 1998, p.33). “Take-Back” legislations enforced by governments have also led to this feeling of product stewardship amidst producers sinking in (Neitzel, 1992, p.53).

Especially so in the case of *complex goods* which have a long usable life span and have complex designs comprising several different components (Ryden, 1995, p.1). Cars are one such example, the waste disposal management of which reached menacing proportions in many industrialized countries during the sixties. The EPR management approach worked extremely well in the Netherlands to manage end-of-the life vehicles by coordinated action of all stakeholders (ARN, 2005, p.32).

Ships are complex products too and the sustainable management of them requires a “cradle to grave” approach. Ships are an energy efficient means of transport. (Murlis, 2005, pp. 34-37). Corporate social responsibilities might enable a beneficial shift of freight to reduce greenhouse gas emissions (Seum, 2005, p.41).

However, shipping is still a major contributor to emissions in regions where it is in frequent use (Donkers, 2005, pp. 59-61). Most solutions adopted with respect to emissions are the typical piecemeal solutions where reductions in one source work to the detriment of the other. For example certain methods to decrease NOx emissions result in an increase of CO2 emissions and sulphur emissions are still considered to be a regional problem. Besides, legal and illegal discharges of ship and cargo generated wastes continue unabated into the marine environment (Wilkins, 2005, p.95).

Shipping has a reactive approach to emissions and waste management with short term goals in mind. Control strategies have strived to mitigate impacts in each individual stage with scant attention to the ensuing effect on the other stages of the product chain. The traditional management of viewing wastes in a narrow context based on the medium (such as water and air) in which they end up has led to practices that shift pollutants from one medium to the other (Davis, 1998, p.33).

Obviously, with existing practices as a background, it is necessary for the shipping industry to apply sustainable tools such as life cycle assessment (LCA) to calculate the environmental load along all the phases of a product, process or an activity. Both for shipping companies and for shippers, it will help document that the activity undertaken takes place in accordance with sustainable principles (Ellingsen, Magerholm & Fet, 2002, p.2).

Perhaps the most negative aspect that stands out today is the manner in which the shipping industry today handles the end-of-the-life management of ships. The work practices in the Asian ship recycling yards leave much to be desired. Thus the social dimension of sustainable shipping at this crucial phase stands clearly neglected. Though governments in these recycling yards are equally to be blamed for the misery, such an approach does little help to aid the image of sustainable shipping. It goes against the spirit of United Nation's Environment Programme's (UNEP) Cleaner Production Programme as hazardous waste products make their way to countries having slack environment and social protection rules (Kryger, 1992, p.6).

New strategies are needed to be put in place to reduce consumption of virgin raw materials and ensure maximum utilisation of waste followed by clean methods of disposal. Extended Producer Responsibility is one such strategy that can be prescribed for managing end-of-the-life ships. This can be given teeth by maritime legislations that can draw parallels from the EU directive on end-of-the-life vehicles. Social and ethical issues are becoming an important part of the debate along with wider stakeholder involvement and environmentalism in shipping too will have to increasingly embrace ethics (Seum, 2005, p.41).

1.2 Aims and Objectives

This dissertation attempts to carry out a study of the end-of-the-life management of ships that exists today and seeks to borrow ideas from other spheres which have been successful in managing the same. Enumerated below are a few broadly defined objectives of the study:

- To compare between end-of-the-life management of ships and cars and find if there exists a possibility to borrow and apply good management practices from the automobile industry.
- To bring out applicability of sustainable tools such as LCA that can aid in building cleaner ships and have an integrated approach to pollution and waste prevention.
- To study existing regulations affecting this activity and access the needs of funding.
- To draw conclusions from the study and make recommendations based on the analysis.

1.3 Methodology

The design of this research is primarily based on documentary review, a questionnaire survey and few interviews.

Considerable emphasis has been placed on literature review in collecting the necessary data. To be able to identify the materials and issues of particular relevance to my topic required reference to documents pertaining to car recycling and ship recycling practices. These materials including journals, textbooks, conference papers and other academic papers were obtained from the university library. A number of journal articles and documents related to my research topic have been accessed via electronic means through the internet.

A set of questionnaires (see Appendix 1) has been evolved to elicit opinion on the issues raised. The return rate of the answers has been below the desired level. However, there has been considerable unanimity in the opinions expressed in several questions. I have therefore given a brief mention of the same in the form of an appendix. A few telephonic interviews were conducted with informed persons of the industry to clarify matters which I had not been able to put in the right perspective from the document reviews.

Key topics from the data sources were abstracted and relationships established between them to carry out a comparative analysis. Underlying assumptions of the selected texts, the significance of the arguments to the chosen topic and their relationship with each other were examined to analyse and select key elements. Identification of relevant elements has been made possible by the comparative analysis of the texts concerned. Through inference and evaluation the collected data could be placed into a context relative to the research objectives.

1.4 Scope and Limitations

The scope of sustainability in shipping is a broad topic. However, this dissertation restricts its focus on the end-of-the-life management and the application of LCA. The research has been undertaken on a small scale. Hence, the use of documentary reviews to derive the potential benefits arising out of secondary analysis was needed to be exploited.

CHAPTER 2
DEVELOPMENT OF DIFFERENT PRINCIPLES OF POLLUTION PREVENTION

2.1 Polluter Pays Principle (PPP)

As industrialised economies developed, widespread pollution emanating from the production, consumption and disposal of the products heralded the need for development of policies and strategies aimed at reducing the menace at the place of occurrence by either diluting or dispersing the pollutants to diminish risks (Lindhqvist, 2000, p.33).

In the 1970s, the "Polluter Pays Principle" (PPP) was developed by the OECD and the same has been the guiding principle for pollution control policies. The basic idea behind PPP was to internalise external costs of pollution. It warrants that the polluter should bear the expenses of preventing and controlling the pollution to ensure that the environment is in an acceptable state (Davis, 1998, p. 29).

This is a traditional management of wastes with the focus on the production process and the pollution discharged. It is a control strategy and brings about a reactive approach to pollution. It is applied at the back end of the industrial process and lays emphasis on the collection of generated wastes and then applying control strategies such as dilution, detoxification or solidification (Kryger, 1998, pp 6-7). In shipping, fines for air pollution or oil pollution are based on the polluter pays principle.

The PPP focuses on the controlling of pollution outputs at the facility level from each individual firm without any regard to its linkages to the product chain. It further views wastes quite narrowly in separate terms and under different regulatory schemes depending on where they end up- air, waterways or the land. Such a focus has resulted in:

- Ignoring the upstream and downstream impacts of the product chain.
- Shifting of the pollutants from one medium to another due to segmented approach applied along the product chain. (Davis, 1998, pp. 29-30)

For e.g. the builder of a ship may reduce the emissions at its production facility but the ship during its entire lifetime would continue to have significant emissions. Thus the downstream effects have been ignored. The PPP does not create incentives for the producers to address basic choices of materials and product designs which influence the whole life cycle environmental impacts of the product cycle. This principle is not adequate to deal with situations in which a useful product embodies pollution or becomes pollution itself at a later stage in the life cycle (Davis, 1998, p. 31). An end-of-the-life ship is an example where the hazardous materials render the ship as a waste in itself. Therefore in order to address the root cause of the problem, the need for new approaches became apparent.

2.2 Cleaner Production (CP) Approach

This approach focuses on the product and the problems which will occur during repair, reuse and disposal. It finds application at the front end of processes and at the idea stage of products. Cleaner production is thus preventive rather than reactive with the focus on the entire system rather than an isolated stage or an output (Kryger, 1998, p.7).

This approach in the initial stages strategies involved in the development of low and non waste technologies, waste minimisation and pollution prevention. Later on, several companies big and small in the eighties adopted such preventive strategies with a broader approach that was not so technology intensive. Financial benefits were reported due to:

- Decreased environmental abatement costs.
- Reduced use of energy and raw materials (Lindhqvist, 2000, p.16).

The new mantra was pollution prevention pays. Since the mid-eighties, Sweden has been the pioneer in encouraging cleaner development mechanisms. Other nations such as the Netherlands, Finland, Germany and Norway also reported notable successes in this field. The United Nations Environment Programme Industry and Environment Programme (UNEP/ IE PAC) have since 1989 given immense emphasis to the cause in its Cleaner Production Programme (Lindhqvist, 2000, p.17).
The definition of cleaner production as formulated by United Nations Organisations is:

> Cleaner Production (CP) is the continuous application of an integrated preventive environmental strategy applied to processes, products and services to increase eco-efficiency and reduce the risks to humans and the environment. For processes, CP includes conserving raw materials and energy, eliminating toxic raw materials and reducing the quantity and toxicity of all emissions and wastes.
> For products, CP involves reducing the negative impacts along the life cycle of a product, from raw materials extraction to its ultimate disposal. For services, the strategy focuses on incorporating environmental concerns into designing and delivering services (as cited in Lindhqvist, 2000, p.17).

Cleaner production strategies strive to stop the pollutants from being generated rather than spreading them in nature. It encompasses an entire gamut of activities from application of technology to managerial skills and policies to effectively implement the same (Kryger, 1992, pp.7-8).

Development of double hull tankers in shipping after the forceful intervention of the Oil

Pollution Act (OPA), 1990, by the USA can be one example of such approaches. However, this development has to be viewed in its totality. The manufacture of a double hull results in increased welding and therefore increased toxic emission during the welding process. Added loads would be greater consumption of virgin minerals, more transportation and emissions. Extended Producer Responsibility and life cycle assessment pay more attention to such analysis.

2.3 Extended Producer Responsibility (EPR)

EPR as a defined policy strategy was introduced by Thomas Lindhqvist in a report to the Swedish Ministry of the Environment in 1990. The concept implies that responsibilities which were traditionally assigned to consumers and authorities responsible for waste management are to be shifted to the producer of the products. The concept can be defined as:

> Extended Producer Responsibility (EPR) is a policy principle to promote total life cycle environmental improvements of product systems by extending the responsibilities of the manufacturer of the product to various parts of the entire life cycle of the product, and especially to the take-back, recycling and final disposal of the product (Lindhqvist, 2000, p.v).

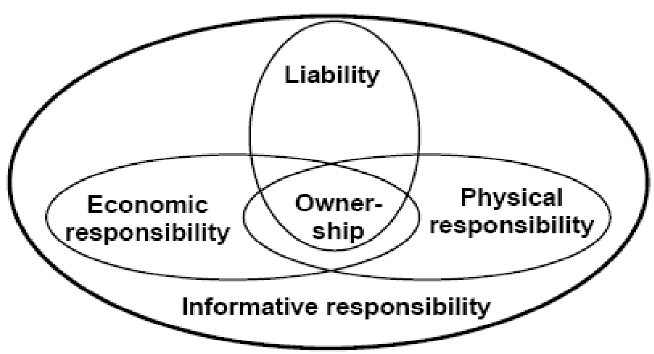

Figure 1- Model for Extended Producer Responsibility
Source: Lindhqvist, T. (2000). *Extended producer Responsibility in Cleaner production.* Doctoral Dissertation. (p.iii). Lund University, Lund, Sweden.

Producers accept their responsibility when they design their products to minimise the life cycle environmental impacts and when they accept legal, physical, economic or informational responsibility for the environmental impacts that cannot be eliminated by design (Davis, 1998, p.32).

2.3.1 Need for an EPR

Production facilities which have been targets for pollution reduction have been very successful in reducing their pollution levels for example in Sweden it has been estimated that in 1990, there has been a 70% reduction in the emissions emanating from the most polluting industries as compared with 1970 levels (Lindhqvist, 2000, p.19). However, besides the manufacturing stage, there existed environmental impacts in the entire life cycle of the product. This was made more complicated by:

- The time aspect of the usage and
- The time dimension of the impacts.

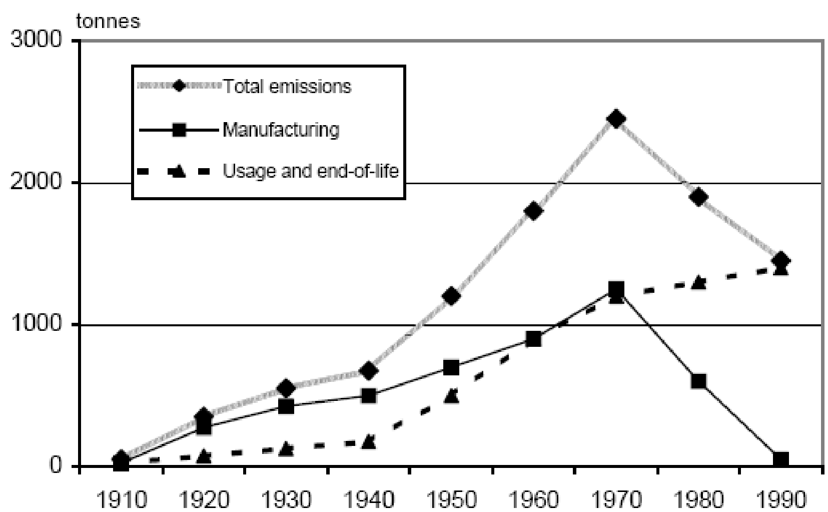

Figure 2- Estimated emission of Chromium in Sweden.
Source: Lindhqvist, T. (2000). *Extended producer Responsibility in Cleaner production.* Doctoral Dissertation. (p.20). Lund University, Lund, Sweden.

As shown in Figure 2, the process related emissions were reduced for chromium since 1970 though there is a relative increase in the usage and the end-of-life management has continued to increase.

Focus for the end-of-the-life treatment in the eighties led to concentrating efforts on waste incineration with energy recovery and separation of recyclables. Tighter air emission regulations led to necessary preparations made prior to incineration. The emissions of mercury were traced back to batteries and thus the first “take back” of batteries by manufacturers began to take shape. Also demands were placed on manufacturers to reduce the mercury content of batteries (Lindhqvist, 1998, p. 4). Similar cases of producer responsibility were applied for aluminium cans and Polyethylene terephthalate (PET) bottles in Sweden.

Most discussions of EPR rely on and refer to the pioneering German initiatives on packaging. The Dual system (DSD-Duales System Deutschland AG) has produced exemplary results since its inception in 1991 (Lindhqvist, 1998, p. 4). The same ideas have been prevailing in the field of phytosanitary compounds and in pharmaceuticals where producers are obligated to invest increased resources in the pre-market assessment phase (Pesso, 1998, p. 16). Similar success was replicated in the Dutch end-of-the-life vehicle treatment system. This system is elaborated in chapter 4.

The reasons for making the producer responsible are:

- Producers have the knowledge about their product systems.
- Complex products require special design for end-of-the-life management.
- Waste handlers do not have actual control over the discarded products.

2.3.2 Who is the producer?

The general idea is that if a firm in the early stages of production process is made liable, it will have an incentive to minimise costs. These costs may be reduced by judicious selection of raw materials, design or processing of goods. In order to reduce transaction costs and to increase the efficiency of recycling, it is essential to place the legal liability directly on the party that enjoys comparative advantage. With free competition the costs will be ultimately passed down to the end consumer (Lidgren & Skogh, 1998, pp.13-16).

In addition, in order to establish liability, the right to transfer liability by contract must be limited. For instance a legally liable shipowner contracts with other firms for dismantling and disposal of wastes and it is discovered later that the recycling has not been completed or has been inefficient because of incompetence, fraud or insolvency. Thus it is essential that though the principal is provided with the freedom to contract, he does so at his own risk. In a system where a party is solvent and is able to control others at a low cost, it is efficient to make this "principal" liable. Furthermore, public enforcement is simplified and supervision is concentrated on a solvent party which has control over its contractors (Lidgren & Skogh, 1998, p.16)

In the case of shipping, shipowners enjoy the comparative advantage and can exercise the necessary control over others in the chain. During its entire operable lifespan, the ship lies in the hands of the shipowner who remains responsible for her upkeep. Shipowners also have the adequate expertise and have to liaise effectively with all the stakeholders of shipping. Hence it is natural to place the burden of responsibility on the shipowner. However, there is also the need to place some responsibility on the shipyards to actively engage them in the development of cleaner ships.

2.3.3 Important Tools of an EPR

Life cycle Assessment (LCA)

Extended producer responsibility mandates that producers bear a degree of responsibility for the environmental impacts of their products throughout the life cycle of the product (Davis, 1998, p.32). Establishment of responsibility is only possible with the knowledge of the actual environmental consequences a product may have along its lifecycle. Life cycle assessment is an important information tool to trace the contours of responsibility (Pesso, 1998, pp. 19-21). LCA of a ship is described in greater detail in Chapter 6.

Guarantee funds

Recycling funds are one essential mechanism to ensure that it is financially feasible to carry out end of the life management of a product. There are many ways to ensure that there exist adequate financial reserves for the scrapping of a product. Equity funds, mutual funds with the participation of all the actors or eco-cycle insurance are a few viable alternatives. This topic is described in greater detail in Chapter 7.

2.4 Advantages of EPR

In addition to being resource efficient, it also helps ease the burden on public authorities. Since producers retain legal or even physical responsibility for their products from the cradle to the grave, the costs of meeting the requirements are fully internalized into the cost of the product.

EPR has the characteristics of a *performance standard* which is quite different from design based standard or command and control regulations. This leaves producers with the desired flexibility to optimize on inexpensive approaches and to innovate (Lifset, 1992, p.33).

EPR strives to attain environmentally conscious product development so that the real improvements needed for sustainable development can be achieved. Introduction of instruments that encourage producers to adapt such an approach is essential (Lindhqvist, 1992, p.3).

EPR as a tool of sustainable development has to find its place in shipping so that a life cycle perspective from the cradle to grave can be developed which will include all processes of design, manufacturing, use, disposal and reuse.

CHAPTER 3

END-OF-THE-LIFE MANAGEMENT OF SHIPS AND CARS

This chapter gives a brief picture of the end-of-the-life management approaches that are currently being followed by ships and cars. The car has been chosen as a comparable model as cars can be classified as complex products along with ships. They are both made of different components and have a long life span. (Ryden, 1998, p.75). But, there exist stark contrasts in the life cycle management of the two units. A comparative analysis is thus carried out so as to draw out the unique aspects of the end-of-the-life management of cars.

Of all the stages of a ship's life cycle viz. designing, production, use and final disposal, it is the end of the life stage that is the least regulated and has immense environmental and social impacts.

3.1 End- of-the-Life-Management of Ships

3.1.1 History

Location of ship scrapping centres has been fairly transient and has followed regions of high scrap demand and low labour costs. It found its home in the growing economies of Europe in the sixties and was then relocated to Taiwan and Korea in the early eighties. In the nineties, countries like China, India, Pakistan and Bangladesh were able to exploit the advantages of cheap manpower resources to take business away from the technologically efficient Taiwanese ship breaking yards (Chhabra, 2002, pp. 4-7). This move also relegated ship-breaking to the beaches of South-East Asia where it evolved into a primitive and dangerous occupation.

3.1.2 The Chain (Role of the Intermediaries)

A range of intermediaries are employed between the ship-owner and the recycling yard to complete the disposal process. A ship-owner in most cases appoints a broker and the broker may further deal directly with the breakers or take the help of a specialist intermediary. Depending on the market leeway he enjoys, a breaker too might deal via a broker or a specialist agent (Drewry, 1996, pp. 58-59).

Purchases are sometimes made possible only upon the availability of a customer. To cover this time, a scrapping entrepreneur finances to purchase the vessel in either "as is" or "as is where is" condition in lay up or after discharge of the last cargo. Such middlemen then make arrangements to tow the vessel to the demolition yard after a letter of credit has been opened with the scrap buyer (Drewry, 1996, pp. 59-60). Thus a single deal may involve a "chain of intermediaries" (Drewry, 1996, p. 59) with little or no information sharing between the actual owners and the breakers after the deal leading to further complications during the dismantling.

3.1.3 The Process

As mentioned earlier, the move to South-East Asian countries heralded a change in the working practices. The ship is run up to the beach usually at full speed and at high tide. The vessel can be moved further into the beach by usage of more chains fixed to the winches and passing them through a hole cut at the bow of the ship. Structural work starts off once the ship is secured. Work commences from the bow and moves backwards to the stern (Drewry, 1996, p.46).

At Bhatiary beach in Bangladesh, a typical approach would be:

- Removal of movable items as the beaching finishes.
- Cutting up of the vessel into large sections and then winching them further up the beach.
- Cutting of the plates to uniform size.
- "Scrap cutters" further cut through the heavier parts for re-rolling thus enabling further movement up the beach (Drewry, 1996, p.51).

Before work commences within the ship, openings of the size of six-by-ten foot are cut out in the hull. This serves as a vent and an emergency escape route in the ghost ship which is totally devoid of proper lighting after stripping. Within four weeks, the ship loses one third to one half of its volume. Most ships have been demolished and disappear from the site within eight weeks (Kanthak & Bernstoff, 1999, p.23).

Operations seem to be very much ancient in approach with the overwhelming use of hand operated oxy-fuel gas-cutters. Use of mechanical equipment is restricted to a block and tackle or a shared crane – often salvaged from a demolished vessel itself. Working practises have been described as shockingly hazardous (Drewry, 1996, pp.47-49).

3.1.4 The Environmental Impact

3.1.4.1 Ships as Toxic Wastes

Use of certain materials in the structures of ships lends them their toxicity. A few notable ones worth mentioning are:

- Asbestos used as a fire retardant and insulation.
- Anti-corrosives – lead oxide and zinc chromate – to prevent corrosion.
- Antifouling paints, containing mercury, arsenic, and Tributyl Tin (TBT) applied to prevent sea-growth in the hull.
- Polychlorinated biphenyls (PCB) used as an additive in mineral oils and as insulation material (Kanthak & Bernstoff, 1999, pp.7-11).

Added to these are the remnants of fuel and lube oils, cargo, bilges and the ballast water which are present on board in considerable quantities and need to be removed from the wreck. Unclean ships dispatched for demolition ensure that workers come into contact with these toxic substances. Further, beaching of vessels leads to the poisoning of the sea and land by these toxic wastes.

3.1.4.2 The Toxins

A brief view of some toxins that continue to be carelessly handled during the demolition stage is presented below.

A) Asbestos

Asbestos found widespread application on ships because of its chemically neutral and excellent insulation qualities. Even low concentration of asbestos dust causes formation of scar like tissues resulting in permanent breathing difficulties (asbestosis). The long term effects of ingestion of asbestos being:

- Irritation of eyes and mucous membrane.
- Shrinking of connective tissues in the lung.
- Lung Cancer (Kanthak & Jayaraman, 2001, pp.19-22).

The striking feature of yards in Alang and Bombay is the open, careless handling of asbestos without any kind of safeguards. The result being that asbestos is omnipresent both at the workplace and the common habitats of workmen (Kanthak & Bernstoff, 1999, p.10).

Table 1- Analysis results for asbestos in Alang-Sosiya ship-breaking yard.

Sample No.	Location of sampling	Date of sampling	Description of the sample	Result
18	Shipbreaking Plot	06.06.00	Insulation material	Chrysotile
21	Open waste dump 200 m inland	06.06.00	Dust + soil	Chrysotile
23 A	Living area I Outside	06.06.00	Dust	Chrysotile
23 B	Living area I Inside, floor	06.06.00	Dust	Chrysotile
47 C	Living area II Inside, floor	07.06.00	Dust	Amphibolite
48 C	Living area III Temple inside, carpet	07.06.00	Dust	No asbestos

Source: Kanthak, J. & Jayaraman, N. (2001). *Ships for ScrapIII Steel and Toxic wastes for Asia,*. (p.15) Hamburg: Greenpeace

The effect of the long term damages caused by asbestos in the yards is yet to unfold as cancer caused by asbestos fibres takes decades to emerge, thus exposing the younger working populace to greater risks.

B) Heavy Metals

Primary sources of heavy metals in ships are paints, coatings, anodes and electrical equipment. Certain substances of concern and their effects are:

- Mercury: It affects the central nervous system and causes delayed neurological and physical development.
- Lead: It accumulates in the blood or bones after inhalation and causes anaemia. It is considered toxic to the kidneys and the nervous system.
- Arsenic: Exposure can cause disfiguring growth in the skin and is considered highly carcinogenic.
- Chromium: Chromium causes eczema and respiratory diseases.

Children are the most vulnerable to these elements as exposure leads to irreversible learning difficulties, mental retardation and delayed neurological and physical development (Matser, Liu & Harjono, 2001, p.14).

Table 2- Heavy Metals in the soil at scrapping site and background levels

Sample		Chromium	Iron	Nickel	Copper	Arsenic	Lead	Zinc
No. 110 (Bombay)	mg/kg dry matter	776	282	347	888	163	806	2112
No. 306 (Alang)	mg/kg dry matter	77	90	108	112	35	<2	74
No. 317 (Velavadar)	mg/kg dry matter	-	-	-	58	2	10	53
Holy soil (Palitana Temple Area)	mg/kg dry matter	-	-	-	34	2	4	80

Source: Kanthak, J. & Bernstoff, A. (1999). *Ships for Scrap Steel and Toxic wastes for Asia.* (p.17). Hamburg: Greenpeace.

Table 2 shows the levels of heavy metals and arsenic found in the recycling yards of Mumbai and Alang. A publication made in 1997 by the Oslo-Paris Convention, OSPAR, for the protection of the marine environment in the North-East Atlantic, may be referred to here in order to make an assessment of the dangers arising from heavy metal contamination (see Appendix 2). The Ecotoxicological Assessment

Criteria (EAC) agreed by the OSPAR states that the provisional criteria for arsenic (1-10 mg/kg), for cadmium (0.1-1 mg/kg), for chromium (10-100 mg/kg), for copper, lead and nickel (5-50 mg/kg), for mercury (0.05-0.5 mg/kg) and for zinc (50-500 mg/kg) (Greenpeace, 2003, p.10). The values of the contaminants mentioned in Table 2 when compared with the set provisional criteria bring out the seriousness of the problem. The effect of such poisons entering the water table and the food chain will certainly be manifold.

C) Organotanins

Extremely toxic tin based compounds such as tributyl tin oxide (TBTO) tributyl tin chloride (TBCL) have found their application in anti fouling paint. These paints have defined discharge rates of the toxins into the water. Release of poisonous TBTs into the environment causes irreparable damage to the aquatic ecosystem (Kanthak & Bernstoff, 1999, p.18). Though the intended function of TBT is to kill living organisms that get attached to the hull, its impact on marine organisms has been lethal. TBT has been found responsible for:

- The development of male characteristics in female marine snails.
- Impairing the immune system of organisms.
- Shell malformation in shell fish (Kanthak & Jayaraman, 2001, p.23).

The wrecks at the scrapping yards at Alang and Mumbai continually discharge tributyl tin into the seawater on account of the pre-defined leaching rates.

Metal parts coated with TBTs are disassembled manually by labourers without any protective aid and thus enter the body through skin contact or by inhalation. Organotoxins affect the nervous system and the endocrine hormone system in human beings (Kanthak & Bernstoff, 1999, p.18). Table 3 shows high levels of TBT concentration in the soil samples of Alang and Mumbai. The EAC agreed by the OSPAR states that the provisional criteria for TBT to be a maximum of 0.005-0.05 μg/kg in marine sediment (Greenpeace, 2003, p.10). A comparison made with the figures in the table shows the gravity of the problem.

Table 3- TBT concentrations in Alang and Mumbai scrapyards.

Sample / No.	Sampled site	MBT	DBT	TBT	TTBT
		µg Sn/kg dry matter	µg Sn/kg dry matter	µg Sn/kg dry matter	µg Sn/kg dry matter
Soil / 110	Mumbai scrapping yard	145	349	1090	67
Sediment at sea / 310	Alang scrapping yard, eastern fringe	18	33	119	<1
Sediment at sea / 314	Alang, 500 metres from eastern fringe	6	3	5	<1
Sediment at sea / 315	Alang, 4000 metres from eastern fringe	7	3	9	<1
Sediment at sea / 401	Alang scrapping yard, western fringe	22	31	170	2
Sediment at sea / 402	Alang scrapping yard, western fringe	11	25	184	4
Sediment of pond/ 306	Alang freshwater pool, 500 metres inland from scrapping yard	<1	<1	<1	<1

Source: Judith, K. & Bernstroff, A. (1999) *Ships for Scrap, Steel and Toxic Wastes for Asia,* (*p*. 18). Hamburg: Greenpeace.

D) Toxic fumes

Cutting of coated steel is carried out by gas torches and ensuing high temperatures from the flames generating poisonous fumes containing polycyclic aromatic hydrocarbons (PAH) renders workers in the vicinity extremely vulnerable to exposure. PAH's are a health hazard and some of them have been classified as carcinogenic (Kanthak & Jayaraman, 2001, p.23). Burning plastic (PVC) insulated cables can result in the release of highly poisonous chemicals such as dioxins and furans. Dioxines and furans are two of the most toxic products known and are linked to cancer and birth defects (Matser, Liu & Harjono, 2001, p.14).

Apart from the release of deadly materials as described above, other pollutants such as oil, ballast and bilge water are also discharged at the vicinity of the shore-line. Absence of reception and recycling facilities for refrigerants leaves ample scope for the misuse of CFC and HCFC gases on board. Huge mounds of waste that cannot be recycled lie in the open further poisoning the soil and its ambient environment.

The phasing out of the single-hull tankers will also create a huge impact. A study conducted by the European Commission estimates the volume of tankers to be scrapped in the range of 0.8m to 7.7million tonnes during the period 2004-2015. The study further expects the amount of hazardous materials such as oil sludge, asbestos and heavy materials that would arise out of the scrapping to be in the range of 480,000 and 1.5million tonnes per year over the period 2004-2015 (Stares, 2005).

The sheer volume of toxins that will be generated clearly spells out the need to put in place short term and long term measures to manage these end-of-the life problems. Short term measures for safe handling and disposal will only provide temporary respite. Long term goals towards development of cleaner products that minimize or prevent the use of hazardous materials should be encouraged.

3.1.5 The Social Impact

The appalling living and working conditions of the breakers needs mentioning in the overall context of sustainable development.

Workers are deployed in extremely confined conditions leading to increased risk of unwarranted emergencies and incidents. Use of protective clothing is virtually unheard of. Most of them have a cloth wrapped around their heads and work in vests or short sleeved shirts thus leaving arms and shins exposed to danger. Light shoes are or slippers are prominently used as footwear (Kanthak & Bernstoff, 1999, p.23).

Provisional accommodation is provided to the workers at less than a stone-throwing distance from the working place. Normal health and safety concepts of contaminant exposure in one 8-hour shift do not apply here. The workers spend their leisure time at the close proximity of their workplaces and are therefore always exposed to the emission sources (Kanthak & Bernstoff, 1999, p.24). Poisonous fumes generated during gas cutting operations render the workers in the vicinity extremely vulnerable to exposure. Openings cut in the hull form the only source of ventilation during such operations. These fumes once started continue to emanate and find their way to the living spaces of the workers (Kanthak & Bernstoff, 1999, p.15).

Most frequent causes of deaths and casualties are due to explosions and fires due to cutting of pipelines having fuel remnants. Fatal accidents also occur due to falling steel plates, burns and fractures (Kanthak & Bernstoff, 1999, p.24). Given the high levels of workplace exposure to asbestos dust, heavy metal fumes and polycyclic aromatics and dioxins, an array of diseases is a certainty. Ironic though as it may seem but this may be a possible cause for the very low average age of workers (Kanthak & Bernstoff, 1999, p.24).

Most workers are contractual labourers and are provided with minimal protection and compensation in the unfortunate instance of unforeseen incidents taking place. There exists no awareness of the broader health hazards and almost every toxic product is handled by bare hands (Kanthak & Bernstoff, 1999, p.15). Workers are therefore constantly put in life-endangering situations due to lack of adequate personal protection measures and poor working conditions. Lack of formal training in dealing with hazardous materials further adds to the misery. It is hard, physical, dangerous and unhealthy labour at its best.

Though governments in the recycling countries are clearly at blame for the appalling state of the recycling yards, for shipping to be sustainable, the social dimension and ethics will have to attain centre-stage. It should be kept in mind that such disposal methods give a negative image to the entire shipping industry. Hence, there lies a need for a coordinated approach by all the stakeholders with an EPR approach. It is worth borrowing the experiences from the car recycling industry which has managed to put its stables in order.

3.2 End-of-the-Life Management of Cars

3.2.1 Introduction

This section draws the attention to the manner in which the automobile industry currently manages the aspects of its end-of-the-life-vehicles. This has been done so with the view to draw comparisons between the management approaches of the two different units of transportation i.e ships and cars.

The car manufacturers' responsibility does not end with the delivery of the vehicle to the customer. It extends over the whole product life cycle – from production to disposal. The recycling concepts of car manufacturers are aimed at closing material loops and to carry out the disposal in a safe manner.

3.2.2 Legislation

3.2.2.1 End-of-the-Life Vehicle Directive (2000/53/EC)

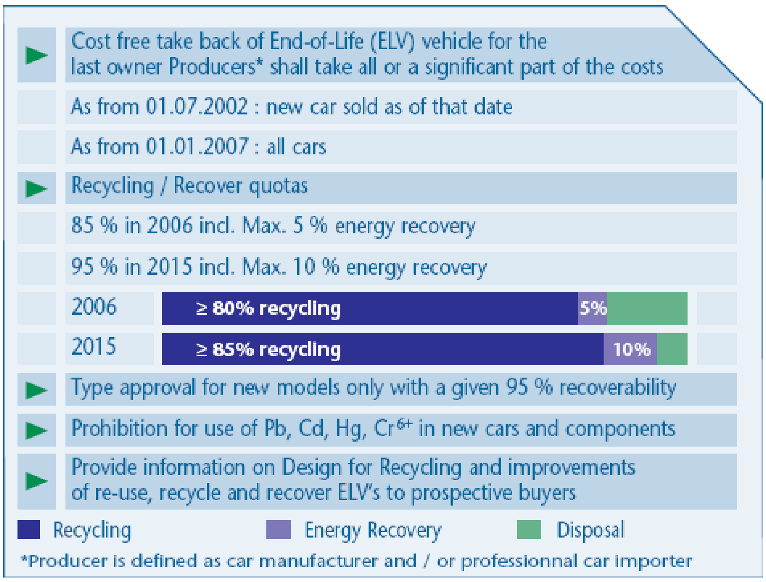

Figure 3- Main ELV Directive Requirements.
Source: Toyota. (2003). European Environmental report 2003. (p.44). Brussels, Belgium: Author.

In the early 90s the European Commission started a campaign for the management of the ELV's in the framework of its prioritised waste streams programme. Directive no.

2000/53/EC of the European Parliament and the Council of the European Union dated 18 September 2000 on end-of-the-life vehicles took effect from 21 October 2000 (ARN, 2002, p.11). Though the proposals are based on producer responsibility, its purpose is to improve the environmental performance of all the economic operators throughout the ELV treatment chain.

3.2.2.2 Salient features of the Directive

Under mentioned are some important features of EU Directive no. 2000/53/EC (ARN, 2000) that would be adaptable to mandatory recycling regulations in shipping.

Prevention

Article 4 of the Directive states that the manufacturers/ economic operators will undertake all measures to promote prevention by:

- Restricting the use of hazardous substances at the designing phase.
- Designing and manufacturing of new vehicles to facilitate dismantling and useful application of their materials and spare parts.
- Increased application of more recycled materials.

The regulations prohibit the use of lead, mercury, cadmium or hexavalent chromium after 1 July 2003 unless exempted (ARN, 2000, p. L 269/ 36).

EU ELV Directive (effective June 2002)

Lead	Usage prohibited, in principle from July 2003, except in the following: No deadline: Steel containing up to 0,35 % lead by weight, copper alloys, bearing-shells, batteries, vibration dampers, vulcanising agent for high pressure or fuel hoses, solder May be used until the deadline: Aluminum alloys, stabilizers in protective paints, motor brushes, brake linings, glass in bulbs, valve seats, pyrotechnic initiators, some rubbers
Mercury	Usage prohibited, in principle from July 2003, except in the following: Discharge lamps and instrument panel displays
Hexavalent chromium	Usage prohibited, in principle from July 2007, except in the following: Absorption refrigerators in caravans
Cadmium	Usage prohibited, in principle from July 2003, except in the following: Thick film paste (until July 2006), batteries for electrical vehicles (until Dec. 31, 2005)

Figure 4- EU ELV Directive on Substances of Concern.
Source: Toyota. (2004). Environmental & Social Report 2004. (p.37). Japan: Author.

Collection

As per Article 5 of the Directive, manufacturers/ economic operators are obliged to build nationwide intake and processing systems for ELV's. A "Certificate of Destruction" should be issued to the owner by authorized operators of demolishing and processing plants. This certificate is a precondition for deregistration (ARN, 2000, p. L 269/ 37).

Treatment

Article 6 of the Directive mandates competent authorities to issue permits to storage and treatment sites and to carry out inspections to ensure compliance with regulations and meeting of desired objectives. Strict technical requirements (see Appendix 4) are to be complied by these facilities (ARN, 2000, p. L 269/ 36).

Reuse and Recovery

Targets to be achieved as per Article 7 of the Directive are:

- By January 1 2006, at least 85% of the mean vehicle weight must be recycled, of which a minimum of 80% by re-use and material recycling. (5% energy retrieval)
- By 2015 the recycling percentage to be achieved rises to 95% of the mean vehicle weight of which a minimum of 85% should be by re-use and material recycling. (10% energy retrieval) (Bianchi, 2005, p.2)

As from 2005, proof must be furnished with the type approval that these requirements are being fulfilled (ARN, 2000, p. L 269/ 38).

Coding and Dismantling Information

As per Article 8 of the Directive, components and materials suitable for recovery and reuse must be codified in accordance with required standards. Producers are obliged to provide dismantling information for each type of new vehicle within six months of its entry into the market. Manufacturers should provide all information to treatment facilities in the form of manuals or electronic media (ARN, 2000, p. L 269/ 39).

Reporting and Information

As per Article 9 of the Directive, manufacturers are to make available information on every phase of the life cycle and activity that have a bearing on the re-cyclability and reuse of the vehicle. Such information should be included in the promotional literature for marketing purposes (ARN, 2000, p. L 269/ 39).

The EU ELV Directive is based on the foundations of EPR and lays stress on elaborate preventive mechanisms. Such mandatory regulations have spawned responsible actions from the automobile industry. As an example, car manufacturers have joined forces to set up the IDIS i.e International Dismantling Information System.(www.idis2.com).The IDIS database contains information on materials, dismantling methods, weight and drawing of structures. Information is available in 15 different languages in the form of free CD-ROM (State and Business community for Bavaria, 2001, p.73).

3.2.2.3 Applications for Shipping

Currently, there exist guidelines on recycling of ships that have been developed by the IMO and UNEP. However, there lies a need to make them mandatory as the recycling phase is too important to be ignored. The EU ELV Directive forms a good policy document from which necessary parallels are needed to be drawn.

A certificate of Disposal for ships making their terminal voyage to the scrapyards should help in better reporting procedures. It is essential to make the shipowner responsible for the clean recycling of his vessel so as to drive in accountability and better monitoring capability into the system. Proper information dissemination should be allowed across all sections of the chain. Manuals should be made available by shipyards for the safe dismantling of ships. Creation of online information systems like IDIS should also be encouraged. Furthermore, collective efforts must be made by all the players in the product chain to achieve sustainable shipping. An example from the car industry is given in the ensuing pages.

3.2.3 The Collective Effort

In this section the collective system operated in the Netherlands by the automobile manufacturers will be discussed. The Netherlands had a fairly mature ELV disposal system before EU regulations came into place and is also the first country to have already achieved the recycling targets as laid down in the EU directive (ARN, 2005b, p.7). In addition, a unique chain of collectors, dismantlers and recyclers have been created to efficiently complete the product loop.

3.2.3.1 History

In the early nineties, the automobile sector in the Netherlands voluntarily took on the responsibility for setting up an intake and processing system for Dutch end-of-life vehicles with an objective of being able to reuse 86% (by weight) of the material. This was financed by a disposal contribution made voluntarily by manufacturers and importers. This contribution was later made mandatory by legislation. This system has proven to be a success by the fact that by 1997 the recycling objective had been achieved (ARN, 2002, p.12).

3.2.3.2 Organisation

To manage the intake and processing system for end-of-life vehicles the Auto Recycling Nederland BV (hereinafter referred to as ARN) was founded by the car industry. The board consists of several branch organisations such as:

- STIBA - car dismantlers.
- RAI - car manufacturers and importers.
- BOVAG - car dealers/workshops (repair & maintenance).
- FOCWA - damage repair companies.

As a policy making body, the Auto & Recycling Foundation ensures non-profit goals of the organization are met whereas ARN at the implementation level administers collection of waste disposal fees and distributes the disposal contributions to the dismantling, transporting and processing companies (ARN, 2005a).

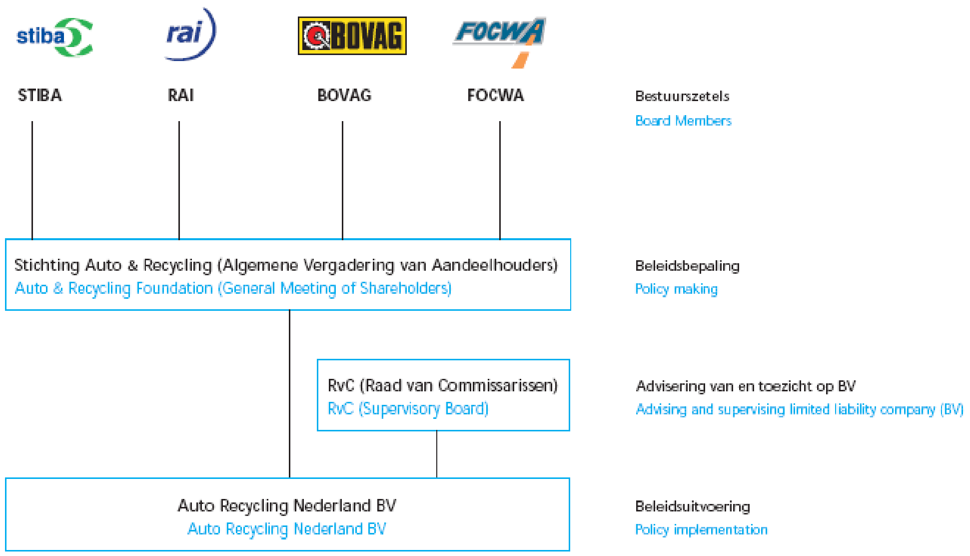

Figure 5- Organizational structure of the recycling industry.
Source: ARN. (2005b). *Environmental Report 2004*. (p.42). Amsterdam: Author.

3.2.3.3 The Chain

ARN collaborates with dismantling, collection, recycling and shredder companies. Details of the functions as described below are based on the ARN Environmental Report 2004 (ARN, 2005b, pp. 45-46).

Car dismantling companies

ARN contracts with a nationwide network dismantling companies to whom it pays a premium. Criteria for payment are based either on per unit (kilo, litre or piece) of material handled or the time spent on dismantling a particular material. The quantity of material actually dismantled is submitted for processing and checks are made by ARN to verify if the provided quantity matches with the number of deregistered cars as recorded in the database. No payment is made if a deregistered car wreck no longer contains the materials or it has been sold as a spare (ARN, 2005b, p.45).

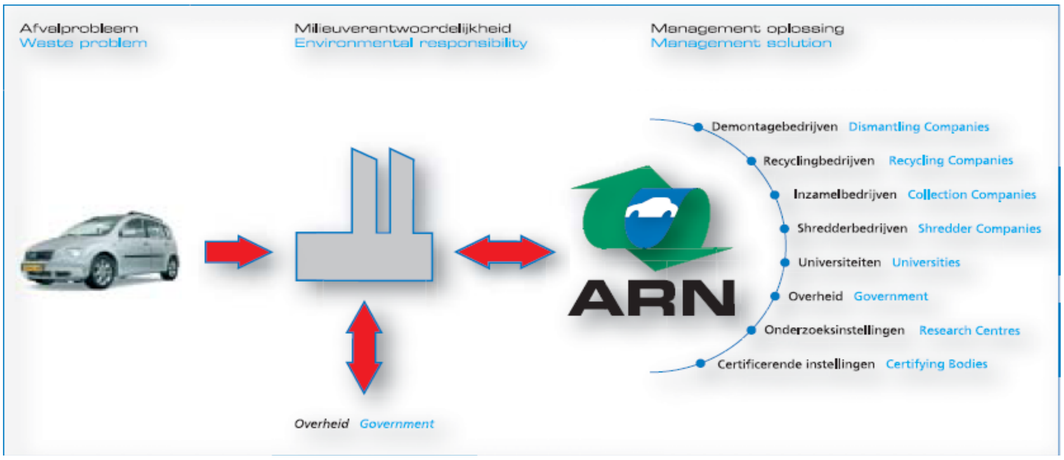

Figure 6- Chain partners of ARN.
Source: ARN. (2005b). *Environmental Report 2004*. (p.34). Amsterdam: Author.

Collection Companies

These companies are responsible for packaging and transporting materials from dismantling companies to the recycling companies. Collection companies are selected by ARN on the basis of a tender. ARN ensures that strict quality measures are adhered to by these companies during handling and storage by carrying out periodic inspections (ARN, 2005b, p. 46).

Recycling companies

Processing (reuse) of materials is carried out by recycling companies. Extensive processing tests are carried out at the company in order to ensure high-grade recycling. The recyclers are obliged to submit accurate reports on the quantity and quality of the materials they have taken delivery of and recycled (ARN, 2005b, p. 45).

Shredding Companies

Shredder companies are the final link in the end-of-life vehicle recycling chain. ARN currently collaborates with 14 certified shredder companies. Intake controls at the shredder plant are monitored to achieve self imposed targets that mandate a minimum of 95% of an ELV to be recycled by 2007 (ARN, 2005b, p. 46).

3.2.3.4 Financing the Chain

Each vehicle manufacturer and importer is under obligation to take upon itself the financial burden of the intake and processing system of the end-of-the-life vehicles. ARN has collectively managed to build a very effective and efficient system till date. Vehicle manufacturers and importers make payments to a waste management contribution for each vehicle they introduce to the market and they are free to factor this in, either partially or in its entirety, in the invoice to the consumer (ARN, 2002, p.17). Besides, a waste disposal fee of 45 Euros is paid by the customer during the registration of the car (ARN, 2005c).

3.2.3.5 Key Success Factors

The Auto and Recycling Foundation has effectively set up a finely meshed monitoring system that ensures total chain management. Certain noteworthy achievements are:

- First European country to achieve recycling targets as mentioned in the EU directive (ARN, 2002, p.12).
- Reduction in the waste disposal fee from NLG 250 in 1995 to Euro 45 as of today (ARN, 2005d).
- Increase in the number of dismantling companies (ARN, 2005d).
- Application of new technologies to further improve recycling yields and reduce costs.

The automobile industry has thereby demonstrated that a joint environmental approach can work. Parallels can therefore be drawn and applied to the shipping sector as well.

Shipping as of today still functions in the traditional “linear” mode of manufacture. A move towards the “closed” loop is essential to optimise on utilisation of scarce resources and have an efficient end-of-the-life management. This will also raise the profile of the stake holders such as collectors, dismantlers and recyclers that exist in the return loop (Henry, 1998, p.65).

3.3 P&O Nedlloyd's Efforts in EPR

The extraordinary voluntary efforts of another Dutch company, P&O Nedlloyd, needs mentioning in this context. Braving a maze of public criticism by green lobbies on its end-of-the-life management of ships, the company choose a path of product stewardship in 1997. After a world wide search, it signed Letter of Intent with Jiangyin shipyard in China. This was followed by training of the yard management and the workers and in the year 2000, M.V.Coral was recycled under company supervision (Blankestijn, 2005, p. 2). The activities for the recycling consisted of the pre-delivery Stage and the post-delivery Stage. The activities of the pre-delivery stage are:

- Sales activities.
- Phase-out Preparations by office and crew.

This is followed by the post-delivery phase consisting of:

- Supervision of the phase out by head-office.
- Supervision of the Ship-yard activities by the Superintendent.
- Co-ordination of the sales activities by the office (Blankestijn, 2005, pp. 2-3).

The crucial activities in the shipyard consist of the pre-cleaning stage which lasts for 6 weeks and upon completion of which a pre-cleaning certificate is obtained. This is followed by the demolition phase which lasts for approximately 6 weeks and upon completion, a certificate of recycling is obtained. All the activities in the shipyard are co-ordinated under the watchful eyes of a company superintendent. P&O Nedlloyd has formalised and documented the working procedures for recycling. It has managed to emulate this success in disposing off nineteen vessels of its fleet till date (Blankestijn, 2005, pp. 2-3).

This has demonstrated that collective efforts can work even without legislative controls. However, such voluntary efforts in shipping are rare, hence the need for regulatory measures to be directed on enhancing the producer's responsibility in shipping towards his product.

CHAPTER 4
GUIDELINES FOR CLEAN SHIP RECYCLING

4.1 IMO Guidelines on Ship-Recycling

IMO adopted guidelines for safe recycling of ships on 5th December 2003 [Assembly Resolution A.962. (23)]. These guidelines envisage a role for all stake holders and call upon them to make worthwhile contributions towards clean ship recycling (IMO, 2003).

4.1.1 Identification of Potentially Hazardous Materials

The guidelines bring out two key lists for identification of potentially hazardous material. The lists are based on the List of Hazardous Wastes and Substances under the Basel Convention that are relevant to Ship Dismantling and the Industry Code of Practice on Ship Recycling (IMO, 2003, pp.7-8).

4.1.2 Green Passport

The Green Passport is a document providing information on potentially hazardous materials on board a ship. It is to accompany the ship from its cradle-to-grave. The accuracy of the document needs to be maintained by every successive owner. The green passport should contain information on the ship's details and a comprehensive inventory of hazardous materials on board mentioning the quantity and location of each substance. The inventory is split in three parts:

Part 1 - Potentially hazardous materials in the ship's structure and equipment.

Part 2 - Operationally generated wastes.

Part 3 – Stores (IMO, 2003, pp. 8-9).

4.1.3 Procedures for New Ships

The guidelines stress that problems of disposal be kept in mind when the ship is being conceptualized at the design and construction stage. The same lies with the equipment suppliers. This requires identification of hazardous substances, application of less hazardous alternatives and minimisation of emissions during the life cycle of the ship.

It encourages usage of recyclable materials by manufacturers. It requires competent authorities in shipbuilding states to encourage research in cleaner production technologies. It wants producers to provide owners with information on optimum recycling approaches to be taken, limit the usage of material that are difficult to separate and enhance the use of recycled material on ships (IMO, 2003, pp.10-11).

4.1.4 Preparations for Ship Recycling

The guidelines require recycling facilities to have the expertise to recycle the ships it purchases. This capability should be monitored by the appropriate national authority and should be in compliance with the relevant Guidelines as developed by ILO and UNEP (Basel Convention).

Before sending the ship for recycling the ship owners should consult the competent authorities and consider if the working practices and facilities in the yard match the required standards. It requires shipowners to take upon themselves the responsibility of handling and disposing off hazardous substances if expertise of the yards is found lacking. It asks shipowners to reserve the right to monitor the recycling process and specify methods of recycling. It calls upon shipowners to identify and minimize hazards that may endanger worker safety in breaking yards (IMO, 2003, pp. 12-17).

4.1.5 Ship Recycling Plan

Guidelines envisage a ship recycling plan to be put in place much before the ship is actually delivered to the recycling facility. The plan should be developed by taking inputs from all the stakeholders. The recycling plan should take into account:

- The Green Passport and technical advice from the shipbuilder.
- Details of the ship's operational equipment and potential sources, amounts and relative hazards of potential contaminants.
- Potential hazards to worker safety arising during the recycling operation.

It lays down technical considerations needed for the development of the plan and measures needed to be taken to mitigate pollution risks (IMO, 2003, pp.14-15).

The guidelines further bring out the importance of the flag and port states in implementing them and the need for the different flag states to work in close co-operation (IMO, 2003, pp.17-18). It lays down measures to be adopted by recycling states to control end of the life ships. Examples of such measures being adequate pre-inspections by competent authorities before acceptance of the vessel and issuance of gas-freeing certificates. Measures required for controlling recycling facilities relate to bringing out rules and guidelines on handling of hazardous substances (IMO, 2003, pp.18-19). Finally, the guidelines also spell out the need for technology transfer and the financial aid to build required infrastructure and expertise in recycling states (IMO, 2003, p.25).

4.1.6 Developments in the IMO

The Marine Environmental and Protection Committee (MEPC) at its fifty second session (11-15 October 2004) approved detailed guidelines for the development of a Ship-Recycling Plan (MEPC/ Circ. 419). The plan is based on the guidelines developed by the UNEP (Basel Convention) and ILO. Further, the MEPC at its 53rd session (18-22 July 2005) formally adopted a resolution (MEPC 53/WP.10) agreeing that the IMO would develop a legally binding instrument to regulate ship recycling. This resolution will now be formally adopted by the Assembly in November this year. A provisional timetable has also been provided which aims for a draft instrument to be ready by 2007, with a view to final adoption at a diplomatic conference during 2008-2009 (IMO, 2005).

4.2 The Basel Convention

The Basel Convention on the Trans-boundary movements of Hazardous Wastes and their Disposal was initiated by the United Nations Environmental Programme (UNEP) in 1989. It came into force in 1992. The convention regulates the international trade with hazardous waste. It aims to minimise the generation and transboundary movement of hazardous waste (Basel, 1992).

Trans-boundary movements of hazardous wastes can take place only upon prior written notification by the state of export to the competent authorities of the states of import and transit. As per Article 6/9 of the Convention, each movement must be accompanied by a *movement document* and consent by the latter.

In order to manage the increasing number of ships to be disposed, the Conference of the Parties to the Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal decided to address the subject at their fifth meeting (COP 5) in December 1999 (UNEP, 2002, p.2).

4.2.1 The Technical Guidelines for the Environmentally Sound Management of the Full and Partial Dismantling of Ships (UNEP/CHW.6/23)

The guidelines provide information and recommendations on procedures, processes and practices that must be implemented to attain Environmentally Sound Management (ESM) at the ship recycling facilities. Article 2, paragraph 8 of the Basel Convention defines ESM as:

> Taking all practicable steps to ensure that hazardous wastes or other wastes are managed in a manner which will protect human health and the environment against the adverse effects which may result from such wastes (Basel Convention, 1992).

The guidelines lay out good practices in environmental control procedures that need to be developed at the ship-dismantling facilities. These deal with:

- Ship decommissioning for disposal.
- Identification of potential contaminants and prevention of their releases.
- Monitoring and Setting of standards and limits.
- Contingency preparedness (UNEP, 2002, pp.40-59).

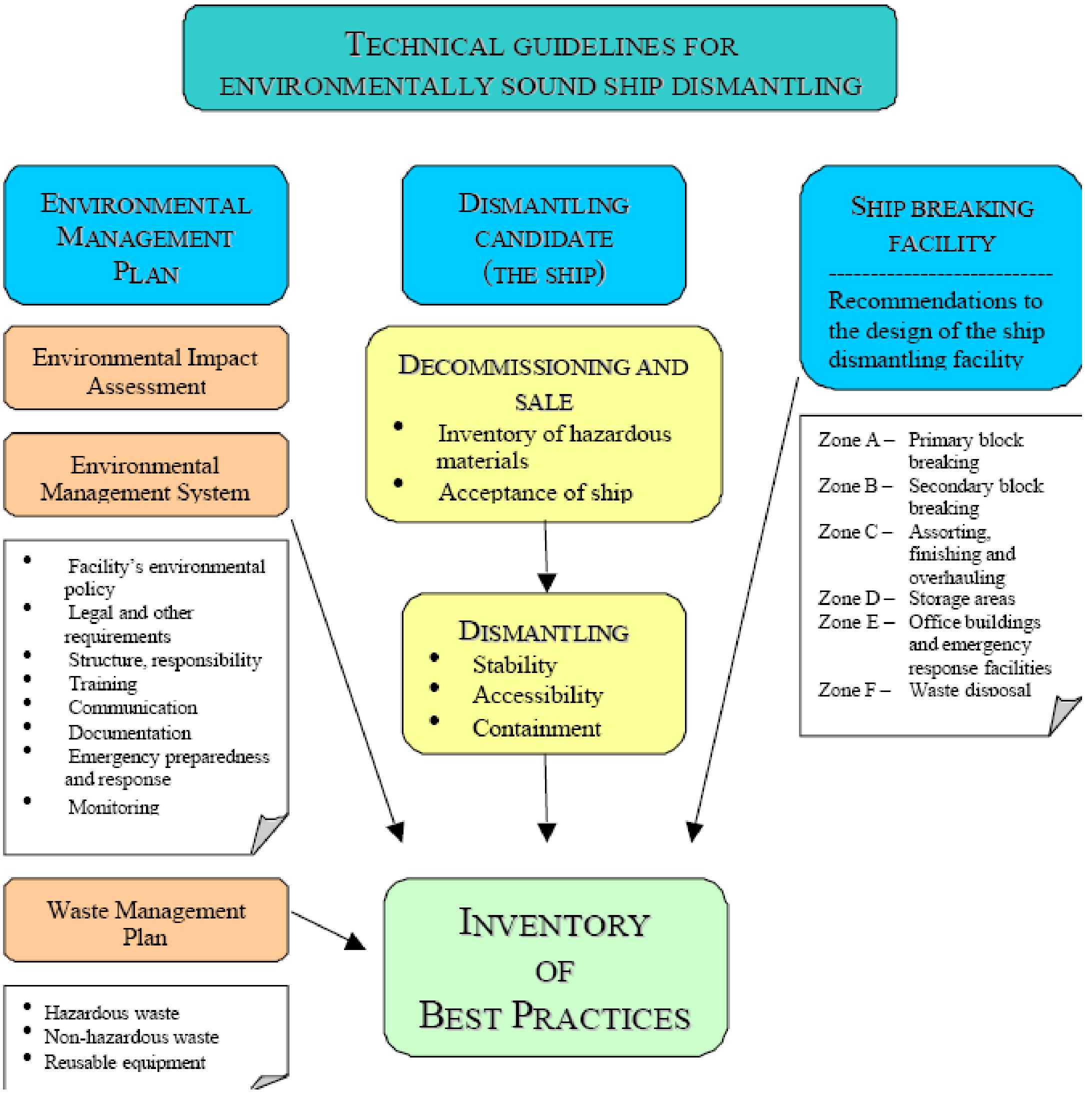

Figure 7 Overview of elements to consider for ESM of a ship dismantling facility
Source: United Nations Environment Programme. (2002, December). *The Technical Guidelines for the Environmentally Sound Management of the Full and Partial Dismantling of Ships.* (p.7). Geneva: Author.

Since most guidelines for ship recycling developed by IMO trace their roots to the Basel guidelines, there is ample similarity in their scope. The Basel guidelines go one step further and describe the hardware and software involved in setting up of environmentally sound ship recycling yards.

An example of a model ship dismantling yard is shown in Figure 8. Such a facility comprises:

- Workstations to facilitate secondary dismantling.
- Specially-equipped workstations for removal of Hazardous and toxic materials.
- Temporary storage areas.
- Storage areas secured for hazardous waste.
- Storage areas housing fully processed equipment and materials that are ready for reuse, recycling or disposal (UNEP, 2002, p.62).

The most important environmental design aspect of any ship breaking yard are measures to contain releases within the confines of the yard and then ensure adequate collection mechanisms are in place for the spilled or released materials.

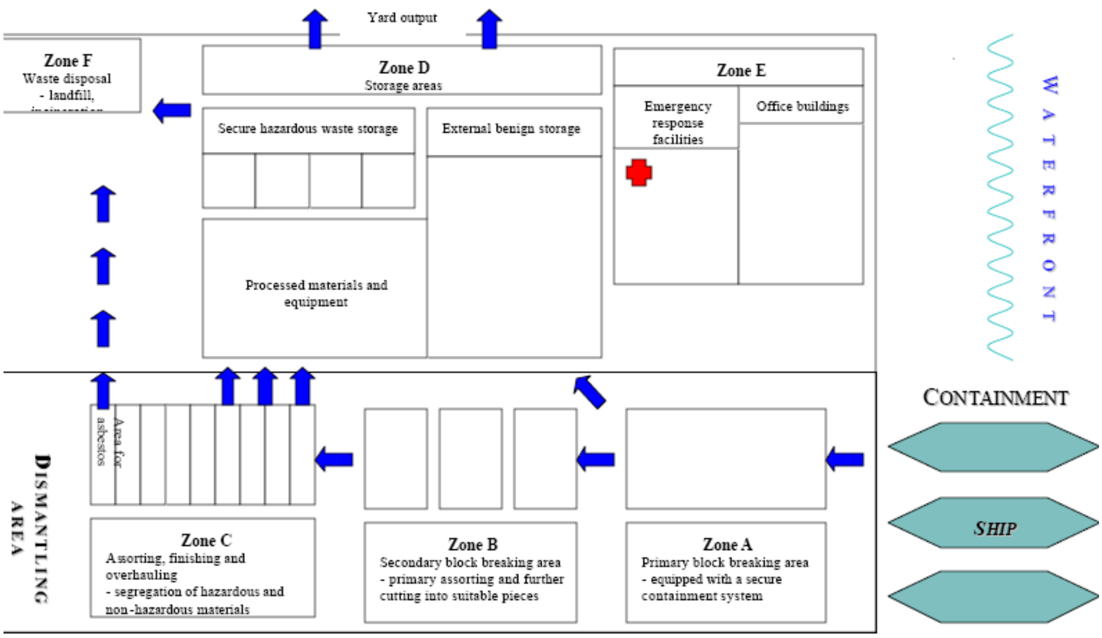

Figure 8-Model Ship recycling Yard

Source: United Nations Environment Programme. (2002, December). *The Technical Guidelines for the Environmentally Sound Management of the Full and Partial Dismantling of Ships.* (p.11). Geneva: Author.

Table 4 enumerates the activities associated with each zone and the associated hazards.

Table 4- Activities of the zones and associated hazards.

Zone	Activities	Environmental hazards	Health & safety hazards
Containment zone	- Initial containment	- as in column below	- as in column below
Zone A Primary block breaking area	- Removal of oil (sludge) and fluids - Dismounting of re-useable equipment - Cutting of large ship segments - Removal of asbestos and batteries - Emptying fire extinguishing systems, and CFCs from cooling systems	- Oil and fuel spills - Bilge and ballast water spills - Paint and coatings - Heavy metals - PCB - Others *	- Asbestos - Vapours (solvents and metals) - CO_2 - Risk of explosion - Radiation
Zone B Secondary block breaking area	- Primary sorting of components - Further cutting into suitable size for further transport	- Paint and coatings - PCBs - Others *	- Asbestos - Vapours - Risk of explosion
Zone C Assorting, finishing and overhauling areas	- Definitive sorting of materials and equipment - Segregation of composite materials - Finishing of materials for re-sale - Overhauling of equipment	- Oil and fuel spills - PCB - Others *	- Asbestos - Vapours
Zone D Storage areas	- Stockpiling of assorted, finished materials	- Oil and fuel spills - PCB's - Others *	- Asbestos - Risk of explosion
Zone E Office buildings and emergency facilities	- Administrative work - First Aid help (if not dealt with on the spot)		
Zone F Waste disposal facilities	- Landfilling - Incineration - Wastewater treatment	- Seepage of toxic liquids	- Toxic liquids - Asbestos

* "Others" represent i.a. anodes, radiation sources, heavy metals, TBT, batteries and freon.

Source: United Nations Environment Programme. (2002, December). *The Technical Guidelines for the Environmentally Sound Management of the Full and Partial Dismantling of Ships.* (p.11). Geneva: Author.

4.2.1.1 Environment Management Plan

The Guidelines further mention the operational practices that are to be put in place to attain the goals of ESM. An environment management plan for the yards is considered to be the most viable. It is to contain:

- Environmental Impact Assessment (EIA).
- Preventive measures and Practices.
- Environmental Management System (EMS) encompassing a waste management plan, a contingency preparedness plan and a monitoring plan.

The guidelines provide a time based approach along with steps that are needed to be implemented to upgrade the ship dismantling facilities (UNEP, 2002, p.12).

4.3 Draft Guidelines on Safety and Health in Shipbreaking.

The International Labour Organisation (ILO) submitted Draft Guidelines on Safety and Health in Shipbreaking at a meeting in Bangkok on 23-27 May 2003. These guidelines acknowledge that shipbreaking aids sustainable development but the current practices make it a hazardous form of waste management. It also makes for one of the most hazardous professions as there are no labour laws or social protection for the workers at these sites (ILO, 2003, p.2).

It encourages governments to acknowledge the contribution of shipbreaking to their economies and urges them to form a policy for ship breaking to promote the implementation and integration of Occupational Safety and Health (OSH) management systems based on the ILO Guidelines on Occupational Safety and Health management systems (ILO, 2003, p.5).

The policy should incorporate laws, regulations and inspections for the protection of the workers. It should help promote a systematic approach in respect of the assessment of hazards, risks and control measures and for appropriate occupational health surveillance.

Such a system should further:

- Specify employment conditions (working time breaks, leave and payment).
- Have monitoring systems for reporting, recording, investigation and compensation of work related injuries and diseases, ill health, and incidents.
- Aid development of occupational health services for all ship-breaking workers (ILO, 2003, p.6).

These guidelines call upon the employers as equal stakeholders to show responsibility in maintaining workplaces, equipment, tools and machinery safe and without risk to health factors. In addition, employers should provide for:

- Competent supervision of work practices.

- Regular surveillance of the worker's health and the working environment.
- OSH education and training to workers (ILO, 2003, pp.7-8).

The guidelines specify the workers duties and rights towards the implementation of OSH measures and spell out the need for adequate mechanisms to be put in place for information sharing with workers for risk minimization (ILO, 2003, pp.8-10).

4.3.1 Safe Ship Breaking Operations

The guidelines divide the shipbreaking activity into three core phase:

- Preparation.
- Deconstruction.
- Material (Scrap) Stream Management (ILO, 2003, p.19).

Table 5- Safe Ship-breaking Plan.

Model Safe Ship-breaking Plan		
Ship Specific Details and Inventory		
Preparation	*Deconstruction*	*Material Stream Management*
Ship Specific Breaking Plan		
▪ National & Industry regulatory requirements ▪ Verification of stated waste materials & ship details. ▪ Locate & mark inventory materials. ▪ Decontamination. ▪ Shutting down and decommissioning.	▪ Safe work principles, prevention measures and precautions. ▪ Identification of work operations, scheduling of work. ▪ Allocation and deployment of human resources. ▪ Determination and placement of tools, equipment and	▪ Secondary deconstruction. ▪ Sorting. ▪ Separation. ▪ Reception facilities and storage. ▪ Disposal ▪ Recycling

Source: International Labour Organisation. (2003, May). *Draft Guidelines on Safety and Health in Ship breaking.* (p.21). Geneva: Author.

It asks for drawing of plans for each phase as it is vital to have advanced information and planning to safeguard health and safety of those involved. It emphasizes the need of:

- Training workers in safe working procedures.
- Providing workers with personal protective equipment.
- Development of contingency plans for emergencies (ILO, 2003, pp.19-20).

4.3.2 Shipbreaking Plans and Schedule

The guidelines lay stress on the development of ship-breaking plans by competent persons. These plans should encompass:

- Determination of the necessary work procedures for each phase.
- Identification and assessment of associated risks.
- Selection of appropriate preventive measures (ILO, 2003, p.20).

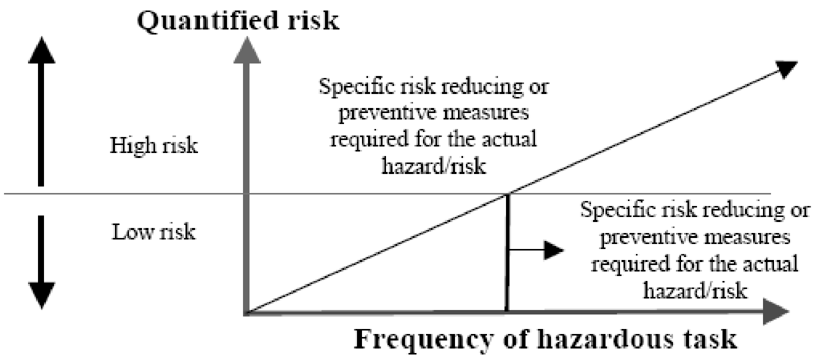

Figure 9 Increase of risk by carrying out repetitive tasks aided by fatigue and poor health.
Source: International Labour Organisation. (2003, May). *Draft Guidelines on Safety and Health in Ship breaking*. (p.30). Geneva: Author.

With a view to control the risks to safety and health, it calls for the application of the following ILO Conventions:

- Working Environment (Air Pollution, Noise and Vibration) Convention (No. 148), and Recommendation (No. 156), 1977.
- The Occupational Safety and Health Convention (No. 155), and Recommendation (No. 164), 1981.

- The Occupational Health Services Convention (No. 161), and Recommendation (No. 171), 1985.
- The Chemicals Convention (No. 170), and Recommendation (No. 177), 1990 (ILO, 2003, pp.68-69).

Other codes of practice developed by ILO to be followed are:

- Safety in the use of chemicals at work.
- Ambient factors in the workplace.
- Occupational exposure to airborne substances harmful to health.
- Safety in the use of asbestos.
- Safety in the use of synthetic vitreous fibre insulation wools (glass wool, rock wool, slag wool).
- The ILO guide on Dust control in the working environment (silicosis) (ILO, 2003, p.40).

Thus the ILO guidelines help to design a system to promote a "safety first" culture and reassure workers by providing health, welfare & surveillance services. Time and resources devoted to installing safety and health and protection measures are known to increase productivity rather than the contrary.

4.4 Joint Efforts

The formation of a joint working group of IMO, ILO and UNEP (Basel Convention) was approved at the fifty-first session of the MEPC (MEPC 51/WP.5). This will help:

- Avoid duplication of work.
- Co-ordination of efforts.
- Establish joint Technical co-operation of activities (Secretariat of Basel Convention, 2005).

The first meeting of the Joint Working Group took place at the IMO headquarters in London (15-17 February 2005).

4.5 Kong Fredrick IV case

The recent episode of the Kong Fredrick IV highlights the need for building transparent systems and harmonious legislations. The 51-yr old ferry was sold to Indian intermediaries who changed its flag from Danish to Saint Vincent. She was renamed as Frederick and set sail to Alang from the Danish Coast. The name was further changed to Ricky during the course of her voyage ("No Indian," 2005).

It seemed apparent that a false declaration was made that the ship would be put for further commercial use and the real intentions became clear only after she had left the shores of Denmark (Stares, 2005). In India, authorities provided permission for the breaking operations to commence ignoring requests from the Danish government and a recommendation from a Supreme Court advisory committee ("Frederik's fate", 2005).

According to article 9 of the Basel Convention, trans-boundary movement of hazardous cargo without prior notification is deemed illegal. Also the Open Ended Working Group of the Basel Convention (OEWG-III/3) held in Geneva (26-30 April, 2004) had noted that a ship may become a waste as per article 2 of the Basel Convention but continue to be defined as a ship as per other international conventions (UNEP, 2004, p.28). There is no provision to stop a ship with valid IMO certificates from sailing even if she is destined for scrapping (Stares, 2005). Also recycling states like India have not yet banned the use of asbestos (Kanthak & Bernstoff, 1999, p.11).

The current anomaly that exists between IMO, UNEP (Basel Convention) and the national legislations clearly needs to be bridged. An end-of-the-life ship containing toxic products should first of all be classified as a waste under article 2 of the Basel Convention. Regulations in the IMO should also reflect the same in the form mandatory regulations. Such a move will not only remove differences in international regulations but will also help set up transparent mechanisms for reporting. Further, recycling states need to act responsibly to formulate national legislations that are in harmony with the international conventions.

4.6 Discussion

Currently, effective guidelines do exist to promote cleaner ship recycling. However, there has been no voluntary effort either by shipowners or by recycling yards to implement them. Besides, it is an important issue concerning lives of people and disposal of toxic wastes and governmental control along with internationally developed legislation is essential. Mandatory legislations are therefore crucial. There is a clear need to put in place time bound programmes in the recycling yards to lift their standards as has been mentioned in the Basel Conventions but IMO guidelines are silent about the same.

Further, the guidelines are silent on assigning the responsibility of the end-of-the-life management of ship to a single actor. Mandatory regulations should be developed on the foundations of EPR and the shipowner must be made responsible for the total life cycle management of his ship. Assignment of responsibility will make supervision and control easier. Recycling targets needed to be achieved should be clearly spelt out with effective cut-off dates. Also, target dates should be set for removal of hazardous materials from the ships. Reporting and inspecting mechanisms need to be set into the regulations. The EU ELV Directive can serve as a good basis and parallels should be drawn from the same.

4.7 Clean Ship Recycling in the Netherlands

Briefly enumerated are a few ship breaking practices that currently exist in an OECD country today.

Removal of Asbestos

In the Netherlands, the removal of asbestos is governed by strict regulations. The process is detailed below:

- The inventory of the asbestos is taken by a specialised company.
- Asbestos waste is checked and disposed off in a controlled atmosphere after removal by a certified company.
- Removal is carried out under containment and use of breathing apparatus is mandatory.
- The asbestos areas are inspected, the air samples are inspected for fibres and if found satisfactory, an asbestos free certificate is issued by an accredited laboratory (Matser, Liu & Harjono, 2001, p.9).

Oil Pollution

The ships are scrapped on impermeable slopes. The regulations call for the installation of oil drains, installation of separators and controlled disposal of oil (Matser, Liu & Harjono, 2001, p.9).

Breaking and Recycling

Hydraulic cutters are used for breaking the ship thus avoiding dioxin fumes that are caused by flame cutters on paint surfaces. Copper is recovered from the cables by a mechanical process. The waste products are disposed off or processed by specialized companies. The PCB containing fractions such as jute, paper and bitumen are transported to controlled disposal sites (Matser, Liu & Harjono, 2001, p.10).

Waste Disposal

Water proof floors in the ship breaking yards are mandatory so as to avoid contamination of ground water. The waste collected are sorted and delivered to appropriate processing companies (Matser, Liu & Harjono, 2001, p.9).

The few processes mentioned above bring out the stark contrast of the ship recycling activities as it is carried out today in the Asian yards.

CHAPTER 5

LIFE CYCLE ASSESSMENT (LCA) OF A SHIP

A firm's environmental performance is a total measure of the environmental impacts caused by its products and its activities in a lifecycle perspective. The goal must be to reduce the environmental and social impacts in every phase of the life cycle of a product. Further, for shipping having trained its eyes on certain part functions like air pollution and oil pollution, it is time to focus on the bigger picture of sustainable developmental practices. Hence the need for life cycle assessment of a ship from cradle to grave involving economical, environmental and social dimensions.

5.1 LCA Phases

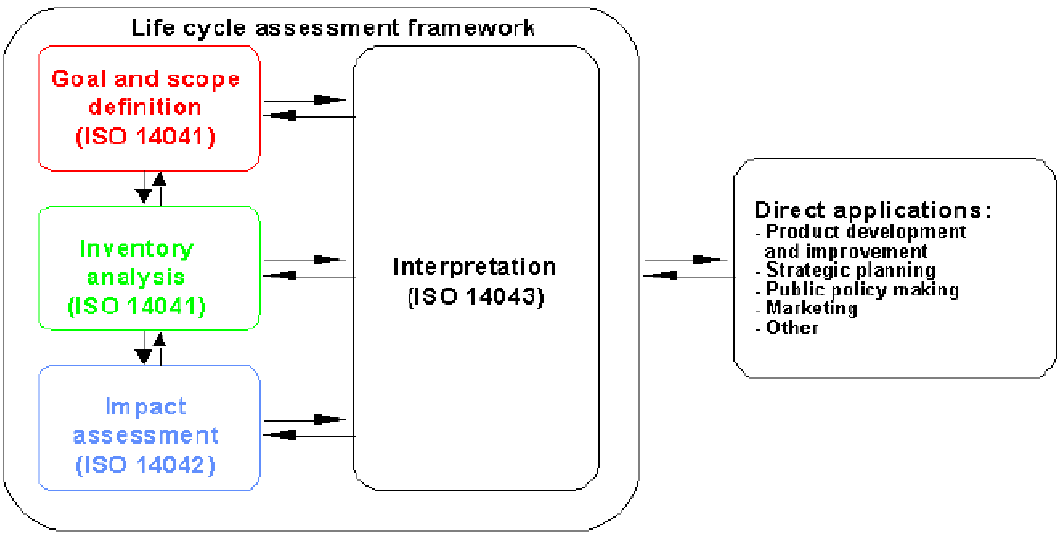

Figure 10 – Phases of an LCA

Source: Jiven, K., Sjobris, A., Nilsson, M., Ellis, J., Tragardh, P., and Nordstrom, M. (2004a). *LCA-ship, Design tool for energy efficient ships - A Life Cycle Analysis Program for Ships.* (p.16). Sweden: Mariterm AB, SSPA, TEM.

Figure 10 shows the four phases of an LCA. They are goal and scope definition, inventory analysis, impact assessment and interpretation.

5.1.1 Goal and Scope Definition

A goal defines the reasons for carrying out the study, the intended application and the audience (EEA, 1998, p.54). A ship is a complex system hence there is a need to build a simplified model and to define the goal and scope in a precise manner to reduce distortions affecting the end result. Certain goals in a shipping context can be:

- Demonstrate and confirm that the LCA method is applicable for environmental life cycle evaluation for ship transportation.
- Comparison between different ship systems from an economical, environmental and social view.
- Comparison between different parts of the transport chains.

The scope will help define the methodical choices, assumptions and limitations. It helps set up:

- The initial system boundary limits.
- The functional unit. For example in a study of different transport chains, the functional units can be defined as transport of tons or number of passengers per route described between specified points.
- Criteria for inclusion of inputs and outputs depending on mass, economic value or environmental load of the inflow (or process) in the process tree.
- Allocation of environment load for processes performing more than one function or output.
- Keeping track of data quality requirements (Simapro 6, 2004, pp.4-7).

5.1.2 Inventory Analysis

The most demanding task of an LCA is the data collection. Two different types of data required would be foreground data and background data. Foreground data would be the data required very specifically for the project. Background data are the generic data that can be sourced from various data banks (Simapro 6, 2004, p.9).

Inventory analysis consists of:

- Data collection.
- Refining system boundaries to match the goal and scope definition.

- Calculation procedures.
- Validation of data to improve data quality.
- Relating data to a specific system.
- Allocation while dealing with multi input/output systems (EEA, 1998, p.58).

A flow sheet showing the different processes correctly is considered crucial. A comprehensive data of all the inputs (resources and energy) and the outputs (emissions and wastes) is compiled and tabulated.

5.1.3 Impact Assessment

Life cycle Impact assessment is aimed at evaluating the magnitude and significance of the potential environmental impacts of a product system. This phase contains obligatory elements such as classification and characterisation. Optional elements such as weighing are considered if valuation of the impacts is to be carried out.

5.1.3.1 Classification

In the *Classification* step, data from the inventory analysis are grouped under different impact categories (Hillary, 1995, p. 22). It is a qualitative process where the inputs and outputs from the inventory data are assigned to potential environmental impacts (EEA, 1998, p. 65). The choice of impact categories is subjective depending on whether global, regional or local impacts have to be considered. Preferential choices are therefore to be made during the goal definition phase (Hillary, 1995, p. 22).

5.1.3.2 Characterisation

In the *characterisation* step, the relative contributions of each input and output to its assigned impact categories are assessed and the contributions are aggregated (Jiven, Sjobris, Nilsson, Ellis, Tragardh, Nordstrom, 2004a, pp.16-17). It is a quantitative step (EEA, 1998, p.67). Equivalence factors are used for quantification of different impacts. A reference substance is than selected and all potential impacts are weighted against the impact of the reference substance (Hillary, 1995, p. 22).

5.1.3.3 Impact Categories

For the goals as mentioned above in the shipping context, the following characterisation categories can be considered:

Acidification

Emissions which are acidic cause harm to aquatic and plant species due to the acidification of water and soil respectively. The site of occurrence is important, for example the harm to the ecosystem in a sensitive area or its close proximity would be greater than the acid falling into the open seas where it can be easily neutralised.

Table 6- Acidification potential of certain compounds related to SO2

	Compound	Characterisation
Acidification	SO_2	1,00
	NO_X	0,70
	NH_3	1,88

Source: Fet, A., Michelson,O. & Johnsen, T. (2000, October).*Environmental performance of transportation – a comparative study*, (p.53). Oslo: Research Council of Norway.

Global Warming

Greenhouse gases reflect back the earth's heat and contribute to global warming. The Global Warming Potential (GWP) depends on the atmospheric lifetimes and absorption properties of different gases. These properties are then compared to the properties of CO2 and converted into CO2 equivalents.

Table7- GWP of certain compounds related to CO2

	Compound	Characterisation
Climate change	CO_2	1
	CH_4	25
	N_2O	320

Source: Fet, A., Michelson,O. & Johnsen, T. (2000, October).*Environmental performance of transportation – a comparative study*, (p.53). Oslo: Research Council of Norway.

Similarly, other impact categories would be ozone depletion, local air pollution, land use, work environment, abiotic and biotic resources and eutrophication.

5.1.3.4 Valuation

In this step, the different environmental impacts are weighted. Valuation is used for comparing:

- The relative importance of different environmental impact categories.

- The environmental performance of alternative systems (Fet, Michelson & Johnsen, 2000, p.33).

Valuation elements require incorporation of political, ideological and/or ethical values which are influenced by perceptions. For example a potential impact on people's health would be weighed against the impact on the ecology or the consumption of finite resources (Jiven et al 2004a, p.20). Quantitative and qualitative analysis tools are used to achieve a rational process.

5.1.5 Interpretation

In this phase, information from the inventory analysis or the impact assessment are checked, evaluated and are combined in line with the defined goal and scope. It is an iterative process and consists of the following steps:

- Identification of significant environmental issues.
- Methodology evaluation.
- Conclusion consistency to meet goal and scope.
- Report of final conclusions.

These steps are repeated until defined goals are met (EEA, 1998, p.70). The aim of the interpretation is to aid the decision making process. The results of an LCA will therefore have to be presented in an objective and transparent manner in order to communicate effectively with target audiences (Hillary, 1995, p.33). Results are an outcome of the definition of system boundaries, selection of data sources and allocation rules and methodologies used. A sensitivity analysis is therefore carried out to gauge the criticality of different parameters (Hillary, 1995, p. 35).

It is worth mentioning that currently in shipping, the importance of having an inventory of only hazardous materials (Green Passport) is being emphasized. However, efforts must be made to formulate a life cycle inventory of all the materials in use. Besides helping calculate the environmental load, this will also help in mapping different options for treatment, processing and recycling (Binder, 2005, pp.1-2). Life cycle inventory analysis of a ship is described in the next section.

5.2 Carrying Out an Inventory Analysis

The Life Cycle of a ship can be sub-divided into different phases of construction, operation, maintenance and scrapping as shown in the Figure 11. The information unearthed by the application of such a tool will help include aspects in the design phase to improve the overall environmental performance of the ship. Most assumptions in this inventory analysis are based on LCA-SHIPS, a project carried out by MariTerm AB, SSPA Sweden, TEM and the Department of Marine Transportation at Chalmers University for a period between 2002 and 2004.

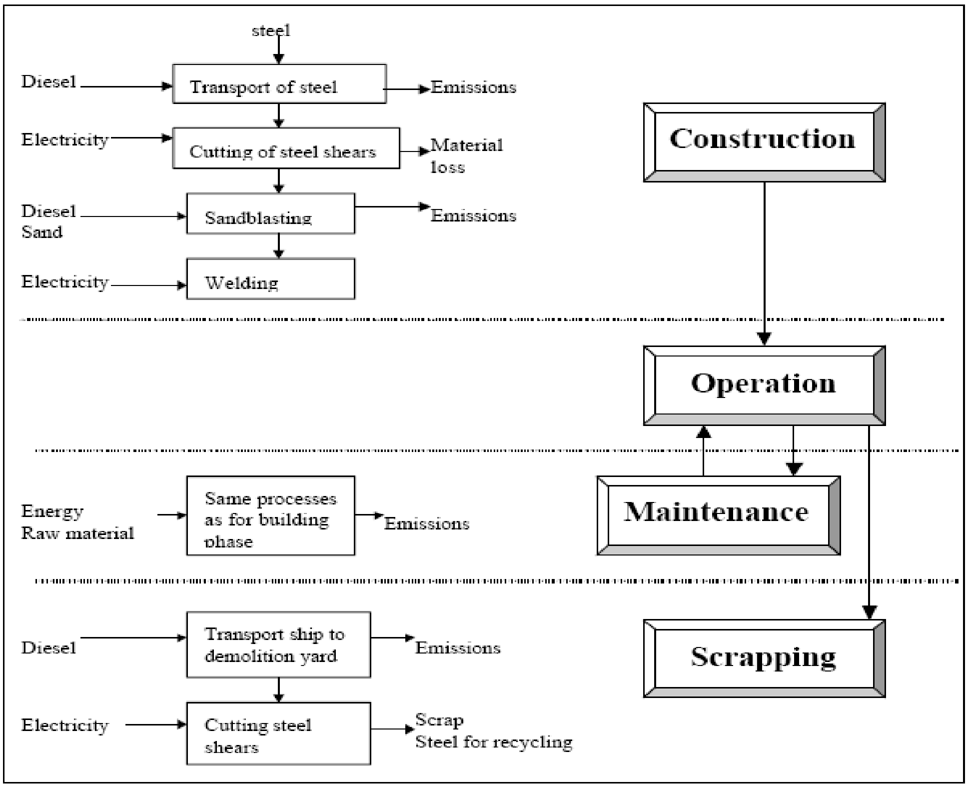

Figure 11-Flow chart for hull materials and work.
Source: Fet, M. (2002). Environmental reporting in marine transport based on LCA. in *The Journal Of Marine Design and Operation.* (B1). (pp.17-25).

5.2.1 Construction

A simplified model of the construction phase includes three major parts consisting of the hull, machinery parts (including cargo handling equipment), and equipment for the crew and passengers.

5.2.1.1 Hull

The flow processes of the hull are enumerated in Figure 12. The hull weight is assumed to be 85% of the light ship weight (Jiven et al, 2004a, p.22).

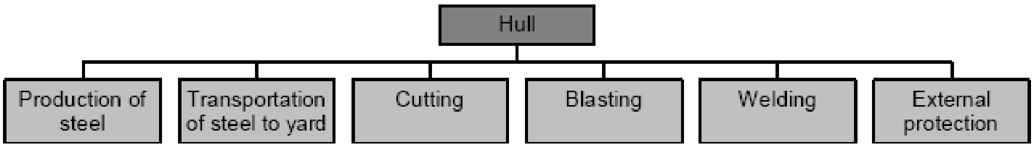

Figure 12-Flow chart for hull.
Source: Jiven, K., Sjobris, A., Nilsson, M., Ellis, J., Tragardh, P., and Nordstrom, M. (2004a). *LCA-ship, Design tool for energy efficient ships - A Life Cycle Analysis Program for Ships*. (p.22) Sweden: Mariterm AB, SSPA, TEM.

Cutting Phase

During this phase 10% of materials is assumed to be lost and approximately 95% of the cut-off material is recycled. The primary consumption is electricity which as assumed from previous LCA data is 8.5MJ/m2 (Jiven et al, 2004a, p.23).

Blasting phase

Choices have to be made between the use of water or sand. It is assumed that about 10kg of sand is required to blast 1m2 of steel (Jiven et al, 2004a, p.23).

Welding phase

Based on previous data it is assumed that one tonne of steel would require about 90.2 metres of welding and one metre of welding would require about 15.1MJ of electricity (Jiven et al, 2004a, p.23).

External Protection

For the painting below the water line, it is assumed that per tonne of the hull would require 0.397l of paint, 0.284l of antifouling and 0.0782l of primer. It is estimated that 0.147 kg zinc would be required for anodic protection of one tonne steel (Jiven et al, 2004a, p.23).

5.2.1.2 Machinery

The machinery phase is simplified to include engines, boilers and propellers. For simplification, steel with the same weight as the engines is recommended. Further, the weight is estimated to be approx. 7.5 % of LSW. The weight of the propellers is assumed to be about 0.2% of LSW. (90% copper and 10% tin). Boilers are estimated to be about 0.7% of the LSW (Jiven et al, 2004a, p.24).

5.2.1.3 Equipment for Crew and Passengers

Plastics, steel and textiles are the primary components of this phase. The environmental load of such materials is procured from existing LCA data. Besides, insulation materials in the accommodation should be accounted for (cargo spaces in case of a reefer ship). Also, worth mentioning would be the electrical cables, the insulation materials of them being the source of hazardous substances.

5.2.2 Operation

The operation phase is the longest of utilization of the ship and carries the greatest environmental load. Fuel combustion and leakage from anti-foulings form the biggest loads during this phase (Fet, 2002, p.8). A comprehensive data of the type and quantity of fuel consumed and the environmental impact by the use of fuel is calculated and stored in the LCA data of the computer tool.

5.2.3 Maintenance

This phase includes the periodic repair, steel renewals or conversions if warranted. Certain assumptions made for the sake of simplification are:

- 10% of the steel & 50% of the equipment renewal during the ships life time.
- 50% of the area below water line is painted with primer and anti fouling with the flexibility resting with the user to assign values for sandblasting and extra hull work (Jiven et al, 2004a, p.25).

5.2.4 Scrapping

The amount of recycled steel reduces the need for virgin steel and hence reduces the environmental load during the construction phase. If 75 % of the hull is recycled in the scrapping phase the amount of virgin steel in the production phase is also reduced by about 25 % (Jiven et al, 2004a, p.23). A total life cycle approach would further weigh the impacts of recycling steel with the production of virgin steel and help make better ecological choices. Major environmental impacts during this phase are the use of non-recyclable materials and the disposal of hazardous materials.

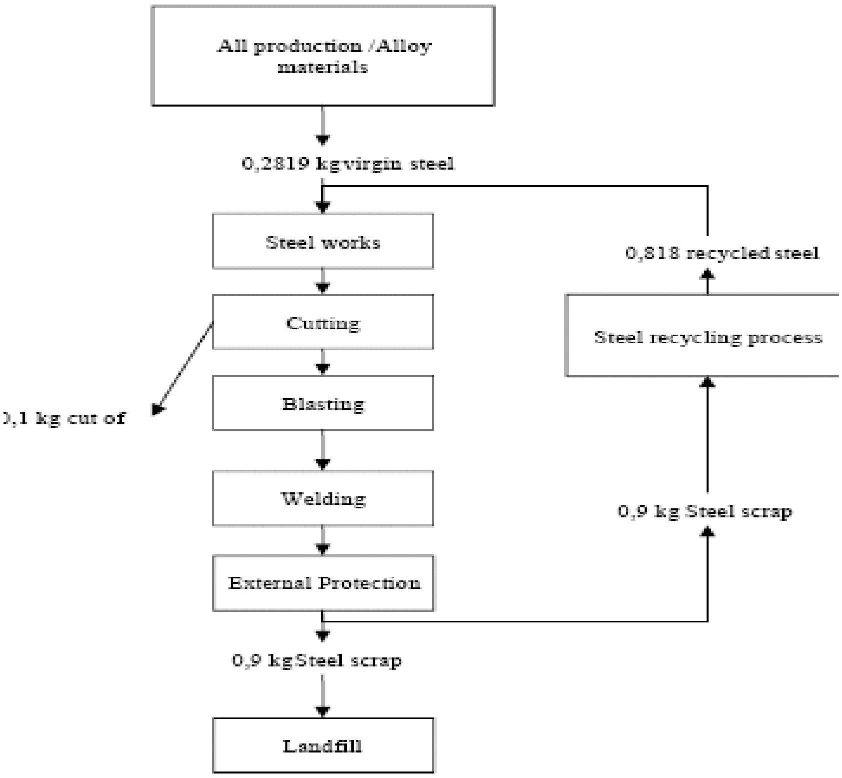

Figure 13-Flow chart for scrapping.
Source: Jiven et al. (2004a). *LCA-ship, Design tool for energy efficient ships - A Life Cycle Analysis Program for* Ships. (p.25) Sweden: Mariterm AB, SSPA, TEM.

The LCA model not only establishes relationships between included unit processes, it also sets the system boundary between the technical system and the environmental system. Resources from the environmental system are inputs such as iron ore and steel whereas emissions and wastes are the outputs from the technical system to the environmental system. All three phases of an ecological cause effect chain i.e the technical system, the environmental system and the social system are significant and need evaluation (Karlson, 2002, p.30). A social dimension would further calculate the dangerous manner in which such activities are currently carried out in the Asian yards.

5.3 Onboard Energy System

Ships have a long lifetime and the emissions generated during the actual use of a ship contribute immensely to the environmental impact. The system boundaries of a life cycle assessment of a ship will therefore have to include the operational phase of the ship. The major environmental impacts during the operational life of a ship can be apportioned to the emissions arising out of consumption of fuel oil. Hence it is necessary to model and evaluate the energy systems on board.

The ensuing pages describe an LCA modelling based on the onboard energy system. It is based on LCA-SHIPS, a project carried out by MariTerm AB, SSPA Sweden, TEM and the Department of Marine Transportation at Chalmers University.

Modeling of the environmental load from the ship is based on the operational data from the ship. Ships are subjected to varying loads and speeds depending on the ambient conditions. Hence it is essential to have specific data on the state of operation of the ship. Such data must contain information on:

- Name of the state of operation and speed (at different ambient conditions).
- Type of energy consumed in the engines and in the shore power system if power from shore is used at berth.
- Amount of energy consumed in the main engine, auxiliary engines, burners and shore power system.
- Emission factors for the engines at actual conditions.

The energy used by the consumers on board is matched with the energy production of the engines to module the energy consumption on board (Jiven et al, 2004b, p.9).

5.3.1 Energy Flow through the System

Shipboard energy systems are interconnected and complex system. Simplifications are therefore needed to be made in the model for calculation of estimates. The system components and their connections will therefore have to be defined for each state of operation.

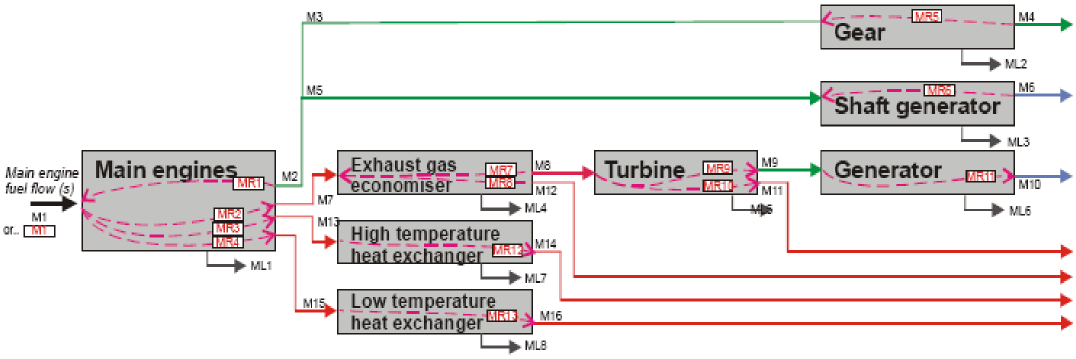

Figure 14-Interconnection between engines and components by energy inputs and outputs.
Source: Jiven et all. (2004). *LCA-ship, Design tool for energy efficient ships - A Life Cycle Analysis Program for Ships.* (p.51). Sweden: Mariterm AB, SSPA, TEM.

Figure 14 enumerates a simplified flow diagram of the inputs and outputs of a main engine system. The mechanical outputs are used for propulsion whereas the heat energy emanated is used in heat exchangers. The energy inputs into the system can be derived from the available LCA data on heavy fuel oil and diesel oil used on board. For the outputs, values can then be assigned by the user of the application for different states of operation (Jiven et al, 2004b, p.14). The energy system onboard can be classified into two Sub-systems. They are:

1. Systems producing propulsive energy (main engines).
2. Auxiliary systems producing electricity (auxiliary engines).

Description of these sub-systems will provide an approximate picture of the energy consumption on board (Jiven et al, 2004b, p.13).

5.3.2 Energy Consumers

Once the energy production system on board has been defined, the next logical step would be to define the energy consumption for that state of operation. Energy consumption is entered for all energy consumers. For a particular state of operation, each process that is running has its own energy consumption such as propulsion, fans and accommodation heating. The consumption for an *Energy consumer* is defined by the sum of each of the available energy flows for example main engine consumption would be assigned to flows from the shaft energy, electricity, low/high temperature flows that emanate from it (Jiven et al, 2004a, p.51).

5.3.3 Balancing the System

Energy consumers for a specific *State of operation* are summed up by *energy type* such as electricity and shaft energy. If the shaft energy requirement for a particular state of operation is say "P". If for that operation, the user has assigned a value for the shaft energy to be 45% of the system input, then the input required would be P/.45= 2.2P (Jiven et al 2004a, p.52).

Fuel Consumption can be calculated for that specific state of operation if the calorific value of the fuel is known. Other flows like exhaust, high/low temp can be calculated in the similar manner. Besides, *emissions* can also be calculated on the basis of the life cycle data as entered in the system for the primary energy inputs of HFO or MDO (Jiven et al 2004a, p.52).

Total amounts of available energy in the flows are made available by the system to enable the user for comparison. The application has features to calculate the environmental loads and emissions generated in particular routes or over particular distances. This will help optimise operations (Jiven et al 2004b, pp.15-16).

5.3.4 Results

In the computerized software, the result menu will contain the vessel performance and calculated LCA data for the ship. Results can be viewed in the life cycle perspective or for individual phases. There is a provision of a range of functional units against which the result can be shown such as the environment load for one tonne of paper transported from Moss to Hamburg (Jiven et al, 2004b, p.16).

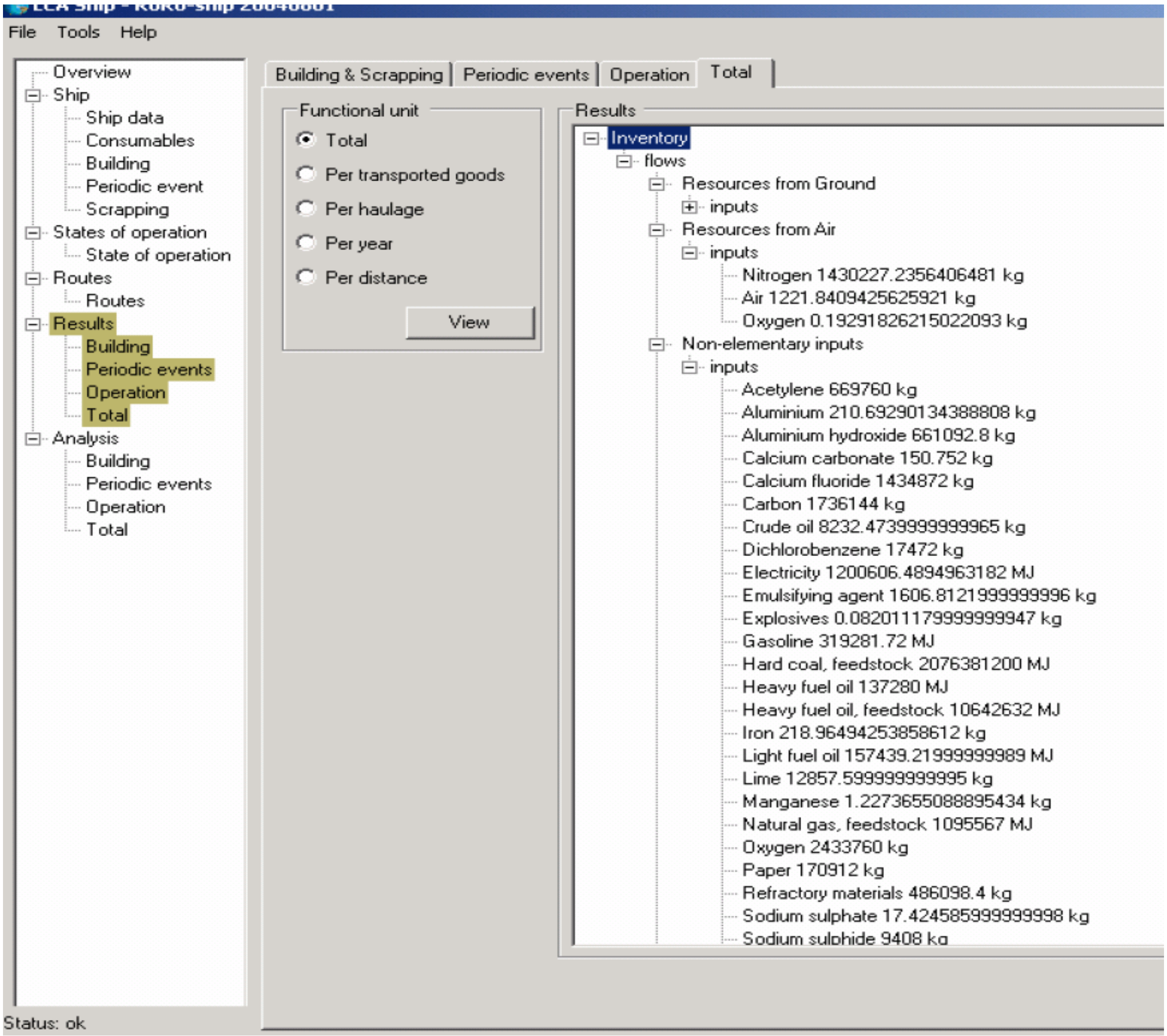

Figure 15– Results Menu
Source: Jiven, K., Sjobris, A., Nilsson, M., Ellis, J., Tragardh, P., and Nordstrom, M. (2004b).. *Computer application manual: LCA-ship, A life cycle analysis tool for ships.* (p.17). Sweden: Mariterm AB, SSPA, TEM.

5.3.5 Analysis

Data gathered in the result phase is put through classification and categorisation techniques for impact assessment. Valuations are also carried out as per different methods and interpretations of results are carried out. Comparisons are made by category if no valuations are carried out (Jiven et al, 2004b, p.19).

Comparison of the different impacts are carried out by weighing one against the other for example an underwater cleaning of the hull of a ship to increase fuel efficiency should be valued against the possible contamination caused to a eco-sensitive zone by removal of under water organisms from the hull in those waters. Thus mere scientific methods are of no avail. The advantages of application of such a module are numerous. Few that can be named are:

- Optimisation of the energy system onboard.
- Identification of energy losses with the possibility of reduction of the losses.
- Identification of energy flows and maximising on reutilisation/recycling of energy by using after heaters and exhaust boilers to improve efficiency.
- To module and calculate the energy need according to best possible technical and operational solutions (Jiven et al, 2004a, p.46).

An LCA may be carried out for various sub-systems such as the antifouling system or the sewage systems to carry out studies on their impacts upon the environment. One such comparative study yielded positive results for a new system with 10% less use of paints and antifouling, changed drydock frequency, 20% less leakage of TBT and 5% increased fuel consumption (Fet, 2002, pp.7-8). Hence, decisions will therefore have to be made on the whether society would be willing to accept greater air pollution resulting from higher fuel consumption or greater poisoning of the sea.

An LCA provides valuable insights into general product (policy) strategies. For instance assessment of bulk transport by road, rail or short sea. The move to short sea can reduce congestions along with associated noise pollutions from the land. But, the effects of shipping near the ports or eco-sensitive land adjacent to busy shipping lanes have to be evaluated too.

An LCA is an integral part in the development of EPR policies. It aids decision makers in prioritising actions and avoiding implementation of sub-optimal solutions. It should be used in conjunction with other tools such as risk assessment, environmental impact assessment and cost-benefit analysis for better results (EEA, 1998, pp. 46-47).

CHAPTER 6
RECYCLING FUNDS

One of the requirements of the EPR system is a guarantee fund (see Chapter 2). Ships are complex products and have a life span of above 20 years and are subjected to the vagaries of highly fluctuating freight and scrap markets. Furthermore, the owner of a rust bucket may become insolvent or may simply vanish. Also additional environmental costs like pre-cleaning and safe disposal of waste will make the price of scrap originating from ships uncompetitive. Establishment of such funds will act as a guarantee to cover risks arising from such eventualities and ensure that adequate reserves are maintained to recover costs for a safe recycling.

Borrowing from the example of ARN as mentioned in the recycling of cars (see Chapter 3), such a fund would have the liberty to purchase recycling services. Strict monitoring methods should be put in place to check compliance of the recycling practices before these entities are actually paid for their services. It is important for a fund to have defined targets so that implementation of the recycling liabilities is carried out in fair manner. Excessive profits might allow it to focus on increased recycling whereas recurring losses may lead to pressure for lowering targets (Lidgren and Skogh, 1998, p.18).

6.1 Fund Ownership

Risks inherent with a recycling fund are:

- Inflation can eat into the reserves and
- Future recycling costs may increase.

Carefully calculated margins have to be set into the premiums to take care of the risks that may arise from future bankruptcies. Further, the reserves may be organised on the lines of a mutual fund with the owners as policy holders. Another model mentioned is where the producers/importers, recycling firms and dealers own equity of the fund. Both mutual and equity funds simplify contracting with the optimisation of recycling goals in mind. It also helps in exercising better control of accounting and monitoring performance (Lidgren and Skogh, 1998, p.18).

Another idea suggests the introduction of compulsory eco-cycle insurance to insure the product against the possibility of an economic deficit arising out of the end-of-the-life management of the product. In this system, insurance companies play a key role. Adjustment of the fee structure is also important. A certain marginal may be considered on top of the premiums paid. In the event of the recycling costs of the product falling short of the investments made, the surplus is returned to the producers. This will act as an impetus for the development of cleaner and recycle-friendly products (Ryden, 1998, p.26).

Efficient management of such funds is critical. As discussed in the ARN model of the Netherlands (see Chapter 3), proper management and turnover has brought about a reduction in the waste disposal fees. Certain parallels can also be drawn from the IOPC fund where instruments are in place to cover oil pollution liability.

6.2 A Car Recycling Fund Model

This pioneering model for the Swedish Association of Automobile Manufacturers and Whole sellers (BIL) was designed by Erik Ryden and Thomas Lindhqvist for the management of end-of-the-life vehicles in 1994. As stated earlier in Chapter 3, cars as *complex goods* match favourably with ships and hence the comparison.

6.2.1 ELV fees

All manufacturers are to pay a uniform fee which is charged in connection with the sale of a new car. The level of the fee should cover the estimated future management costs for the respective manufacturer's end-of-the life car (Ryden, 1998, p.79).

6.2.2 Fund Shares

The fees paid are consolidated in a fund to ensure that adequate reserves are built in. Fees paid for a particular vehicle is linked to the scrapping of that car. This is done by depositing the fee into a fund share owned by the respective car producer. There are inbuilt restrictions preventing the producers from withdrawing money from the fund share. This ensures vital reserves are maintained for covering any risk (Ryden, 1998, p.80).

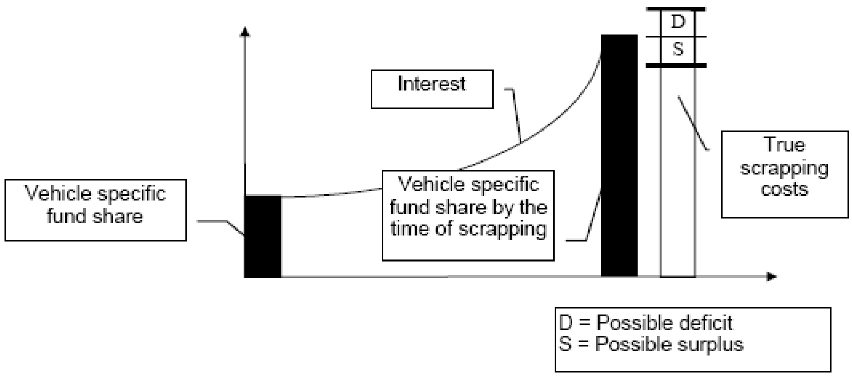

Fig 16- Financial development a fund share of an individual vehicle over its lifecycle. Source: Lindhqvist, T. (2000). *Extended producer Responsibility in Cleaner production.* Doctoral Dissertation, Lund University, Lund, Sweden.

If a deficit results in the cost of managing the ELV, then the same is recovered from the respective fund share.

6.2.3 Fund Administration

An administrative board consisting of representatives of the producers, government agencies, collectors, recyclers and all the other actors is constituted. The fees placed in individual producer-owned fund shares are administered to generate a profit. The proceeds are divided among the fund shares in proportion to their size (Ryden, 1998, p.80).

6.2.4 Funding a deficit

If despite taking all precautions, a deficit still exists for recycling of vehicles of a particular brand, then the deficiency should be made good by either of the following:

- Additional funding by the producer.
- In the case of insolvency of the producer, provisions exist for the setting up of a venture capital fund to take care of the management of the ELV.

This venture capital fund is built up through the annual appropriations of the fund shares (Kvist, Jansson, Lindhqvist, Ryden, 2001, p.253).

6.2.5 Refund to Car Manufacturers and Producers

Improved methods might lead to the ELV management cost of a vehicle model from a certain car producer to be lower than the estimated fees that had been charged and a surplus is then created. Withdrawal from the fund is permitted when a certain surplus liquidity has been achieved. This helps to provide incentives for the development of environmentally conscious product development. This also creates a differentiation for producers having integrated product development schemes (Ryden, 1998, p.81). (Lindhqvist, 2000, pp. 139-142)

Certain challenges that the designers of the fund had anticipated are:

- Producer participation: Mere collection of fees may not prevent the producer from disappearing or discontinuing his activity. Hence the overall goal of producer responsibility for end-of-the-life management might not be achieved.
- Fees and tools of assessment: Difficulties may arise in predicting fees as new discoveries may change the requirements for future handling. Assessing tools to identify the total cost to society need to be developed.
- Given the global nature of the automobile industry systems developed should not act as barriers to free and fair competition (Ryden, 1995, pp. 94-95).

Ships like cars are individually registered and are uniformly described with respect to size and design (Ryden, 1995, p.95). A model for funding recycling of ships with required modifications to fit its characteristics is described in the next section.

6.3 The Ship Recycling Fund Model

A research and consulting firm, ECORYS was commissioned by Greenpeace to carry out a study for an economic system to ensure safe and environmentally sound ship recycling. This study formed the basis of a report "The Ship Recycling Fund, Financing environmentally sound scrapping and recycling of sea-going ships" (ECORYS, 2003).

As with other recycling funds, this fund also tries to internalise the cost of the end-of-the-life management of ships. The fund is expected to be managed by either IMO in cooperation with ILO or UNEP.

6.3.1 Costs

The study estimates the cost components that would arise for the safe disposal of vessels. These are costs incurred for:

1. The removal of structural components of the ship.
2. The removal of operational wastes of the ship.
3. Upgradation of the existing facilities of the scrap yard.
4. Dealing with onboard waste generation.

In addition the future supply of ships for scrapping has to be included to find out the total financing needs of the fund over a desired time-frame (ECORYS, 2003, p.19).

6.3.1.1 Costs of Removing Structural Components

Certain limitations which the study mentioned for estimating the costs are:

- Very few shipowners have actually carried out such work.
- Shipyards are not forthcoming with information.
- Difficulty of separating remedial costs from dismantling costs.

The study cites the figures from the US Ship Scrapping Interagency Panel, 1998 which mentions that the estimated cost for one US warship for removal and disposal of structural components (with asbestos) to be USD 1 million (ECORYS, 2003, p.20).

For a container ship of 20,000-29,000 deadweight (dwt.), the cost of pre-cleaning are anticipated in the range of 20-40 USD per light displacement tonne (ldt.) in China. The costs in a European country are expected to be 3 to 4 times higher. In the US the costs are in the range of USD 100-500 per ldt. inclusive of remediation and dismantling (ECORYS, 2003, p.20).

6.3.1.2 Costs for Removing Operational Wastes

Cost estimates for the container ships as mentioned earlier are in the range of USD 5-10 per ldt. or at least one-third of the pre-cleaning costs. The cost is expected to be higher for tankers. The costs for upgradation of the facilities and the waste management at the scrapyards have not been estimated by the study. However, the report anticipates an extra cost of about USD 25- 50 per ldt. that will have to be incurred (ECORYS, 2003, p.21).

6.3.2 Supply of Ships

Assuming that the average life of a bulk carrier is 25-30 years and that of a tanker is 20-25 years, the report figures out the expected supply of ships for scrapping in the future will be as shown in Figure 2 (ECORYS, 2003, pp.22-24).

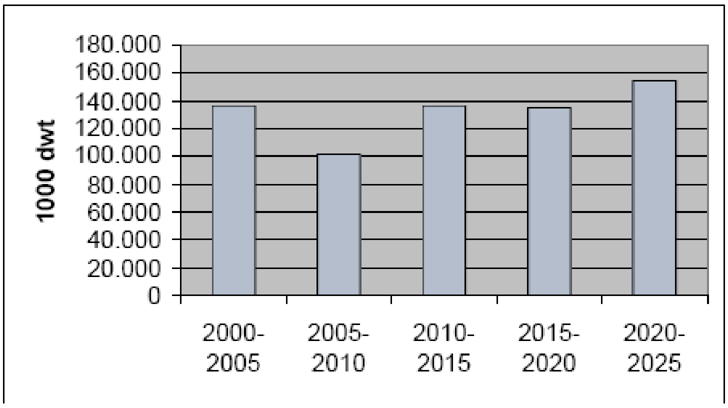

Figure 17- Indicative Supply of Ships for Scrapping
Source: ECORYS. (2003). *The Ship Recycling Fund.* (p.23).Rotterdam: Author.

Further, the actual weight of the ship is estimated on the ldt/dwt ratios (ECORYS, 2003, p.24). The same is mentioned in Table 8.

Table 8- Average ldt/dwt factor by ship type.

Tanker	Bulk carrier	General cargo, container, RoRo, reefer	Other
0,30	0,33	0,44	0,34

Source: ECORYS. (2003). *The Ship Recycling Fund.* (p.24). Rotterdam: Author.

6.3.3 Total Additional Funding Requirements

The estimates are made for the additional funding as mentioned in Table 9. The 5 yearly requirement is calculated as 1100-2200 M USD implying an annual lay out of approx. 220 to 440 M USD per annum (ECORYS, 2003, p.24).

Table 9- Financial requirements for the ship recycling fund.

	2000-2005	2005-2010	2010-2015	2015-2020	2020-2025
Ldt volume for scrapping (x1000)	44,100	35,400	46,200	43,800	51,000
Funding requirement (mln US$)					
Low (25 US$/ldt)	1,100	880	1,160	1,090	1,280
High (50 US$/ldt)	2,200	1,770	2,310	2,190	2,550

Source: ECORYS. (2003). *The Ship Recycling Fund.* (p.24). Rotterdam: Author.

The costs related to monitoring and managing the fund are however not included in the calculations.

6.3.4 Financing the Fund

The financing can be achieved either by contributions at the new building phase or during the life time of the vessel.

6.3.4.1 Contribution in the New-Built Phase

A fee during the registration of the ship is considered the most feasible option as it can be monitored by a central collecting organization. The drawback being that it will place the owners of newer ships at a comparative disadvantage with those of the existing owners (ECORYS, 2003, pp.27-29).

6.3.4.2 Contribution during the Lifetime of the Vessel

The fee levied should be based on the gross tonnage of the ship. This system applies to both new and existing ships and thus avoids market distortions. Two methods of application exist in this case:

1. Inclusion of the fees in the insurance premium.
2. Levying by the flag states.

In the case of the first option, it is advisable to include it in the P&I insurance since in several countries, the provision for mandatory P&I insurance already exists. Besides, flag states do have the necessary authority to collect such fees which can then be passed on to the fund (ECORYS, 2003, pp.30-32).

6.3.5 Introduction of Scrapping Life Insurance

Another alternative is the introduction of an obligatory life insurance to cover the cost of the end of the life management of the ship. There should be a margin above the future estimated costs of scrapping included in the premium. Any excess is then refunded to the owner after the production of clean scrapping certificate. This will be an incentive for cleaner shipping (ECORYS, 2003, p.31).

6.3.6 Functions of the Fund

The primary tasks of the fund would be:

- Collection of fees and certification of scrapping yards.
- Disbursement of funds for environmentally sound scrapping.
- Financing R&D on clean and safe scrapping (ECORYS, 2003, p.32).

The unique IMO number which is already been assigned to ships can be used to establish funding for specific ships. Mechanisms have to be further evolved for an administrative body to monitor the fund. All scrap yards applying for funding would have to comply with the guidelines on ship recycling under the IMO, UNEP and ILO regulations and then be certified by the fund. Monitoring mechanisms such as certifications and regular audits are to be put in place to ensure quality. Pre-cleaning or other activities undertaken as per the guidelines will be charged to the fund either by the last shipowner or by the scapyard. The fund is further expected to take a lead in encouraging research and development on clean recycling methods for the future (ECORYS, 2003, pp.32-33).

6.3.7 Conclusions

Guarantee funds help ensure clean ship recycling and in meeting EPR goals by:

- Solving the problems with the treatment of existing end-of-the-life products.
- Providing incentives for environmentally conscious product development (Ryden, 1998, p.24).

The *Sandrien* proves to be a classic case where the ageing chemical tanker (1974 built) was arrested by the Dutch authorities in Amsterdam in August 2000 in the "spirit of the Basel ban" as it was feared to be carrying hazardous waste to the beaches of Alang. The owners (same Italian company that owned *Erica*) proved elusive and the ownership of the company could be traced back to a letterbox company in Mauritius (Greenpeace, 2005). The Dutch government had to pay approximately Euro2M to dispose off the vessel in an environmentally sound manner. The only silver lining being that it was the first recorded ship to be disposed off in a "clean" manner by Ecodocks & Amsterdam Ship Repair. A whole new concept of zero discharge ship recycling emerged from the process (Garfield, 2004, p.22).

Recycling funds can provide a viable cushion for such exigencies. A ship recycling fund should be set up and the proposal of Greenpeace needs to be studied seriously at the IMO. Certain points that can be borrowed from the car recycling fund model are:

- Setting up of individual funds based on a ship's unique IMO number and the fees paid into this fund can be utilised for managing the end-of-the-life activities of that particular vessel.
- Provision of refunds to shipowners after deducting costs of recycling from the accumulated fund. This will provide incentives for improved and cleaner methods of disposal.

In order to meet the goals of sustainable shipping, policy makers should ensure that efforts are made in the proper direction.

CHAPTER 7
Conclusions and Recommendations

7.1 Conclusions

Ship recycling is a sustainable process in itself with a major portion of the vessel being recycled or put to reuse. However the manner in which these activities are carried out leaves behind an irrecoverable trail of human and environmental costs. The situation calls for structural changes in the end-of-the-life management of ships.

Extended Producer Responsibility is a strategy that appeals to the current situation. EPR entails a switch from the conventional open loop process to a sustainable closed loop production process. The actors of the return loop i.e collectors, dismantlers, recyclers will become equal stake-holders in the process.

In this case it is natural to identify the ship-owner as the producer as he enjoys the comparative advantage and can exercise better control over the other players. A single point of liability will further streamline supervision and control. Shipyards will however have to be active participants in the collective effort to build cleaner ships.

EPR will evolve a natural economic interest on the part of the ship-owner to develop a cleaner and resource efficient ship as he is aware that the burden of disposal lies on his shoulders. Besides, it will also ensure that the entire life cycle costs are reflected in the cost of the product and thus help the designer and the consumer make a value based choice.

Life cycle assessment is an important tool to calculate the life-cycle environmental load and it aids in building cleaner ships by providing solutions to problems before they occur. It is applied at the front end of processes at the idea or design stage of the product and thus views the system in its totality rather than focussing on one component or output.

Such approaches can be given added teeth by mandatory legislations on ship recycling. Guidelines by IMO, ILO and UNEP (Basel Convention) are already in existence but there has been hardly any positive change and compliance by competent states. It is a serious matter and government control based on international agreements is essential. Such a mandatory legislation should have cut off dates for phasing out hazardous material from ships. It should also set realistic recycling targets to be achieved and verified.

Parallels need to be drawn from the existing EU ELV Directive (200/53/EC) which is based on producer responsibility. The reason being that this legislation also deals with complex goods and it is primarily international in nature. The ARN model in the Netherlands had proved to be an efficient model for the disposal of cars. The automobile sector has put its act together and has set up effective collection and reporting systems. Information is made available in the form of dismantling manuals and online portals. Foundations have been laid for active research and development for removal/reduction of substances of concern.

Introduction of economic steering mechanisms are essential to complement regulatory actions. This helps in fully internalizing environmental costs and prevents malpractices. It provides incentives for clean recycling and covers for risks such as insolvency. Establishment of a Ship recycling fund under the auspices of IMO like the IOPC fund will help in better management of end-of-the-life vessels and provide impetus to develop cleaner products.

7.2 Recommendations for Implementation

Based on the above conclusions, certain recommendations can be made:

- A mandatory international regulation on ship recycling by IMO is essential. This legislation should set precise cut off dates for removal different hazardous substances from ships. It should set realistic recycling targets that are to be achieved within established time-frames. Such regulation should be the basis of harmonized national legislation promulgated by member states.
- The ship-owner should be made responsible for the end-of-the-life management of his ship.
- A Vessel Disposal Certificate must be issued to a ship on its last voyage to the recycling yard. This makes it possible to have a better reporting system with the risk of reuse of rust buckets destined for scrapping being minimised.
- A collective effort should be made by all the stakeholders such as manufacturers, shipowners, brokers, dismantlers, recyclers on similar lines with the ARN model of car recycling in the Netherlands to achieve recycling goals.
- An online information system for safe dismantling of ships on the lines of IDIS as set up by car manufacturers must be set up. Further, such information should be made available by manufacturers in the form of updated manuals that can be placed both on board and ashore.
- Wherever information on environment impact is available, a life cycle assessment should be carried out at the initial development stage to aid decision making.
- A ship recycling fund should be set up under the auspices of IMO to finance recycling activities. Certain unique points such as the creation of fund shares in the name of individual ships based on their unique IMO number and the provision of financial gains for cleaner recycling methods should be incorporated from the car recycling fund model.
- Beaching of ships should be discouraged given its toxic effects both on the land and the sea.

7.3 Challenges for future research

This research had aimed to focus on principles that will lay the foundations of preventive environmental policy making in shipping. Further research still needs to be carried out on the following aspects:

- To establish economic, physical and legal responsibilities of individual stakeholders. This will help achieve the overall goal of product development rather than simply closing the product loop.
- Life cycle assessment is a fairly young tool. Hence, further research is essential to build an extensive data bank to make fair assumptions of environment loads.
- Funding necessities to the last task concerned in the recycling chain should be further analysed. To decide the fees and premiums that are to be paid, further studies are required to make a realistic estimation of the future costs that will be incurred for the final management ships.
- Should shipyards be made entirely liable for the end-of-the-life management of the ships they built? Then the link between ownership and operation in shipping has to be further analysed. This can form the basis of further studies.

References

Andersson, R. (1992). Cleaner Production and Extended Product Responsibility. In *Extended Producer Responsibility As a Strategy to Promote Cleaner Products, 4-5 May1992*, *Trollehom Castle, Sweden,*(pp.91- 100). Lund: International Institute for Industrial Environmental Economics at Lund University.

ARN. (2000). *EU Directive*. Amsterdam: Author. Retrieved June 22, 2005 the World Wide Web: http://www.arn.nl/files/EU%20richtlijn%20UK%2026920001021en00340042.pdf

ARN. (2002). *End-of-the-vehicle Management Decree*. Amsterdam: Author. Retrieved June 22, 2005 from the World Wide Web: http://www.arn.nl/files/pdf%20bba.PDF

ARN. (2005a). *Birds Eye View of ARN, Organisation*. Amsterdam: Author. Retrieved June 28, 2005 from the World Wide Web: http://www.arn.nl/engels/1vogelvlucht/13.php

ARN. (2005b). *Environmental Report 2004*. Amsterdam: Author.

ARN. (2005c). *Financing*. Amsterdam: Author. Retrieved June 24, 2005 from the World Wide Web:http://www.arn.nl/engels/1vogelvlucht/15.php

ARN. (2005d). *RESULTS ARN at the moment*. Amsterdam: Author. Retrieved June 24, 2005 from the World Wide Web:http://www.arn.nl/engels/3resultaten/31.php

Basel Convention on the control of Transboundary movements on Hazardous Wastes and their Disposal (1992). Retrieved July 29, 2005 from the World Wide Web: http://www.basel.int/text/con-e-rev.pdf

Bianchi, R. (2005). The European 2000/53/EC Directive: Problems regarding recovered materials. In *5th International Automobile Recycling Congress, 9-11 March 2005, Amsterdam,* (pp.1-5) Switzerland: International Congress & Marketing.

Binder, M. (2005). Modular Life Cycle Model- Basis for Analysing the Environmental Performance of different Vehicle End of Life Options. In *5th International Automobile Recycling Congress, 9-11 March 2005, Amsterdam.* (pp.1-9) *Switzerland*: International Congress & Marketing.

Blankestijn, P.T. (2005). P&O Nedlloyd- The Experience of Human/Safe and Environmental Ship Recycling In *Ship Recycling Conference2005, 11-12 April 2005, Amsterdam,* (pp. 1-6) London: Lloyd's List Events.

Chabra, P. (2002). *A Study of Ship Scrapping Economics, Environmental Problems in South Asia and Solutions.* Unpublished master's thesis, World Maritime University, Malmo, Sweden.

Davis, G. A. (1998). Is There A Broad Principle of EPR? In K.Jönsson & T.Lindhqvist (Eds.) *Extended Producer Responsibility as a Policy Instrument—What is the Knowledge of the Scientific Community? 8-9 May, 1998, Lund, Sweden,* (pp. 29-33) Stockholm: Swedish Environmental and Protection Agency.

Drewry. (1996). *Ship Scrapping Locations, Activity, Private Trends and Problems.* London: Author

Donkers, Edo. (2005). The Pathway to Sustainable Shipping in *IMareEST/MCA conference: Sustainable Shipping...progress in a changing world. 1-2 February 2005. London,* (pp.54-62), London: Institute of Marine Engineering, Science and technology.

ECORYS. (2003). *The Ship Recycling Fund*. Rotterdam: Author. Retrieved on July 27, 2005 from the World Wide Web: http://www.greenpeaceweb.org/shipbreak/fund.pdf

Ellingsen, H., Fet, A. M. & Aanondsen, S. (2002). Tool for Environmental Efficient Ship Design. In *ENSUS 2002 The international Conference on Marine Science and Technology for Environmental Sustainability, 16-17 December 2002, University of Newcastle, Newcastle, United Kingdom.* (pp. 1-12). Retrieved August 1, 2005 from the World Wide Web:http://www.pre.nl/LCAsearch/

European Environmental Agency. (1997). *Life Cycle Assessment A guide to approaches, experiences and information sources.* Copenhagen: Author. Retrieved August 1, 2005 from the World Wide Web:http://www.pre.nl/LCAsearch/

European Environmental agency. (1998). *Life Cycle Assessment (LCA) A guide to approaches, experiences and information sources*. Copenhagen: Author

Fet, A. M., Michelson, O. & Johnsen, T. (2000, October). *Environmental performance of transportation – a comparative study*, Oslo: Research Council of Norway. Retrieved May 10, 2005 from the World Wide Web:http://www.pre.nl/LCAsearch

Fet, A. M. (2002) Environmental reporting in marine transport based on LCA in *The Journal Of Marine Design and Operation.* (B1). pp.17-25. Retrieved June 15, 2005 from the World Wide Web: http://www.pre.nl/LCAsearch/

Frederik's fate decided. (2005, July 11). *Fairplay.* Retrieved August 16, 2005 from the World Wide Web: http://www.fairplay.co.uk/

Garfiel, G. (2004, November12). Dutch Carry Chem Tanker scrap costs. *Trade Winds*, p.22

Greenpeace. (2003). *Ships for ScrapVI   Steel and Toxic wastes for Asia*. Netherlands: Author. Retrieved July 12, 2005 from the Worldwide Web: http://www.greenpeaceweb.org/shipbreak/mumbaireport.pdf

Greenpeace. (2005). *Remarkable Ships.* Retrieved July 27, 2005 from the World Wide Web:http://www.greenpeaceweb.org/shipbreak/remarkableship_sandrien.asp

Henry, A. (1998). An Introduction to EXPRES, a multidisciplinary research project on Extended Producer Responsibility 1994-1996 In *Extended Producer Responsibility as a Policy Instrument—What is the Knowledge of the Scientific Community? 8-9 May, 1998. Lund, Sweden,* (pp. 64-67) Stockholm: Swedish Environmental and Protection Agency.

Hillary, R. (1995) *Life Cycle Assessment.* Cheltenham, United Kingdom: Stanley Thornes.

International Labour Organisation. (2003, May). *Draft Guidelines on Safety and Health in Ship breaking.* Geneva: Author. Retrieved July 29, 2005 from http://www.ilo.org/public/english/protection/safework/sectors/shipbrk/draft_guide.pdf

International Maritime Organisation [IMO]. (2003, December). *IMO Guidelines on Ship-recycling.* (A23 / Res 962). London: Author. Retrieved July 7, 2005 from: http://www.imodocs.imo.org/log_page.html?lang=english&username=WMU-A&pdf_location=%2FENGLISHpdf%2FASSEMBLY%2F23%2FRES%2F962.pdf

International Maritime Organisation [IMO]. (2005, July). *Report of the 53rd Session of the Marine Environment and Protection Committee.* London: Author. Retrieved July 29, 2005 from the World Wide Web: http://www.imo.org/home.asp

Jiven, K., Sjobris, A., Nilsson, M., Ellis, J., Tragardh, P., and Nordstrom, M. (2004a). *LCA-ship, Design tool for energy efficient ships - A Life Cycle Analysis Program for Ships*. Project Report 27 August, 2004. Sweden: Mariterm AB, SSPA, TEM. Retrieved May 10, 2004 from the World Wide Web:http://www.pre.nl/LCAsearch

Jiven, K., Sjobris, A., Nilsson, M., Ellis, J., Tragardh, P., and Nordstrom, M. (2004b). *Computer application manual: LCA-ship, A life cycle analysis tool for ships.* Project Report 27 August, 2004. Sweden: Mariterm AB, SSPA, TEM. Retrieved May 10, 2004 from the World Wide Web: http://www.pre.nl/LCAsearch

Kanthak, J. & Bernstoff, A. (1999). *Ships for Scrap Steel and Toxic wastes for Asia.* Hamburg: Greenpeace. Retrieved July 3, 2005 from the Worldwide Web: http://www.greenpeaceweb.org/shipbreak/shipsforscrap1.pdf

Kanthak, J. & Jayaraman, N. (2001). *Ships for ScrapIII Steel and Toxic wastes for Asia.* Hamburg: Greenpeace. Retrieved July 3, 2005 from the Worldwide Web: http://www.greenpeaceweb.org/shipbreak/shipsforscrap3.pdf

Karlson, L. (2002). *Life Cycle Assessment (LCA)-a Sustainable Management Tool?* Dissertation for a Licenciate of Technology, Royal Institute of Technology, Stockholm, Sweden: Royal Institute of Technology.

Kryger, J. (1992). Cleaner Production and Extended Product Responsibility. In Extended *Producer Responsibility as a Strategy to Promote Cleaner Products, 4-5 May1992*, *Trollehom Castle, Sweden,* (pp. 6-9). Lund: International Institute for Industrial Environmental Economics at Lund University.

Kvist, K., Jansson, U., Lindhqvist, T. & Ryden, E. (2001). Recycling Coordination and Planning are necessities – seen against experiences from the Swedish car scrapping system. (pp. 247-254) In *First Annual- World Car 2001 Conference, 2001, California.* California: University of California – Riverside.

Lidgren, K & Skogh, G. (1998). Extended Producer Responsibility – Recycling, Liability and Guarantee funds. In *Extended Producer Responsibility as a Policy Instrument—What is the Knowledge of the Scientific Community? 8-9 May, 1998. Lund, Sweden,* (pp.11-22) Stockholm: Swedish Environmental and Protection Agency.

Lifset, R. (1992) Extended Producer Responsibility: Rationales and Practices in North America. In *Extended Producer Responsibility as a Strategy to Promote Cleaner Products. 4-5 May1992*, *Trollehom Castle, Sweden,* (pp.33-49). Lund: International Institute for Industrial Environmental Economics at Lund University.

Lindhqvist, T. (1998). What is Extended Producer Responsibility? In *Extended Producer Responsibility as a Policy Instrument—What is the Knowledge of the Scientific Community? 8-9 May, 1998. Lund, Sweden,* (pp.3-10) Stockholm: Swedish Environmental and Protection Agency.

Lindhqvist, T. (1992) Extended Producer Responsibility In *Extended Producer Responsibility as a Strategy to Promote Cleaner Products. 4-5 May 1992*, *Trollehom Castle, Sweden,* (pp.1-5). Lund: International Institute for Industrial Environmental Economics at Lund University.

Lindhqvist,T. (2000). *Extended producer Responsibility in Cleaner production.* Doctoral Dissertation, International Institute for Industrial Environment Economics at Lund University, Lund, Sweden. Retrieved July 26, 2005 from the World Wide Web: http://www.pre.nl/LCAsearch/default.htm

Matser, E., Liu, H. & Harjono, M. (2001). *Ships for ScrapIV Steel and Toxic wastes for Asia.* Hamburg: Greenpeace. Retrieved July 11, 2005 from the Worldwide Web: http://www.greenpeaceweb.org/shipbreak/shipsforscrap4.pdf

Mayr, J. (1992, May). Environmental Orientated Liability and Stewardship Principles for Products-General Remarks and German Initiatives and Experiences. In *Extended Producer Responsibility As a Strategy to Promote Cleaner Products, 4-5 May1992*, *Trollehom Castle, Sweden,* (pp. 79-90). Lund: International Institute for Industrial Environmental Economics at Lund University.

Murlis, J. (2005) Future environmental pressures: Opportunities for Shipping. In *IMareEST/MCA conference: Sustainable Shipping...progress in a changing world, 1-2 February, 2005. London,* (pp.28-37), London: Institute of Marine Engineering, Science and technology.

Neitzel, H. (1992, May). Environmental Orientated Liability and Stewardship Principles for Products – General Remarks and German Initiatives and Experiences. In *Extended Producer Responsibility As a Strategy to Promote Cleaner Products, 4-5 May1992*, *Trollehom Castle, Sweden,*(pp. 6-9). Lund: International Institute for Industrial Environmental Economics at Lund University.

No Indian Action against rogue ship. (2005, April 29). *Fairplay.* Retrieved August 16, 2005 from the World Wide Web: http://www.fairplay.co.uk/

Pesso, C. (1992). Extended Producer Responsibility through products: A Step Closer to Cleaner Production and Consumption. In *Extended Producer Responsibility As a Strategy to Promote Cleaner Products, 4-5 May1992*, *Trollehom Castle, Sweden,*(pp. 15-21). Lund: International Institute for Industrial Environmental Economics at Lund University.

Ryden, E. (1995) *Car Scrap –Throw It Away OR Make It Pay.* Dissertation for Licenciate in Engineering. International Institute for Industrial Environment Economics at Lund University, Lund, Sweden.

Ryden, E. (1998) Car Scrap –Throw It Away OR Make It Pay. In *Extended Producer Responsibility as a Policy Instrument—What is the Knowledge of the Scientific Community? 8-9 May, 1998. Lund, Sweden,* (pp.74-82) Stockholm: Swedish Environmental and Protection Agency.

Ryden, E. (1998). Extended Producer Responsibility – an emerging field for new actors. In *Extended Producer Responsibility as a Policy Instrument—What is the Knowledge of the Scientific Community? 8-9 May, 1998. Lund, Sweden,* (pp.24-28) Stockholm: Swedish Environmental and Protection Agency.

Secretariat of the Basel Convention. (2005). *Joint Working group.* Retrieved July 30, 2005 from the World Wide Web: http://www.basel.int/ships/iloimobcwg.html

Seum, S. (2005). A path to Sustainable Shipping, BSR's Sustainable Transport Initiative and Clean Cargo. In *IMareEST/MCA conference: Sustainable Shipping...progress in a changing world. 1-2 February, 2005. London,* (pp.38-43), London: Institute of Marine Engineering, Science and technology.

Simapro 6 (September, 2004). *Introduction to LCA with Simapro*. Netherlands: Pre-Consultants. Retrieved May 10, 2005 from the World Wide Web: http://www.pre.nl/download/manuals/UserManual.pdf

Stares, J. (2005, August 03). EC highlights problems of enforcing Basel Convention. *Lloyds List.* Retrieved August 16, 2005 from the World Wide Web: http://www.lloydslist.com/

State and Business community for Bavaria. (2001). *Integrated product policy instruments from practice using the automobile as an example.* Munich: Industrie- und Handelskammer fur Munichen und Oberbayern. Retrieved July 12, 2005 from the World Wide Web:http://www.pre.nl/LCAsearch/

Toyota. (2003). *European Environmental report 2003*. Brussels, Belgium: Author Retrieved June 22, 2005 from the World Wide Web: http://www.toyota-europe.com/Images/envionmentalreport2003_tcm280-169067.pdf

Toyota. (2004). *Environmental & Social Report 2004*. Japan: Author. Retrieved June 22, 2005 from the World Wide Web: http://www.toyota.co.jp/en/environmental_rep/04/download/pdf/c36_41.pdf

Toyota. (2005). *The Recycling Process*. Retrieved July 10, 2005 from the World Wide Web:http://www.toyotaeurope.com/innovation/environment/reduce_reuse_recycle/the_recycling_process.asp

United Nations Environment Programme [UNEP].(2002, December). *The Technical Guidelines for the Environmentally Sound Management of the Full and Partial Dismantling of Ships.* Geneva: Author. Retrieved July 29, 2005 from the World Wide Web:http://www.basel.int/meetings/cop/cop6/cop6_23e.pdf

United Nations Environment Programme [UNEP]. (2004). *Report of the Open Ended Working Group of the Basel Convention on the control of the Trans-boundary movements of Hazardous wastes and their Disposal.* Geneva: Author. Retrieved July 29, 2005 from the World Wide Web: http://www.basel.int/meetings/oewg/oewg3/34repe.pdf#III3

United Nations Environment Programme. [UNEP]. (2005). *Introduction.* Retrieved July 30, 2005 from the World Wide Web: http://www.basel.int/pub/basics.html

Wilkins, T. (2005). Environmental Sustainability in Shipping: Changing Regulatory Development to assist in achieving environmental Sustainability in *IMareEST/MCA conference: Sustainable Shipping...progress in a changing world. 1-2 February, 2005. London,* London: Institute of Marine Engineering, Science and technology. Retrieved March 1, 2005 from the World Wide Web: http://www.intertanko.com/about/presentations/

Bibliography

Drewry. (1977, March). *Ship Obsolescence and Scrapping.* London: Author

Drewry. (1983, October). Ship *Scrapping.* London: Author

Drewry. (1985). *Ship Scrapping New Developments* London: Author

Governing Council of the United Nations Environment Programme. Environmental Challenges in the new century. In *Global Ministerial Environment Forum, 29-31 May, 2000, Malmo, Sweden.* Malmo: UNEP.

Governing Council of the United Nations Environment Programme. Private Sector and Environment- preparing for the twenty-first century. In *Global Ministerial Environment Forum, 29-31 May, 2000, Malmo, Sweden.* Malmo: UNEP.

Governing Council of the United Nations Environment Programme. Civil society- responsibility and role vis-a-vis environment in the globalised world. In *Global Ministerial Environment Forum, 29-31 May, 2000, Malmo, Sweden.* Malmo: UNEP.

Hussein, M. A. (2004). *Principles of Environmental Economics*. London: Routledge Taylor and Francis group.

Legaspi, D. R. Ship Recycling: *Analysis of the problems it represent to the shipbreaking countries.* Unpublished master's thesis, World Maritime University, Malmö, Sweden.

Sinha, S. Ship scrapping and the environment – the buck should stop! *Maritime Policy and Management.* 25, 397-403.

United States Environmental Protection Agencies. (2000) *A Guide for Ship Scrappers Tips for Regulatory Compliance.* Washington: The Federal Facilities Enforcement Office (2261A)

United Nations Conference on Trade and Development. [UNCTAD] (1995, January 5) *Incentives and Disincentives for the Adoption of Sustainable Development by Transnational Corporations.* Geneva: Author.

United Nations Conference on Trade and Development. [UNCTAD] (1995, January 5) *The Integration of Environmental Performance Indicators with Financial Information by Transnational Corporations.* Geneva: Author.

APPENDIX 1

Questionnaire & Responses

Questionnaire

Dear Sir/Madam,

Your opinion is being solicited for the completion of the attached questionnaire. The purpose of this questionnaire is to collect data for a dissertation on "Practices towards Cleaner Ships and Sustainable Social Development" being carried out at the World Maritime University.

For shipping having trained its eyes on certain part functions like oil pollution, air pollution, ballast water management etc., it is time to focus on the bigger picture of sustainable developmental practices. There is a clear need to move from pollution control techniques to cleaner production approach.
Extended Producer Responsibility is one of the mechanisms that is effectively used for achieving cleaner production goals. This means that responsibilities which were earlier assigned to consumers and authorities responsible for waste management are to be shifted to the producer of the products.
This study shall focus on the producer led mechanisms that have been successfully put in use in the end of the life management of cars and automobiles in Europe and gauge if such a model can be replicated to recycle end of the life ships.
It shall also throw light on how implementing a Life Cycle Assessment tool can lead towards cleaner and efficient ships.

Your answers will be kept strictly confidential and your organization will not be identified if so desired.
Your precious time and effort in answering the questions is highly appreciated. I thank you for your kind cooperation.

RETURN OF QUESTIONNAIRES

Please send your completed questionnaire to this address by **15th July 2005**.

Prasant Kumar Padhi
World Maritime University
P.O. Box 500, S 20124
Malmö, Sweden

EMAIL: s05103@wmu.se

Please indicate your preference on being quoted by CLICKING the option that is applicable:

I object to be quoted ☐
I have no objection to be quoted ☐

QUESTIONNIARE: (Please click the choice that is appropriate)

1. Keeping in mind the negative image that shipping suffers today in the Disposal of End –of- life Vessels, *IS THERE* a need to draw parallels from the automobile industry and form a collective effort by Shipyards. Shipowners, Ship repair yards, Suppliers and Equipment manufacturers etc. to maximise recycling of ships and to ensure safe and environmentally friendly disposal of End- Of- Life vessels ?

   YES ☐

   NO ☐

   Any Other Comments

2. In the automobile chain, the end responsibility of disposal also rests with manufacturer.
   In order to internalise this cost, who should be made responsible for the safe disposal of ships:

   a) *Shipowner* ☐

   b) *Shipyard.* ☐

   c) *Both* ☐

   d) Other parties.

   (Pls. give any reasons for the choice)

3. A Waste Disposal fee is set out during the registration of a car in Europe. Also vehicle manufacturers / importers have to make contributions to Automobile Recycling Funds of their respective countries to manage the chain of recycling of End – of – the – life vehicles.
   a) Should such a Waste Disposal Fee be made mandatory during the registry of a ship?

   YES ☐

   NO ☐

   Any Other Comments

   b) Do you think that creation of an International Ship Recycling Fund is the need of the hour?

YES ☐

NO ☐

Any Other Comments

If your answer to the above question is yes then,
c) Do you think that shipowners, shipyards and all other players need to make such contributions to an International Fund for a certain number of years?

YES ☐

NO ☐

Any Other Comments

d) Given the international nature of shipping, do you think that such a fund should be managed by:

UNEP ☐

IMO ☐

Both ☐

Some other mechanism (Please Mention)

e) Should such a fund help share some financial burden to build necessary infrastructure for the safe disposal of ships in affected countries?

YES ☐

NO ☐

Any Other Comments

f) Should countries where such disposal facilities are being initiated, make equal contributions for the development of necessary infrastructure?

YES ☐

NO ☐

Any Other Comments

4. IMO already has in place guidelines for the safe recycling of ships and calls upon all stakeholders to make worthwhile contributions towards clean recycling of ships. However, to have the desired effect,
a) Do you think that IMO needs to pass Mandatory regulations on Ship recycling as the European Union has done on End of the Life recycling of cars?

YES ☐

NO ☐

Any Other Comments

Given the fact that the social, environmental and health issues at stake in the recycling yards are regulated by national or local laws where such an entity is located.
b) Do you think that IMO would be overstepping its authority by passing such mandatory regulations on environmental, social and health requirements at these facilities?

Strongly agree ☐

Agree ☐

Do not agree ☐

c) In the absence of a Global regulatory regime, do you think ship recycling states will voluntarily act within a given timeframe to efficiently regulate the above mentioned issues at their recycling yards?

YES ☐

NO ☐

Any Other Comments

5. Beaching of end – of – the – life vessels for recycling causes irreparable harm to the land and sea by releasing harmful and hazardous materials.
a) Do you think the practise of "beaching" end of the life ships needs to be stopped?

YES ☐

NO ☐

Any Other Comments

If your answer to the above question is yes then,
b) Should ships be scrapped in closed environment of Ship repair yards?

YES ☐

NO ☐

Any Other Comments

c) Is building of fluid tight/ zero discharge docks such as ECO DOCKS an answer to safe disposal of ships in future?

YES ☐

NO ☐

Any Other Comments

6. In the recent Kong Frederick alias Riky case, the Supreme Court Tribunal of India ruled that the vessel needed to leave the shores of India and recorded that "a ship considered as waste in the exporting country should be considered as a waste in the importing country". (As per the Basel Convention)

   Life Cycle Assessment is one of the effective tools of sustainable development that monitor the impact of a vessel from cradle to grave. It helps reduce emissions and renders efficiencies at all stages viz. design, development, production, use and final disposal. Such a programme will also help uniformly decide if "*A WASTE IS UNIVERSAL IN NATURE*".

   A) Is it therefore required to have such a programme that measures the social/ environmental / economic impacts of the entire life cycle of a ship from its cradle?

   Strongly agree ☐

   Agree ☐

   Do not agree ☐

7. In the same case as mentioned above, serious inconsistencies of thought and action arose between the previous and the last owners of the vessel who decided to scrap the vessel within a few weeks of buying the vessel.
   It seems that shipowners fear a public outcry and frenzy by green activists if found directly responsible for despatching waste ships to Asian recycling yards. Hence bringing into existence a chain of unscrupulous brokers and agents.
   In the car industry, a destruction certificate is obtained upon deregistering the vehicle this helps prevents any misuse of the vessel.

   In this context,

a) Do you think that A vessel destruction certificate should be issued to a ship during her last voyage to the recycling yard after deregistering?

YES ☐

NO ☐

Any Other Comments

b) Will such a certificate prevent further misuse (like pulling a rust-bucket back in use) once a owner has decided the ship to be at her end-of-the life stage?

Strongly agree ☐

Agree ☐

Do not agree ☐

c) Will issuance of such a certificate reduce the number of intermediaries and thus help better information flow between the previous users of the vessel and the recyclers thereby thereby helping in safe and clean recycling?

Strongly agree ☐

Agree ☐

Do not agree ☐

Summary of the Responses to the Questionnaire

To elicit opinion on the research topic, a set of questionnaires was prepared and despatched to senior personnel working with maritime administrations, shipowning companies, ship managers and influential shippers. About twelve completed questionnaires were received from the entire lot of seventy that were mailed out to respondents.

All respondents agreed with the view that a collective effort was needed by all the actors i.e shipowners, ship building yards, ship repairers, suppliers and equipment manufacturers to ensure effective management of the end-of-the-life ships.

Views expressed on the assignment of responsibility for the management of the end-of-the-life ships were clearly tilted in favour of a "dual" responsibility with both the shipowner and the shipyards being made responsible for the same. Eight respondents held this view. Two felt that the shipowner should be liable and only one respondent wanted the responsibility to lie with the shipyards. Two out of the four respondents from maritime administrations felt that the shipowner should be made responsible for the end-of-the-life management of the ship. However, responses from representatives of shipowners, shipmanagers and shippers preferred a dual responsibility.

Eight respondents were of the view that a "waste disposal fee" should be imposed at the time of the registry of the ship whereas three respondents did not want such a fee to be levied. Five respondents believed that such a fund should be managed by IMO. One respondent was of the view that UNEP should manage the same whereas two answers required a joint supervision by both IMO and UNEP.

All eight respondents who were in favour of setting up a ship recycling fund wanted shipowners to make contributions to the fund. Seven of them were of the view that the fund should help build infrastructure facilities in the recycling countries whereas one respondent did not favour this approach. However there was near unanimity in the opinion that the governments in the recycling states should bear an equal share of the responsibilities. All respondents barring for one were of the opinion that IMO must pass mandatory regulations on recycling of ships. Opinion was equally divided on whether IMO would be overstepping its authority if it mandated regulations affecting recycling sites in member countries.

Seven respondents felt that even in the absence of a global regulatory regime, the recycling states would act on their own within given timeframes to efficiently regulate their recycling yards. Five respondents held the contrary opinion. Opinion of respondents from recycling states stood divided with four stating that recycling states would not act on their own to improve the lot of their recycling yards and three mentioned otherwise.

All respondents except for two had the opinion that beaching of vessels needed to be stopped and breaking should be carried out in shiprepair yards. Seven respondents concurred with the opinion that fluid tight zero discharge scrapyards might be an answer for clean disposal of ships in the future. There was also a view that other options for clean recycling were needed to be explored too.

Application of life cycle assessment as a tool to promote sustainable shipping was endorsed by all the respondents except for one. Ten respondents believed that a "vessel destruction certificate" should be issued to ships proceeding for recycling whereas two respondents held the opposite opinion. Nine out of these ten respondents regarded that such a certificate would be able to:

- Reduce the possibilities of rust-buckets being pulled out from the scrap yards and put for further use.
- Reduce the number of intermediaries between the shipowner and the recyclers thereby easing the information flow.

Conclusions

By summing up the views of the respondents, certain conclusions can be drawn.
It seems that there is a total unanimity of opinion:

- To build collective mechanisms to manage end-of-the-life vessels.
- To have mandatory regulations on ship recycling passed by IMO.

There is a strong belief that:

- LCA must be increasingly used as a tool to achieve sustainability in shipping.
- Vessel destruction certificates must be issued for ships ready for recycling.
- Beaching of vessels needs to be stopped and breaking should be carried out in drydocks or repair yards.

However, a small sample renders in itself several handicaps. Thus views of different sub-groups such as shipowners, shippers, administrators and shipmanagers could not be analysed separately due to the absence of a critical mass of opinions.

APPENDIX 2

COMPARISON OF TOXICITY

The comparison of the levels of the toxicity discovered in the samples taken at Darukhana shipbreaking yard in Mumbai in December 2002 is demonstrated in table 10.

A publication was made in 1997 by the Oslo-Paris Convention, OSPAR, for the protection of the marine environment in the North-east Atlantic. OSPAR criteria are not limits for remedial action but only highlight areas of concern. Provisional criteria determined by the Ecotoxicological Assessment Criteria (EAC) of OSPAR for certain toxins are given below:

- Provisional criteria for Heavy metals:
  Arsenic (1-10 mg/kg), cadmium (0.1-1 mg/kg), chromium (10-100 mg/kg),
  copper lead and nickel (5-50 mg/kg), mercury (0.05-0.5 mg/kg) and for
  zinc (50-500 mg/kg).
- A provisional criterion for PCB is 0.001-0.01 mg/kg.
- A provisional criterion for TBT is 0.000005 to 0.00005 mg/kg.
- Provisional criteria for PAHs:
  1. Naphthalene and Anthracene 0.05-0.5 mg/kg.
  2. Phenanthrene 0.1-1.0 mg/kg.
  3. Pyrene 0.05-0.5 mg/kg.
  4. Fluoranthene 0.5-5 mg/kg.

(Greenpeace, 2003, p.10)

Table 10- Comparative analysis of Darukhana Samples with OSPAR values.

Substances	1	2	Target value	Limit Value	Test value	Interv en- tion value	OSPAR EAC
	mg/kg ds	Mg/kg ds	mg/kg ds	Mg/kg ds	Mg/kg ds	mg/kg ds	mg/kg ds
Mineral oil	6600	5500	50	1000	3000	5000	------
Metals							
Arsenic	12	20	29	55	55	55	1-10 (p)
Cadmium	2.7	3.9	0.8	2	7.5	12	0.1-1 (p)
Chromium	140	300	100	380	380	380	10-100 (p)
Copper	240	380	36	36	90	190	5-50 (p)
Mercury	0.96	0.82	0.3 *	0.5	1.6	10	0.05-0.5 (p)
Lead	470	480	85	530	530	530	5-50 (p)
Nickel	66	130	35	35	45	210	5-50 (p)
Zinc	910	1300	140	480	720	720	50-500 (p)
PAHs							
sum 10 PAHs	5.3	11	------	1	10	40	------
Naphthalene	<0.05	0.06	0.001	0.015	------	------	0,05-0,5 (f)
Phenanthrene	0.13	1,6	0.005	0.05	------	------	0,1-1 (f)
Anthracene	0.16	0.30	0.001	0.05	------	------	0,05-0,5 (f)
Fluoranthene	0.65	2.4	0.03	0.3	------	------	0,5-5 (p)
Pyrene	1.5	2.5	------	------	------	------	0,05-0,5 (p)
Benz(a)anthracen e	1.0	1.6	0.003	0.05	------	------	0,1-1 (p)
Chrysene	0.92	1.2	0.1	0.05	------	------	0,1-1 (p)
Benzo(k)fluorant hene	0.32	0.53	0.02	0.2	------	------	n.d.
Benzo(a)pyrene	0.60	1.3	0.003	0.05	------	------	0,1-1 (p)
Benzo(ghi)peryle ne	0.71	1.0	0.08	0.05	------	------	n.d.
Indenopyrene	0.80	0.68	0.06	0.05	------	------	n.d.
PCBs							
no 28	0.073	0.043	0.001	0.004	0.03	------	------
no 52	0.021	0.022	0.001	0.004	0.03	------	------
no 101	0.021	0.044	0.004	0.004	0.03	------	------
no 118	0.036	0.079	0.004	0.004	0.03	------	------
no 138	0.029	0.067	0.004	0.004	0.03	------	------
no 153	0.030	0.068	0.004	0.004	0.03	------	------
no 180	0.024	0.061	0.004	0.004	0.03	------	------
sum 7-PCBs	0.230	0.380	------	------	0.2	1	0.001-0.01 (p)

Source: Greenpeace. (2003) *Ships for Scrap VI Steel and Toxic Wastes for Asia*. (p.11). Netherlands:Author.

APPENDIX 3

Information on Substances of Concern

Table 11- Information on Substances of Concern

Oil

Oils and fuel exhibit toxic characteristics.Main exposure routes are inhalation and consumption of contaminated fish and water. Oil spills threatens birds, mammals and water organisms.

Heavy metals

Toxic heavy metals associated with shipbreaking include lead,mercury and cadmium. Metals can be found in many products onboard a vessel in varying quantities. Paints and coatings might contain metals such as zinc,lead and copper. Both zinc (typically in topcoats) and copper are still present in considerable amounts in modern paints.Heavy metals compounds are also present in anodes, insulation,batteries and electrical compounds. Heavy metals can cause harm to human health and environmental systems. Mercury for example is a toxic heavy metal and a persistent, bioaccumulative pollutant that affects the nervous system.The effects of lead upon human health have been known for a long time. Young children are most vulnerable to its toxic effects. Long-term exposure to even low levels can cause irreversible learning difficulties, mental retardation and delayed neurological and physical development.

PAHs

Approximately 250 different polycyclic aromatic hydrocarbons (PAHs) are known.Some 30 PAH compounds and several hundreds of derivatives are classed as carcinogenic. The health hazard from PAHs comes from directly inhaling fumes, which are released primarily during torchcutting, after torchcutting when paints continue to smoulder, or when wastes are deliberately burned. PAHs accumulate in dust and sediment,and tissues of lifeforms. As a result they are available for uptake either through inhalation,dermal contact or via the foodchain.

PAHs cause malignant tumours by interfering with enzymatic breakdown, affecting the lungs, stomach, intestines and skin. The potential of substance mixtures containing high PAHs levels to cause skin cancer is known since 1775.

PCBs

Polychlorinated organic compounds (PCBs) are found in solid (waxy) and liquid (oily) forms in equipment and materials on ships being scrapped.

These equiment and materials which may contain PCBs in concentrations of at least 50 parts per million (ppm) include cable insulation, transformers, capacitors and electronic equipment with transformers and capacitors inside, oil-based paint, anchor windlasses, in electrical systems in equipment for cargo handling (such as crane and pump arrangements), in sealing materials and glues used in windows in vessels built up to mid 1980's, in electrical components in powering systems and in electric lighting including fittings and heat exposed electrical components (condensators). Since PCB was phased out as a compound in ship paintings in the mid 70's, it is likely that most of the exposed paint structure does not contain this.

However, some paint surfaces such as in engine-, pump and boiler rooms and also ground coatings in accommodation areas are most likely of original specifications. PCBs are highly toxic and persistent pollutants and they bioaccumulate in the environment. Exposure to PCBs has been associated with a variety of adverse health problems. PCBs have been linked to cancer, liver damage, reproductive impairments, immune system damage and behavioural and neurological damage.

Organotins

Tributyltin (TBT) is an aggressive biocode (kills living organisms) that has been used in anti-fouling paints since the 1970s. TBT is considered as one of the most toxic compounds in the aquatic ecosystems; its impact on marine organisms range from the subtle to the lethal. TBT is responsible for the disruption of the endocrine system of marine shellfish leading to the development of male characteristics in female marine snails. TBT also impairs the immune system of organisms. Shellfish are reported to have developed shell malformation after exposure to extremely low levels of TBT in the seawater.

As organotins compounds can damage human health even in small doses, in industrialised nations, legal regulations are in place to protect workers from exposure to antifouling paints containing TBT. Skin, eye and lung protection are mandatory for any contact work with TBT-containing paints.

References: DNV1999, Greenpeace reports 1999 and 2001, ILO 2001 and US-EPA 2000

Source: Matser, E., Liu, H. & Harjono, M. (2001). *Ships for ScrapIV Steel and Toxic wastes for Asia.* (pp.14) Hamburg: Greenpeace.

APPENDIX 4

TECHNICAL REQUIREMENTS

Table 12 mentions the minimum technical requirements for the ELV storage and treatment sites as per Article 6 (1) and 6 (3) of EU Directive (2000/53/EC).

Table 12- Technical requirements for ELV storage and treatment sites.

1. Sites for storage (including temporary storage) of end-of-life vehicles prior to their treatment:

- Impermeable surfaces for appropriate areas with the provision of spillage collection facilities, decanters and cleanser-degreasers.
- Equipment for the treatment of water, including rainwater, in compliance with health and environmental regulations.

2. Sites for treatment:

- Impermeable surfaces for appropriate areas with the provision of spillage collection facilities, decanters and cleanser-degreasers.
- Appropriate storage for dismantled spare parts, including impermeable storage for oil-contaminated spare parts.
- Appropriate containers for storage of batteries (with electrolyte neutralisation on site or elsewhere), filters and PCB/PCT-containing condensers.
- Appropriate storage tanks for the segregated storage of end-of-life vehicle fluids: fuel, motor oil, gearbox oil, transmission oil, hydraulic oil, cooling liquids, antifreeze, brake fluids, battery acids, air-conditioning system fluids and any other fluid contained in the end-of-life vehicle.
- Equipment for the treatment of water, including rainwater, in compliance with health and environmental regulations.
- Appropriate storage for used tyres, including the prevention of fire hazards and excessive stockpiling.

3. Treatment operations for de-pollution of end-of-life vehicles:

- Removal of batteries and liquefied gas tanks.
- Removal or neutralisation of potential explosive components, (e.g. air bags).
- Removal and separate collection and storage of fuel, motor oil, transmission oil, gearbox oil, hydraulic oil, cooling liquids, antifreeze, brake fluids, air-conditioning system fluids and any other fluid contained in the end-of-life vehicle, unless they are necessary for the re-use of the parts concerned..
- Removal, as far as feasible, of all components identified as containing mercury.

4. Treatment operations in order to promote recycling:

- Removal or catalysts.
- Removal of metal components containing copper, aluminium and magnesium if these metals are not segregated in the shredding process.
- Removal of tyres and large plastic components (bumpers, dashboard, fluid containers, etc), if these materials are not segregated in the shredding process in such a way that they can be effectively recycled as materials.
- Removal of glass.

5. Storage operations are to be carried out avoiding damage to components containing fluids or to recoverable components and spare parts.

Source: ARN. (2000). *EU Directive*. (p. L 269/41). Amsterdam: Author.