CHAPTER 2

SHIP RECYCLING PROCESS

2.1 OPERATIONS IN SHIP RECYCLING PROCESS

Various engineering activities in ship recycling industry have been viewed as ship recycling processes in the present study. An overview of the processes in ship recycling is presented in this chapter. This is essential for understanding the state of art of this industry. Moreover the recommendations and suggestions for improvement to be proposed by the present study are to be based on the existing operations involved in ship recycling processes.

2.2 BACKGROUND OPERATIONS IN SHIP RECYCLING

Ship recycling being the last activity in the life cycle of a vessel, certain important commercial and engineering operations are to be carried out well in advance to facilitate the objectives of dismantling and recycling. Thorough knowledge regarding these background activities are essential for understanding and realising the ship recycling processes and treating ship recycling as a modern industrial business activity. A schematic representation of flow of related activities has been given in fig 2.1.

2.2.1 Decision on Decommissioning of Ships

At present there are no international regulations, seeking the retirement of a ship from service. Ship classification societies are very active in merchant shipping technical operations and take a lead role in various decision making activities. However, they have little role to play in the decommissioning. There are no ship classification society rules recommending dismantling of an obsolete ship. However the ship classification societies can declass a ship according to their rules and regulations. This decision does not mean that the ship declassed by the ship classification society be scrapped immediately. The owner can change the flag, or can approach other ship classification societies which are not affiliated to International Association of Classification Societies (IACS) which may be ready to register any vessel under their classification survey.
Decision to decommission vessel by the owner

Appointment of a broker for selling the vessel

Identification of buyer

Preparation of terms and conditions of sale

Inspection by buyer’s surveyors

Change of ownership of the vessel to buyer

Acquirement of certificates as per rules of recycling nation

Transfer or towage of vessel to recycling yard

Positioning of vessel at the site of dismantling

Dismantling of vessel by sliding

Intermediate storage of dismantled products

Disposal/Reuse/Selling of dismantled products

Fig. 2.1 Schematic Diagram of Flow of Activities in Ship Recycling
This will enable the ship owners to extend the life of their vessels. Ultimately, the decision of withdrawing a vessel from service is fully left to the owner of the vessel. Based upon the prevailing returns from shipping operations or scrap ship value the owner decides the fate of his vessel.

2.2.2 Activities Involving Ship Recycling Brokers

Before reaching the last owner (who is responsible for towing the ship to the positioning site for dismantling) the obsolete ship may pass through different intermediate owners. Owners of decommissioned ships are not called ship owners as the ship ceases to be operational and becomes scrap [Basel 2005]. Intermediate owners of such vessels are called as ship recycling brokers. Whenever the ship owners decide to decommission their vessels, information regarding this is made available in global information platforms such as internet websites and maritime publications. Interested ship recycling brokers approach the owners and transfer the ownership by paying advance amount. Then the broker invites quotation from potential buyers. Based on the highest bid offer from the buyers, the broker fixes the buyer and Memorandum Of Understanding (MOU) is signed between the ship owner and the buyer. The MOU clearly states the conditions of transfer of the ship to the dismantling site and other prerequisites. A ship surveyor as representative of the buyer will thoroughly inspect the vessel and give a report. The buyer pays the price to the owner based on surveyor’s report. It is the responsibility of the broker to arrange all these activities including arranging relevant certificates for transferring the vessel from a foreign owner to the end buyer or dismantler treating the vessel as imported commodity (or import).

2.2.3 Obsolete Vessel Positioning Methods

The three commonly used positioning methods in ship recycling are the beach method, dry dock method and buoy method.

**Beach method** is employed at shallow basins with long shelf bed where high tidal variations are available. The main beaching is done during high tide. The beached vessel is progressively slide up, to the recycling yard during successive high tides. Entire dismantling operations are done in the beach area available in the water front of the recycling yard. This method has been employed at Alang Recycling yard, in
Gujrath, Darukhana in Mumbai, Chittagong in Bangladesh and Gaddani in Karachi. Obsolete ships beached in a ship recycling yard for dismantling is shown in fig. 2.2.

![Fig. 2.2 Obsolete Ships Beached for Dismantling (Sibal 2001)](image)

In **Dry Dock method or Berth method**, obsolete ship is taken to dry dock facility in a ship recycling yard. This method can be called as disassembly method of ships in ship recycling yards. The major difference between dry dock method and beach method is the presence of a concrete barrier between the dismantled vessel and sea water. Progressive sliding for transporting the vessel within the yard premises is absent in the latter. Western European countries and United States practice this method. Obsolete ship docked in a dry dock ready for dismantling is shown in fig. 2.3.

**Buoy method** is named after the dismantling process being carried out in floating conditions. Obsolete vessels are berthed in quay side of sea ports and shipyards for dismantling. The dismantling is done by cutting and removing the ship parts in vertical direction. Starting from top of navigation deck and subsequently reaching double bottom. The cutting peripheries do not come in contact with sea water. Most of the recycling yards operating in China make use of buoy method of ship dismantling.

![Fig. 2.3 Obsolete Ship Docked in Dry Dock for Dismantling (Sibal 2001)](image)

Fig. 2.4 shows dismantling operations using buoy method which uses quay side for mooring the obsolete vessel.
2.2.4 Permission for Positioning

On arrival at the outer port, brokers or agents of the ship owner inform the recycling yard/port authorities regarding positioning of vessels at the anchorage. The inspection team of the recycling yard makes a thorough check of various mandatory certificates regarding the import/export shipment and payment of taxes and excise duties to be produced by the owner before beaching the vessel. As per existing practice, one deck officer, one certified marine engineer and the master of the vessel must be present during the check by the yard/port authorities. A detailed inventory of communication equipment used by the obsolete vessel is prepared. These are to be handed over to the wireless board of the recycler state immediately after completion of beaching. A comprehensive list of marine supplies and safety measures implemented onboard are prepared by the yard/port authorities. After this, permission will be granted and the ship will be allowed to enter the beach either by towing or by its own propulsion.

2.2.5 Preparations for Dismantling

The preparation for dismantling begins with the submission of man entry certificate and hot work certificate from the explosive department to the recycling statutory authority operating from the recycling yard. All kinds of petroleum oils including even inflammable gas in the fuel tank of the vessel have to be emptied and evacuated before starting of the cutting operations. Cutting is started after taking written permission from the local port authority. If the ship is beached away, shore lightening is allowed with the permission of port office.
2.2.6 Dismantling Operations

Major steps involved in the ship dismantling practices in beach method are briefly explained here. Practices involve various engineering activities performed prior to dismantling and during dismantling, buffering, lifting, transporting and disposal.

On the beach, workers use cutting torches and saws to dismantle the ship from the end facing the beach to the end facing the sea. Large blocks are cut and allowed to fall down freely. Further removal is from flat lying block using gas cutting. The cutting operations continue till the dismantled item can be handled by manual labourers or by a small crane to nearby stack location. The handling is done manually as well as using crude mechanical lifting procedures. No weight lifting calculation or lifting analysis is done prior to lifting. Along with the removal of hull steel and other items for the dismantled ship it is towed further inland by teams of men using winches simultaneously. Ship dismantling operations presently undertaken at Alang, state of Gujrath, are analysed compiled in the study [Sivaprasad 2006]. The salient features of the ship recycling activities undertaken at Alang Ship Recycling Yard, Gujrath are given in appendix 1. A schematic representation has been developed and presented in fig. 2.5. Dismantled metal is sorted by material type viz., steel, aluminum, copper, etc.,. Steel plates are often sold to re-rolling mills. Various machinery items are sorted and kept separately in a covered region. If a reverse engineering method of all activities involving disassembly of hull, outfit and machinery of ship is adopted during dismantling, that will improve the overall performance of the dismantling significantly. However, layout constraints, lack of infrastructure and unscientific procedures practiced in recycling yards make the ideal case far from realising.

2.3 GUIDELINES REGARDING SHIP RECYCLING OPERATIONS

Certain codes and recommendations from United Nations conventions, court ruling, codes and regulations framed by various agencies are acting as governing rules in ship recycling activities. Legally binding statutory rules and regulations are seldom seen in the field. Almost all regulations are still operating in a qualitative level and these can be collectively called as guidelines in ship recycling. Major agencies and bodies involved in making of codes and guidelines in ship recycling field include the following,

a. International Maritime Organisation,(IMO)
Fig. 2.5 Beach Based Ship Recycling Activities at Alang Ship Recycling Yard

b. International Labour Organization (ILO)

c. Department of Trade and Industry (DTI), UK

d. Secretariat of Basel Convention (BC)

e. Environmental Protection Agency (EPA), USA

f. Dets Norske Veritas (DNV), Norway
g. United Nations Environment Programme (UNEP)

h. Regional Rules and Regulations – Gujrath Maritime Board regulations

The guidelines provided by bodies differ slightly both in focus and direction. Most of these guidelines and directions are in the qualitative level and not very concrete. The focus of the guidelines has been summerised and is provided in table 2.1 that has been used in the generation of expert system in the present study. These deal with the aspects like sea, air and land pollution, operational and occupational safety, hazardous and non-hazardous waste, working practices and seaworthiness. The focus of these guidelines has been identified as the consequence of ship recycling.

**Table 2.1 Focus of the Guidelines in Ship Recycling Industry**

<table>
<thead>
<tr>
<th>Guidelines</th>
<th>Sea Pollution</th>
<th>Air Pollution</th>
<th>Land Pollution</th>
<th>Safety Operation</th>
<th>Occupation Safety</th>
<th>Hazardous Waste</th>
<th>Hazardous Material</th>
<th>Working Practice</th>
<th>Sea Worthiness</th>
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</table>

The guidelines of ship recycling procedures by the Gujrath Maritime Board cover all the ship recycling factors except seaworthiness of vessels. However modifications are required to make it the guidelines as mandatory rules and regulations covering entire ship recycling processes.
2.4 SHIP RECYCLING PROCESSES IN VARIOUS GLOBAL LOCATIONS

South East Asia contributes to more than ninety percent of global ship recycling activities. Countries such as Pakistan, India, Bangladesh and China are the major ship recycling centres of the world. Fig. 2.6 shows the statistics of world ship recycling volume up to 2008. Besides Turkey in Asia, ship recycling activities are reported from isolated locations of Europe including UK. Ship recycling activities carried out in these destinations are discussed briefly on the following subsections.

2.4.1 Bangladesh

Very steady growth is reported in ship recycling volume from ship recycling yards in Bangladesh during the last five years. Chittagong is the major ship recycling location in Bangladesh. Sixteen kilometers stretch available at Fauzdarhat, a city 16 km southwest of Chittagong where 8 square kilometers area is available for the recycling related activities. Due to high tidal difference available these yards are suitable for dismantling of big tankers and bulk carriers. The recycling yards in Bangladesh follow minimum safety standards for recycling. The yards seldom follow recommended ship recycling practices given by leading international ship recycling agencies. Pre-beaching and beaching activities are done without proper routine checks [DNV 2000].

2.4.2 China

Chinese ship recycling yards are located in Jiangmen and Jiangsu provinces and are situated in Pearl and Yangtse river deltas. There are more than 50 ship recycling yards located in these provinces. There are a few inland recycling yards which are operating exclusively for inland vessels. Chinese ship dismantling yards are using buoy (wharf based) method. The dismantling is done using vertical lift off method with concrete support base. Chinese authorities claim that beaching method of dismantling of ship is forbidden in China [Xie 2007]. Most of these yards have either acquired ISO 14001 or OHS 180001. Fully developed asbestos treatment and ballast water treatment facilities are present in these yards. The hull paint removal is done using advanced Rough Paint Treatment (RPT) facility. Chinese government has included ship recycling industry in the environmental industry category. Special policy on energy saving and environmental protection has been envisaged very
recently. Cooperation between stakeholders of ship recycling is identified by the
government as key to clean and efficient ship recycling. Advanced dismantling
facilities, futuristic vision based recycling policy, stringent laws and regulations and
“stakeholders cooperative working model” are reported to be the four pillars of
enterprising ship recycling industry in China.

2.4.3 European Union

U.K has only recently joined the ship recycling nation group. Very stringent
environment ship recycling regulations based on principle of sound management are
implemented in UK. ABLE group a pioneer in decommissioning works of other

![Fig. 2.6 Global Ship Recycling Statistics (Nikos 2007)](image)

industrial plants is the major establishment in UK involved in ship recycling
[Stephenson 2005]. In ABLE, ship recycling is carried out in dry docks.
Environmental Protection Agency and Maritime Administration of the US
government have audited the recycling yard owned by ABLE and they have qualified
the yard enabling dismantling of ships by US owners. ABLE ship recycling yard
works in tune with control of Major Accidents for Health regulation act of UK
government [Stephenson 2005]

2.4.4 India

Major Ship dismantling centres in India are given in table 2.2. The modes operating
remains the same as other neighbouring countries like Pakistan and Bangladesh.
Gujarat Maritime Board has an exclusive wing for monitoring ship recycling in
Gujarat region whereas other states do not have any such administrative or technical
mechanism to manage ship recycling activities in the centres coming under their geographic limits.

Table 2.2 Major Ship Recycling Centres in India

<table>
<thead>
<tr>
<th>No.</th>
<th>State</th>
<th>Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Andhra Pradesh</td>
<td>Vishakapatnam</td>
</tr>
<tr>
<td>2</td>
<td>Gujarat</td>
<td>Alang</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sachna</td>
</tr>
<tr>
<td>3</td>
<td>Karnataka</td>
<td>Tadri</td>
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<tr>
<td></td>
<td></td>
<td>Mangalore</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Malpe</td>
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<tr>
<td>4</td>
<td>Kerala</td>
<td>Baypore</td>
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<tr>
<td></td>
<td></td>
<td>Cochin</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Azhikkal</td>
</tr>
<tr>
<td>5</td>
<td>Maharashtra</td>
<td>Mumbai</td>
</tr>
<tr>
<td>6</td>
<td>Tamilnadu</td>
<td>Tuticorin</td>
</tr>
<tr>
<td>7</td>
<td>West Bengal</td>
<td>Kolkatta</td>
</tr>
</tbody>
</table>

2.4.5 Pakistan

Major ship recycling yards are located near Karachi, the largest port entry of Pakistan. The yards are under the control of Baluchistan Development Authority situated in Gaddani. These yards use mainly beaching method to position the obsolete ships arriving at Gaddani. The yards here have the capacity to dismantle large ships. More than 50 large ships can be dismantled at a time. The recycling yards are underdeveloped and they are using combination of manual and mechanical method for dismantling activities. The beaching is done by experienced hands in this field and no statutory inspection is carried out during beaching. Environmental impact survey and safety system are seldom done. The yards use deck lift - winch lift combination for lifting operations. No concrete flooring is provided where cutting and removal TBT based paints are carried out. There is no inspection and control over the down stream industries which collect the waste and pre- used items from the dismantled ships. The government control over ship dismantling is not very effective, though few agencies are working in tandem with the ship recycling industry [Shahid 2005]
2.4.6 Turkey

Ship recycling industry was established in Aliaga and Itmir regions of Turkey during early Seventies. The industry got recognition and the ship recycling was declared as a legal industrial activity in 1986. Now the industry has capacity of producing 1 million tones recycled steel per year [CEC 2007]. Turkish ship recycling facilities use beach based ship recycling. Environmental and occupational controls are being exercised rigorously by the concerned government authorities. Turkey is placed 4th in the current ranking of world ship recycling output [Nikos 2007].

2.4.7 Comments on Ship Recycling Practices at Various Global Locations

From the above mentioned facts and figures it can be observed that beach based ship recycling method is being followed in all the major ship recycling countries except China. Ship recycling becomes economically viable in the developing countries only when the actual operations are carried out in beaches. There are number of guidelines in ship recycling which, when applied to the respective fields would improve the status of the industry as safe and environment friendly. Considering these two observations, ie., operations in beach based activities and guidelines, a set of best practices for the industry can be formulated. If these best practices are implemented through a user friendly knowledgebase system, like computer based expert system, it will serve as the stepping stone to make ship recycling effective, efficient and sustainable.

2.5 SHIP RECYCLING AS AN ENGINEERING INDUSTRY

The various aspects involved in treating ship recycling as an engineering industry have been analysed under the following subheadings.

2.5.1 Engineering Perspective

2.5.1.1 Engineering Project Management Tool

By looking at the man made chaos in product design and development, the process of recycling can be explained as the following;

“Recycling is an engineering project management tool used to plan and control the process abandonment of manmade products strictly according to the underlying principles of sustainable development. Recycling should be considered as an
engineering philosophy which tries to incorporate the essence of sustainable
development mantra in all product design and development undertaken by all the
industries in the world”. This concept is applicable to ship recycling industry as well.
The sustainable development is to be considered and emphasized in the ship recycling
process. It is this philosophy which differentiates ship recycling from “making steel
scrap and managing that”.

2.5.1.2 Elements of Sustainable Development

A comprehensive recycling plan should envisage the following points in the ship
recycling processes which is catering to the spirit of development with some control
and quality, viz.,

- Environmental orientation
- Energy consciousness
- Safety focus
- Technological soundness
- Economical viability
- Ergonomics

These elements have a very critical role to play in the sustainable development of
marine industry sector. To implement sustainable development concept in ship
recycling, characteristics of each of these elements has to be separately analysed. A
suitable index has to be assigned taking into consideration the strength of each of
these elements present in a vessel.

2.5.1.3 Trends in Global Ship Recycling

India, Bangladesh, China, Pakistan and Turkey are the main ship recycling
destinations in the world. China during the shipbuilding boom (year 2005 onwards)
had less focus on ship recycling industry and hence went down in recycling output.
Similarly due to stringent control by the government and local bodies, Indian ship
recycling industry is also on a slow down process now. Bangladesh with very loose
regulation and very relaxed government control on the industry is flourishing at
present [Nagarsheth 2008]. European Union has taken some initiation to develop
sustainable ship recycling facilities in European countries [Karpowicz et al 2006].
Ship recycling facilities in Turkey is likely to get maximum benefit out of these
attempts undertaken by the European Union.
2.5.2 Attributes of the Products from Marine Sector for Recycling

Marine structures such as Air Defense Vessels, Very Large Crude-oil Carriers and Oil Rig Platforms are probably the most complex man made industrial products which have to undergo the recycling process along with the conventional ships. The unique features of ships and marine structures call for special attention and focus on a systematically planned and technologically executed recycling activity. Fig 2.7 shows the steps in ship dismantling. The special attributes of the products for recycling and conditions existing in the marine sector are discussed in detail in the following sections.

2.5.2.1 Situations in Global Ship Recycling Locations

The major points of attraction for the owners of the obsolete vessels for the selection of destination for breaking of their ships include flexible and relaxed rules and regulations, cheap labour, minimum investment on infrastructure, abundant coastline unaffected by severe weather, heavy demand for used parts, and advantageous geographical features. These factors prevailing in the dismantling yards have been a case for degradation in the quality recycling of ships. The ship recycling sites are not well managed as these are planned to be. Environmental impacts and risk levels are two major areas of concern of these ship recycling locations. Some of the original fleet nations and green NGOs have been successful in setting a right course for ship recycling activities in the current recycling locations.

2.5.2.2 Complexity of Ship Structures

The weight, tonnage/displacement, shape and size of ship and her components individually as well as in combination, demand an additional technology focus on various activities undertaken during beaching, dismantling, handling and marshalling. This unique complexity generates scope for more comprehensive analysis of the recycling process for finding out the best practices.

2.5.2.3 Presence of Non-ecofriendly Materials

Toxic and hazardous materials like asbestos based insulation, oil traces etc., which can be termed as hazardous and / or non eco-friendly elements may be present in large quantities in as contaminants in ships. All types of protective coatings, insulation coverings and laggings, paneling components, glues and deck covering materials and
various types of waste oil pollutants contributes to this. Extremely hazardous stuffs such as radioactive substances and asbestos are rarely seen whereas less dangerous materials like oil, coatings etc., are found in almost all types of ships. During the recycling process these heavy pollutants emerge out and become a potential environmental threat. Handling of these environmentally hazardous elements is quite dangerous since the quantity to be handled is quite high and all the yards are located in relatively heavily populated coastal zone. Besides, these non-ecofriendly pollutants are likely to contaminate sea water.

2.5.2.4 Involvement of Naval Architects

At present recycling of ship and offshore structures is not treated as an entity in shipbuilding. Recycling yards do not employ naval architects and almost all the ship
dismantling is carried with minimum guidance from an engineer who knows total technology of ships and offshore structures. The disassembly and subsequent recycling activities, which are integral parts of life cycle of ship, have to be guided by the basic principles of naval architecture and shipbuilding. Very limited number of naval architects and offshore engineers take part in ongoing research and training programmes in ship recycling at global level. Environmental scientists, chemical engineers, structural engineers, production engineers and safety engineers usually steer such projects.

2.5.2.5 Lack of Rules and Regulations

There exists a very solid framework of rules and regulations pertaining to shipbuilding and ship operations. Various agencies are actively involved in framing and implementing these rules like ship classification societies, flag state administration, local governmental bodies, ports, canal and inland authorities and coastal protection agencies.

Individual as well as combined operations of these agencies accomplish relatively safe shipping and shipbuilding activities around the globe. IMO has a lead role in bringing about changes in modifying existing rules and introducing new rules as situation demands. But a similar type of situation does not exist in dealing with the last phase of life cycle of the product. From among the ship classification societies, only DNV has come forward with concrete and well documented plans. Though the other ship classification societies are entering to this arena, their presence is felt only at various discussion platforms convened by IMO and similar agencies. Team work of responsible agencies is yet to be take place effectively and the mechanism to implement the guidelines as rules and regulations are not that much effective.

2.5.3 Benefits of Ship Recycling

The benefits of ship recycling have been described, by considering it as a modern industrial activity, under the subheadings.

2.5.3.1 Effective Removal of Obsolete Vessels

The global marine industry is facing a tough situation, regarding decommissioning and physical dismantling of its obsolete fleet. The situation is much worse than that prevailed after the Second World War. Number of vessels and other marine structures
destined towards the dismantling yards of India, China, Bangladesh and Pakistan in the coming years will be uncontrollably high and unmanageable. Ships built during the economic boom during the last decade may not remain in the active service due to certain technical and commercial reasons. This may also cause an increase in the number of obsolete vessels in the global shipping sector. Both the delay in decommissioning of obsolete vessels and dismantling conducted in haphazard manner are likely to introduce adverse problems in the international marine industry. Implementation of sustainable development oriented ship recycling is the only solution to get rid of the adversities creating this massive problem.

2.5.3.2 Global Sustainable Development Tool

The idea of sustainable development surfaced in the international scene after some of the major global summits which deliberated some of the burning issues related to earth’s ecosphere. The hot issues which compelled the international development policy makers to think in the direction of sustainable development included hazardous gas emissions from industries and automobiles, ozone depletion, global warming and green house effects. These were mainly pertaining to atmospheric pollution and their impact on global environment. Sustainable development issues connected with land and water pollution have been taken up in different viewpoints and one of the practical solutions is pointed towards the concept of recycling. The major thrust areas identified by the present study on sustainable development of water and land include the following.

a) Minimizing impacts of environmental pollution due to industrial products and by-products.
b) Preserving energy sources
c) Maximization of renewable energy utilization
d) Minimization of cost of manufacture by the use of more productive techniques
e) Minimization of risk levels by improving safety standards in work places
f) Partial replenishment of depleted resources by products from recycling

Ship recycling methodology addresses these thrust areas in an integrated approach within a common platform of product life cycle activities. So ship recycling acts as an effective tool implementing sustainable development action plans. More coordinated
efforts from academic and industrial research agencies are required to formulate a master plan for accomplishing the major objectives set by the individual thrust areas identified

2.5.3.3 Generation of Employment

Like ship and offshore production industries, ship recycling industry also offers massive potential for direct employment generation including skilled and unskilled manufacturing tradesmen, ship brokers, transporters, recycling plant workers, recycled goods traders and trading agents. Application of more mechanised methods and systematic approach will certainly have a negative impact on employment potential. However this can be partly solved by attracting more business due to improved quality and productivity attained using the modern techniques.

2.5.3.4 Creation of ‘Recycling Role Model’

Consumption essentially creates the unwanted and unusable material termed as waste or scrap. Recycling aims at re-engineering of these wastes and scraps and bringing back their re-usability. It is the massive consumer population that makes unmanageable waste and scarp in major cities of the world. Disposal of these wastes is a headache for the concerned authorities and recycling is most effective remedy. The marine industrial sector is also going to experience a similar kind of situation in the near future. The hostile environment in which the structures are operating is one of the major issues related to this. Corrosion of hull and machinery parts makes the structures obsolete in a faster rate than their land counterparts. Ship owners are more concerned about availability of their vessels for operation and due to this their approach towards maintenance and refitting of ships has changed. Any decision to short cut the routine and scheduled repair and maintenance of vessels operating in the hostile marine environment will have a significant effect on age and health of the vessels. Usually ship operation management policies influence the rate of obsoleteness of marine vessels, and thereby decide the future of ship recycling industry in terms of capacity, standards, productivity etc. For finding everlasting solutions to these complex situations, a comprehensive interdisciplinary recycling approach based on various factors involving engineering, economics, environment, ergonomics and energy and management issues should be formulated. The stake
holders in global maritime industrial sector should take important steps towards this by supporting academic and industrial research in sustainable global ship recycling.

2.5.4 State of Art of Ship Recycling Industry

The present status and capacity of ship recycling as an engineering industry is presented in the following subheadings. The analysis can provide some fundamental information on the development of best practices in ship recycling.

2.5.4.1 Undefined Industry Status

Even today the activity involving removal of obsolete vessels are not defined as to which branch it belongs to. It is not clear whether recycling is a manufacturing activity or a re-engineering process or all together a new branch of engineering. This confusion is prevalently seen in various attribute which define the process. Still debates are on how to lay down common international rules and regulations in this field. The West and the South Asia are divided on various aspects of implementation recycling norms, as evident in the case of issues related to dismantling of obsolete French Air Craft Carrier Clemenceau [Nagarsheth 2008].

2.5.4.2 Limited Global Recycling Capacity

Ship recycling industry which has been treated as dirty industry by the West has very takers in the developed countries. Even the leading shipbuilding nations backtrack while dealing with setting up of ship recycling facilities within their geographic territory. The reason behind this policy of avoiding building up a very profitable industrial base, can be attributed to the following reasons.

a) Pollution from the scrap material from dismantling of ships  
b) Unsafe dismantling operations and the risk factor involved in it  
c) High cost of labour, transportation and yard area  
d) Stringent rules regarding safety and environment pollution  
e) Inactive used product market  
f) Prevailing modern rich / wealthy consumer culture which does not show interest in buying and using recycled products.

Other regions where ship recycling is carried out, the industrial climate support the recycling activities. Some of the characteristics of this industrial climate do not
promote ship recycling industry like unavailability of re-processing technology for recycling, lack of naval architecture/ shipbuilding tradition, lack of effective involvement in international maritime trade, minimum governmental support and unsuitable geographical features. These are true with respect to African and South American countries. The Middle East Asia has not come up with any policy on ship recycling, though the region has become world’s capital of ship repair and conversion.

In this context it is evident that the international marine industrial sector has no other option than to destine their vessels and structures to South Asia for dismantling. This way the capacity for ship recycling is limited to the facility available in countries such as India, China, Pakistan, Bangladesh and Sri Lanka.

### 2.5.4.3 Beach Based Low Technology Industry

As on today ship recycling is graded as low technology industry with limited infrastructure and facilities to support. This will continue to remain in the same status unless and until some major policy change occurs in the marine business and stringent measures from the flag state administrations. Since the dismantling operations in the yards make use of low level technology gadgets combined with unskilled labour, implementation of flow line production concept is not possible. The yards are overcrowded and the area is restricted due to over allocation of plots in the major facility location of conducting ship dismantling operations resulting in lack of scope for an efficient engineering layout. Absence of proper flow line will lead to haphazard way of getting things done resulting in a combination of low productivity, higher risk rates, potential pollution source and poor quality output.

The ideal tidal and other oceanographic conditions of some of the coast lines are the main driving factor for the creation and development of ship recycling sites. These advantages provided by such beaches can not be replaced by any other facility as on today. However these advantages are marred by many critical drawbacks which include remote location, unsuitable conditions for civil constructions and infrastructure development like covered dismantling sheds and cranes and other supporting facilities, hostile environment like occasional severe environmental factors such as waves, wind, humidity and salinity.
2.5.4.4 Market Features of Recycled Products

Numerous products and byproducts of ship recycling can be generally classified, according to their re-usability as, readily reusable, (without additional dismantling, spare parts) recyclable, scrap and hazardous elements and parts.

Information regarding the route through which these dismantled marine components and parts are moving out to reach the pre owned market elsewhere is not properly studied and documented so far. It is unofficially known to all that these dismantled items somehow manage to enter the new building sites. The prevailing rules and regulations in ship recycling and maritime activities do not cover this aspect of re-entry of used items to fresh and new building.

The very presence of active “used marine industrial goods market” determines the degree to which ship recycling extends. If one region or a country is having very live market for used goods trade, dismantled goods will reach the nook and corner of that country and those items will come back into the product market. In this situation there will be high chance of manipulation in the condition of the products. Possibilities for unauthorized preowned trading where the traders will somehow manage the deployment of used products, labeling it as brand new exist. The market will flood with these items and that will generate a new threat in new building and repair sector of the maritime industry.

2.5.4.5 Presence of Unskilled Labor

A low technology industry which is remotely located with low safety standards can attract only semi-illiterate and unskilled workforce. To train and educate the workforce for developing various skills for accomplishing safe and environment friendly ship recycling with some engineering orientation is an uphill task. The common disadvantages associated with this workforce are the lack of general engineering orientation, unawareness about safety and environmental issues and high standard of rules and regulations.