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Ship Recycling Practice and Annual Reusable Material Output from Bangladesh Ship Recycling Industry

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Abstract

Ships are valuable and their materials are useable and have always been recycled. Ship recycling is an engineering process of dismantling obsolete ship to collect useable materials. There are few dozen operational ship-recycling yards located along coastal belt at Chittagong of Bangladesh. The beaching method is the most common ship demolition today, make it difficult to ensure proper safety and to contain and manage pollutants. Most of the local ship recycling yards neither have good containment to prevent pollution of soil, air, marine and freshwater resources, nor follow the appropriate technology to ensure the environmentally safe management and disposal of hazardous wastes and materials. The objectives of this research paper are to identify and analyze the present ship recycling practices in Bangladesh and evaluate the status in respect of national and international rules and regulation. Average 2000000 Metric Ton of different types of obsolete ships are recycled annually in different yards in Bangladesh. There is average 1,833,461 MT reusable materials that has been produced annually in ship recycling industry of Bangladesh.

Keywords: Ship recycling; Beaching; Hazardous waste; Slipway; Pier breaking; Dry-dock

Introduction

Ships have always been recycled. The fabric of a ship, whether of wood a century ago, or steel today has always had considerable value. Ship recycling is an engineering process of dismantling obsolete ship to collect useable materials. One interesting point is that, the shipping industry is well ahead of other industries, such as the automotive and aviation sectors, in reusing some 85-98% of a ship by weight [1]. On the other hand, even if ship recycling has been efficient in providing a ready supply of steel and other metals for re-use, there has been a cost in terms of lives lost and local environmental impact. The demolition of ships is widely associated with dangerous practices and pollution. Cutting apart big steel structures is a complex and hazardous business. And even though a high proportion by weight of the ship's structure is reusable, there are significant amounts of plastics, chemical product and other materials that should be handled carefully and appropriately. However, there are few dozen operational ship-recycling yards located along coastal belt at Chittagong of Bangladesh comprehensively. This industry provide main source of steel, create huge employment and generates large amounts of revenues for the government of Bangladesh. It is also contributing to the local ship building industry [2].

Local ship recycling yards are following beaching method for recycling the ship. The beaching method is the most common ship demolition today, make it difficult to ensure safety and to contain and manage pollutants. In this method, ship is beached over the flat muddy land where it is dismantled to small parts using semi-skilled and unskilled labor. Then the dismantled parts are pulled to the dry shore area using electric winch and labor force [3]. Gas cutting is widely used to make relatively small pieces from the steel structure. Usually, minimum knowledge of safety is needed in this process and that leads to some accidents like explosion, causing death, fatal injuries and permanent disabilities. Apart from economic benefit from this industry, the social and environmental costs demand huge attention for further development. The improper storage and disposal of hazardous material (HazMat) result in air, soil and water contamination [4]. In many ship breaking yards in south Asia and particularly in Bangladesh, workers are not using proper personal protective equipment (PPE), such as skin, eye or lung protection. It's mainly managerial and motivational failure to workforce along with socio-economic problem of the country. There is usually less equipment for machine, fire, and chemical safety. With a few exceptions, the vast majority of workers do not receive proper information on the hazards or risks to health and safety, nor do they receive require training [5]. Most of the local ship recycling yards neither have good containment to prevent pollution of soil, air, marine and freshwater resources, nor follow the appropriate technology to ensure the environmentally safe management and disposal of hazardous wastes and materials.

It is no doubt that ship breaking is necessary for South Asia, particularly for Bangladesh. We should ensure that our ship recycling yards are maintaining at least minimum standard in respect of health, safety and environmental issues [6]. It does not necessarily to imply that we have to follow dry docking instead of beaching, rather keeping the beaching method intact, we can improve the situation by providing some common facilities and training, which we are lacking now. The objectives of this research paper are to identify and analyze the present ship recycling practices in Bangladesh and evaluate the status in respect of national and international rules and regulation. At the same time, to determined reusable material of different types of recycled ships in MT/LDT for Bangladesh ship recycling industry by analyzing the on ground data [7].

Methodology

It is a pure research work to evaluate ship recycling practice and to calculate the reusable material output of different types of recycled ships in MT/ LDT in Bangladesh ship recycling industry by analyzing

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on ground data; which has collected by author physically since last eight years (2009 to 2016). Data of the ship recycling activity were collected from actual ship recycling industry located in Bhatiary, Chittagong and provided by the different stake holders and Bangladesh Ship Breakers Association (BSBA) [8]. Results have based on original on ground data and take considerable help/guideline from the methodology followed in available literature. Primary and secondary data about output of material/component of different types of selected recycled ships has collected from the industry by physical involvement by the author. However, nuclear waste and other releases, such as emissions of atmospheric pollutants and diffuse emissions of pollutants to the water, were not included in the scope of this research work. In case of missing or unreliable data, benchmarks available in literature were used for calculations of average annual reusable material output [9,10].

Brief History of Global Ship Re-cycling Practice

Ships are valuable and their materials are useable and have always been recycled. Ships are the greatest resources ever moved in bulk, assets which represent such investment that entire new systems of banking and government have been designed to finance them. Ships do not simply disappear once they are no longer seaworthy. The wood in the earliest hollow canoe would have provided walls and shelters, the fittings on a Viking long ship would have benefited the local village where she was laid to rest, and the copper on a ship's bottom and the long, high-quality timber of her mast and strakes would have been invaluable in future construction projects. A famous example of ship recycling was the Fighting Temerarious, the ship that broke the line at Trafalgar. She was famously painted by J.M.W. Turner on her way to be broken up at Beaton's yard, Rotherhithe. Records show that, the ship was sold for £5500 and the copper alone was sold back to the admiralty for £ 3000 [11].

With the advancement of shipbuilding, wood gave way to iron and steel. These ship metals were of the highest quality available. So, ship breaking played a major part in resourcing the industrial revolution. The German High Seas Fleet was scuttled in Scapa Flow; a group of islands in the rough north of the British Isles in 1919 [12]. The value of the steel these ships contained was underlined by the dangerous conditions that people braved to retrieve it. The salvage operation began in 1922 and took almost 20 years. Again, World War II also left a vast amount of steel locked up in redundant warships and cargo ships. After the war, ship scrapping continued in places such as Spain, Italy, and Japan. However, as the ship building industry shifted eastwards in the 1970s, so did the ship breaking industry also [13-15].

Taiwan was the principal destination, and ships were broken literally in the centre of Kaohsiung port, until, August, 1986; an explosion and fire on board the tanker Canari killed 14 people and injured 47 more. Due to a huge public outcry, what had been an unregulated industry in Taiwan suddenly became subject to a major crackdown. As is typical within the waste sector, the ship breaking industry moved overnight [16]. At exactly this time, Alang, a coastal town in the Indian state of Gujarat, experienced its first major growth spurt in ship breaking. Gujarat Maritime Board records the first ship dismantle at Alang as the MV Kota Tenjung, beached February, 1983. Reports indicate that by 1989 the number of employees in Alang had reached 40,000. Bangladesh and Pakistan followed costume and now become the two big ship breaking or recycling giant of the world. The shipping industry was slow to notice these developments. This is not so surprising [17].

Any waste is often 'out of sight and out of mind', and when a ship changes hands for breaking, the original owner is commonly unaware of its destination. However, there was a growing realization that working conditions at ship recycling locations were extremely hazardous, and not only in the Indian subcontinent [18]. Will Englund from American newspaper, The Baltimore Sun, first became aware of the issues surrounding ship recycling in 1995 when the aircraft carrier USS Coral Sea was being scrapped in Brownsville. Problems with the breaking of this ship had resulted in the company responsible being prosecuted for the first environmental violations within the USA ship breaking industry [19]. The owner, Kerry L Ellis, was convicted under the Clean Air and Clean Water Acts and died in prison in 2000. Englund dug deeper. He teamed up with the investigative reporter Gary Cohn and between them they ran a series of articles exposing the worst excesses of ship breaking around the world. In April 1998, they won a Pulitzer Prize and today the news articles still make fascinating and engaging reading [20].

Present Ship Recycling Practice in Bangladesh

Ship recycling in Chittagong started accidentally through the dismantling of Greek ship M D Alpine that was brought to shore near Fauzdarhat by the 1960's cyclone. It was dismantled in 1965 by Chittagong Steel House. Subsequently, the Pakistani ship Al Abbas was salvaged, beached at Fauzdarhat and dismantled in 1974 by Karnafully Metal Works. These incidents draw the attention of a few entrepreneurs on the suitability of the coast line near Fauzdarhat for beaching [21]. Over the years, the ship recycling industry in Chittagong has gone through lean and boom periods, to become the world's largest ship recycling industry in 2015 and now the ship breaking and recycling industry (SBRI) spans over 18 km coast of the Bhatoary- Fauzdarhat-Baroiyawlia area. SBRI consists of around 200 ship recycling yards in register (physically exist only 65), of which about 45 are in regular operation, The industry directly employs over 200,000 laborers and accounts for the supply of half of all the steel products in Bangladesh. Around one million people are indirectly earning their bread and butter from this industry [22].

A number of factors have pushed the growth of this sector over time which include the favorable beaching condition, the proximity of the beach to the industrial hub of Chittagong mainly the steel rerolling mills which consume most of the output from the industry, availability of risk-taking entrepreneurs, access to abundant labor from the northern districts of Bangladesh, the weak legislative framework allowing the operation of the industry for decades even without it being considered as an industry. The high demand in the local market for scrap ferrous and non-ferrous metals and other cheaper items recovered from the industry, access to finance from the formal financial institutions and informal money lenders. At the same time, the growth of a swarm of upstream and downstream industries forming an informal industrial symbiotic and inter-dependent network [23].

However, there is a list of problem against SBRI. The main problems are poor labor management due to the harsh work environment for the manual laborers, the lack of protective clothing and equipment, predominance of manual processes and a high rate of accidents along with environmental damages caused by poor hazardous waste management, coastal contamination, air pollution, the spread of hazardous materials into the environment, forest destruction, etc. Based on these visible problems, the Bangladesh Environmental Lawyer's Association (BELA) filed a petition to the High Court in 2008. This resulted in the order by the Bangladesh High Court directing the expert-supervised removal of hazardous wastes from ships before dismantling [24]. It also ordered ship recycling yards to obtain Environmental Clearance Certificates

(ECC) from the Department of Environment (DOE) in order to be allowed to import ships and the Government to formulate regulations to control SBRI. Due to the ruling by the High Court, in 2010, the import and dismantling of ships in Bangladesh was stopped. Ship recycling activities resumed a few months later in 2011; the Ministry of Industry (MOI) issued the Ship Breaking Waste Management Rules. Currently, the SBRI is bound by the Ship Breaking and Ship Recycling Rules 2011 under the MOI along with Environmental Protection Act 1995, and Environmental Protection Rules 1997 under the supervision of DOE under the Ministry of Environment and Forest (MOEF). The labor safety and the environmental management standards in the local yards are showing signs of distinct improvement after the implementing those roles and regulation and taking those measures [25,26].

At present, Bangladesh Government has established the "Ship Building and Ship Recycling Board" (SBSRB) as the one-stop service provider under the MOI. After operational, it is providing integrated services including granting required permissions and certificates for Ship breaking, recycling and other related activities in cooperation with other responsible departments and ministries. The DOE was placed under the MOEF in 1989 as its technical wing and is statutorily responsible for the implementation of the Environment Conservation Act, 1995. DOE is working to ensure sustainable environmental governance for pollution control. This department is solely responsible for issuing an ECC prior to the establishment of any industrial unit in Bangladesh and thus ship recycling yards as well. It also issues authorizations for handling hazardous wastes generated from ship recycling activities [27].

The Non-Government Organization (NGO) ship breaking platform is an international coalition of environmental, human and labor rights organizations campaigning to prevent end-of-life ships from being beached in developing countries. Active since 2005, it counts as its member's organizations from both ships owning as well as ship recycling countries, including Bangladesh. BELA is a public advocacy group that has raised concerns over the activities of the ship recycling industry as being detrimental to the environment and human rights. Carrying out continuous movements, it has brought cases before the Supreme Court of Bangladesh, one of which resulted in the ban of all ship recycling activities not meeting adequate environmental standards in 2009. On the other hand, BSBA is a representative body of ship recyclers or yards in Bangladesh established in 2003. This trade organization is working in the interests of ship recycling activities, safeguarding the rights of its members and ensuring environmentally sound ship recycling.

International Effort for Safe Ship Recycling Practice

If we look to the international regulation, ships with wastes subject to a trans-boundary movement for recycling are *regulated by the Basel Convention (BC). This was the first initiative and adopted on 22 March 1989*. It also investigates the issue of improper handling and disposal of hazardous wastes generated in ship breaking process. It prohibits exports of wastes from Organization for Economic Cooperation and Development (OECD) countries to non-OECD countries. It strictly restricts control mechanisms of trans-boundary movement of wastes and to protect human health and the environment against the adverse effects that may result from the generation and management of hazardous waste. Hong Kong Convention (HKC) was adopted on 15 May 2009 under the auspices of the International Maritime Organization (IMO). The Convention provides regulations for the design, construction, operation and preparation of ships to facilitate safe and environmentally sound recycling. Important objective is to promote substitutes for hazardous materials to reduce the use of hazardous material in the construction of ships. According to convention, hazardous materials shall be recorded, regularly updated in the inventory of hazardous material and ensure certification of standard specification of hazardous materials. Recycling state needs to develop regulations, standards, adequate supervision and verification system to ensure safe and environmentally sound Ship Recycling Facilities (SRF) are designed, constructed and operated.

The Marine Environment Protection Committee of IMO during sessions adopted a set of guidelines within the scope of the detailed solutions dedicated to the problems of ships' recycling and ship recycling facilities. As per EU Ship Recycling Regulation, 2013 Ships must record the inventory, location and quantity of hazardous materials. Ships headed to breaking yards will require a ready-for-recycling certification and that must be verified by a port state authority. It also regulates the installation and use of hazardous materials like asbestos and ozone-depleting substances. Occupational Safety and Health (OSH) constitutes a major target of the ILO to achieve decent work. And the main purpose of OSH is to promote decent work in ship-breaking yards and in the hosting countries. Bangladesh ratified both important conventions of IMO and ILO. Inventory of Hazardous Materials (IHM) is one of the prime requirements of regulation 5 of HKC for safe and environment friendly sound recycling of ships and that to be followed by ship owners. IHM aims to minimize hazard/danger due to presence of unknown hazardous materials or substances which may create hazards to human health and/or the environment. IHM shall be developed at the design and construction stages. It shall be specific to each ship and shall be verified by the Administration or a recognized organization authorized by it. IHM consists of three parts, where Part I deals with materials contained in ship structure or equipment; Part II deals with operationally generated wastes and Part III deals with hazardous materials in store [28].

Ship Recycling Plan (SRP) shall address any material or any ship specific considerations that are not covered in the ship recycling facility plan or that require special procedures. The SRP shall describe how the ship recycling facility (SRF) will recycle the specific ship in a safe and environmentally sound manner, covering the recycling process steps and their sequence over the entire process. Any processes or procedures that deviate from the Ship Recycling Facility Plan (SRFP) and specific to the ship shall be described in detail in the SRP. The final survey is conducted prior to the ship being taken out of service and before the starting of recycling of the ship. The final survey verifies all three parts of the inventory of hazardous materials, the SRP and inclusion of the ship recycling facility into the European List (EL). The EL of SRF is established, maintained and updated by all member states of European Union (EU). The EL comprise of a list of ship recycling facilities located both in the EU and in non-EU countries and authorized by recognized organization of EU member state meaning operating in accordance with IMO, ILO and EU guidelines and principles [29].

Ship Recycling Methods

Various techniques are used for ship recycling, with varying costs and degrees of environmental and social impacts associated as per UNEP 2013. There are four important methods of ship recycling or dismantling of old ship around the world. Brief description of all those four method will be narrated below:

Beaching

In this method, a ship is emptied of cargo and ballast, and is driven

to a tidal flat on a high magnitude tide (spring tide). Following the stranding of the ship on the coast, the workers cut it into pieces, which are dragged closer to the beach. The beaching method may be unsuitable for the use of heavy lifting gear that can make the dismantling work safer. It may not allow for containment of hazardous substances. This is the process used in 80% of ship recycling today. The key locations of beaching for ship recycling are Chittagong in Bangladesh, Alang in India and Gadani in Pakistan. Their very big tidal ranges and wide mudflats make these areas 'hotspots' for recycling. This combination means that at spring tides, ships can be driven as far up the beach as possible, over the mudflats and onto the beach. Ships often don't make it to the beach and are stranded on the mudflats. If this happens, they are pulled higher with chains or heavy steel wire hawsers at the next suitable tide after being made lighter. The chains are attached to large winches in huts on the beach, and as items and steel are removed from the ships by gas or oxygen cutting, and the winches progressively drag them up the beach. Large blocks may also be cut from the ship, released onto the mudflats and dragged individually by the winches. Once onshore, everything is cut into progressively smaller pieces and then taken from the yard by lorry or truck. The steel is often cut up into around two by four meter pieces (usual practice) and then sold for cold rolling. Although it may also be cut into inch thick square bars using hydraulic shears and used directly for re-enforcing concrete or similar materials. Those plates, frames, bars, girder, stiffener, longitudinal, etc are also used in local ship building or repair industry.

The beach is generally divided up into plots about 60 meters wide and up to 90 to 160 meters deep. Infrastructure is minimal. It may consist of office building, few heavy duty winches, vehicle mounted cranes and some walls between plots if preferred. Some temporary storage facilities and areas on concrete or steel bases usually exist. More sophisticated operations may have extensive offices, storage areas, and concrete areas within the facility. And even large separate secondary operations areas on the shore behind the facility, which might include asbestos treatment areas, materials handling areas, medical facilities, shower room, labor shelter and messing. Moreover, they have their own fire service and hospitals as well as a large and useful training facility on the hill overlooking the beach. The surroundings are typically made up of worker's houses as well as shops reselling the items that come from the ship. A major environmental issue with dismantling ships on tidal mudflats is that any spills of oil or cargo remaining on board are likely to be swept out to sea by the next tide.

Slipway or landing

In this method, the vessel is driving onto the shore or on a concrete slipway connecting shore and sea. This method is typically used in areas where the tidal flow is low and easily predictable. Thus it facilitates the control and avoidance of spillage of toxic substances in the water. A mobile crane removes sections from the ship and the ship is progressively pulled further on the shore. This is essentially a modification of beaching method; but with some crucial differences. At present, the main exponent of slipway or landing recycling is Aliaga, Turkey, and some other EU Countries. Although there are many small-scale and historical recycling locations which may be described as slipways, such as Inverkeithing in the UK, used after the World War II, and other locations in Europe today. A critical difference between beaching and today's slipway recycling is the tide. Slipway recycling, especially in the Mediterranean, is typified by virtually no tide, making the intertidal zone easier to predict and control. The ship still goes hard against the shore or preferably, a concrete slipway extending to the sea. In either case, the lack of racing tides provides an element of control and means that any accidental spillages have a reasonable chance of being contained. Normally pieces are removed from the ship by mobile crane working from the shore. The ship is still dragged up the shore as it is lightened, but because the tide is constant, a permanent, predictable and stable water front exists, where the lifting and access operations take place. A temporary quay or semi-permanent jetty may also be added. This method is comparatively safe and sound than beaching method.

Alongside or pier breaking

In this method the ship is immobilized on a wharf or quay in a sheltered harbor or river, and dismantled piece by piece in a top-down manner. A crane removes the pieces starting with the upper pieces, then the main body, until the bottom of the hull. The last piece may be lifted or sent to a dry dock for final cuttings. Areas where pier breaking takes place are usually in calm water. This method is followed in China, Myanmar and few places in Europe. This approach is typified by Chinese yards. An abandoned wharf, quayside, or purpose built facility may be used. The vessel is secured alongside in the sheltered waters and pieces are removed by crane. The process is 'top down' such as the superstructure and upper pieces are removed first, and then the work continues along the ship into the engine room until only the double bottom is left. This is called the 'canoe'. Through a process of ballasting and lifting, in turn, the aft and forward ends clear. This canoe is further and further reduced until it is either lifted out in one piece, or sent to dry dock for final cutting. The local impact of any pollution is likely to be increased during alongside recycling since there is no tidal dispersal effect. However, this means that concentrations can be properly monitored, contained and cleaned if necessary. China uses this method widely and recycled the old ships safe and sourced way.

Dry-dock

In this method the ship is driven to an enclosed, flooded dock, the water of which is subsequently pumped out. The ship is then dismantled piece by piece. This method provides a well-controlled environment in which dismantling activities are performed, and which minimizes the risk of environmental pollution. However the costs associated with dock building and maintenance are high and therefore dry-docking is presently rarely used for ship recycling. USA and Europe practices this method. This is the safest, cleanest method of ship recycling. But is undertaken relatively and rarely due to the expense of building and maintaining dry dock facilities. One of the main dry-dock recycling locations is Leave Sley International's facility in Liverpool in the UK. Here the ship enters dry-dock and is dismantled piece by piece. On completion, the dock is cleaned and flooded again for the next ship. The chances of accidentally polluting surrounding waters are virtually zero; since everything is contained by the dock. However, dry-dock recycling is expensive; But the safest method. This method is use rarely at present due to its high cost [30,31].

Present Local and Global Ship Recycling Scenario

The world-wide ship recycling industry dismantles around 1,000 large ocean-going vessels per year, such as container ships, cargo and bulkers, oil and gas tankers (LNG, LPG), passenger ships and other types of ships, in order to recover steel and other valuable metals or recyclable items. However at present almost all ship recycling activities are concentrated in five countries: the three South Asian countries (India, Bangladesh, China and Pakistan), China, and Turkey. Further capacity is available in North America (US, Canada, Mexico) and within the European Union (amongst others Denmark, Belgium and UK). At present, South Asia is undoubtedly the global centre for ship recycling activities (Figure 1).

If we look to the on ground statistics of ship recycling yards of

Bangladesh, we can see that, average 200 different types of obsolete ships are recycled annually in different yards located in Chittagong. Those different types of ships are bulk carrier, tanker, container carrier, cargo carrier, passenger or ferry, refrigerator ship, floating pontoon/restaurant, and other different types of ships. In Figure 1, total number of different types/category of ships recycled annually in Bangladesh between the years 2009 to 2015 has been shown. Again, from on ground statistics of ship recycling yards of Bangladesh, we can see that, average 2000000 Metric Ton (MT) or Light Dead-Weight Ton (LDT) different types of obsolete ships are recycled annually in different yards in Bangladesh. In Figure 2, total LDT of different types/category of ships recycled in Bangladesh between the years 2009 to 2015 has been shown. On the other hand, in Table 1, average LDT ships recycled annually in Bangladesh by types/category between the years 2009 to 2015 has been shown (Figure 2).

Reusable Material Output from Ship Recycling Industry of Bangladesh

To determine the total amount of reusable material in MT and reusable material factor in percentage of local ship recycling industry in Bangladesh; author has been involved directly with the local ship recycling yards since last eight years. Author collect and made inventory of materials, equipments, machinery, items and HazMat on different types of ships recycled in local yards in different years from 2009 to 2016. Total 27 in number of different types/category of recycled ships has been considered as sample to calculate the average annual amount of reusable materials output. For this research work, 6 bulk carrier, 5 tanker, 5 container carrier, 5 cargo ship and 6 other different types of ships has been selected. For a single ship, it takes six to twelve month to complete an inventory of different materials and item output from the obsolete ship. There are hundreds and thousands of line items found of a recycled ship and data has been collected on daily basis. So to prepare a detail inventory of materials and items of 27 ships was a time consuming and hardworking task. Again to collect on ground data from such industry is a challenging and ambitious job. As a result, author takes eight years to complete this vast task with dedication and patient. Summarize fact and figure of those sample ship's data for 27 in number different type/category of recycled ships has been shown in

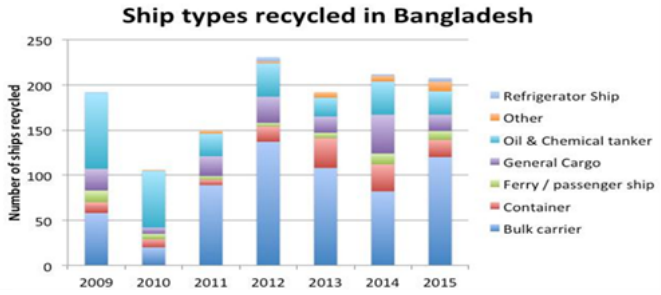

Figure 1: Total number of ships recycled in Bangladesh by type/category between the years 2009 to 2015.

Type of ship	Average Annual Ships Recycled Between 2009 to 2015 in MT or LDT
General Cargo	111'486
Bulk carrier	1'094'566
Oil & Chemical tanker	579'542
Container	186'583
Refrigerator Ship	7'873
Passenger Ship	67'680
Other	44'616
Total	2'092'346

Table 1: Average LDT ships recycled annually in Bangladesh by types/category between the years 2009 to 2015.

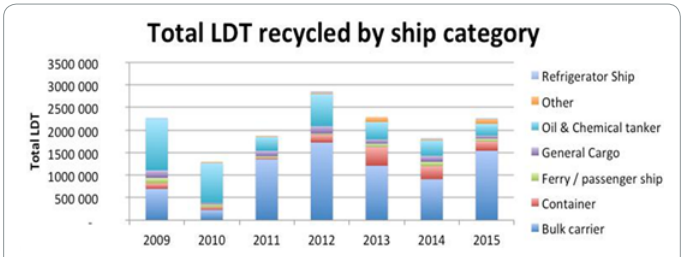

Figure 2: Total LDT of ships recycled in Bangladesh by type/category between the years 2009 to 2015.

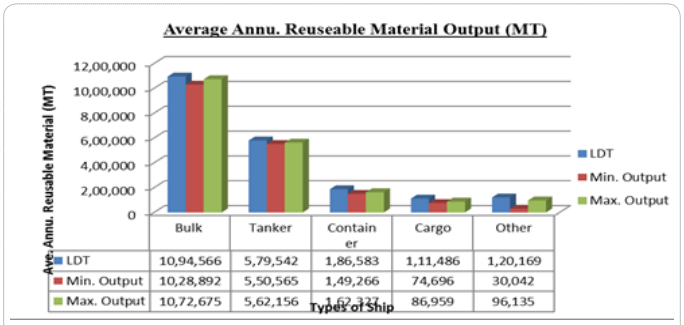

Figure 3: Average annual LDT vs. average annual reusable material output in MT for different types of recycled ships in local yards (between the years 2009 to 2015).

S. No.	Ship Category/Type	No of Sample Ships	Range of LDT	Manufacture/ Build Year
1	Bulk Carrier	6	11834 to 21592	1978 to 1986
2	Tanker	5	11182 to 29324	1981 to 1989
3	Cargo	5	5008 to 18302	1984-1990
4	Container	5	6698 to 16053	1977 to 1992
5	Other Ships (Refrigerator, Ore Carrier, Passenger, LNG/LPG, Motor, etc.)	6	5625 to 25997	1966 to 1981

Table 2: Summarize fact and figure of sample ship's data for 27 in number different type/category of recycled ships of Bangladeshi yards.

S. No.	Type of Ship	Average LDT (MT) per year	Reusable Material Factor (%)		Average Reusable Material per year (MT)
1	Cargo	111,486	0.67	Min.	74,696
			0.78	Max.	86,959
2	Bulk Carrier	1,094,566	0.94	Min.	1,028,892
			0.98	Max.	1,072,675
3	Tanker	579,542	0.95	Min.	550,565
			0.97	Max.	562,156
4	Container	186,583	0.8	Min.	149,266
			0.87	Max.	162,327
5	Other	120,169	0.25	Min.	30,042
			0.8	Max.	96,135
	Total	2,092,346		Min.	1,833,461
				Max.	1,980,252

Table 3: Reusable material factor and amount of materials output per year in MT for different types of recycled ships in Bangladesh (between the years 2009 to 2015).

Table 2. It has been determined that, there are average 1,833,461 MT (minimum) and up to 1,989,252 MT (maximum) reusable material produce annually from ships recycling industry of Bangladesh. In Table 3, reusable material factor and amount of materials output per year in MT for different types of recycled ships in Bangladesh has been shown (Figure 3). The average annual LDT vs. average annual reusable material output in MT for different types of recycled ships in local yards has been shown in Tables 2 and 3.

Conclusion

The recycling of ships is widely associated with dangerous practices and pollution. Cutting apart big steel structures is a complex and hazardous business. And even though a high proportion by weight of the ship's structure is reusable, there are significant amounts of plastics, chemical product and other materials that should be handled carefully and appropriately. However, there are few dozen of running ship-recycling yards, located along coastal belt at Chittagong of Bangladesh. The beaching methods most common during demolition today make it difficult to ensure safety and to contain and manage pollutants. In this method, ship is beached over the flat muddy land, where it is dismantled to small parts using semi-skilled and unskilled labor in Asian countries. At present Bangladesh Government has established the "Ship Building and Ship Recycling Board" (SBSRB) as the one-stop service provider under the MOI. The labor safety and the environmental management standards in the local yards are showing signs of distinct improvement.

The world-wide ship recycling industry dismantles around 1,000 large ocean-going vessels per year. At present, South Asia is undoubtedly the global centre for ship recycling. In Bangladesh, average 200 different types of obsolete ships are recycled annually in different yards located in Chittagong. Again, from on ground statistics of ship recycling yards of Bangladesh, we calculate that; average 2000000 MT different types of obsolete ships are recycled annually in different yards in Bangladesh. Author collect and made inventory of materials, equipments, machinery, items and HazMat on different types of ships recycled in local yards in different long span of time from 2009 to 2016. Total 27 in number of different types/category of recycled ships has been considered as sample to calculate the average annual amount of reusable materials output. It has been determined that, there are average 1,833,461 MT (minimum) and upto 1,989,252 MT (maximum) reusable material has been collected/output annually from ship recycled in Bangladeshi yards. However, in future ships will be safer and more environment friendly. So quantity of different HazMat or waste output will be reduced at future as well as reusable material will be increased further.

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