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A Review on Ship Recycling Industry in Bangladesh from Global Perspective

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A Review on Ship Recycling Industry in Bangladesh from Global Perspective

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1. INTRODUCTION

Ship recycling involves dismantling a ship once it has reached the end of its operational life. This process includes activities such as beaching, cutting, extracting valuable materials, and repurposing them. The practice of shipbreaking in Bangladesh has its origins in 1960 when the Greek vessel MD Alphin ran aground in Shitakunda, Chattogram, due to a powerful hurricane. This event led to the ship's purchase by Chittagong Steel House, which subsequently dismantled it. This marked the inception of the shipbreaking industry in Bangladesh. Another pivotal moment occurred in 1974 when Karnaphuli Metal Works Limited procured a bomb-damaged Pakistani ship named Al-Abbas. Through its scrapping, this company laid the foundation for the commercial shipbreaking sector in Bangladesh. The industry has undergone significant evolution, especially since the 1980s, as detailed by Rabbi and Rahman (2017). Driven by advantageous geographical positioning, cost-effectiveness, and the availability of a low-wage labor force, Bangladeshi investors are enthusiastically investing in the expansion of the shipbreaking industry.

This paper contains a statistical analysis of the growth of Bangladesh's ship recycling industries and the sector's detrimental impacts on various aspects. The literature review discusses shipbreaking capacity, limitations, and effects on humans and the environment. Some articles focus on the ship recycling method for sound ship recycling in Bangladesh, and others discuss worker safety and environmental sustainability. The data acquisition method and analysis procedures are discussed in the next section. Global shipbreaking and market conditions have been presented in the later part of this paper. A comparison of ship recycling's overall picture between Bangladesh and the rest of the world has been made with statistical analysis in the consequent section. Finally, the paper seeks to identify some flaws affecting Bangladesh's sound ship recycling process and make some recommendations for resolving the issues.

2. LITERATURE REVIEW

A significant number of researchers have studied ship recycling in Bangladesh. Much literature is available on different aspects of the ship

recycling industry, with few articles on problem identification and solutions with pragmatic recommendations.

Hossain et al. (2010) discussed the ship recycling prospects of Bangladesh. The authors mentioned that in Bangladesh, almost 100% of materials and equipment collected from shipbreaking are recycled. Besides, the contribution of ship recycling to inland shipbuilding is noteworthy. Zakaria et al. (2012) analyzed the ship recycling industry, identifying its underlying problems and evaluating their nature to overcome detrimental issues. Additionally, the authors provided insights on the sector's development and proposed potential solutions to help establish a standard for the industry within the global ship recycling market. Pasha et al. (2012) discussed the impact of Ship Breaking and Recycling Industries (SBRI) based on a study on a specific shipbreaking yard. The study focused on environmental impact assessment through seventeen parameters from personnel involved in the related workforce and water quantity parameters like Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Electric conductivity (EC), pH, Turbidity, Total Dissolved Solids (TSS), Chloride, Ammonia, Oil, and Grease Concentrations. The parameters were assessed concerning their weightage and alteration impact in the sector. Also, it shared recommendations to ensure adequate steps toward achieving environmental stability. Sujauddin et al. (2015) characterized the shipbreaking industry of Bangladesh. According to the study, it was observed that ships being dismantled in Bangladesh were comparatively younger, with an average age of 27 years. Out of the total outflows from these ships, approximately 85% consisted of reusable or recyclable steel, while the remaining portion included machinery, hardware, fittings, and consumable items. The researchers encountered a significant challenge as the stakeholders hesitated to disclose relevant information. The authors recommended maintaining organized records and transparent disclosures are crucial for developing a comprehensive understanding of this industry.

Hoque and Emran (2016) conducted a comprehensive study on the role of shipbreaking industries in Bangladesh. The authors identified several areas for improvement and suggested four key policy measures to address them. These measures included implementing a registration policy to increase transparency and accountability in the industry, creating a fund specifically dedicated to promoting sustainable and environmentally friendly shipbreaking practices, developing a green forest belt around shipbreaking yards to mitigate adverse environmental impacts, and establishing a research institution focused on advancing green shipbreaking technologies and techniques. Sujauddin et al.

(2017) studied the relationship between shipbreaking and steel industries in Bangladesh. The authors highlighted that the country's steel consumption in 2008 was 3,220,000 tons or 22 kilograms per person. The intensity of steel usage was 40 grams per US dollar, significantly higher than other developing nations with similar per capita Gross Domestic Product (GDP). These results suggested that the contribution of shipbreaking industries in Bangladesh is significant, as evidenced by the high level of steel consumption relative to the country's GDP.

Ahmad and Sujauddin (2017) conducted a study on the economic impact of ship recycling in Bangladesh. The study also focused on the regulatory frameworks, both domestic and international, that govern the industry. Additionally, the study explored the various factors and developments that have influenced the industry's performance. Rahman (2017) discussed the scenario, which includes the physical and economic growth of the sector till 2015 and the process of ship ownership transfer. It briefly discussed ship recycling methods like beaching and dry docking. It also sheds light on the loopholes of the ship declassification system. Finally, the paper suggested some recommendations to minimize the detrimental effects on human life and the environment. Rabbi and Rahman (2017) investigated the issues and challenges of Bangladesh's ship recycling sector. The article discussed the environmental impact, worker safety, and rights. The study also suggested solutions to this industry's obstacles to building a green recycling sector. Hossain (2017) studied ship recycling practices in Bangladesh. The author found that the beaching method is most commonly used in Bangladesh. Besides, most shipbreaking yards have no appropriate technology to ensure environmental safety management and disposal of hazardous materials.

Hossain (2018) determined reusable materials for ship recycling by sampling 27 recycled ships. The study found that recycling yards are becoming more concerned about protecting the environment. The author predicted that local recycling yards in Bangladesh would be sustainable soon. The author concluded that this promising industry needs continuous monitoring, financing, guiding, motivation, and support from every corner of the home and abroad. Das and Shahin (2019) tried to represent a picture of Bangladesh's shipbreaking industry capacity, constraints, and national or international regulations required for ship recycling. The article also analyzed human rights and safety issues along with economic factors. Finally, it showed how to overcome the obstacles to developing this green industry. Gunbeyaz et al. (2019) studied the shortcomings of occupational training in the ship

recycling industry of Bangladesh. The authors conducted a field survey based on the IMO-NORAD SENSREC project to ensure a practical approach. The field data included recycling yards, government agencies, universities, and Bangladesh Ship Breakers Association's (BSBA) training center. The study highlighted the immediate requirements of occupational training to avoid poor working practices and low environmental standards. Abdullah et al. (2020) conducted a comprehensive analysis of recent data concerning worldwide ship recycling and dismantling activities. The analysis delved into various aspects including vessel categories and tonnage. The study also explored the importance of raw steel production and consumption rates, illustrating their profound impact on Bangladesh's economy. Conclusively, the authors not only presented several innovative ideas for fostering the growth of eco-friendly ship recycling in Bangladesh but also put forth strategies to effectively address the obstacles within this sector.

Uddin (2021) studied the impact of the international standard system on the ship recycling industries of Bangladesh. The author surveyed different recycling yards and found that most workers are unaware of the risk and pollution this industry poses, and they are attempting to avoid the rules and guidelines established for them. The author recommended that proper training be regularly organized for workers to make conscious. Sheikh (2021) studied competitive advantages of ship recycling industries of Bangladesh. The study revealed that Bangladesh's competitive advantage is rooted in factors such as inexpensive labor costs, low tax rates, a strong domestic demand for scrap steel, and a flexible regulatory framework. The study suggested necessary guidelines based on the findings in order to maintain a competitive position in ship recycling. According to Chowdhury et al. (2021), adequate training of shipbreaking workers is crucial for creating an environmentally friendly atmosphere and protecting health and safety in Bangladeshi shipbreaking yards. In this regard, it is the fundamental responsibility of both the government and the owners of the shipbreaking yards to ensure that workers in the shipbreaking industry in Bangladesh receive proper vocational training. Mehtaj et al. (2022) discussed the problems with most Bangladeshi yards' current ship recycling processes regarding cutting technology and material handling. The advantages and disadvantages of cutting procedures and material handling techniques have also been discussed. The study recommended cost-effective mechanization to upgrade cutting technology and material handling systems to facilitate safe and sustainable ship recycling in Bangladesh.

3. DATA COLLECTION AND METHODOLOGICAL APPROACH

An essential aspect of world trade is the magnitude of the global shipping fleet. The collected data in this paper was compiled from various sources, including journal articles, conference papers, reports from non-governmental organizations (NGOs), steel industry reports, daily newspapers, etc. After obtaining data, it is organized, and the less critical data are separated. Finally, all the data are shown in different graphical and tabular formats, which overall interpret the actual situation of Bangladesh's ship-breaking condition compared to the rest of the world.

4. STUDY OF GLOBAL SHIP-BREAKING

The smooth operation and profitability of the global economy are significantly dependent on the extensive network of international shipping vessels. The existing worldwide fleet, consisting of approximately 95,402 ships with a collective capacity of 1.97 billion deadweight tons (DWT), plays a vital role in this process (UNCTAD, 2019). Each year, a substantial number of maritime vessels are decommissioned, contributing to a considerable volume. The worldwide shipbreaking activity during the period spanning from April 1, 2021, to March 30, 2022, is depicted in Table 1.

Table 1: Tonnage recycled and percent value of various types of scrap ships (July 1 to September 30, 2021).

Serial	Type	Tonnage	Percent value
1	Drilling Ship	82,000	6%
2	Tankers	11000000	74%
3	Bulkers	67,000	5%
4	Offshore	42,000	3%
6	General Cargo	41,000	3%

Figure 1 shows the annual number of ships demolished and beached around the global market. Because of so many restrictions, the value of scrapped ships was lowest in 2020 from its peak in 2013. Additionally, this number gives statistics on the average demolition of almost 835 ships annually, with an average of 553 vessels being beached.

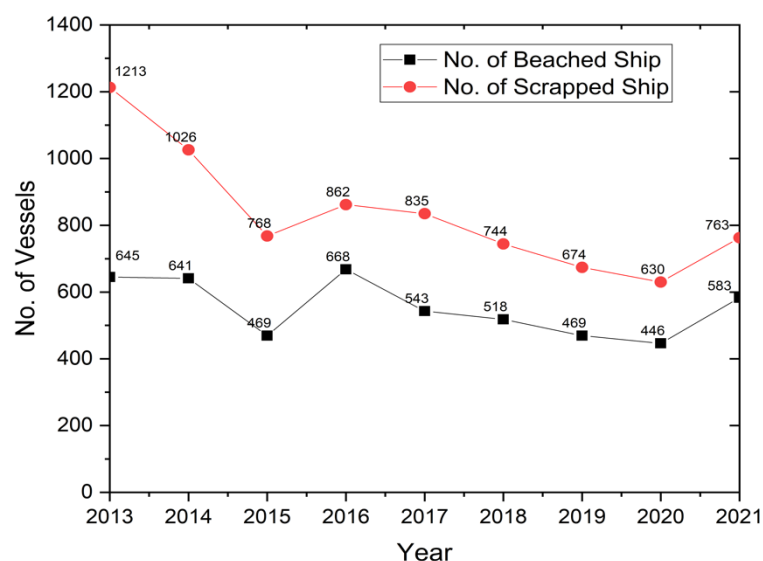


Figure 1: Number of beached and scrapped ships in the ship-breaking countries of the world (Off the beach, 2022).

5. BANGLADESH'S SHIP RECYCLING INDUSTRY COMPARED TO THE REST OF THE WORLD

Before the 1960s, the ship recycling industries were considered to be largely reliant on technology. Moreover, ship recycling was mainly done by industrialized nations like the United Kingdom, Germany, Italy, and the United States. However, the situation began to change significantly in the 1980s, as ship owners started to become more and more interested in sending their scrapped ships to South Asian shipbreaking yards situated in Bangladesh, India, Pakistan, Philippines, and Vietnam in order to maximize their profits.

The shipbreaking industries of Bangladesh are primarily located in Sitakunda (Bhatiary to Kumira), the northern side of Chittagong City, and the Bay of Bengal. Ship recycling is expected to thrive because of the geographical advantages of this location. South Asian countries like Bangladesh, Pakistan, and India are currently regarded as the global hub for shipbreaking and recycling. Ship recycling has excellent significance in Bangladesh's impoverished macro- and micro-economies and plays a significant role in developing this country. Bangladesh receives raw material support from these shipbreaking industries yearly, contributing significantly to the national economy.

After analyzing ship-breaking data from the past decade, Figure 2 illustrates the annual ship-scrapping statistics within the shipyards of Bangladesh. The data suggests an average of approximately 202 ships being dismantled each year. Additionally, the figure presents the yearly values for gross tonnage (GRT) or light displacement tonnage (LDT), with an average of 6.8 million per year. The graphical representation highlights that the peak year for ship scrapping was 2021, while the maximum GRT/LDT value was recorded in 2014. Notably, the figure also signifies a significant decrease in shipbreaking activities and GRT/LDT values during the year 2020. The catalyst for this phenomenon was the worldwide impact of the COVID-19 pandemic.

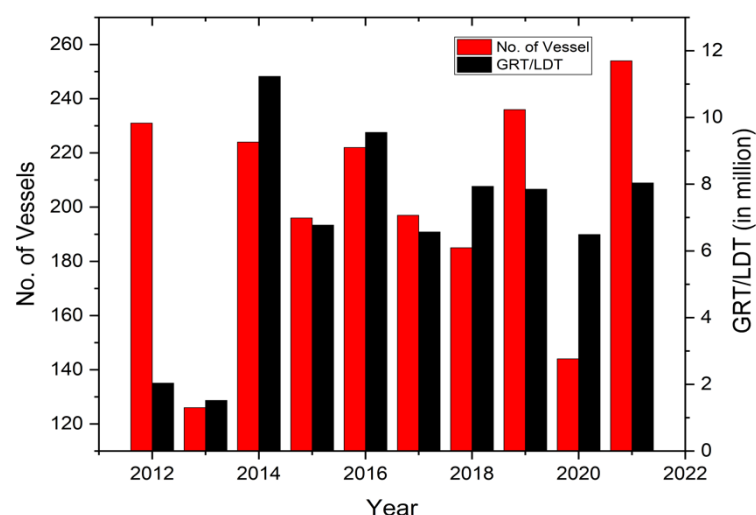


Figure 2: Yearly number of scrapped ships and associated GRT/LDT in Bangladesh (NGO Shipbreaking Platform, 2022).

Figure 3 provides a visual representation of ship-breaking activities across various countries over the past decade (2012-2021), including India, Bangladesh, Pakistan, Turkey, China, the EU, and the rest of the world (ROW). Notably, the figure emphasizes India's prominent role in global shipbreaking, contributing significantly to this industry. Additionally, the figure highlights the evolving status of Bangladesh in this sector, with intermittent improvements. Bangladesh notably claimed the top position in 2021. In contrast, Turkey, Pakistan, China, and the EU are progressively establishing their presence in shipbreaking. The data indicates a gradual increase in their contributions. In addition, Figure 4 complements this dataset

by presenting a comprehensive breakdown of the yearly GRT/LDT values for the individual countries that are actively participating in the shipbreaking industry.

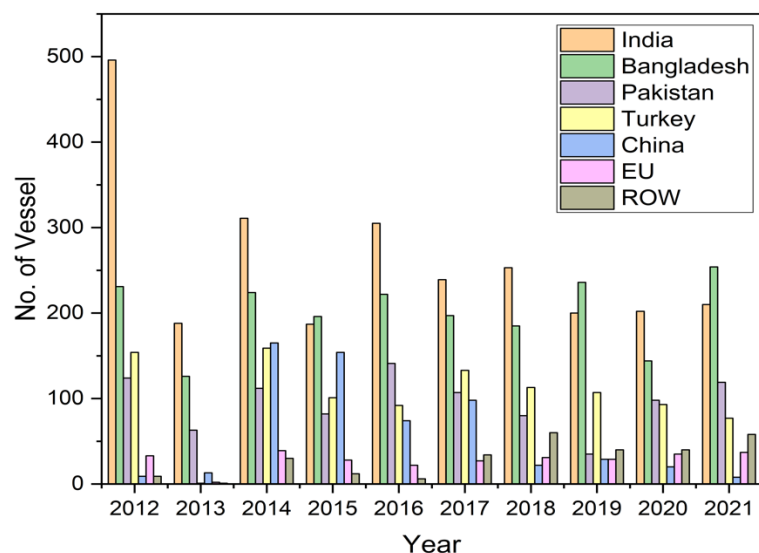


Figure 3: Yearly number of scrapped ships in India, Bangladesh, Pakistan, Turkey, China, EU, and ROW (NGO Shipbreaking Platform, 2022).

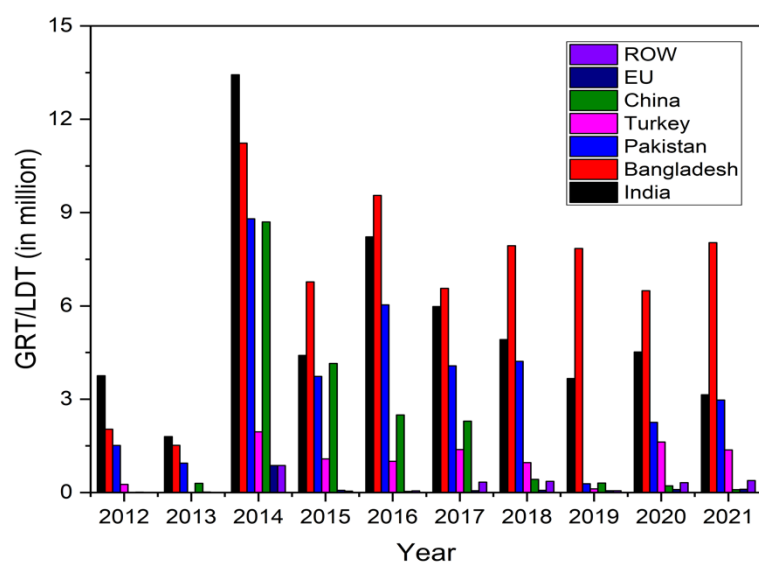


Figure 4: Yearly representation of GRT/LDT of India, Bangladesh, Pakistan, Turkey, China, EU, and ROW (NGO Shipbreaking Platform, 2022).

In a nutshell, Table 2 draws a compelling comparison between Bangladesh's shipbreaking sector and the global scenario. It's readily apparent that India holds a numerical advantage over Bangladesh. However, when

delving into the GRT/LDT aspect, a promising trajectory for Bangladesh's shipbreaking industry comes into view, setting it apart on the global stage.

Table 2: Ship-breaking scenario of different countries over the last ten years (2012-2021) (NGO Shipbreaking Platform, 2022).

Country	Avg. Ship Breaking Number	Avg. GRT/LDT (in million)
Bangladesh	202	6.68
India	259	5.38
Pakistan	96	3.48
Turkey	103	0.98
China	59	1.89
EU	28	0.14
Rest of the world	29	0.24

6. IMPORTANCE OF SHIP RECYCLING INDUSTRIES IN BANGLADESH FOR THE NATIONAL ECONOMY AND OTHER ISSUES

Shipbreaking plays a crucial role in the economy of Bangladesh through various avenues. The country's cost-effective workforce, streamlined importation infrastructure, and enthusiastic entrepreneurship have contributed to this industry's continuous growth (Das and Shahin, 2019). As a result, the contribution of shipbreaking to the national economy is substantial. Ship scrapping is Bangladesh's primary steel supplier, resulting in significant savings in foreign exchange by minimizing the requirement for importing steel materials. According to reports, Bangladesh requires 500,000 tons of metal/steel, but the country lacks domestic iron ore sources or mines. As a result, ship scrapping has become an indispensable and significant source of raw materials for Bangladesh. Besides, over the last few years, the industry has consistently generated a substantial output valued at approximately BDT 53.3 billion (equivalent to USD 770 million) annually (Ahammad and Sujauddin, 2017). Furthermore, the industry has been a significant source of government revenue (Table 3), with customs duties, income taxes, and value-added taxes totaling over BDT 5 billion (around USD 68 million) per year (Ahammad and Sujauddin, 2017). The industry also fulfills its obligations by

paying considerable charges as the existing regulatory and compliance frameworks require. Table 4 provides an overview of the annual charges paid to the Ministry of Industries based on ship-breaking activities.

Table 3: The revenue generated through tax payments from the ship-breaking industry in Bangladesh (Ahammad and Sujauddin, 2017).

Fiscal year	Customs duty (USD million)	Income tax (USD million)	Value-added tax (USD million)
2010-11	15	Not available	Not available
2011-12	30	34	0.2
2012-13	41	28	9.2
2013-14	31	21	7.0
2014-15	42	22	7.5

Table 4: Allocated charges for Bangladesh's ship-breaking industry (Ahammad and Sujauddin, 2017).

Cal endar year	No- Objection Certificate fee (USD)	Inspec tion fee (USD)	Beach ing fee (USD)	Cutti ng fee (USD)	Safety service cost (USD)
201 1	6.1	81	20	56	61
201 2	8.8	118	29	146	88
201 3	7.4	99	25	117	74
201 4	8.5	113	28	97	123
201 5	8.6	114	29	121	143

Besides, ship recycling industries also contribute significantly to the growth of the economy of Bangladesh by generating several profitable opportunities. Shipbreaking industries provide a lot of byproducts, e.g., steel,

furniture, paint, oil, electrical accessories, lubricants, oil, and so on. These byproducts meet a significant portion of the local market's demand, which reduces the need to import those goods from other countries. Figure 5 shows the typical material flows of bicycle products.

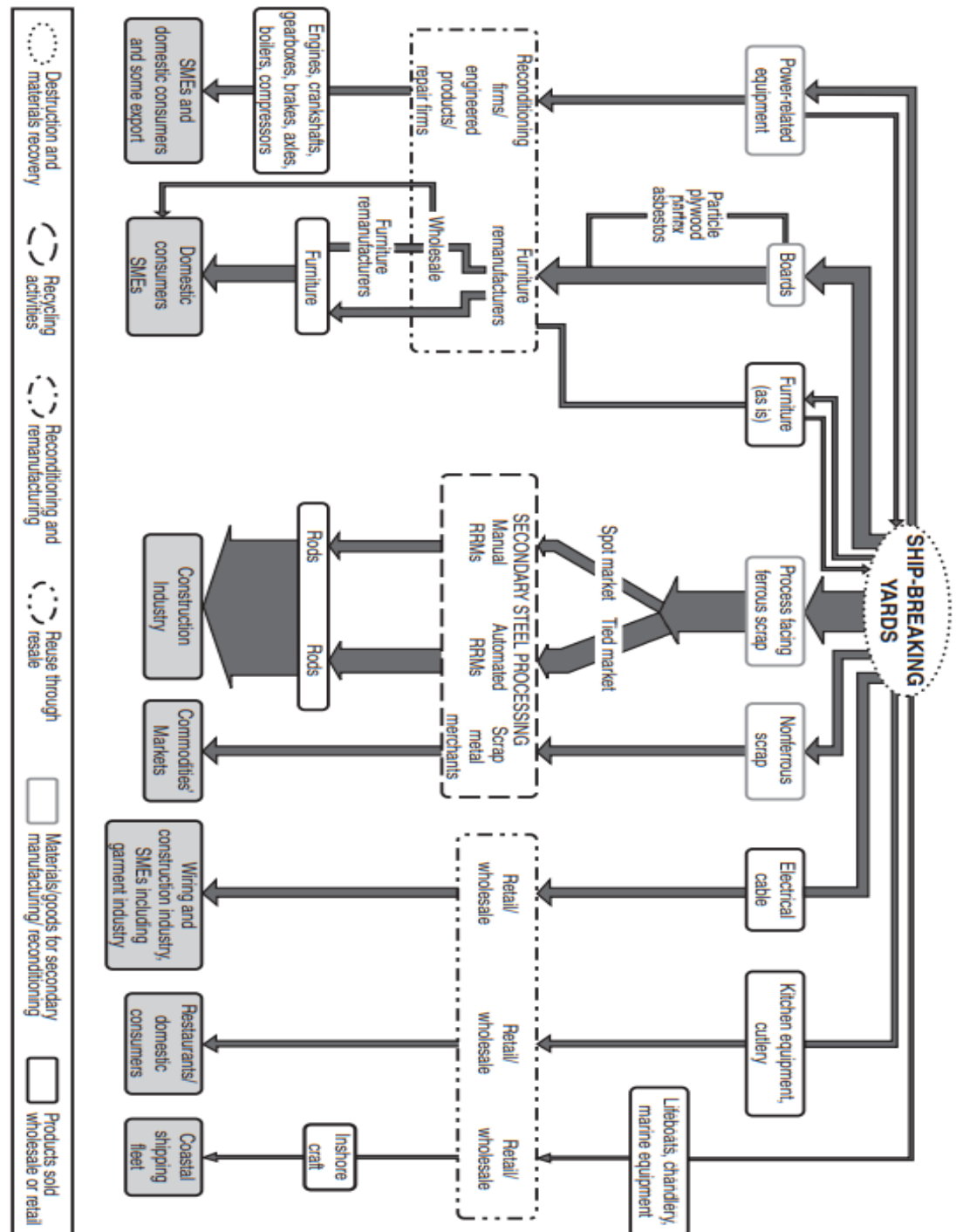


Figure 5: Schematic diagram of material flows and other recycled byproducts found from ship-breaking yards in Chittagong (Gregson et al., 2012).

Steel is one of the main byproducts. As Bangladesh lacks iron ore, shipbreaking industries have become essential for collecting raw materials for iron industries. In the country, there are about 300 steel industries in operation. Among these, there are 150 re-rolling plants and 30 auto steel mills. The other sectors use traditional methods to produce steel. The Bangladesh Shipbreakers and Recyclers Associations' study showed that 60 to 70 percent of the steel used in Bangladesh's re-rolling mills comes from the ship recycling sector. This supports Bangladesh's substantial foreign currency reserves. Additionally, it supplies local shipyards, docks, repair, and maintenance businesses (Abdullah, 2021; Awal and Abdullah, 2021; Abdullah et al., 2022), etc., with more than 60% of its raw steel needs and partially consumable items used by TIG welding technology (Dhar et al., 2023).

Significantly, the shipbreaking industry offers employment opportunities to numerous skilled and semi-skilled workers from various regions of Bangladesh. In 2015, it was estimated that the sector provided between 25,000 and 40,000 full-time equivalent jobs, encompassing diverse roles ranging from management and administration to technical and support positions (Ahammad and Sujauddin, 2017). Technical and support roles include supervisors, foremen, cutters, fitters, wire experts, and assistants.

Nearly 50,000 individuals are likely to be employed directly in this sector, and another 100,000 are dependent on it for their income indirectly. About 300-350 workers are needed temporarily to demolish a ship. So, the country is greatly benefiting from the ship recycling industry. Thus, these industries have great importance in the development of Bangladesh.

6.1. The Impact of Ship Recycling Industries on Economies through Forward Linkages

Forward linkage involves the scenario where the output of a recently established industry is utilized as a resource by another industry. This process facilitates the emergence of further new industries. The ship-breaking industry has led to the establishment of numerous local industries, encompassing both heavy and light engineering. In certain aspects, it can be regarded as an environmentally sustainable sector. Over 350 re-rolling mills rely on ship scraps as their primary source of raw materials. Presently, this industry provides over 60 percent of the raw materials required by the local steel industry. (Ahammad, H. and Sujauddin, M., 2017). This contributes to the expansion and advancement of steel mills, foundries, and businesses involved

in metal recycling. As a result, it generates more job opportunities and promotes economic growth.

Apart from the positive effects cascading down the supply chain of various items (ferrous, non-ferrous metals, machinery equipment, hardware items, furniture and fittings, oils, and other consumables), the ship recycling industry in Bangladesh also stimulates various upstream activities that contribute to output and employment. These include transport and construction services, utilities such as electricity, oxygen plants, machinery and equipment maintenance and repair services, and the provision of banking, insurance, and regulatory services (Ahammad, H., and Sujauddin, M., 2017). These ancillary services and support systems generate additional economic value, representing the indirect value added derived from the shipbreaking industry. Additionally, the expenditure by ship recycling workers bolsters numerous economic activities and services such as retail, real estate, and personal services, not only within the local economy but also across the entire country.

Shipbreaking operations frequently necessitate inventive solutions and technological advancements to improve efficiency, safety, and environmental sustainability. This, in turn, can stimulate innovation and enhance processes in areas such as recycling, waste management, and occupational safety, ultimately benefiting the broader economy.

It is essential to acknowledge that while the shipbreaking industry can generate favorable forward linkage effects, it is imperative to prioritize addressing health, safety, and environmental considerations. Achieving a balance between economic development and sustainability is critical to ensure the long-term sustainability and positive influence of the shipbreaking industry on the broader economy.

7. DIFFICULTIES OF SHIP RECYCLING INDUSTRIES

7.1. Environmental Effects

As mentioned earlier, Bangladesh's ship-breaking industry has significantly contributed to Bangladesh's economic development and growth by accommodating new employment opportunities and providing the raw material for other sectors; however, the ship carries various hazardous materials that might adversely affect human health, safety, and the environment. Hazardous materials include paint containing lead, cadmium, asbestos, and other materials depending on the size and type of ship. The most

frequent hazardous substances found during the dismantling of a vessel and their adverse effects are listed in Table 5.

Table 5: Hazardous material of scrapped ship and its detrimental consequences.

Serial	Hazardous Material	Description of associated Adverse effect
1	Asbestos (ACM, PACM), Glass Wool	Acute and chronic exposure causes serious health risks, followed by fatal diseases like Asbestosis (causing breathing difficulties from lungs scarring), Mesothelioma (cancer of the lung lining and abdominal cavity), and lung cancer
2	Polychlorinated Biphenyls (PCB)	PCBs have effects such as Increased levels of some liver enzymes, possible hepatic damage, Chloracne and related dermal lesions, and respiratory problems. Fatal impacts are cancer in animals, non-cancer health effects in animals, degraded immune system, reproductive system, nervous system, endocrine system, and other health effects.
3	CFC, HCFC	These Ozone-depleting compounds play a significant influence in the formation of malignant melanoma and can induce non-melanoma skin cancer.
4	Anti-fouling Organotin (TBT, TPT, TBTO)	Even in small doses, organotin can alter the biology of animals and the marine environment. It damages the endocrine systems of invertebrates, causing sterility and death, and bioaccumulates most marine mammals.
5	Heavy Metal Lead	Damage to the nervous system, hearing, vision, reproductive system, blood vessels, kidneys, and heart, particularly children's growing bodies and minds.
6	Heavy Metal Mercury	This toxic metal is bioaccumulative and affects neurologically

7	Heavy Metal Cadmium	Cd cannot be converted into less dangerous chemicals since it is a persistent chemical element. It is poisonous to plants, animals, and microorganisms and can build up in the liver, kidneys, and bones.
8	Heavy Metal Chromium	Cr causes lung cancer, nasal irritation, nasal ulcers, contact dermatitis, asthma, and other conditions through inhalation and the skin. Chromium can either stimulate or depress the immune system by affecting several immune system components.
9	Radioactive Substances	Higher radiation levels can result in sickness, damage to the central nervous system, and even death.
10	Polyvinyl Chloride (PVC)	It may harm human reproductive systems and cause asthma, cancer, and allergies. Burning can produce CO, extremely hazardous dioxins, and furans.
11	Residual Oil	Along the air-sea interface, oil film combines with water, lowering the oxygen content and raising the carbon dioxide level, affecting marine life.
12	Bilgewater, Waste Oils	Bilge water and waste oils are causing beach soil to lose its ability to adhere to one another, which leads to shore erosion. Additionally, the coastal region sees silt accumulation and turbidity in the sea.

Many precautions, measurements, and steps are needed to deal with hazardous materials to mitigate the adverse effect of those hazardous materials on the environment. But unfortunately, due to a lack of education and proper management in Bangladesh ship recycling industries, those hazardous materials are dealt with without following the correct way. Those are discharged, spilled from the wrecked ship, and eventually mixed with sand and water, seriously threatening the environment.

7.2. Worker Health and Safety Issues in Shipbreaking Yards

Low health and safety standards for workers are another major issue in the shipbreaking sector. The demand for this industry has risen rapidly in the last few decades due to Bangladesh's shipbreaking sector getting significant international recognition. As a result, many investors have invested in this industry without upholding a minimal standard of health and safety regulations for workers, which has caused many accidents in this sector over the past several years. The required Personal Protective Equipment (PPE) and formal safety training are not yet available to the workers in most ship-breaking industries. In addition, most of the workforce in ship-breaking industries are uneducated. Statistics show that almost 46.42% of the workforce at ship-breaking yards have no high school diploma or equivalent, which allows workers unaware of their legal rights and international health and safety laws that may keep them safe while at work. As a result, numerous workers die or suffer grave injuries every year while at work. Table 6 represents the accident and death statistics of our ship-breaking yards in Bangladesh for the last few years (Off the beach, 2022). Moreover, to make a lot of profit, the owner of ship-breaking industries hires a lot of child labor, around 10.95% of the total labor force, which is against international labor law.

Table 6: Accidents and death statistics in the Ship Breaking industry (Off the beach, 2022).

Year	Dead Worker	Seriously Injured
2016	22	29
2017	15	22
2018	20	12
2019	24	34
2020	10	14
2021	14	34

7.3. Challenges Related to Changes in Prices

Fluctuations in steel market prices can directly influence the profitability of shipbreaking yards. When steel prices are low, shipbreakers may need help

recuperating their expenses and attaining satisfactory profit margins. This situation can discourage potential investments in the industry and potentially result in the closure or downsizing of current operations. The competitiveness of Bangladesh's shipbreaking industry in relation to other global ship recycling destinations can be impacted by price fluctuations. When steel prices are more advantageous in other countries, ship owners may prefer to sell their vessels for scrapping in those alternative locations, leading to a decrease in the number of ships available for breaking in Bangladesh. Consequently, local shipbreakers may experience a decline in their bargaining power and potential constraints on the industry's growth prospects. Besides, in the event of financial difficulties arising from low steel prices, the shipbreaking industry may encounter outcomes such as decreased job prospects, salary reductions, or workforce downsizing.

To secure the long-term growth and sustainability of the shipbreaking industry in Bangladesh, it is crucial for industry stakeholders, policymakers, and investors to closely monitor global steel market patterns and devise strategies for managing the risks linked to price fluctuations. This may involve fostering collaborations, enhancing operational efficiency, encouraging innovation, and exploring avenues for value-added activities within the industry. By taking these measures, the industry can mitigate the adverse effects of price volatility, ensuring a sustainable future for shipbreaking in Bangladesh.

8. PROPOSITIONS

8.1. Professional Development and Worker Education Issues

- Personal Protection Equipment (PPE) should be provided by management, and proper PPE use must be considered mandatory.
- Formal training must be provided routinely to make aware of the safety and health protections. Workers in hazardous positions should go through a strict training process.
- Different warning signs need to be set around hazardous products to alert people. To prevent the spread of toxicity, workers must be aware of these signs' significance and safeguard themselves and the material.
- International rules and regulations like the Hong Kong Convention, Basel Convention, and IMO guidelines must be preached as training or demos yearly or half-yearly.
- Most workers lack adequate education. The shipbreaking yard can start a primary education program outside or nearby for its unschooled employees. If

local education is not possible, employment security should be provided based on that educational foundation, and everyday life security should be provided.

- Under-age labor should be strictly prohibited, and the minimum educational qualification should be set to a higher secondary school certificate to engage in shipbreaking-related work.
- Trade unions must be formed to make aware the labor right.
- Recruitment policies must be approved by the yard authority and trade union, where the work environment, salary, weekends, and facilities will be briefly mentioned.
- Certified trainers must establish the framework and promote workers according to their training certifications.

8.2. Sound Ship Recycling: Health, Safety, and Environmental Issues

In 2004, the International Labour Organization (ILO) released a report titled "Safety and Health in Ship Breaking: Guidelines for Asian Countries and Turkey." These guidelines aim to adhere to the ILO standards, codes of practice, and other policies concerning occupational safety, health, and working conditions. The May 2009 Hong Kong Convention (HKC) aimed to ensure that ship recycling does not pose undue risks to human health, safety, and the environment. This convention's written content is divided into three primary sections: articles, regulations, and appendices (Jain et al., 2013). It emphasized the importance of inventorying hazardous materials, establishing ship recycling plans, authorizing ship recycling facilities, and promoting safe and environmentally responsible ship recycling practices. The HKC explicitly addresses concerns about ecologically hazardous substances such as asbestos, hydrocarbons, and ozone-depleting substances (Hiremath, 2016). The ship recycling sector in Bangladesh encounters notable challenges in terms of health, safety, and the environment. Nevertheless, some measures can be implemented to tackle these issues and encourage adopting improved practices. The following are some suggested recommendations:

Health

- Adequate health safety measures must be provided for workers, with strict exclusion of children and women from the shipbreaking process and handling of heavy materials. Workers who may come into contact with hazardous waste that can affect the respiratory system should be allowed to use masks and protective coats (Pasha et al., 2012).

- Every ship-breaking yard should have a medical center inside the boundary, and first aid treatment must be accessible to all workers around the clock (Shameem, 2012).
- Weekly or monthly health checkups and recovery opportunities for workers' conditions must be regulated (Hossain, 2015).
- Each employee must be decontaminated after the decontamination process is complete. They move through the purification unit of the disinfection chamber, which has sealed surfaces, such as foils, as part of the procedure.

Safety

- It is crucial to ensure a well-designed cutting plan that prioritizes technological advancements, safety measures, and environmental considerations to prevent worker casualties in the ship recycling industry in Bangladesh (Zakaria et al., 2012).
- A well-equipped firefighting system must be ensured near flammable workplaces within the breaking yard to prevent fire-borne accidents.
- Enforcing national policy is necessary to maintain safety in industrial settings (Andersen, 2001)
- Make sure that personal protective gear and equipment are accessible and utilized. Shipbreaking yards must have safety equipment like firefighting, rescue, and first-aid facilities (IMO, 2009).
- Create a methodology for the ship recycling industry in Bangladesh that emphasizes integrating scientific and technological knowledge, risk, and safety analysis (Zakaria et al., 2012).

Environment

- Efforts should be made to enhance environmental monitoring by bolstering the capabilities of relevant departments and establishing laboratory facilities. Conducting an immediate baseline study focusing on ecological aspects is imperative to determine the extent of pollution and identify necessary remedial measures (Zakaria et al., 2012).
- Before importing any scrap ship, it is necessary to establish a system for submitting a list of hazardous materials (hazmat) to the administration (Hossain, 2015).
- Before entering the Ship Recycling Facility, it is recommended to take specific measures to minimize the presence of cargo residues, residual fuel oil, and onboard waste. If the vessel is a tanker, it should arrive at the facility with cargo tanks and pump room(s) in a state that meets the requirements for certification as Safe-for-entry, Safe for-hot work, or both, as specified by the national laws,

regulations, and policies of the governing authority overseeing the Ship Recycling Facility (IMO, 2009).

- Before beginning the beaching process, every hazardous material must be labeled (Hossain, 2015).
- The Ship Recycling Facility (SRF) plan is vital to prevent any adverse effects caused by inappropriate handling of hazardous materials. The Ship Recycling Facilities must create a Ship Recycling Plan specific to each ship before initiating any recycling activities. This plan should consider the guidelines provided by the Organization (IMO, 2009).
- Asbestos-contaminated areas have toxic air, so they must be isolated from other places and restricted for any unauthorized worker, and work in that area must be conducted by trained personnel. It is recommended that recycling of asbestos and materials containing asbestos should be strictly avoided (Hossain, 2015).
- Decontaminated stations on shore should be used for waste separation of smaller contaminated parts.
- Waste disposal at hazardous waste management sites should be carefully monitored and handled.
- Conduct thorough environmental sampling of the air, water, and soil within and surrounding shipbreaking yards to examine the immediate and long-term effects (Zakaria et al., 2012).
- The government and port authorities should adopt national policies that align with international standards regarding environmental safety (Pasha et al., 2012).

8.3. Hong Kong Convention Implementation

The Hong Kong Convention on the safe and environmentally sound recycling of ships, which aims to improve safety and environmental standards in the ship recycling industry, is set to enter into force in Bangladesh by June 26, 2025 (IMO, 2023). Bangladesh, as a significant contributor to the shipbreaking industry, has been actively working towards implementing the convention's provisions. With the implementation of the Hong Kong Convention in Bangladesh, considerable progress is expected in enhancing worker safety, minimizing environmental pollution, and promoting sustainable practices in the ship recycling sector. The country has been making efforts to upgrade its shipbreaking yards, ensuring compliance with international standards, and providing proper training and protective measures for workers with the help of an IMO-implemented project on Safe and Environmentally

Sound Ship Recycling in Bangladesh (SENSREC) (IMO, 2023). By aligning with the Hong Kong Convention, Bangladesh can demonstrate its commitment to responsible ship recycling. It can contribute to global efforts to create a safer and more environmentally friendly shipbreaking industry.

8.4. Overcoming Local Precarious Conditions

To succeed in the expanding shipbreaking industry between 2023 and 2030, it is necessary to navigate the challenging local circumstances and establish a competitive edge. This can be achieved by collaborating with various stakeholders in the industry and receiving substantial backing from the government. Several actions can be considered to achieve this goal, such as infrastructure development, regulatory reforms, research and development, international collaboration and market promotion, etc. Allocate resources to enhance the infrastructure of shipbreaking yards and their neighboring regions. The government and industry stakeholders should work together to create a thorough blueprint for infrastructure development that facilitates secure and efficient shipbreaking processes. Later, collaboration with industry professionals, international organizations, and other relevant parties to thoroughly assess and revise regulations pertaining to the shipbreaking sector. Enhance the effectiveness of current regulations concerning health, safety, and environmental criteria, and enforce their implementation rigorously. Additionally, the government should contemplate adopting global best practices and standards to maintain competitiveness in the international market. Besides, capacity development endeavors by establishing training initiatives and vocational institutes that specifically target acquiring skills and knowledge essential for shipbreaking operations.

Promoting research and development endeavors to discover inventive solutions to enhance safety, efficiency, and environmental sustainability within shipbreaking activities. In this case, Government can play a crucial role by offering funding and incentives to support research and development initiatives in the shipbreaking sector. Besides, enabling more accessible access to financial resources for ship breakers, particularly for small and medium-sized enterprises (SMEs). This approach will empower ship breakers to invest in modern equipment, infrastructure enhancements, and technology integration, thereby bolstering their competitiveness within the market. Finally, increasing the cooperation with international organizations, ship owners, and buyers to encourage adopting responsible ship recycling

practices. Engage in international forums, conferences, and exhibitions to demonstrate the capabilities, standards, and progress of the shipbreaking industry in Bangladesh. The government should actively participate in bilateral and multilateral agreements to enhance trade relations and broaden market opportunities for ship breakers.

8.5. Prospects of Green Ship Recycling

The process of environmentally friendly ship recycling encompasses various aspects, including the management aspect, equipment used for dismantling, proper disposal of hazardous materials, water, and energy consumption during cutting, implementation of environmental protection facilities and strategies, certification and transparency, and more (Zhou et al. 2021). Besides, ship recycling facilities must possess the capacity to recycle ships in compliance with both national regulations and international conventions. These facilities should be subject to monitoring by a capable national administration, following regulations outlined by the International Labour Organization (ILO) in the Guidelines on Safety and Health in Ship-breaking Processes, as well as the Basel Convention's Technical Guidelines on Environmentally Sound Control, Management, and Dismantling of Ship Parts (Sunaryo & Pahalatua, 2015). Some key points are discussed below for making the green ship recycling industry in Bangladesh.

Improved waste management:

Develop effective waste management protocols to manage dangerous substances, including asbestos, PCBs, heavy metals, and other harmful materials discovered in vessels. It is essential to ensure appropriate containment, handling, treatment, and disposal methods for these substances in order to reduce environmental and health hazards.

Sustainable dismantling techniques:

The objective of enhancing process control is to make adjustments to the production process in order to gain improved management over discharges, emissions, and waste generation. The effectiveness of this approach relies on comprehending and examining the process itself. Hence, a process mapping tool can be advantageous in comprehending the overall ship recycling process and pinpointing areas of concern that can be specifically addressed. This not only aids in the development and promotion of environmentally-friendly ship recycling practices but also contributes to the overall improvement of the ship recycling industry (Jain, 2017)

Infrastructure and facilities of the yard:

Allocate resources to establish adequately equipped ship recycling facilities that accommodate ships of various sizes and types. These facilities should have suitable containment and treatment systems to mitigate adverse environmental effects.

Certification and transparency:

Promote the acquisition of certification from reputable organizations by ship recycling facilities, showcasing their adherence to global standards and optimal methodologies. Transparency in reporting and disclosing recycling practices can play a pivotal role in fostering trust and accountability within the industry.

Research and development:

Allocate resources towards research and development endeavors to investigate novel technologies, processes, and materials that can enhance the sustainability of ship recycling. Foster a culture of innovation and promote the advancement of alternative recycling methods that minimize environmental impact and enhance the recovery of valuable resources.

9. CONCLUSIONS

Bangladesh has emerged as a global hub of shipbreaking and recycling due to geographical advantages and cheap labor. This industry has contributed significantly to Bangladesh's economic development and growth by accommodating new employment opportunities and providing the material flow rate of other sectors. However, this industry has also brought severe environmental and social problems, e.g., environmental pollution, child labor, and working safety which have become a threat to the future of this industry. Bangladesh must build out its shipbreaking infrastructure under legal requirements and international standards to maintain its position as the market leader while also emphasizing worker health and safety. Pollution may be unavoidable in shipbreaking yards; still, it must be kept to a minimum not to endanger the environment or the local population. Therefore, many precautions, measurements, and steps are needed to regulate this industry. The government and private business owners should collaborate to maintain the industry's leadership position.

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