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Status of Local Ship Recycling Industry of Bangladesh in Contest of Global and Way Forward

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Abstract:
The ship recycling industry refers to the dismantling and recycling of End-of-Life (EOL) vessels and is widely recognized as a crucial and sustainable global practice. Each year, thousands of obsolete ships are recycled, making ship recycling an environmentally significant and economically viable industry. In Bangladesh, ship recycling has evolved from informal, beaching-based operations into a globally important sector. Currently, the country accounts for over 45% of global ship recycling tonnage, making it among the top ship recycling companies in the world hubs alongside India and Pakistan. What began when stranded ships are dismantled grown into a profitable industry, contributing significantly to the national economy. The industry provides employment to tens of a large number of semi-skilled laborers, particularly in poverty-prone coastal areas. It also supplies essential raw materials—such as scrap steel—to local industries. However, the sector faces challenges in terms of coastal zone management, including environmental degradation, weak law enforcement, and occupational health and safety concerns. While fully green ship recycling—aligned with stringent European standards—remains expensive, a more viable and environmentally responsible model is possible by upgrading existing beaching methods commonly used in South Asia. Despite its limitations, Bangladesh's ship recycling industry has made notable socio-economic contributions. This research utilizes a mixed-methods approach, incorporating secondary data analysis of gross tonnage (GT) records from 2014 to 2024, alongside more than 500 structured interviews with key stakeholders—including workers, yard owners, engineers, regulatory authorities, NGOs, and international experts. Additionally, the study employs ARIMA-based scenario forecasting to project future industry trends up to 2050. Findings highlight significant shortcomings in adherence to the Hong Kong Convention (HKC), with only approximately 40% of operational ship recycling yards currently certified. Deficiencies were also noted in areas such as workplace safety, environmental protection measures, and institutional oversight. A comparative analysis reveals that India has successfully modernized around 120 HKC-compliant yards, supported by substantial governmental and donor investments, while Pakistan is actively upgrading its Gadani facilities through a large-scale financial initiative. Forecasting under ARIMA modeling presents three scenarios: a "business-as-usual" trajectory maintaining roughly 2.7 million GT annually through 2050; an optimistic scenario reaching around 5 million GT with green yard expansion; and a pessimistic outlook dropping below 2 million GT if reform efforts falter. Overall, this analytical study offers a comprehensive assessment of Bangladesh's ship recycling sector in comparison with global industry practices.

Keywords: Ship recycling, compliance, beaching, ARIMA, HKC, Ship recycling policy

1. Introduction

Ship dismantling, commonly referred to as ship recycling is essentially a converse engineering process involving the deconstruction of obsolete or EOL ships to recover recyclable materials in a safe and environmentally responsible manner. Over the past three decades, the majority of ship recycling activities have taken place in a few South Asian countries, primarily Bangladesh, India, China, and Pakistan—where vessels are typically beached and dismantled using labor-intensive methods and moderate safety precautions. These countries have played a crucial role in global ship recycling, handling the majority of EOL vessels with considerable efficiency, albeit often in a less professional or regulated manner. In fact, over the last twenty years, recycling yards in Bangladesh, India, and Pakistan have accounted for nearly 90% of global ship recycling by tonnage. The growing need for ship recycling has led to improved regulatory oversight at both national and international levels. Despite this, the beaching method remains prevalent in South and Southeast Asia due to favorable tidal conditions and geographic advantages. In contrast, the dry-dock method—considered the safest and most environmentally sound—is mainly used in developed countries like those in the EU and the USA, although it is significantly more expensive to construct and operate. Some countries, such as Turkey and China, have adopted a middle-ground approach using the "alongside" or "pier breaking" method rather than beaching. Among these, Aliaga in Turkey and certain locations within the European Union are leading advocates for high-standard, environmentally friendly ship recycling practices, openly opposing the traditional beaching or slipway techniques.

End-of-life (EOL) ships are usually beached for recycling and deconstruction in South Asian nations including Bangladesh, India, and Pakistan, taking advantage of the region’s favorable tidal conditions. These countries have played a significant role in environmental preservation by efficiently recycling obsolete and decommissioned vessels—many of which, as history suggests, were once discarded in deep seas. At present, over 40% of the global EOL gross tonnage (GT) is recycled annually on the beaches of Bangladesh alone. This sector employs approximately 200,000 workers and contributes around USD 1 billion to the national economy. Looking ahead, it is estimated that nearly 20,000 ships worldwide—each over 500 GT and aged between 25 to 30 years—are approaching the end of their service life and will soon require recycling. To ensure environmentally sound practices, the International Maritime Organization (IMO) introduced the International Convention for the Safe and Sustainable Recycling of Ships in Hong Kong (HKC) in 2009. Although the HKC has now been ratified by key maritime nations, many local ship recycling yards in South Asia must still upgrade their practices to meet HKC compliance standards and obtain certification. Notably, decisions made in 2017 under the European Union Ship Recycling Regulation (EU SRR) are expected to significantly reshape the global ship recycling landscape. If the European Union formally accepts the Statement of Compliance (SOC) with HKC-2009 as a recognized standard, it could trigger a substantial wave of investment—particularly in upgrading ship recycling facilities in Alang, India, and across South Asia. For the beaching method to remain viable and sustainable in this region, the three major South Asian ship recycling nations must collaborate more closely. A coordinated effort is essential to improve industry practices, ensure environmental and worker safety standards, and preserve the economic benefits of ship recycling in the region.

Ship recycling is a crucial global industry that promotes environmental sustainability and resource recovery by dismantling EOL vessels to extract valuable materials such as steel, machinery, and equipment. Each year, thousands of ocean-going ships—including tankers, bulk carriers, and container vessels—are dismantled, with South Asia responsible for nearly 90% of global ship recycling due to favorable geography and comparatively low labor costs. Among the leading countries in this sector, Bangladesh has emerged as a key player. The coastline of Chattogram, particularly the Fauzdarhat area, serves as the nation's primary hub for ship recycling operations. Since the industry's unplanned inception in 1965, ship recycling in Bangladesh has grown into a billion-dollar enterprise. It now supplies more than 60% of the country's raw materials for steel production and domestic shipbuilding. The industry provides huge employment to over 200,000 workers and supports the livelihoods of approximately one million people directly/indirectly, making it a vital source of income in economically vulnerable regions. Despite its substantial economic contributions, the sector faces growing criticism for its continued use of the beaching method—a cost-effective but environmentally controversial approach. This study also aims to analyze the quantity and types of reusable and waste materials generated by the ship recycling process in Bangladesh, based on field-level data. It will further assess how these materials are distributed and managed in terms of reuse, recycling, and disposal.

The global regulatory landscape for ship recycling is undergoing significant transformation, driven by frameworks such as the European Union Ship Recycling Regulation (EU SRR) and the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships (HKC 2009).These regulations impose stricter environmental and safety standards, posing operational challenges for traditional ship recycling yards in South Asia. While countries like India and Turkey have successfully upgraded a substantial number of yards to meet HKC and EU compliance requirements, Bangladesh has made slower progress. Only a limited number of yards in the country have attained green certification. In response, Bangladesh passed the Ship Recycling Act in 2018 and set a national target to bring all operational yards into compliance with HKC standards by 2023. Although this goal has not been fully achieved, notable advancements have been made in infrastructure development, regulatory compliance, and institutional oversight—particularly through the Shipbuilding and Ship Recycling Board (SBSRB) under the Ministry of Industries. This study provides a comprehensive assessment of Bangladesh's ship recycling industry within the broader global context. It examines the industry's historical development, current regulatory challenges, comparative performance against other leading ship recycling nations, and its socio-economic contributions. Additionally, the study employs market forecasting methodologies to estimate future demand and explore strategic directions for aligning with evolving global standards. As an analytical and research-based investigation, the study offers critical insights into the current state of Bangladesh's ship recycling sector, forecasts its future trajectory, and outlines actionable pathways for sustainable and competitive growth in the global market.

2. Global Major Ship Recycling Locations

Every year, the world's ship recycling business disassembles over 1,000 oceangoing end-of-life (EOL) ships. These vessels include container ships, cargo ships, bulk carriers, oil tankers, LNG and LPG carriers, and cruise ships. The primary objective is to recover valuable materials such as steel, non-ferrous metals, and other recyclable components. Currently, ship recycling activities are heavily concentrated in five countries, with four located in South Asia—India, Bangladesh, Pakistan, and China—and the fifth being Türkiye. Additional, though limited, recycling capacities exist in a few North

American countries, including the United States, Canada, and Mexico, as well as select European nations such as Denmark, Belgium, and the United Kingdom. Despite these global presences, South Asia remains the undisputed center of the ship recycling industry, accounting for nearly 90% of global activity. Given the continued use of the beaching method in South Asia, viable operational guidelines—aligned with IMO standards—can be developed to enhance safety and environmental responsibility. If implemented effectively through a user-friendly knowledgebase system and robust monitoring mechanisms, these procedures could make the beaching method both sustainable and competitive for long-term use in the region.The global ship recycling market, however, continues to face several challenges. Although the year began with cautious optimism, trading activity soon slowed due to persistent financial constraints, particularly in India, where tight liquidity has limited market participation. In Bangladesh, attention remains focused on meeting upcoming regulatory milestones. While there has been some progress on compliance, broader market sentiment remains cautious, influenced by uneven yard readiness and slow approval processes. In Pakistan, market activity has been minimal, with weak buying interest and price levels that remain misaligned with regional benchmarks. This disconnect has stifled transactions and contributed to ongoing stagnation. In Türkiye, local price movements have remained flat, even as import costs have risen—reflecting a cautious market approach amid broader economic uncertainty. Adding to this market pressures are recent geopolitical tensions between India and Pakistan, marked by increased military activity and strained diplomatic relations. As both nations are central players in South Asia's ship recycling sector, the current instability raises concerns about regional security and cross-border economic cooperation. It is hoped that diplomatic efforts can lead to de-escalation to preserve regional stability and ensure the continuity of trade and industry operations. Meanwhile, global economic conditions are forecast to deteriorate further. The United Nations Conference on Trade and Development (UNCTAD) projects global economic growth to slow to 2.3% in 2025—below the threshold for recession. This slowdown is attributed to rising trade tensions (including U.S. tariffs on Chinese goods), declining global trade volumes, reduced investor confidence, and capital flight from developing economies due to high interest rates. In response, UNCTAD urges immediate policy interventions to restore economic stability and support sustainable development.

2.1 Bangladesh. Chattogram is the primary hub for ship recycling in Bangladesh, with the Fauzdarhat area—located approximately 16 kilometers southwest of the city—serving as the epicenter of these activities. Spanning roughly 12 square kilometers, this coastal zone is well-suited for dismantling large ocean-going vessels due to its high tidal range and soft, muddy shoreline. Several dozen local yards in this region follow recommended recycling practices outlined by leading international ship recycling organizations. The regulatory framework governing these operations is established under the Ship Breaking and Recycling Rules (SBRR), 2011, issued by the Ministry of Industries (MoI). Among its provisions, Section 15 of the SBRR mandates that all yards obtain official approval for a Ship Recycling Facility Plan (SRFP) from the MoI. In addition, yards handling hazardous waste must be authorized by the Department of Environment (DoE), also under the MoI. To date, approximately 18 local yards have achieved certification under the Hong Kong Convention (HKC), with several more expected to receive certification in the near future. However, despite this progress, Bangladesh risks losing its leading position in the global ship recycling market. The number of active or operational recycling yards has declined significantly over the past decade—an alarming trend that could impact the industry's long-term competitiveness. To maintain Bangladesh's global standing in the ship recycling sector, it is imperative

that both government authorities and yard owners take proactive and coordinated measures. Strategic investments, improved regulatory compliance, and consistent enforcement are essential to sustaining growth and leadership in this critical industry.

2.2 India. India's primary ship dismantling hub is located in Alang, Gujarat, which hosts approximately 150 designated plots suitable for ship recycling using the beaching method. The operational practices in Alang are largely similar to those in neighboring countries such as Pakistan and Bangladesh. Oversight and regulation of ship recycling activities in the region are managed by a dedicated wing of the Gujarat Maritime Board, which plays a key role in ensuring compliance and monitoring. Currently, Alang has around 132 registered ship recycling yards, of which 120 have been certified under the Hong Kong Convention (HKC), giving India a strong and competitive position in the global market. India has adopted a clear and strategic approach to developing this sector, and as a result, it now holds the second-largest share of the global ship recycling industry. With continued progress and investment, India is well-positioned to claim the top spot in the near future.

2.3 Pakistan. In Pakistan, the primary ship recycling facilities are located in Gaddani, near Karachi. These yards operate under the jurisdiction of the Baluchistan Development Authority, which oversees the area. The beaching method is predominantly used to position and dismantle obsolete vessels that arrive at Gaddani. The yards at Gaddani have the capacity to dismantle over 50 large ships simultaneously. However, the facilities remain relatively underdeveloped, relying on a combination of manual labor and basic mechanical tools for their operations. Oversight of downstream industries—which handle the collection, resale, or recycling of waste and used items from dismantled ships—is minimal, leading to concerns about safety and environmental impact. Despite these challenges, the Pakistani government has recently taken notable steps to improve the sector. With support from various agencies, new ship recycling regulations have been introduced to ensure safer and more environmentally sound dismantling practices. Backed by a substantial budget, these reforms are expected to lead to significant improvements in Pakistan’s ship recycling capabilities. Currently, Pakistan is holds the third-largest share in the global ship recycling market and is positioned to achieve a more viable and sustainable recycling process in the near future.

2.4 China. China's capacity to recycle ships has increased. Alongside the Pearl and Yangtse river deltas, in the provinces of Jiangmen and Jiangsu, are Chinese ship recycling yards. More than fifty ship recycling yards have been established in these provinces. A small number of inland recycling yards are only used by inland vessels. In China, beaching is prohibited, and ship recycling is done in conjunction with the slipway approach. Using a concrete support foundation and vertical lift off, this approach disassembles. Additionally, the procedure is managed from the ship to the landfill. The government of China regulates recycling yards in a relatively strict manner, and local authorities may also closely monitor them[26, 54, 57, 64]. Facilities for treating asbestos and ballast water were established in such yards. The four foundations of China's innovative ship recycling sector are tough laws and regulations that created a cooperative working model among stakeholders, advanced dismantling facilities, and a recycling strategy based on a forward-thinking vision[26, 51, 54, 57].After visiting the yards in Shanghai and Guangzhou, Lloyd's Register concluded that the safety, welfare, and environmental consciousness were first-rate. Despite having a limited global market share, China takes pleasure in being a member of the International Ship Recycling Association (ISRA).

2.5 Türkiye. The ship recycling industry in Turkey was first developed in the provinces of Aliaga and Itmir. In 1986, ship recycling was recognized as a legitimate industrial operation, and the business

gained notoriety. On the west coast of Turkey, at Aliaga, close to Izmir, the government has now permitted ship recycling. Because the Mediterranean has a fairly narrow range of tides, the Turkish yards at Aliaga are regulating the intertidal zone by utilizing a slipway technique. Large sections of the yards now have permanent hard standing, and permanent drainage systems have been installed to reduce sea pollution [8, 14, 54, 58, 64].The relevant government authorities have taken strict measures to ensure occupational and environmental safety. After visiting every yard in Turkey, Lloyd's Register expressed satisfaction with their operations. They are engaging in small-scale ship recycling.

2.6 America. The U.S. Maritime Administration (MARAD) and the U.S. Environmental Protection Agency closely monitor ship recycling facilities in American yards. Among the operational recycling yards in the United States are Marine Metals Inc. and Bay Bridge Enterprises in Maryland, and All Star Metals and Esco Marine Inc. in Texas [43, 54, 51, 57]. In the United States, ship recycling yards operate under extremely strict guidelines. They recycle activates using the dry docking process. In comparison to recycling yards in South Asia, the cost of recycling there is extremely high in order to recover material and other valuable products. They are doing very small ship recycling activities.

3. Literature Review and Methodology

3.1 Evolution and Global Dynamics of Ship Recycling

In the post-industrial era, ship recycling has emerged as a critical global industry, fueled by increasing demand for raw materials and the need for economically viable disposal of end-of-life (EOL) vessels. Over the past two decades, the industry has become highly concentrated in five countries—Bangladesh, India, Pakistan, China, and Turkey—with nearly 90% of global EOL vessels processed in South Asia alone [1, 4, 5, 51]. This regional dominance is largely driven by favorable geographic conditions, low labor costs, and limited environmental oversight [7, 26, 56].In contrast to the prevailing practices in South Asia, Turkey and China have adopted slipway-based and dry-dock recycling methods. Though more expensive, these approaches offer significantly improved worker safety and environmental protection, reflecting a broader transition toward compliance-based ship recycling models [21, 58]. The European Union's Ship Recycling Regulation (EU SRR) exemplifies this shift, mandating that EU-flagged vessels be dismantled only in facilities listed on the European List, thereby prohibiting the use of beaching techniques [10, 49].Despite growing regulatory efforts, traditional beaching remains the predominant method in South Asia, especially in Bangladesh, which accounted for the largest share of scrapped vessels in 2023, according to data from NGO ship recycling [54, 58]. In this method, vessels are run aground at high tide and dismantled manually—a process that, while cost-effective, results in the direct release of hazardous substances such as oils, heavy metals, and asbestos into the intertidal environment [28, 29, 57]. Although international frameworks like the EU SRR and the International Maritime Organization's Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships seek to standardize and certify ship recycling practices globally, most facilities in South Asia have yet to meet these compliance standards [55, 69, 70]. As the industry evolves, bridging the gap between cost-efficiency and environmental sustainability remains a pressing challenge.

3.2 Historical Development of Global and Local Ship Recycling

According to the International Maritime Organization (IMO), ship recycling encompasses all related operations, including mooring or beaching, dismantling, material recovery, and reprocessing, as defined in IMO Resolution A.951 [69]. Often referred to as ship dismantling, this process is inherently sustainable, offering global environmental and economic benefits through the reuse of valuable

materials. Historically, until the 1960s, ship recycling activities were primarily conducted in industrialized nations such as the United States, the United Kingdom, and Germany [2, 5]. However, during the 1960s and 1970s, the industry gradually shifted to semi-industrialized countries including Spain, Turkey, and Taiwan, driven by the availability of inexpensive labor and the growth of re-rolling steel markets. By the early 1980s, the sector experienced another significant shift as shipowners increasingly opted to dismantle end-of-life (EOL) vessels in developing countries such as India, China, Pakistan, Bangladesh, the Philippines, and Vietnam. This relocation was largely motivated by the desire to reduce operational costs by capitalizing on minimal safety, health, and environmental (SHE) regulations and an abundant supply of low-wage labor [9, 17, 51].In Bangladesh, the ship recycling industry began in 1965 with the dismantling of the Greek vessel *M D Alpine*, followed by the Pakistani ship *Al Abbas* in 1974 [4, 5, 54]. These initial cases demonstrated the geographical suitability of Chattogram's coastal region, particularly its gently sloping beaches and tidal characteristics, which facilitated the manual beaching and dismantling of large vessels. This attracted growing interest from local entrepreneurs, eventually transforming the area into a major hub for ship recycling.Today, Bangladesh's ship recycling sector has evolved into a vital component of the national economy, with a 20-kilometer-long industrial corridor along the Chattogram coast dedicated to dismantling activities [7, 8, 11]. Approximately 40 operational yards are currently active in the region, each exhibiting varying levels of regulatory compliance and adherence to international standards [13].

3.3 Economic Contributions and Socio-Industrial Linkages

Bangladesh's ship recycling industry contributes over USD 1 billion annually to the national economy and supplies more than 60% of raw materials for local shipbuilding and steel rerolling mills 3, 52]. It supports the country's infrastructure boom by supplying essential construction materials for megaprojects like the Padma Bridge, Metro Rail, and Rooppur Nuclear Power Plant [51, 56]. Furthermore, it creates extensive forward and backward linkages across informal industrial networks, integrating recyclables into various downstream industries [16, 22]. Ship recycling is a major contributor to Bangladesh's economy. The sector has grown at an average of ~14% per year, with a current annual turnover on the order of US$1 billion [21, 39]. It provides raw materials and jobs that support the broader manufacturing economy. For example, more than half of Bangladesh's steel comes from recycled ships: over 60% of the raw materials for local shipbuilding and steel mills are scrap-steel recovered on Chattogram's beaches [43, 57]. The industry directly employs on the order of 200,000 workers and indirectly supports roughly a million more livelihoods in Chattogram and beyond [49, 58]. The study by Hossain revealed that government revenues are also significant: Bangladesh's customs records show that ~250–270 scrap vessels per year generated on the order of Tk 8 billion (~US$75 million) in import duties in 2016–2019. In addition, ship recyclers pay income and value-added taxes (roughly Tk 5 billion per year) and various fees to the Ministry of Industries, making recycling one of the country's most important formal industrial sectors [22, 58]. This economic base is supported by booming domestic steel demand (driven by megaprojects like the Padma Bridge and industrial growth) that channels more ship-derived scrap into construction.

3.4 Future Outlook and Forecasting

Recent studies forecast sustained demand for ship recycling due to aging global fleets, economic uncertainties, and evolving environmental regulations. UNCTAD (2023) and NGO Ship recycling Platform (2024) confirm Bangladesh's leadership in ship dismantling by tonnage, accounting for over 50% of global recycled tonnage in 2021 [64, 64, 77]. However, market volatility, dollar crises, and L/C

issues have constrained imports of EOL vessels since 2022 49, 59]. Using regression-based forecasting, estimates suggest a continued rise in domestic demand for recycled steel and machinery through 2030 [17, 43, 57].

3.5 Labor and Social Conditions

The ship recycling industry in Bangladesh is a major economic sector, directly employing 20,000–40,000 workers and supporting over a million more in related industries such as steel and equipment trading [73, 74]. Most workers migrate from rural areas and face poor living and working conditions. Historically, the sector was criticized for exploitative practices, including low wages, lack of contracts, and hazardous work environments [80, 81]. Workers were often exposed to toxic substances without proper training or equipment, leading to chronic illnesses and a life expectancy 20 years below the national average. Child labor, once affecting 13–20% of the workforce [43, 77, 80], has been nearly eliminated through enforcement of legal measures like the 2009 High Court directive and 2011 Ship recycling Rules [81]. The 2018 Bangladesh Ship Recycling Act and the 2023 ratification of the Hong Kong Convention have improved safety regulations. NGOs such as YPSA have trained over 5,000 workers in handling hazardous materials and emergency procedures [54, 60, 70].

3.6 Technological Modernization and Capacity

Technological capacity in Bangladesh's yards remains rudimentary. Most operations rely on manual cutting with blowtorches and simple winches, with no dredged approach channels or hard-standing platforms. Only 13 yards (like PHP, SN Corporation, Kabir Steel, KR Shipyard, etc.) have invested in shore-based facilities to secure "green" compliance (including TSDFs and basic pollution controls) [22, 58]. Another dozen of yards are upgrading their standard as per the guidence and requirement of HKC. Moving toward HKC standards will require major upgrades: dredged slipways (to pull ships onto paved ground), enclosed waste-storage areas, and mechanized lifting equipment to avoid dangerous breakups at high tide. Regional peers like India and Turkey already operate such facilities, having paved parts of their beaches and installed drainage/waste systems. By contrast, most Bangladeshi yards lack ready infrastructure or capital. Engineers and NGOs stress that introducing controlled slipway methods or even semi-automated cutting (as used in China's Jiangmen yards) could greatly reduce environmental spillage and accident risk, but the high upfront costs and need for skilled labor are barriers [57, 77, 81]. Some research calls for incremental steps: improving pre-beaching ship preparation (e.g. mandatory cleaning of oil tanks), better waste segregation on-site, and worker training programs [78-81]. However, comprehensive engineering studies of yard redesign are scarce.

3.7 Research Gap

The ship recycling industry in Bangladesh is a crucial contributor to the national economy, supplying over 80% of the country's steel and supporting millions of jobs [58, 73, 78]. Unlike developed countries that follow stringent reuse regulations, Bangladesh reuses up to 98% of dismantled ship materials, offering substantial economic and environmental benefits. However, critical research gaps remain that hinder comprehensive policy development and international recognition. A major gap lies in the lack of comparative studies on material reuse rates and environmental performance between Bangladesh and developed countries. While European Union nations follow strict recycling protocols under the EU Ship Recycling Regulation, Bangladesh's approach emphasizes high reuse, including resale of materials like asbestos, sometimes without proper handling [79-81]. Quantitative research is needed to assess reuse efficiency and safety trade-offs, especially as Bangladesh strives to improve sustainability without compromising economic viability.

Another underexplored area is the environmental benefit of recycling steel and materials locally, which reduces the need for virgin resources and associated emissions [21, 43, 58, 77]. Despite these advantages, little research quantifies these impacts or compares them with practices in developed nations. Bangladesh's upcoming graduation from LDC status in 2026 will intensify scrutiny on labor and environmental compliance, requiring infrastructure investment exceeding BDT 12 billion or 100 million USD [57, 77, 78]. Yet, there is limited research on how this transition will affect industry competitiveness and regulatory adaptation. Moreover, while legal frameworks such as the 2018 Ship Recycling Act exist, gaps in enforcement—e.g., lack of Waste Treatment Storage and Disposal Facilities—remain unaddressed [57, 77, 80, 81]. Research evaluating regulatory effectiveness and social impacts—such as job creation versus worker health risks—is essential. Filling these gaps is vital for positioning Bangladesh as a global leader in sustainable ship recycling amid its transition to a developing nation.

3.8 Research Questions:

a. How can Bangladesh maximize the industry's economic benefits while minimizing health and environmental harms?
b. What investment strategies are most cost-effective for yards to meet HKC/EU standards? \
c. How will global regulatory changes (HKC enforcement, EU SRR, shifting flag regimes) alter international ship flows and Bangladesh's market share? Modeling studies could project future scrap availability under various compliance scenarios.
d. What barriers (institutional, financial, knowledge) keep yard owners from adopting safer practices?
e. What is the feasibility and impact of partial-mechanization or alternate recycling methods (e.g. mobile platforms) in the Bangladesh context?
f. How does ship recycling affect local communities (e.g. fishing villages, small-scale fishers)?

Addressing these questions requires interdisciplinary study – combining environmental science, public health, economics, and engineering – to guide Bangladesh toward a more sustainable ship recycling industry.

4. Methodology

4.1 Basic Methodology

This study adopts a mixed-methods research design to investigate the ship recycling industry in Bangladesh, integrating qualitative, quantitative, and policy analysis tools. The methodology combines secondary data collection, historical and regulatory review, focus group discussions, quantitative forecasting, comparative benchmarking, and expert validation. This multi-pronged approach is intended to provide a comprehensive understanding of the sector's economic, environmental, regulatory, and social dimensions. The data, analysis and findings of this study reveal a nuanced yet critical trajectory for Bangladesh's ship recycling industry as it navigates the post-Hong Kong Convention (HKC) enforcement era. Drawing on both on ground data, primary data from over 500 different stakeholders, long experience/relation of researcher (last 20 years) with this industry and secondary data analysis from global ship scrapping records (2014–2024), the study triangulates industry readiness, competitiveness, and future opportunities. This study will take out the key implications across four major thematic areas: institutional readiness, labor and environmental conditions, market competitiveness, and policy alignment with global norms.

4.2 Methodology for Data Collection and Calculation of Reusable and Waste Material

In this research work author has taken an effort to depict the actual distribution channel of reusable and waste material produced from local industry of Bangladesh by analyzing on ground data [9 and 22]; which has collected by physical involvement of the author in a period of seven years (2011 to 2017). Data of the ship recycling activity were collected from actual ship recycling industry located in Chittagong and provided by the different stake holders as well as Bangladesh Ship Breakers Association (BSBA). The inventory of reusable and hazardous wastes materials from recycled ships was derived and compiled on the basis of collected data by author. Results have based on original on ground data and take considerable help/guideline from the methodology followed in available literature and research paper. Primary and basic data about output of material/component and hazardous material of different types of recycled ships has collected from the industry by physical involvement of the author [13]. However, nuclear waste and other releases, such as emissions to atmospheric pollutants and diffuse emissions of pollutants to the water [22 and 27], were not included in the scope of this research work. Total 26 in number of different types/category as well as sizes of recycled ships has been considered as sample to calculate the average annual amount of reusable materials output. For this research work, 5 bulk ships, 5 tanker, 6 container carrier, 5 cargo ships and 5 other different types of ships has been selected. For a single ship, it takes six to eleven month to complete an inventory of different materials and item output from the obsolete ship by involving long times with the sector. The fact and figure of those 26 sample EOL ships have been shown in table 1 below. This is the first time in Bangladesh such broad data sampling analysis has been taken place.

Table 1: Summarize fact and figure of 26 sample EOL ships.

Sl No	Ship Category/ Type	Sample Ships No	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, Floating Restaurant, etc)	5	5625 to 25997	1966 to 1981

4.3 Secondary Data Collection

The research begins with the collection of secondary data from diverse sources to establish the foundational context. Data were gathered from:

a. Government and institutional reports (e.g., Ministry of Industries, BSRB, DoE)
b. International organizations (IMO, UNCTAD, NGO Ship-breaking Platform)
c. Academic journal articles, books, and policy briefs
d. Industry and yard-level records where available (e.g., tonnage, vessel numbers, steel output)
e. Media reports and grey literature
f. Practical involvement and filed work since last 20 years

Statistical data on ship-breaking volumes, employment figures, scrap steel production, accident rates, and environmental violations were collated to analyze industry trends and compliance issues over the past two decades.

4.3.1Author's Position/Involvement and Field Access: The lead researcher of this study is a naval architect by profession, with over years of field and executive-level experience in shipbuilding and ship recycling, including serving as Managing Director and General Manager of several shipyards in Bangladesh. His professional affiliations and leadership roles have enabled direct access to ship recycling yards, regulatory agencies, workers' unions, and international collaborators. This unique positional/acceptance allowed him for extensive primary data collection across managerial, technical, and labor domains—access that is typically unavailable to purely academic researchers. His dual role as both an industry practitioner and academician with a PhD further contributed to triangulating qualitative insights with technical and economic data, enriching the validity and contextual sensitivity of the analysis.

4.3.2 Historical and Policy Analysis

A **historical-institutional analysis** was conducted to trace the evolution of ship recycling in Bangladesh, focusing on key milestones (e.g., inception in the 1960s, legal recognition in 2006, Ship Recycling Act 2018, HKC ratification in 2023). Relevant policy documents, legal frameworks, and international conventions (HKC, EU SRR, Basel Convention) were reviewed to assess Bangladesh's alignment with global norms. This analysis evaluates not only the policy intent but also the implementation gap—identifying how laws and regulations are enforced on the ground, and where compliance challenges persist. Comparative references to India, Pakistan, Turkey, and China were incorporated to understand global trajectories in regulatory modernization.

4.3.3 Focus Group Discussions (FGDs)

To incorporate **stakeholder perspectives**, a series of focus group discussions (FGDs) were planned and will be conducted with:

a. Shipyard workers (both skilled and unskilled)
b. Yard owners and managers
c. Government officials (e.g., Department of Environment, BSRB)
d. NGO representatives (e.g., YPSA, Shipbreaking Platform)
e. Local and international expertise, Yard Owners and executives
f. Environmental and labor rights activists

Each FGD will involve 6–10 participants, guided by a semi-structured questionnaire. Themes include perceptions of workplace safety, barriers to compliance, social livelihood implications, and views on modernization needs. FGDs aim to capture community-level insights that are often underrepresented in macro-level policy analysis.

4.3.4 Quantitative Market Projection

To forecast the future demand and supply of ship recycling in Bangladesh, quantitative modeling techniques will be used. These may include:

a. Time series forecasting based on historical vessel import data
b. Regression analysis to estimate relationships between ship-breaking capacity, domestic steel demand, global EOL vessel availability, and regulatory variables
c. Scenario analysis to project market shifts under various policy conditions (e.g., strict HKC enforcement, EU SRR exclusion, domestic infrastructure upgrades)

These projections aim to assess whether Bangladesh's capacity can meet anticipated global scrapping volumes, especially under shifting compliance norms.

4. 3.5 Comparative Bench marking Analysis

To evaluate Bangladesh's position relative to other major ship recycling nations, a comparative benchmarking approach will be employed. The study will develop an *index-based framework* with key performance indicators (KPIs), such as:

a. Volume of ships dismantled annually (GRT/LDT)
b. Degree of compliance with HKC/EU SRR
c. Average labor safety indicators (accident rate, PPE use)
d. Infrastructure modernization (e.g., paved yards, slipways, TSDF presence)
e. Economic indicators (scrap value recovered, employment per yard, tax contribution)

Countries included for benchmarking will be India, Pakistan, Turkey, and China. This will help identify best practices and strategic gaps in Bangladesh's readiness for green and globally competitive ship recycling.

4.3.6 Validation through Expert Review

To enhance the validity and credibility of the findings, the study incorporates an expert validation process. Draft findings and interpretations will be reviewed by a panel of:

a. Maritime economists
b. Naval architects and engineers
c. Environmental scientists
d. Policy-makers from the Ministry of Industries and Department of Environment
e. Representatives from the IMO or classification societies.

This review process ensures that the study's recommendations are technically sound, policy-relevant, and grounded in operational realities. Feedback from the expert review will be integrated into the final analysis and conclusion.

5. Reusable Material Output from Local Recycling Yards

Ship recycling yields an extensive range of reusable materials, often comprising hundreds to thousands of distinct items per vessel. In this study, the author undertook the challenging task of preparing a comprehensive inventory of materials and components from 26 end-of-life (EOL) ships. Given the restrictive nature of the industry and the scale of data involved, the process required sustained effort over a period of seven years. To facilitate this data-intensive undertaking, the researcher assembled a dedicated team consisting of six data entry personnel and two supervisory managers. The reusable materials extracted from the selected sample of ships were categorized into four main groups in accordance with the guidelines set forth in the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships (HKC, 2009) [23, 25]. This categorization was further refined using principles of ship design and construction, drawing on the researcher's professional expertise as a naval architect. The classification scheme was also informed by existing academic and technical literature [1, 2, 3, 5–8, 12, 21, 22, 29]. Data collection was conducted through manual tallies and digital entry using Microsoft Excel spreadsheets. The categories of reusable materials identified from EOL ships are as follows:

- **Metal Items**: Includes heavy and light steel plates, brass, copper, MS pipes, nickel, galvanized iron, stainless steel sheets, aluminum, zinc, chains, anchors, shaft plates, cast iron, and various ferrous and

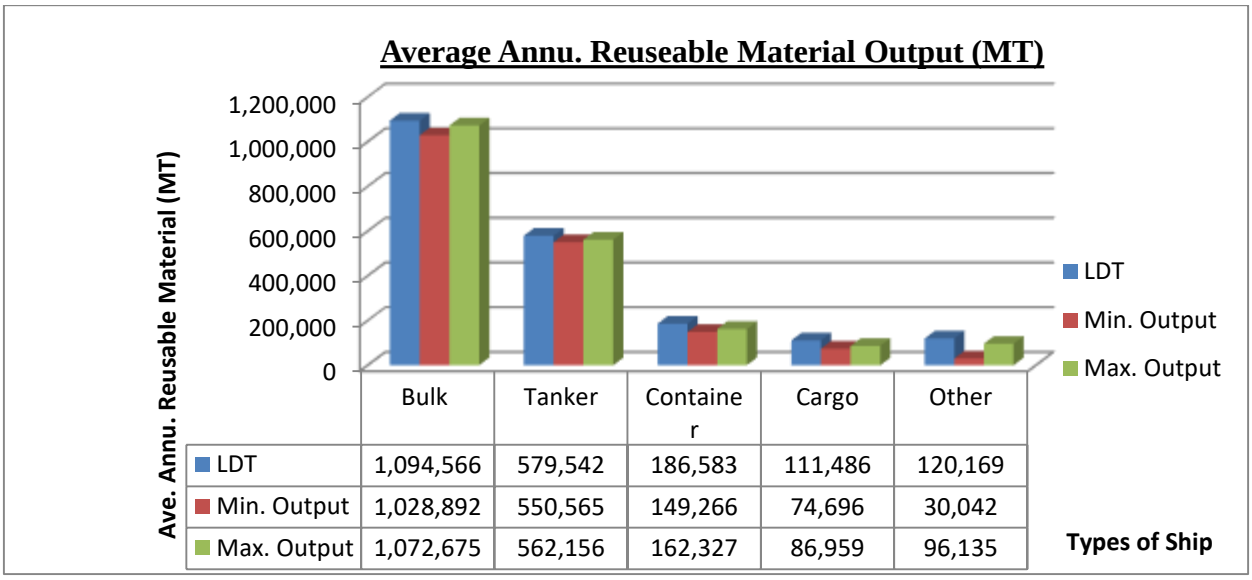
non-ferrous scraps.

- **Machinery, Equipment, and Accessories**: Comprises main engines, generators, gearboxes, propellers, rudders, pumps, condensers, radiators, heat exchangers, air conditioning units, fire safety equipment, lifeboats, kitchen accessories, and personal protective equipment.
- **Electrical and Electronic Items**: Encompasses electrical cables, transformers, motors, navigation and communication systems (e.g., radar, GPS), televisions, washing machines, computer equipment, and assorted electrical tools and spare parts.
- **Outfit and Other Reusable Components**: Includes doors, hatches, port windows, cranes, winches, capstans, valves for various fluid systems, ladders, furniture, and sanitary fittings.

Based on the compiled dataset, the study estimates that the annual output of reusable materials from the ship recycling sector in Bangladesh ranged between *1,833,461 metric tonnes (MT) and 1,989,252 MT* in the year 2018. Material quantification and flow analysis were performed using a combination of manual calculations and software tools, including Microsoft Excel and the Material Flow Analysis (MFA) software STAN [21, 22, 28, 29, 31]. Comparative analysis revealed that manual calculations deviated by a maximum of 0.4% from STAN-generated results, while results obtained via Excel showed no observable variation [26, 27, 30]. *Table 2 presents the average output of reusable materials (in MT per year) for different ship types, while Figure 1* illustrates the relationship between Light Displacement Tonnage (LDT) and reusable material output across ship categories. The detailed compilation, data visualization, and result interpretation for the 26 sampled ships were performed using advanced Excel programming and broadsheet models [31, 57]. Furthermore, *Figure 3* provides a model of the material distribution channel—including both reusable materials and waste—for a typical container ship processed at a local ship recycling yard in Bangladesh [32].

Sl. No	Type of Ship	Average LDT 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
6	Total	2,092,346		Min.	1,833,461
				Max.	1,980,252

Table 2: Reusable material factor and amount of materials output per year in MT in 2018 [22].



	Bulk	Tanker	Container	Cargo	Other
LDT	1,094,566	579,542	186,583	111,486	120,169
Min. Output	1,028,892	550,565	149,266	74,696	30,042
Max. Output	1,072,675	562,156	162,327	86,959	96,135

Figure 1: Average annual LDT against average annual reusable material output in MT [21]

6. Waste Output from Local Recycling yards

According to the *Bangladesh Environment Conservation Act, 1995*, hazardous waste is defined as any substance which, by its inherent physical, chemical, reactive, toxic, flammable, or corrosive properties—either alone or in combination with other substances—poses a threat to human health or the environment. These wastes are broadly categorized into two types: (i) organic hazardous materials such as polymers, which can potentially be chemically treated or incinerated; and (ii) inorganic materials such as heavy metals and asbestos, which typically require containment or specialized disposal. In this study, the researcher classified hazardous wastes generated from ship recycling yards in Bangladesh into six distinct categories. The classification was informed by the guidelines of the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships (HKC, 2009) [23, 25], naval architectural principles, and insights from relevant literature [1, 2, 5–8, 12, 13, 21, 22, 57]. This categorization facilitated efficient data compilation, weight estimation, and waste management planning. The groups are defined as follows:

- **Group A – Asbestos and Asbestos-Containing Waste**: Includes asbestos insulation, glass wool, ceramic wool, damping materials, and other insulation-related substances.
- **Group B – Landfill Waste**: Includes cementitious residues, ceramic dust, iron rust and scale, ash (including incinerator ash), cathode ray tube glass particles, zinc residues, and other solid wastes suitable for landfill.
- **Group C – Incinerable Waste**: Consists of paint residues, coatings, pharmaceuticals, PVC, PCBs, PCTs, PBBs, polybrominated analogues, oil sludge, plastic, textiles, polyurethane foams (PUF), welding fumes, and other combustible or chemically treatable substances.
- **Group D – Bilge and Liquid Waste**: Comprises bilge water, fuel and lubricating oils, organic solvents (halogenated and non-halogenated), hydraulic oils, volatile organic compounds, outdated chemicals, microbial sediments, and pesticide/insecticide residues.
- **Group E – Heavy Metal Waste**: Includes toxic metals such as lead, mercury, and cadmium, commonly found in batteries, anodes, electrical fittings, thermometers, soldering equipment, motor components, cable insulations, and communication devices.

- **Group F – Ozone-Depleting and Explosive Substances**: Contains compressed gas cylinders, fire suppression liquids, and materials with ozone-depleting potential, such as CFCs, halon, and Aqueous Film Forming Foam (AFFF).

For the quantification of waste output and determination of associated factors, a combination of manual calculation and digital tools was employed. Microsoft Excel and the Material Flow Analysis (MFA) software STAN were used to compute and cross-verify results [21, 28, 29]. It was observed that results from manual computation varied by no more than 0.4% compared to those generated by STAN, while outputs from Microsoft Excel showed full consistency with manual estimates [22, 26, 30]. *Figure 2* illustrates the average annual quantity of hazardous waste (in metric tonnes) generated from different categories and sizes of EOL ships recycled in Bangladesh. *Table 3* presents detailed annual data (both minimum and maximum values) for each waste category, derived from the sample of 26 obsolete vessels dismantled in 2018. All data in this study were collected, compiled, and analyzed by the author over a seven-year period through direct field engagement with the ship recycling industry. Data processing and graphical analysis were conducted using structured Microsoft Excel broadsheets and custom programming modules [30, 31].

Sl. No	Type of Ship	Average LDT per year (MT)	Total Waste (Land-filled, Incinerated, and Bilge Waste)							
			Average Land-filled Waste Per Year (MT)		Average Incinerated Waste Per Year (MT)		Average Bilge Waste Per Year (MT)		Total Average Hazardous Waste Per Year (MT)	
1	Bulk	1,094,566	3042	Min.	2,188	Min.	2360	Min.	7590	Min.
			4078	Max.	2,861	Max.	3073	Max.	10012	Max.
2	Tanker	579,542	2244	Min.	1,357	Min.	2087	Min.	5688	Min.
			3030	Max.	1,854	Max.	2852	Max.	7736	Max.
3	Container	186,583	718	Min.	524	Min.	374	Min.	1616	Min.
			808	Max.	574	Max.	410	Max.	1792	Max.
4	Cargo	111,486	582	Min.	260	Min.	208	Min.	1050	Min.
			648	Max.	290	Max.	232	Max.	1170	Max.
5	Other	120,169	580	Min.	299	Min.	400	Min.	1279	Min.
			849	Max.	562	Max.	583	Max.	1994	Max.
Total		2,092,346	7166	Min.	4,628	Min.	5429	Min.	17223	Min.
			9413	Max.	6,141	Max.	7150	Max.	22704	Max.

Table 3: Annual average amount waste produced in MT from different EOL ships [20, 54]

7. Disposal and Management of Waste

Extensive field investigations and repeated visits to ship recycling yards in Bangladesh have revealed that approximately 97% of glass wool and other insulation materials recovered from end-of-life (EOL) ships are recycled and re-enter the market through local contractors. These materials are resold as

insulation products to various sectors, including shipbuilding and repair, construction, small-scale industries, and cold storage facilities. Only an estimated 3% of such insulation waste is directed to Treatment, Storage, and Disposal Facilities (TSDF), primarily when the materials are damaged or contaminated beyond reuse. This high recovery rate is attributed to the generally intact condition of insulation materials upon removal and their consistent demand in the domestic market. For instance, in Bangladesh, second-hand glass wool insulation fetches an average price of USD 110 per metric tonne, while in neighboring India the average price is approximately USD 100 per metric tonne [13, 19, 20, 22]. These figures underscore the economic viability of insulation material recovery in South Asia's ship recycling industry. Interestingly, other forms of ship-borne waste—including bilge water, sludge, spent chemicals, solvents, and even damaged furniture—are frequently sold to local entities. These substances are often repurposed for use in brick kilns, informal housing construction, or small-scale industrial processes. The informal reuse of these materials, while economically beneficial, raises questions about safe handling practices and potential environmental risks. The removal of insulation, flooring, and tiling—sub-processes commonly performed during pre-cutting—may result in minimal environmental release, especially when the recovered materials are in good condition and removed using low-impact techniques. For example, in India, intact insulation panels are directly purchased by resellers to serve the insulation needs of cold storage operators and similar industries [14, 19, 21]. Furthermore, there exists a robust secondary processing ecosystem surrounding the ship recycling yards in Bangladesh. A wide array of firms specializes in refurbishing and reintroducing salvaged materials—including machinery, furniture, electrical components, and metals—back into industrial use [5, 11, 20, 22]. The diverse and dynamic material flows generated through the ship recycling process highlight a complex circular economy network that is shaped by market demand, material condition, and the recycling methods employed.

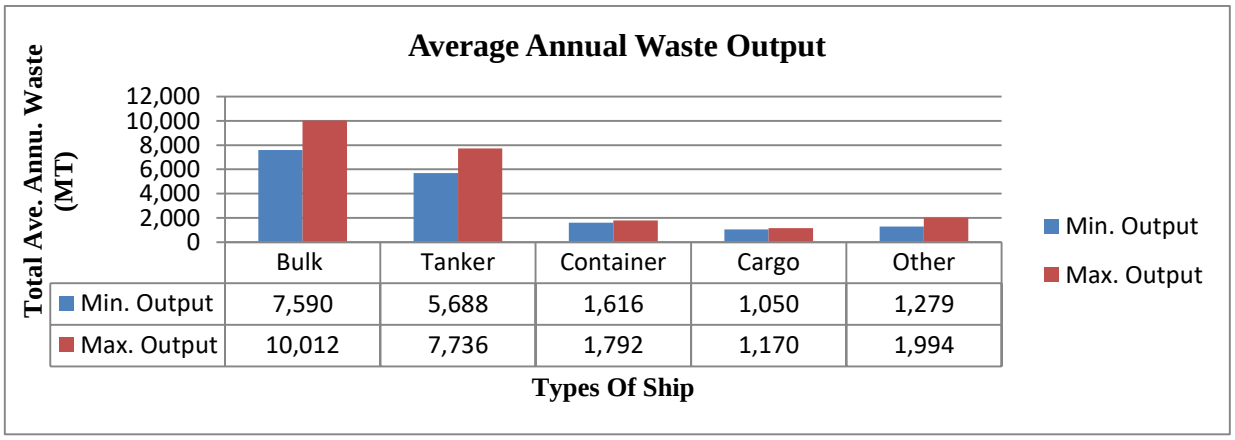


Figure 2: Total average annual HazMat or Waste produced in MT [22, 58]

Material Flow Analysis (MFA) serves as a valuable analytical tool for visualizing, planning, and comparing various scenarios related to the recycling of end-of-life (EOL) ships. It enables stakeholders to trace the movement of materials throughout the recycling process, identify critical points of reuse or disposal, and optimize the distribution of recovered substances and components. A comparative analysis of second-hand markets in two major ship recycling hubs—Alang (India) and Chattogram (Bangladesh)—highlights significant economic activity around the resale of materials recovered from dismantled vessels. For instance, in Alang, legally traded items include electrical cables (USD 1–2 per

kg), electric motors (USD 1 per kg), glass wool insulation sheets (USD 0.02 per kg), sludge (USD 0.02 per kg), waste oil (USD 8–15 per barrel), and scrap machinery (USD 1 per kg) [59].In comparison, the second-hand market in Chattogram reflects slightly higher prices across most categories: electrical cables (USD 1.2–2.2 per kg), electric motors (USD 1.2 per kg), glass wool insulation sheets (USD 0.2 per kg), sludge (USD 0.2 per kg), waste oil (USD 10–16 per barrel), and scrap machinery (USD 1.2 per kg) [18, 21]. These pricing variations are influenced by local demand dynamics, supply chains, and industrial needs, and further demonstrate the economic potential of systematically recovered ship components. A schematic model illustrating the distribution channel of reusable and waste materials from a typical recycled container ship at a local ship recycling yard in Bangladesh is provided in *Figure 3*. This model depicts the pathways through which recovered materials are sorted, processed, sold, or disposed of—offering insight into the circular economy network operating around ship recycling activities in the region.

During the research period from 2012 to 2018, the author conducted regular field visits to ship recycling yards in Chattogram, Bangladesh. These visits enabled detailed observations of operational practices and data collection methods. In the earlier stages of the research, it was evident that record-keeping and documentation regarding reusable and hazardous materials were largely informal. Reporting was primarily based on visual estimations, lacking systematic weighing, tracking, and control mechanisms. In recent years, however, the industry has undergone substantial improvement in multiple critical areas. Notable progress has been made in the handling of hazardous materials, with more structured approaches to safe storage and disposal. Practices related to work in confined spaces and at elevated heights have become more regulated and safety-conscious. Fire prevention and control measures have been introduced more widely across yards, and the use of personal protective equipment (PPE) is now enforced. Cutting and paint-removal activities are increasingly carried out on hard-standing floors to minimize environmental contamination. Worker facilities such as rest areas, recreational spaces, showers, and accommodation have been significantly upgraded, improving overall welfare conditions.

Additionally, emergency evacuation procedures and rescue protocols have been developed and implemented in many yards. There has been a marked improvement in asbestos management practices, including the proper removal, handling, and disposal of asbestos-containing materials. Hazardous waste is now better inventoried and stored, and preventive environmental measures are being implemented alongside regular awareness-building initiatives. Health and welfare planning for workers has gained attention, with more emphasis on long-term well-being and security. Importantly, many recycling yards have begun to employ naval architects and technical professionals to oversee operations, and there is growing investment in worker training and education to ensure compliance with modern technological standards and international regulatory frameworks. As a result of these advancements, thirteen local recycling yards have successfully achieved certification under the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships (HKC). Another six yards are currently undergoing the certification process and are expected to meet HKC standards within the year. It is projected that by the end of the next calendar year, more than thirty operational recycling yards in Bangladesh will be HKC-certified. Nevertheless, to sustain its top position in the global ship recycling market, Bangladesh will need to increase this number to at least forty active HKC-certified yards. Meeting this target poses a significant challenge that demands proactive engagement from both the government and industry stakeholders. Continued improvements in infrastructure, regulatory

enforcement, environmental management, and human resource development will be essential to ensuring long-term sustainability and competitiveness in the global market.

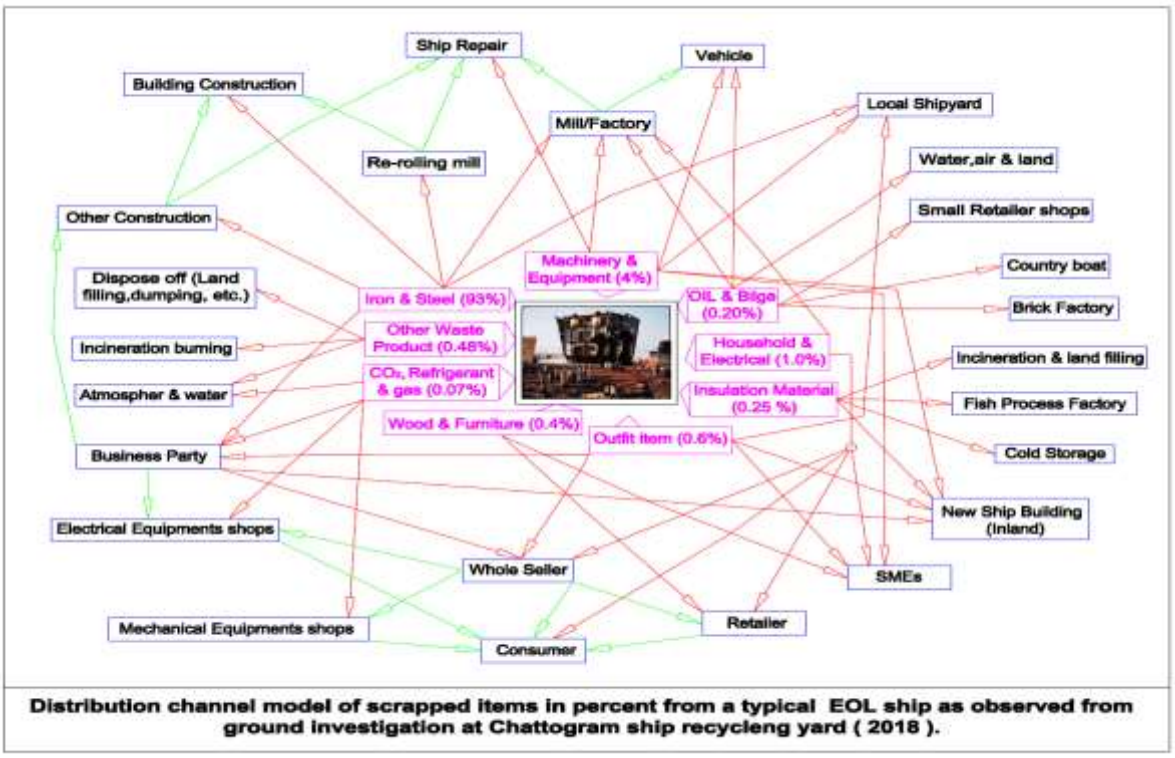


Figure 3: Distribution channel of reusable and waste material of a typical ship[32]

8. Compression of Reusable and Waste Material Factor with other Countries

A comparative analysis of key indicators—namely waste generation and material reuse factors—between Bangladesh and other prominent ship recycling nations provides valuable insight into the performance and efficiency of different ship recycling clusters. Table 4 presents the waste and reusable factors derived from a comprehensive field survey conducted at Alang Port, India. The survey covered 241 ships dismantled over a three-year period (2011–2013) and included various ship types. The analysis was based on ship weight expressed in terms of Light Displacement Tonnage (LDT) and included quantification of significant waste fractions, such as bilge water, landfillable wastes, and incinerable wastes produced throughout the recycling and disassembly process. Among the six major ship types surveyed, general cargo vessels, bulk carriers, and container ships demonstrated notable structural and operational similarities, particularly with respect to the spatial distribution of waste materials within the ship body. These ship types, commonly dismantled during the observed period at Alang, were found to have comparable waste characteristics, thereby enabling a consistent basis for estimating "emission or waste factors," which were expressed in kilograms per LDT (kg/LDT). Correspondingly, the "reusable factor," indicating the proportion of recoverable materials from EOL (End-of-Life) ships, was expressed as a percentage of total LDT. To assess performance differentials between Alang (India) and Chattogram (Bangladesh), the values of waste and reusable factors obtained through sample-based analysis have been compiled and compared in Table 5. This comparison highlights differences in operational efficiency, material recovery, and waste management practices between the two recycling clusters. Further, the relationship between average reusable material output,

waste generation, and asbestos content per LDT for ships dismantled in Bangladesh is graphically represented in Figure 4. This visualization offers a clearer understanding of trends across ship types and supports data-driven insights into the material flow and environmental impact of ship recycling activities in the region.

Sr. No.	Ship type	Total Landfilable wastes	Total incinerable wastes	Bilge water	Cumulative weight of wastes	Reusable material factor in %
		kg/LDT	kg/LDT	kg/LDT	kg/LDT	w/w %
1	General Cargo, Bulk Carrier & Container Ships	16.5-20.0	2.7-3.0	2.1-2.4	21.3-25.4	92
2	Oil & Chemical Tanker	11-16.6	2.5-3.3	4.2-4.5	17.7-24.4	94
3	Refrigerator Ship	40.0-152.0	1.7-10.0	13.8-14.8	55.5-176.8	81
4	Passenger Ship	17.6-36.6	0.8-1.2	1.3-1.47	19.7-39.2	72

Table 4: Comparison of reusable material and waste factors (in Kg per LDT) of different types of ships recycled in the ship dismantling yards in Alang Port in the State of Gujarat, India during the year 2011 to 2013 [21, 27]

Sr. No.	Ship type	Cumulative weight of wastes (for India)	Reusable material factor in %(for India)	Cumulative weight of wastes(for BD)	Reusable material factor in %(for BD)
		kg/LDT	w/w %	kg/LDT	kg/LDT
1	General Cargo, Bulk Carrier & Container Ships	21.3-25.4	92	10.1- 13.5	93
2	Oil & Chemical Tanker	17.7-24.4	94	11.2-14.1	95
3	Refrigerator Ship	55.5-176.8	81	-	-
4	Passenger Ship	19.7-39.2	63	14.1-17.2	62

Table 5: Estimated data of waste factors and reusable factor has compared between Alang Port, India and Chittagong, Bangladesh

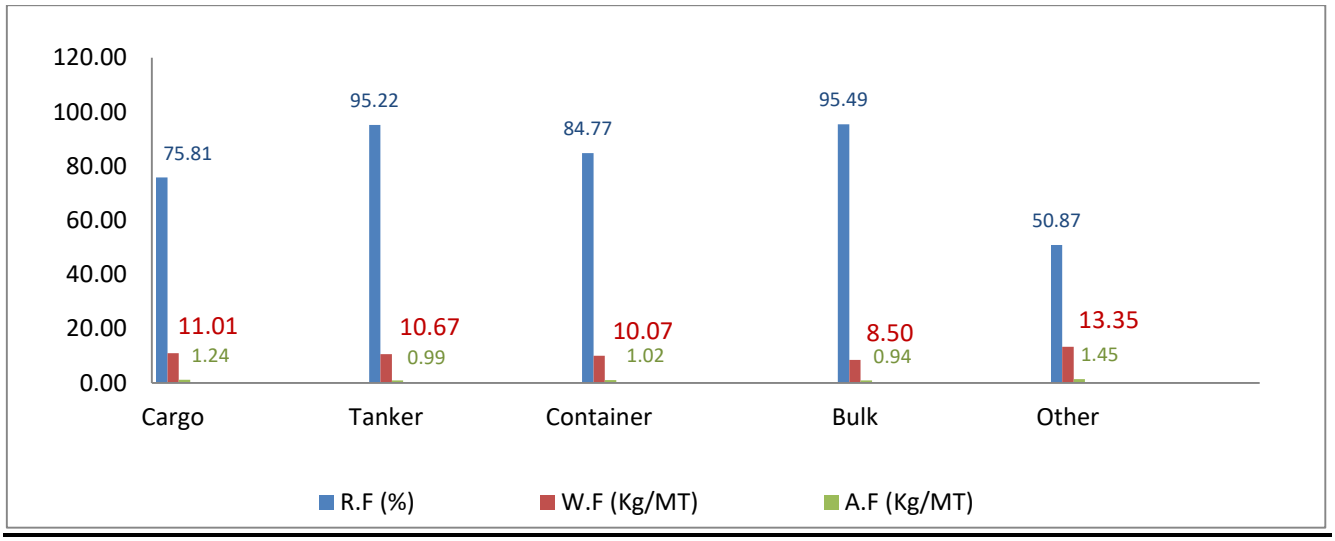


Figure 4; Relation among average reusable, waste and asbestos factor with LDT of EOL ships for Bangladesh [21, 52, 58]

9. Future Outlook for Local Ship Recycling Industry of Bangladesh

In 2024, the global ship demolition sector witnessed a significant downturn, with Bangladesh—long recognized as a leading destination for end-of-life (EOL) ship recycling—reporting its lowest volume of imported scrap ships since 2005. Industry data reveals that both the number of EOL vessels and the total gross tonnage (GT) processed have plummeted to historic lows.Traditionally, Bangladesh has consistently handled over two million GT of EOL ships annually. At its peak in 2021, the ship recycling industry centered in Chattogram dismantled approximately 8.02 million GT across several hundred vessels. According to *Review of Maritime Transport 2022* (published 29 November), in the 12 months up to January 2022, Bangladesh alone recycled 8.02 million GT, accounting for 52.4% of global totals. Of these, nearly 57% were oil tankers, 25% bulk carriers, and 9% liquefied gas carriers. In 2021, Bangladesh, alongside Pakistan, India, and Türkiye, was responsible for 96% of the world's ship recycling activities [61, 64, 74]. However, 2022 marked a significant inflection point. Imports of recyclable ships began to decline sharply, influenced initially by the Russia–Ukraine war, which disrupted global maritime logistics. Since then, additional challenges—ranging from persistent disruptions in the global shipping sector to increased demand for older vessels due to the Red Sea crisis—have further reduced the supply of ships available for demolition. Compounding these operational difficulties, demolition prices saw a steep decline throughout 2024. Rates fell from a peak of USD 600 per light displacement tonnage (LDT) in the first quarter to just USD 450/LDT by the year's end, according to GMS, a major cash buyer of demolition ships. This price drop, coupled with diminished supply, has left many South Asian ship recycling yards in a precarious state, with several opting for temporary suspension of operations. Looking ahead, a modest recovery in the recycling market is projected for 2025. However, the long-term sustainability of Bangladesh's ship recycling sector will hinge on its ability to modernize operations and align with international environmental standards.

A key milestone in this regard is the enforcement of the *Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009 (HKC-2009),* which has come into effect on 26 June 2025. Local few yards will complete their task to become HKC certified yards within June

2026. Compliance with HKC standards will be critical for maintaining access to global supply chains and securing the future of the industry. The outlook for Bangladesh's ship recycling industry through 2050 is shaped by several intersecting factors: the aging of the global fleet, evolving regulatory frameworks, technological modernization, and growing regional competition. To construct a credible forecast, this study utilizes gross tonnage data from 2014 to 2024—sourced from IHS, UNCTAD, and other relevant research—to estimate future volumes using an ARIMA-style time series model [51, 52, 61, 62, 64, 67, 69, 74, 75]. The forecasting approach assumes that, in the absence of major structural reforms, historical patterns offer the most reliable indicators of future trends. Table 6 clearly illustrates a sustained decline in ship recycling volumes since 2021, driven by global market volatility, regulatory ambiguity, geopolitical tensions, financial instability, and Bangladesh's slow adaptation to green compliance standards. This trajectory underscores the urgent need for strategic intervention and policy reform to restore the sector's competitiveness and environmental credibility.

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Year	Gross Tonnage (GT)
2014	4,420,911
2015	8,064,926
2016	9,471,199
2017	6,415,952
2018	6,749,040
2019	7,157,343
2020	6,592,203
2021	8,028,330
2022	2,533,852
2023	3,334,357
2024	2,737,746

Table 6: Historical Gross Tonnage Recycled in Bangladesh (2014–2024)

Figure 5: Global ship recycling comparison and statistics by major vessel types in 2021[22, 51]

An *ARIMA-style time series forecast* was developed using an 11-year historical dataset (2014–2024), as presented in *Table 6*. Given the pronounced downturn in ship recycling volumes following 2021, the statistical model projects a *flattened baseline of approximately 2.7 million GT per year* over the coming

decades. This projection suggests a state of stagnation, unless proactive policy interventions and strategic investments are undertaken. Table *7* presents the *projected gross tonnage (GT) of ships* expected to be recycled in Bangladesh from 2026 to 2050, based on the ARIMA forecast. However, the limitations of forecasting models that rely solely on historical data are acknowledged—particularly in a dynamic sector affected by regulatory shifts, market volatility, and global environmental trends. To address these limitations and provide a more robust analytical framework, this study introduces *three alternative future scenarios*:

- **Baseline Scenario**: Assumes a continuation of current trends, with no major policy reforms, investment surges, or external disruptions. Ship recycling volumes remain stable but unremarkable.
- **Optimistic Scenario**: Envisions a transformative policy environment, where targeted investments, adoption of green technologies, financing instruments, and full enforcement of the **Hong Kong Convention (HKC-2009)** enable Bangladesh to enhance yard compliance and competitiveness, thereby attracting a greater share of the global recycling market.
- **Pessimistic Scenario**: Reflects a deteriorating outlook in which Bangladesh fails to implement key reforms or secure necessary investments, leading to a loss of market share to regional competitors with more advanced and compliant ship recycling infrastructure.

These scenarios provide a structured lens through which policymakers, industry stakeholders, and development partners can evaluate potential pathways for Bangladesh's ship recycling industry under varying conditions of reform and global alignment.

Year	Baseline (GT)	Optimistic (GT)	Pessimistic (GT)
2026	2,750,000	3,800,000	2,000,000
2027	2,800,000	4,100,000	1,900,000
2028	2,750,000	4,300,000	1,850,000
2029	2,800,000	4,500,000	1,800,000
2030	2,800,000	4,600,000	1,800,000
2035	2,750,000	4,800,000	2,000,000
2040	2,750,000	5,000,000	2,100,000
2045	2,750,000	5,000,000	2,100,000
2050	2,750,000	5,000,000	2,100,000

Table 7: Projected future GT of ships recycled in Bangladesh in next 25 years (2026-2050)

In the baseline scenario, Bangladesh’s ship recycling activity stabilizes at approximately 2.7–2.8 million gross tons (GT) per year, yielding a cumulative total of around 70 million GT recycled over the 2026–2050 period. This trajectory assumes a continuation of current practices without significant regulatory or infrastructural shifts. The optimistic scenario envisions a strategic transformation driven by full compliance with the International Convention for the Safe and Sustainable Recycling of Ships in Hong Kong (HKC-2009).Through proactive regulatory alignment, investment in green yard upgrades, and enhanced financing mechanisms Bangladesh positions itself as a preferred destination for higher-value vessels. This includes increased inflow of ships from environmentally responsible owners, particularly in

Japan, the European Union, and other developed maritime nations. Under this scenario, annual recycling volumes rise steadily, reaching approximately 5 million GT by 2040, with cumulative volumes exceeding 100 million GT by 2050. In contrast, the pessimistic scenario reflects a deteriorating outlook in which failure to meet international environmental standards, coupled with insufficient investment and intensifying regional competition—particularly from India and Türkiye—results in a contraction of recycling volumes to below 2 million GT annually. Such an outcome would significantly erode Bangladesh's standing in the global ship recycling market and threaten the long-term viability of the industry. These scenario-based projections underscore the pivotal role of regulatory preparedness, infrastructure modernization, and international credibility in shaping Bangladesh's future in the global recycling sector. While the ARIMA-based forecast presents a flat baseline trajectory, actual outcomes will largely depend on strategic policy decisions and institutional reforms undertaken within the next five years.

Over the next decade, it is estimated that over 15,000 ships will reach end-of-life and require recycling—more than double the number recycled in the previous ten years, according to projections by BIMCO. This surge highlights the urgent need for increased capacity and regulatory alignment within the global ship recycling sector. With the implementation of the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships (HKC), realizing its full potential will require resolving the regulatory conflicts between the HKC and the Basel Convention (BC). Achieving coherence between these two international frameworks is essential to avoid legal ambiguities that may discourage compliance. To support the implementation of the HKC, the industry must significantly expand HKC-compliant recycling capacity and foster a stronger commitment among ship-owners to utilize certified yards. This behavioral shift is critical to reinforcing the economic and environmental case for sustainable ship recycling. BIMCO has been at the forefront of efforts to clarify the legal interplay between the HKC and BC. From our perspective, these conventions should not be viewed as conflicting instruments but as complementary frameworks that, together, can advance global objectives in environmental protection, worker safety, and sustainable maritime practices. The entry into force of the HKC has already prompted notable improvements in industry standards, demonstrating its potential as a transformative force within the ship recycling ecosystem. Recognizing this momentum, BIMCO established the BIMCO Ship Recycling Alliance at the end of last year. This initiative aims to support the industry's alignment with HKC principles, promote best practices, and encourage greater adoption of responsible ship recycling methods. By fostering collaboration among key stakeholders, the Alliance seeks to ensure that the coming decade's unprecedented volume of ship retirements is met with safe, environmentally sound, and economically viable recycling solutions.

As the International Convention for the Safe and Sustainable Recycling of Ships in Hong Kong (HKC) approaches its enforcement date on 26 June, it is imperative to recognize and amplify the efforts of ship recycling yards that have made significant investments in upgrading their facilities to meet international standards. These yards—committed to ensuring safe and environmentally sound recycling practices—deserve greater visibility, both in public discourse and through formal inclusion on regulatory frameworks such as the EU Ship Recycling List. With an increasing number of vessels now destined for HKC-compliant facilities, it is essential to shift the prevailing narrative: end-of-life ships should no longer be viewed merely as waste, but rather as valuable resources within a broader circular economy. When handled responsibly, ship recycling holds tremendous potential for material recovery, job creation, and environmental sustainability. However, realizing this potential requires substantial and

coordinated efforts to elevate operational standards across ship recycling yards, particularly in South and Southeast Asia, where much of the global activity is concentrated. Encouragingly, a growing number of stakeholders—including industry leaders, civil society actors, and ratifying nation states—have aligned behind the principles enshrined in the HKC. From the perspective of BIMCO, this moment marks a pivotal juncture—not just for reflection, but for decisive forward-looking action. The HKC represents a transformative opportunity to redefine the global ship recycling industry, aligning it with the imperatives of sustainable development and occupational safety. It offers a concrete path forward, away from the substandard practices that have persisted under the framework of the Basel Convention, and toward a future grounded in accountability, transparency, and best practice [72]. Now is the time to fulfill the commitments that the global maritime community has collectively endorsed. The solution is in place—and its implementation will determine whether the industry evolves toward sustainability or risks regressing into outdated and harmful practices.

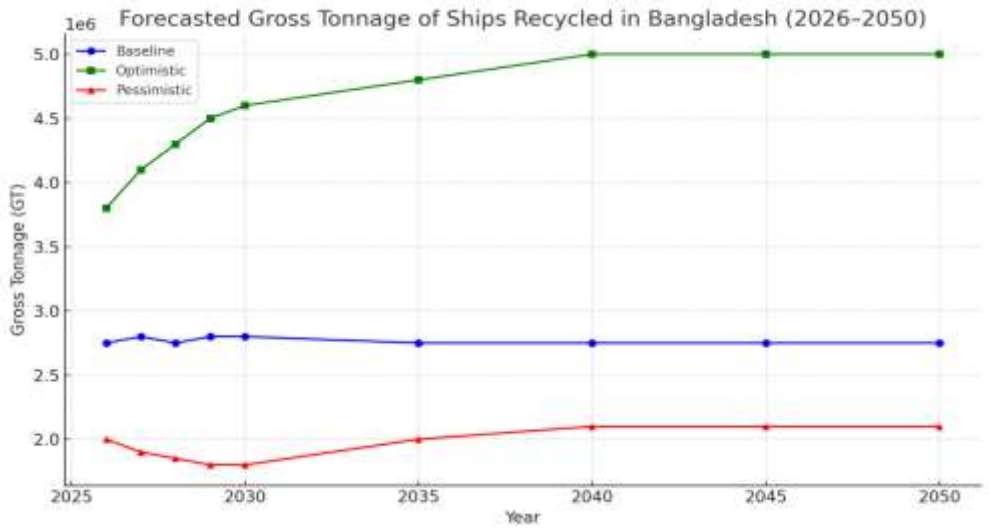

Figure 6: Forecast GT of ship recycled of ships in Bangladesh in next 25 years (2025-2050)

10. Financial Investment and International Support to Local Yards

Compared to its regional competitors, Bangladesh has received limited external investment to modernize and green its ship recycling sector. Most of the international support to date has come through the International Maritime Organization's (IMO) SENSREC initiative, a multi-year technical assistance program funded by the Government of Norway. This initiative has focused on foundational reforms such as drafting national legislation, training inspectors, and improving regulatory oversight [62]. In late 2023, Norway expanded its support by committing approximately $1.36 million in funding aimed at green yard upgrades and the development of waste treatment infrastructure. A central focus of this funding is to minimize the environmental footprint of ship-breaking operations in Bangladesh. By promoting sustainable practices and the adoption of green technologies, the initiative aims to mitigate damage to local ecosystems and contribute to broader global efforts to combat climate change. Norway's intervention reflects its broader commitment to environmental leadership and provides a potential model for other nations seeking to support sustainable industrial transitions. The funding will facilitate the implementation of advanced waste management systems, pollution control technologies, and eco-friendly operational procedures, with the goal of fostering a safer and more sustainable ship recycling

industry in Bangladesh. This targeted investment is emblematic of the growing international recognition of the environmental challenges posed by ship recycling. As one of the world's key players in this sector, Bangladesh continues to provide essential services to the maritime industry. However, sustained progress will depend on continued technical and financial support, as well as the political will to align national practices with international environmental and safety standards.

Conventional ship recycling methods in Bangladesh have long been associated with significant concerns regarding environmental degradation and worker safety. Addressing these issues, recent investments prioritize not only environmental sustainability but also the welfare and safety of workers engaged in the industry. The project includes comprehensive training programs, the implementation of advanced safety protocols, and improvements in working conditions, all aimed at fostering a safer and healthier environment for laborers contributing to this vital sector [63]. While these initiatives represent positive progress, most assessments indicate that Bangladesh requires hundreds of millions of dollars in further investment to fully modernize its ship recycling yards and comply with evolving international standards. In this context, the IMO's SENSREC project has facilitated the development of draft amendments to update Bangladesh's ship recycling and hazardous waste management legislation. These amendments aim to harmonize the national regulatory framework with global environmental and safety benchmarks. The proposed legislative updates were presented and critically reviewed during a high-level workshop held in Dhaka on 16 February 2025, which convened key stakeholders from government and the private sector. The amendments seek to align Bangladesh's ship recycling practices with the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships (HKC-2009), as well as incorporate key provisions from the Basel, Rotterdam, and Stockholm Conventions. Such alignment is essential for Bangladesh to enhance its regulatory compliance, improve environmental stewardship, and secure its position within the global ship recycling industry.

In contrast to Bangladesh's limited external investment, India's ship recycling sector has undergone substantial modernization, primarily financed through over $100 million in international donor and public funds. According to industry sources, this capital infusion has facilitated the construction and equipping of approximately 120 "green" ship recycling yards along the coast of Alang and other locations, featuring modern infrastructure such as shore cranes, concrete hard-standing areas, and waste treatment units. Anam Chowdhury, President of the Bangladesh Marine Officers Association (BMOA), highlighted this disparity in an interview with the Business Standard, stating:"With over $100 million funding from international donors, India has developed 120 green yards on the coast of Alang in Gujarat to recycle ships following the HKC. In contrast, Bangladesh has developed only five green yards in the last 10 years, which are insufficient to compete with India. This means Bangladesh is likely to lose its top position this year" [64]. This significant investment has accelerated India's certification process, enabling it to establish 120 yards compliant with the Hong Kong Convention (HKC), according to BIMCO data, and reducing its dependence on foreign subsidies for basic yard upgrades. Similarly, Pakistan has recently initiated sizable domestic investments to modernize its ship recycling industry. In June 2025, the Pakistani government approved a fund of Rs 12 billion (~$42 million) to transform the Gadani ship-breaking yards into a "model green facility." Planned improvements include the installation of modern cranes, pollution control technologies, enhanced worker infrastructure, and the development of roads, hospitals, training centers, and waste treatment plants [65]. Historically, Gadani was one of the world's foremost destinations for end-of-life vessels, known for dismantling decommissioned ships and recycling valuable materials such as steel. While Pakistan's investments remain modest by global

standards, they represent a concrete commitment to upgrading its facilities and improving environmental management. In comparison, Bangladesh continues to compete for relatively limited foreign aid and credit, whereas both India and Pakistan have successfully mobilized considerably greater financial resources to enhance their ship-breaking sectors. This disparity poses significant challenges for Bangladesh's ability to maintain its competitive position within the regional and global ship recycling markets.

11. Technological Modernization and Yard Infrastructure

In technological terms, Bangladesh's ship-breaking yards lag behind. Most Bangladeshi facilities remain traditional tidal beach sites with limited mechanization – for example, only a few yards have begun installing slipways, rails or modular cranes. A recent industry union report notes that only 13 Bangladeshi yards are HKC certified and will be 20+ soon out of few dozen remain uncertified. There will be obstacles in the way. The workforce is already changing due to mechanization, a decrease in ship numbers, and a lack of safety nets. However, the rise of local trainers and these trainings indicate a growing push to ensure that the sector shift incorporates respectable jobs, improved protections, and worker voice at all levels.[66]. And even these exceptions rely largely on private initiative rather than systematic planning. By contrast, India's coastal hubs have extensively mechanized processes: the 120+ "green yards" in Alang are equipped with shore cranes, forklifts, piped water systems and containment for hazardous waste [64]. This modernization not only improves safety and environmental performance, but also increases throughput and quality – a direct competitive advantage. On the other hand, Pakistan's Gadani yards, historically the least mechanized of the three countries, are now slated for major upgrades. The June 2025 plan for Rs12 billion in investment explicitly focuses on "modernizing infrastructure and safety mechanisms" including new equipment and waste management technology. Gadani's future hinges on this modernization: as Pakistan's maritime minister noted, Gadani "stands at a crossroads either we modernize it in line with green shipping goals or risk further decline" [65].

In summary, Bangladesh faces an uphill climb. It's environmental and HKC compliance levels trail India's highly modernized fleet of certified yards [64]. Its regulatory framework is being rewritten but currently offers less certainty and enforcement than India's 2019 Act, and Pakistan is rapidly catching up in legislative reforms [69]. Financially, Bangladesh's ship-breaking industry has not attracted the volume of donor and state financing seen in India or Pakistan [65]. Finally, Bangladesh's yard infrastructure remains a bit behind to fully mechanized beach plots, whereas India's yards are mechanized and Pakistan has committed funds for a "model" yard upgrade. Unless Bangladesh can accelerate yard modernization and compliance (e.g. by leveraging projects like SENSREC more effectively), it risks ceding market share to its better-funded neighbors [67]. Again government needs to take active step and necessary initiative to fulfill the requirement of HKC 2009. Now the attitude of yards owners need to be more serious, positive, and resilient otherwise nation cannot achieved her goal and keep her position as top in the world recycling market. Recent industry reports, IMO and government publications, and news articles comparing South Asian ship-breaking IMO/IMO media releases and few research articles were used to compile these comparisons [49, 50, 57, 58, 64, 65, 70, 71, 72].

12. Existing Global Ship Recycling Regulation and Subsequence Challenges

To enhance safety and protect the environment, the IMO established the HKC 2009 on ship recycling in

2009. Unfortunately, after all these years, it still hasn't gone into effect. Hazardous waste disposal to non-OECD nations is prohibited under the EU's Ship Recycling Regulation, or EU's SRR No. 1013/2006, which enforces the Basel Convention and its Amendment in Europe. It also prevents the export of trash for disposal outside of the EU/EFTA zone. The European Union Ship Recycling Regulation (EU SRR) went into force on December 31, 2018.Ship recycling operations must adhere to a number of stricter environmental and occupational health and safety requirements under the Regulation than under the HKC 2009[53, 55, 56]. Every ship flying with the flag of the European Union (EU) must be recycled at facilities that have been certified and added to the EU's list of approved sites across the globe. For this reason, the EU keeps a current record of these websites [50, 58]. Since ship recycling contributes significantly to the economies of the countries involved, they are reluctant to pass legislation regulating the industry. In order to protect the industry and assure safety, health, security, and the environment, a number of international laws have been enacted that must be addressed in South Asian practices. Considering these modifications will benefit and guarantee the environment and safety [49, 57]. Due to the failure of the Basel Convention, which regulates ship recycling internationally, and the HKC 2009's non-entry into force, the EU has chosen to act independently.

The EU is already putting some of the HKC into practice and has taken action to control ship recycling [51, 57]. When Regulation No. 1257/2013 on Ship Recycling (EU's SRR) went into effect in December 2013, it produced noticeable outcomes [54, 58]. It is essential for yards to be included in the EU directory because the HKC does not offer the security requirements required for ship recycling. This will ensure that a yard has followed a procedure for quality assurance that is up to par. Ships listed in the new legislation will not be covered by the Waste Shipment Regulation in order to establish clear legal requirements and simplify administrative procedures. This rule will still apply to non-EU registered ships that are sold for scrapping while in European seas, though. The EU's SRR aims to promote a worldwide, rule-based system by achieving early ratification of the HKC. Every expert has concurred that the shipping industry should be subject to international laws. However, because the HKC does not adhere to the EU's SRR criteria, there is debate on whether it is a suitable alternative [54, 55]. Once more, European ships are typically recycled in compliance with EU SRR or HKC standards. If not, the BC guidelines take effect, which can be very time-consuming and challenging to handle [22, 54, 57]. Although the HKC has not yet been implemented legally, it may nevertheless be used as a guideline for vessels flying non-EU flags as long as they do due diligence. Additionally, this protocol's goals are acknowledged and approved globally.

Waste ship exports to nations outside of the OECD are prohibited by the Basel Convention (Basel 2011). Labeling recycling as occurring in international seas, where the Convention's rules cannot be enforced, is a common way to get around this. Ships will no longer be covered by the Basel Convention's (BC) HKC Amendment after it becomes operative. Furthermore, these boats are not covered by the treaty if they are handled in compliance with the EU SRR. In the case of ships specifically, the term "exporting state" might apply to either the flag state or the beneficial owner's nation of origin. This other interpretation is more accurate and appropriate. The IMO moved quickly to draft a new convention with legally enforceable provisions in response to the need for ship recycling regulations. The flag state and the recycling state's implementation of this convention would be crucial [52, 58]. The IMO approved the HKC 2009, which makes ship owners accountable for the sustainable recycling of ships, in order to resolve all of the BC's ambiguities. This convention has yet to be put into effect, even after ten years. While implementing more stringent safety and environmental regulations than those specified in the

IMO's 2009 HKC for Safe and Environmentally Sound Recycling of Ships, the EU's SRR advances the objectives of the 2009 HKC. In particular, the EU's SRR has standards that are higher than those established by the IMO. According to the EU's SRR, the beaching procedure has been outlawed, and stringent laws pertaining to labor rights and hazardous material management are in effect. Once again, EU-listed ship dismantling operations are subject to a far higher degree of oversight, including third-party certification and audits, as well as complaints from non-governmental organizations (NGOs) if they believe such facilities are not abiding by the rules [53, 57]. As a result, South Asian nations like Bangladesh are now facing more challenges overall.

13. Regulatory Enforcement and Policy Frameworks

On June 26, 2023, Bangladesh became a signatory to the Hong Kong Convention (HKC), which is a worldwide agreement for ship recycling that is both safe and ecologically responsible. For the safe and ecologically responsible recycling of ships, the Hong Kong International Convention (HKC) is must. Globally, the Convention has been effected from June 26, 2025. Now that it is one of the biggest ship recycling countries in the world, Bangladesh is at a critical point in carrying out its international commitments. There is the pressing need to protect a vital area of the national economy, and there is also the difficulty of fulfilling pledges to improve worker safety and environmental preservation. One crucial concern this circumstance raises is whether ship recycling facilities that are not yet fully comply with HKC criteria can continue to import end-of-life vessels for recycling after 26 June, 2025, once the Convention goes into effect globally. Currently, the Bangladeshi government has halted the granting of permits for ship imports meant for recycling because of a lack of clarity regarding the effects of the Convention. The ship recycling industry, which has been in operation for more than 30 years and since 2011 under formal authority granted by the Ship Breaking and Recycling Rules, 2011, has been greatly disrupted and embarrassed by this stoppage. Bangladesh, India, Pakistan, and Turkey are the only four nations in the world where approximately 95% of EOL ships are demolished. Bangladesh is essential to international shipping because it offers affordable ship recycling during a period when facilities are in short supply elsewhere. Bangladesh continues to be essential for maintaining marine trade by providing for about half of the world's recycling needs.

However, the ship recycling sector in Bangladesh is currently in a somewhat precarious situation. India has been Bangladesh's closest rival in this field for a number of decades. Approximately 90% of ship recycling yards in India currently meet the requirements set forth by the Hong Kong Convention (HKC). Bangladesh's HKC certification status, on the other hand, shows that local yards are not up to par or acceptable, with the number of yards remaining inadequate. India has effectively updated its ship recycling facilities in their yards to suit international standards by careful legislation and significant investment. Importantly, India positioned itself early on to take advantage of the enormous potential of ship recycling as a worldwide business opportunity rather than just as an environmental issue. Bangladesh, on the other hand, has fallen behind because of a lack of consistent political commitment, poor government assistance, and gaps in the information flow. But there is still hope. Bangladesh still has legal options for implementing the HKC gradually under international law. The crucial question at hand is whether Bangladesh will take advantage of this chance or if it will over restrict itself and run the risk of causing the collapse of a crucial national industry. Developing nations are not required by international law to instantly achieve developed-world environmental norms. The principle of pacta sunt servanda, which states that all treaties are legally binding on the signatory nations and must be

implemented in good faith, is established by Article 26 of the Vienna Convention on the Law of Treaties. This implies that after a nation has ratified a treaty, it cannot break its commitments or behave dishonestly. It must make real and honest attempts to achieve the goals of the treaty while taking into account its own capabilities and circumstances. This means that states must make real attempts while taking their capabilities into account. The idea is now commonly recognized as customary international law. The Rio Declaration's Principle 11 also highlights the need for environmental standards to take into account the socioeconomic circumstances of each nation. Therefore, for nations such as Bangladesh, staggered adoption or "progressive realization" is a legal strategy. In order to legally continue ship imports under a conditional authorization regime, Bangladesh must implement organized development goals, maintain control, and show real progress. This would preserve the fundamental goals of the Hong Kong Convention without seriously harming the sector. The Ship Breaking and Recycling Rules, 2011 offer a legal basis for conditional authorizations through administrative action, despite their partial noncompliance with HKC. With the government presently drafting the new 2025 Rules, extensive modifications are anticipated.

Clear examples are provided by Pakistan's incremental changes and India's adoption of the Recycling of Ships Act, 2019. Both demonstrate that a nation can remain in line with international law by showcasing progress, even if complete compliance is not yet achieved. Additionally, the legitimacy of phased treaty implementation for developing nations is recognized by UNCLOS Articles 202 and 203 as well as by ICJ opinions, such as those in the Gabcikovo–Nagymaros Project case. In accordance with international law, Bangladesh can thus boldly embrace a planned, monitored transition path. A well-thought-out and logical conclusion is now crucial in Bangladesh's administrative structure. The Ministry of Industries and the Ship Recycling Board are in charge of ship recycling. It might be illegal and unconstitutional to halt the issuance of No Objection Certificates (NOCs) only because HKC implementation is not complete. The Constitution's Articles 31 and 40 ensure both legal protection and the ability to do lawful commerce. The higher courts may take legal action if NOCs are arbitrarily denied to licensed yards permitted by the 2011 Rules. Furthermore, the "legitimate expectation" premise is applicable. Policy consistency is a right for stakeholders that made investments based on government promises of a progressive implementation of HKC.A quick reversal could be challenged in court. This idea was firmly supported by the Supreme Court's ruling in Rabeya Basri Erin vs. Bangladesh Biman. According to an assessment of the Hong Kong Convention, ship recycling is directly governed by Articles 6 and 7 as well as Regulation 9. Before recycling starts, parties must make sure each ship has an approved Ship Recycling Facility Plan (SRFP) and authorize and register facilities while taking infrastructural, safety, and environmental regulations into account. Importantly, the Convention encourages a balance between "progress" and "protection" rather than demanding instant complete compliance. Phased compliance is permissible for developing nations, according to IMO standards MEPC 210(63), MEPC 211(63), and MEPC 222(64), which permit ongoing operations under close supervision. The ship recycling sector in Bangladesh would be destroyed by a zero-tolerance policy, leading to significant job losses and economic hardship. Issuing conditional NOCs to facilitate a gradual, monitored transition is still a legal option.

A Transition Plan must be announced immediately by Bangladesh in light of the current circumstances. The government might implement a framework that first establishes the minimal requirements for authorizing a ship recycling plant, contingent on things like prompt infrastructure improvements, improved worker safety protocols, and better handling of hazardous material. There may be three

categories of yards have been distinguished: fully complying (A), advancing (B), and non-compliant (C). Conditional NOCs linked to certain development milestones and frequent third-party audits may be granted to B-category yards; facilities that do not achieve these requirements risk suspension or revocation. Bangladesh might uphold its international commitments and safeguard its crucial ship recycling sector by adopting this strategy. Phased implementation plans are supported by international organizations such as the IMO, financial institutions, and investors. Bangladesh might take advantage of this momentum to obtain additional technical help, notably through SENSREC Phase III and other programs. Maintaining confidence with ship owners worldwide looking for HKC-compliant choices would also be aided by demonstrating believable progress. It is now evident that Bangladesh must choose between two options: a practical, legal transition that maintains the sector's operations while moving closer to complete compliance, or strict inaction that runs the risk of industrial collapse. A stronger, safer, and more sustainable future is what the second route promises. Prompt action based on strategic vision and creativity is necessary to protect the sector as well as Bangladesh's economic, environmental, and global reputation [67].

Bangladesh currently operates under the Ship Breaking and Recycling Rules, 2011, which lack full HKC alignment. The government has recently halted all new recycling ship imports pending HKC compliance, illustrating uncertainty in enforcement [67]. Draft amendments (prepared under IMO's Norway funded SENSREC project) were unveiled in early 2025 to align national law with HKC, Basel, Rotterdam, and Stockholm conventions. Stakeholders (including NGOs) call for much tighter oversight and penalties to enforce environmental and safety standards [69]. New rules are expected in 2025, but until then Bangladesh's regulatory framework remains a patchwork with weak enforcement a critical vulnerability compared to its peers. In contrast, India has already enacted a comprehensive legal framework. India's Recycling of Ships Act, 2019 (in force Dec 2019) fully integrates HKC requirements: all facilities must be officially authorized and ships recycled only under ship specific plans with HKC-compliant "Ready for Recycling" certificates. India's Act also imposes strict waste management duties on recyclers with penalties for violations. These robust laws and active enforcement have been credited with modernizing the sector; indeed, Indian officials note accession and legislation have "consolidated India's position as the market leader" in safe recycling [70]. As a result, India has methodically enforced HKC and other environmental rules and has the infrastructure and training in place to do so.

Pakistan is only beginning to develop a modern framework. It ratified the HKC in December 2023 and is drafting new laws (a Federal Ship Recycling Act and provincial bills in Balochistan are in the works). Currently, enforcement is weak: yards in Gadani operate under outdated rules with minimal oversight, raising serious safety and pollution concerns. The ILO and IMO are assisting Pakistan to identify legal gaps and map a road-map for HKC enforcement; in particular, Pakistan must institute yard authorization, worker safety regulations and hazardous waste controls to meet its HKC obligations. Until these reforms are implemented, Bangladesh will face competition from Pakistan only after Pakistan's sector addresses its "outdated infrastructure [and] weak regulatory enforcement" in other words, once Pakistan fully modernizes its framework [68]. At present, nearly 40% of Bangladesh's yards remain not fully compliant with the HKC requirements. 13+7 or 20 recycling yards are HKC certified (hope that 7 are going to HKC certified soon) out of 40+ (approximate) active/operational yards. Within next year rest of recycling yards hope to get the HKC certification. But continue to hold the leading position of Bangladesh in the global recycling market there should more than 40 active/operation HKC certified

local yards within next year. It is a significant challenge for the nation to continue and remain competitive in this sector.

14. Future Challenges for Local Ship Recycling Industry of Bangladesh

In 2018, the Bangladeshi government passed the Bangladesh Ship Recycling Act, which requires ship-breaking and recycling yard operators to implement safe and eco-friendly recycling practices in accordance with the 2009 Hong Kong International Convention (HKC 2009). Out of the approximately (40+) active/operational recycling yards, only 13 yards *(and hope that another 7 are going to HKC certified soon)* have obtained the Green Passport (HKC certificate). Due to the expenses involved (huge capital investment), the majority of non-compliance yards are hesitant to implement the green ship recycling criteria (HKC 2009 requirement). Currently, more than forty yards are attempting to meet those requirements. Ship recycling yards ought to be in a desperate attempt to improve and meet HKC requirements. However, the high cost of building green yards made local recycling owners hesitant/timid. It would take at least Taka 200 to 300 million (around 2.5 million USD for single yards) to modernize one ship recycling yard, and it would cost about Tata 12 billion (around 100 million USD for whole industry) to upgrade the entire recycling industry/sector in order to have all of these facilities and stay competitive and resilient in business/sector globally [43, 44, 58]. In contrast, Bangladesh's recycling rivals, such as India, are far ahead of us and have already complied with the HKC standard. China and Turkey have already made their ship recycling facilities green in accordance with the guidelines set forth by the HKC, which was adopted in 2009. By the end of 2026, Bangladesh aimed to convert all ship recycling yards into environmentally friendly establishments. However, given the state of affairs and the mindset of the local yard owners, there are questions whether this goal might not be met this year. Additionally, the government had established numerous deadlines for reforming the local recycling sector. There are diversified challenges for SBRI in Bangladesh.

According to a research by the Bangladesh Ship Breakers and Recyclers Association (BSBRA), the appreciation or crisis of the USD and LC concerns caused a fall in the import of scrap vessels in 2023–2024. In this running year very few vessels has imported, showing a significant commercial deficit. The UNCTAD analysis claims that because of the difficult environment brought about by the global geopolitical and financial circumstances, maritime trade, global tariff crisis in 2025 has increase the risk further and more uncertain than it was within 2021–2024. Nonetheless, the present growth rate is 1.4% (2026–2030), and it is anticipated that this significant growth will either stay the same or maybe rise by 2% in the upcoming years. This is a little slower than what was observed in the decades prior [61, 69]. Demand was rising in the post-pandemic globe, which was driving up shipping costs. This has made it more difficult for owners of outdated or EOL ships to dispose of them in recycling facilities. Additionally, new shipbuilding orders were being placed found declining trend. As a result of price of EOL ship is increasing and this upward trend may continue further [58, 69].

Global businesses have been greatly impacted by the current geopolitical environment, which includes the COVID-19 pandemic, the Israel-Iran war, and the ongoing consequences of the Ukraine-Russia conflict and global tariff dilemma. A difficult environment for international business, particularly the ship recycling industry, has been brought about by rising inflation and widespread uncertainty [57, 65, 71]. In order to achieve their goals and compete with other international companies (India, Pakistan, and Turkey), local ship recycling yards need to adopt a more corporate culture and modify their mindset. Local yards can succeed commercially and maintain their competitiveness in the global recycling market

by adopting appropriate tactics and practices and drawing inspiration from highly efficient industrial nations [56, 58]. According to ILO and IMO laws, local recycling yards must take the required actions to ensure health, hygiene, and safety standards [49, 57]. Local recycling yards need to establish a Ship Recycling Facilities Plan (SRFP) and other safety and technical requirement in order to comply with HKC regulations. It will be more difficult and complicated to continue operating local recycling business in the future if local yards don't get ready to ratify HKC and some form of EU RRC as soon as possible [51, 52, 58].

15. Discussion and Way Forward

The study and analysis shows that Bangladesh has taken visible steps toward regulatory modernization, including HKC ratification in 2023 and the initiation of facility audits, SRFP (Ship Recycling Facility Plan) development, and draft legislative reforms aligned with IMO conventions. In Bangladesh, around 60% of yards are either non-compliant or uncertain about HKC obligations. The readiness gap between paper compliance and practical enforcement is evident in the weak institutional frameworks for monitoring, certification, and penalization. By contrast, India's formal adoption of the Recycling of Ships Act, 2019, and the operational/active around 120 HKC-compliant yards, gives it a comparative edge in attracting EU-flagged and environmentally conscious ship-owners. Labor conditions remain one of the most contentious and revealing domains. In Bangladesh a dozen of HKC-compliant local yards have significantly improved workplace safety, where over 30% of respondents reported a lack of PPE, inadequate emergency training, and exposure to hazardous materials without containment. This is consistent with academic critiques of the industry, which highlight that informal labor recruitment and limited oversight continue to dominate yard practices [34, 38]. Bangladesh's poor track record on environmental and health compliance—especially in non-HKC yards—could become a reputational risk, affecting future trade and access to OECD and EU ship disposal contracts [23, 57, 60]. Compared to India's structured workforce training and Pakistan's recent commitments to build hospitals and training centers in Gadani, Bangladesh's social investments remain fragmented and donor-driven rather than systemic.

The competitiveness analysis presented in Sections 8 including ARIMA-based forecasting and scenario modeling, positions Bangladesh in a precarious but potentially resilient state. Forecast data suggest that in a baseline scenario, Bangladesh will continue to recycle approximately 2.7 million GT/year, with significant upside potential in the optimistic scenario (~5 million GT/year) if modernization accelerates. However, the forecast must be interpreted in the context of rising competition. India's technological advancement (with shore cranes, dry-dock recycling, concrete hard-standing), its legislative certainty, and large investment inflows collectively challenge Bangladesh's historic volume leadership. Pakistan's Rs12 billion (~USD 42 million) modernization plan for Gadani—though just beginning—signals a geopolitical pivot that could dilute Bangladesh's regional dominance if not matched with countermeasures. Bangladesh's export of ship recycling services is still heavily dependent on low-cost labor and favorable geography. But these advantages are rapidly diminishing as environmental, labor, and governance factors become critical selection criteria for ship-owners under ESG mandates. Failure to realign with global best practices may not only lead to a drop in market share but also attract sanctions or exclusion from "green" ship disposal networks. Bangladesh needs to finalize and enforce the draft Ship Recycling Act that fully integrates HKC provisions and aligns with Basel, Rotterdam, and Stockholm conventions. This law should mandate facility authorization, hazardous material inventory

tracking, waste disposal compliance, and environmental impact audits. We may create a dedicated Ship Recycling Regulatory Authority (SRRA) with representatives from the Ministry of Industries, Ministry of Environment, Ministry of Shipping, Department of Labor, BUET, Bangladesh Maritime University or BMU (as academic advisor), etc. to coordinate oversight, inspections, and certifications. We can make it compulsory for all yards to submit approved Ship Recycling Facility Plans (SRFPs) and obtain HKC certification within a fixed transition period (within couple of years). Regular third-party audits should be institutionalized with penalties for non-compliance.

Government may provide fiscal incentives (tax rebates, accelerated depreciation, and import duty waivers) for investments in green yard infrastructure such as impermeable floors, drainage systems, shore-based cranes, and waste treatment units. We can establish On-site Medical and Safety Facilities which require every major yard cluster to have on-site clinics, safety response units, and trained emergency personnel. Medical record tracking and regular health checkups should be part of yard licensing. We need to institutionalize a training and certification framework through the Bangladesh Institute of Marine Technology (BIMT) or a new Ship Recycling Safety Academy under BMU. All workers should be registered and receive periodic refresher training on hazardous material handling and emergency response. We need to ensure fair wages, housing, insurance, and legal aid for workers through a dedicated Ship Recycling Workers Welfare Board. Monitor labor rights with cooperation from labor unions and NGOs. We may use multilateral funding (e.g., from IMO, World Bank, ADB, JICA) and national budget allocations to create a blended financing mechanism supporting local recycling yards upgrades, particularly for small and medium recyclers. We may introduce performance-based incentives which offer incentives (e.g., carbon credits, scrapping subsidies, export rebates) to yards demonstrating continuous improvement in safety, compliance, and environmental performance. We may facilitate access to commercial credit to Partner with state and private banks to develop low-interest green loans with technical evaluation support for upgrading recycling infrastructure.

We may create a National Recycling Information System (NRIS) to develop a centralized data repository tracking vessels, tonnage, compliance status, hazardous waste movement, and workforce information with applying smart and advanced technology [44, 46, 48]. Require all yards to report monthly operations into this system. We may conduct regular independent assessments by partner with academic institutions and international agencies to publish annual State of Ship Recycling Reports, benchmarking Bangladesh against global standards and highlighting improvement areas. We need to create fund for academic and private research into alternative recycling techniques, hazardous material recovery, and environmental remediation methods suitable for Bangladesh's context. Smart and digital technology may introduce in this sector [50, 69, 76]. Work with India and Pakistan under IMO or BIMSTEC frameworks to share best practices and address cross-border environmental impacts of ship recycling. We may launch international campaigns to attract EU, Japanese, and South Korean ship-owners to Bangladesh's certified "green" yards, highlighting cost advantages and new infrastructure. This industry may promote partnerships with local industries (e.g., re-rolling mills, manufacturing, construction) to develop downstream value chains using scrap steel, recovered equipment, and refurbished ship parts.

Bangladesh's ship recycling industry now faces severe competition from modernizing yards in India and Pakistan (after completion of their up-gradation plan), especially as international rules tighten. Bangladesh ratified the Hong Kong Convention (HKC) in June 2023 [67, 71], but by mid-2025 few yards (only 13) meet HKC standards. Latest industry data show India has 120 HKC certified/compliant

yards, while Bangladesh has only 13 (soon to be 20) HKC compliant yards. In practice, roughly 95% of India's yards are HKC certified versus only about 40% of Bangladesh's (rest 60% not fully compliant). This gap threatens Bangladesh's market share as it was up to 2023 Bangladesh handled ~46% of global recycling tonnage whereas India handle ~33% [67, 71, 73]. The analysts warn Bangladesh has an potential risks and going to losing its position to Indian yards (where India has managed large donor backed "green yards") and surely India is going to capture more business in coming years ahead [64, 72]. At the same time, Pakistan, which accounts for ~16.6% of global recycling share (in 2022) has only just ratified the HKC (Dec 2023) and is scrambling to upgrade Gadani [67, 68]. Pakistan is also going to catch the global race very soon. So, environmental compliance is a key challenge for Bangladesh. That is why, local recycling yards of Bangladesh need to be earned HKC certificate within short span of time and need to be upgraded rest of the incompliant yards to remain competitive, or else EOL vessels will flow increasingly toward Indian recycling yards and modernizing Pakistani yards. Now, India already mandates 'Ready for Recycling' certificates and strict waste management under its 2019 'Recycling of Ships Act' [64, 70], while Pakistan's government has approved major investments to build a "model green" yard at Gadani [65, 70]. Actually, local recycling yards of Bangladesh and nation as a whole have no alternative except modernization and up-gradation strategy and capital investment in this sector.

16. Conclusion

Approximately a thousand big oceangoing vessels are disassembled and recycled annually by the global ship recycling business. South Asia is currently without a doubt the world's hub for ship recycling and recycling. Nonetheless, three South Asian locations—Chatti (Bangladesh), Alang (India), and Gadani (Pakistan)—account for 90% of ship recycling efforts. On average, 200 different kinds of old ships are recycled every year in Bangladesh in various Chittagong yards. Once more, based on actual data from Bangladesh's ship recycling yards, I estimate that, on average, about 2 million LDT of old ships of various sizes and types are recycled each year in various Bangladeshi yards. Over the past eight years, the author has gathered and compiled an inventory of the materials, machinery, equipment, products, and HazMat on various sizes and types of EOL ships that have been recycled at Bangladeshi local recycling yards. A total of 27 recycled ships of various sizes and types have been used as a sample to determine the average yearly production of garbage and recoverable materials. The average amount of reusable materials gathered from Bangladesh's ship recycling business each year is 1989252 MT (highest) and 1833461 MT (minimum). Once more, Bangladeshi local recycling yards create an average of 17215 MT (minimum) and 22702 MT (maximum) of hazardous trash every year. A few variables, such as the number of ships disassembled and the actual amount of hazardous waste in the demolished ships, affect the formation of hazardous trash. Both variables vary widely. However, there hasn't been any variation in the amount of hazardous trash in the disassembled ships as a result of those elements changing. Once more, the new ship design concept and the enforcement of laws and regulations will alter both of these aspects in the future. Bangladesh, which has a large and inexpensive labor pool, has emerged as a center for recycling EOL ships. In actuality, the ship recycling sector has significantly boosted Bangladesh's economy and is crucial to both the macro and micro economies in lowering poverty.

The ship recycling industry of Bangladesh, long regarded as a global leader in volume and cost-efficiency since last decade, but now is at a critical crossroads. As this study has shown, the enforcement of the HKC 2009 for the Safe and Environmentally Sound Recycling of Ships, coupled with rising global expectations for environmental and labor standards, is reshaping the competitive landscape in

profound ways. Through a combination of primary field data (including over 500 stakeholder interviews) and secondary analysis of ship-breaking trends across South Asia and beyond, this research has critically assessed Bangladesh's readiness, performance, and future prospects. The results indicate a significant compliance and modernization gap between Bangladesh and its key regional competitors, particularly India. While Bangladesh has made important progress—like ratifying the HKC, initiating Ship Recycling Facility Plans (SRFPs), and participating in international donor-supported programs—its progress is uneven, largely fragmented, and heavily dependent on external technical assistance. A majority of its yards (50%) remain non-compliant or only partially aligned with HKC norms and institutional enforcement remains weak due to regulatory ambiguity and limited inter-ministerial coordination.

The labor and environmental dimensions present perhaps the most urgent challenges. Although some yards have embraced reforms, widespread deficiencies in workplace safety, personal protective equipment (PPE), and hazardous waste management persist. Without significant improvements, these deficiencies will continue to undermine the industry's global reputation and block access to high-value recycling contracts from OECD and EU ship-owners. Forecasting analysis, including scenario-based ARIMA projections, suggests that Bangladesh can maintain and potentially expand its gross tonnage recycling capacity to over 4–5 million GT per year—provided it embraces a coordinated strategy of regulatory reform, green infrastructure investment, workforce development, and global market positioning. Without such reforms, however, even the baseline projection of 2.7 million GT per year may be at risk, particularly as India and Pakistan aggressively modernize their ship recycling sectors. This study contributes to the growing academic and policy-oriented literature by providing an integrated, evidence-based roadmap for the future of ship recycling in Bangladesh. It argues that sustained leadership in this sector will depend not on volume alone, but on value-added practices that are safe, green, and governed by transparent institutions. Bangladesh has the geographic advantages, industrial history, and workforce capacity to make this transition. What remains is a matter of political will, institutional coherence, and long-term investment in sustainable development. To remain in global competition, rest of local yards (around 25 yards) need to achieve HKC certificate as soon as possible, otherwise nation will lose the race. But, the high cost of building green yards made local recycling owners still hesitant/timid. It would take at least Taka 200 to 300 million (around 2.5 million USD) to modernize single ship recycling yard, and it would cost about Tata 12 billion (around 100 million USD) to upgrade the entire recycling industry/sector in order to have all of facilities (as per HKC) and stay competitive and resilient in business/sector globally.

Now, around 60% of Bangladesh's yards are remained incompliant with the HKC requirements. Only 13+4 or 17 local recycling yards are HKC certified out of 40+ active/operational yards. Bangladesh's regulatory delays and unclear enforcement mechanisms reflect a critical bottleneck. Stakeholder interviews reveal skepticism about the efficacy of government audits, and many operators are waiting for clarity on whether non-compliant yards will be officially delisted. This limbo state has slowed investment and discouraged long-term planning, a challenge that may intensify post-2025 when global compliance expectations harden. The pathway forward for Bangladesh lies not in resisting global environmental and labor norms, but in strategically aligning with them to capture a new generation of demand for ethical and green ship recycling. The time to act is now—before the market shifts irrevocably toward better-prepared competitors. Within next year rest of the local recycling yards should get the HKC certification. But continue to hold the top position of global market; Bangladesh should

have 40+ active/operation HKC certified yards. As of today, India got authorization 'Ready for Recycling' certificates and strict waste management under its 2019 'Recycling of Ships Act' along with Pakistan's government has approved major investments to build a "model green" yard at Gadani and they are coming back to global competition. As a result, local recycling yards of Bangladesh as well as whole sector have no option, rather than modernization and up-gradation strategy and capital investment in local ship recycling industry.

Abbreviations

Term	Abbreviation
End-of-Life	EOL
Gross Tonnage	GT
Hong Kong Convention	HKC
Occupational Health and Safety	OHS
European Union	EU
Ship Recycling Facility Plan	SRFP
Ship Breaking and Recycling Rules	SBRR
Shipbuilding and Ship Recycling Board	SBSRB
United Nations Conference on Trade and Development	UNCTAD
International Maritime Organization	IMO
Business-as-Usual	BAU
United States of America	USA
Maritime Administration	MARAD
Environmental Protection Agency	EPA
Liquefied Natural Gas	LNG
Liquefied Petroleum Gas	LPG
Statement of Compliance	SOC
Alongside / Pier Breaking	APB
International Ship Recycling Association	ISRA

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