

Research Article

Evaluation of Bangladesh Shipbuilding State and Major Challenges

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Abstract

The shipbuilding industry is considered as one of the most profitable and sustainable industries around the globe. Shipbuilding has long been an appealing industry for many develop and developing countries like Japan, South Korea, and China. Historically, this sector has lacked strong global regulation and often faced problems of over-investment, as it involves diverse technologies, stimulates numerous backward and forward linkage industries, creates significant employment opportunities, generates income, and remains global in nature. Such patterns have been evident among all major shipbuilding nations throughout history. Today, China is the global shipbuilding market leader. Bangladesh, endowed with its traditional shipbuilding expertise and glorious history, progressed to become a small but competitive player in the global market, though it could not sustain its momentum. The global shipbuilding industry is projected to reach approximately USD 200 billion soon, and Bangladesh holds the potential to secure at least USD 4 billion of this market share. By addressing challenges such as low productivity, the need for advanced technology integration, and safety standards, Bangladesh's shipbuilding sector can significantly enhance its international competitiveness and contribute meaningfully to national development and economic growth. This study evaluates the status of local shipbuilding by depicting the challenges within the context of global trends, technological progress, and future market share.

Keywords

Local Shipbuilding, Global Market, Smart Technology, AI

1. Introduction

Ship is the main mode of transportation and shipbuilding is the integral part of development for many nations. Shipbuilding is an ancient industry engrossed on constructing ships and various floating structures. These activities typically ensue in facilities equipped with heavy machinery installations, known as shipyards or dockyards. The sector encompasses designing and building both ocean-going and inland ships and vessels [16]. Today, in modern ports are now highly advanced, integrating smart technologies to enhance their

services and operations. They utilize digital, computerized, and cutting-edge tools such as artificial intelligence (AI), machine learning (ML), deep learning (DL), the Internet of Things (IoT), big data, blockchain, and automation to streamline management processes and reduce environmental impact [33] in port, shipping, and shipbuilding industry. Technologies like AI and ML can optimize logistics by processing data from numerous sources, including shipping schedules and cargo information. Smart technologies also

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automate numerous tasks, significantly decreasing manual labour requirements and boosting overall efficiency [29]. Moreover, these technologies assist in better design and construction processes, detecting anomalies and predicting potential incidents, which enhance safety, security, and compliance with global standards [28, 30]. By optimizing operations and production costs, smart technologies reduce resource consumption, minimize downtime, ensure safety, improve quality, and ultimately lower expenses. Additionally, they contribute to sustainable shipbuilding by optimizing energy use, waste management, and environmental monitoring. For improved efficiency, accountability, sustainability, competitiveness, customer satisfaction, and effective monitoring, the entire maritime sector, including shipbuilding, must adopt smart, safe, and cost-effective practices. Smart shipyards employ digital solutions such as sensors, data analytics, augmented reality, big data, digital twins, blockchain, and automation to enhance production timelines with quality assurance, reduce waste and emissions, and provide better service to customers, local communities, and stakeholders [34]. The economic gains are largely derived from supply chain dynamics, timely delivery, and maintaining quality standards rather than solely internal activities. Thus, ensuring quality assurance, adhering to safety standards, delivering on time, providing after-sales service, and maintaining goodwill are crucial for national competitiveness and the sustainable advancement of the shipbuilding industry.

Modern shipyards increasingly adopt renewable energy, sustainable methods, and smart technologies to minimize environmental impacts while ensuring sustainable growth and maximizing profits. Smart shipbuilding and port systems are also designed for greater integration with logistics and industrial networks [4]. By employing advanced technologies in this sector, it enhances the movement of goods, streamline production processes, and improve information flow and workforce coordination within the broader supply chain. Furthermore, these industries embrace an open innovation approach, allowing continuous improvements in design, operations, construction, production, safety, and efficiency by incorporating new technologies and ideas [34]. On the other hand, cyberattacks targeting energy supplies or automated systems could severely impact the global economy, and such risks also apply to the shipbuilding industry to a considerable extent [28].

The global shipbuilding market suffers from inflation, geopolitical situation, over-capacities, depressed prices, low profit margins, trade distortions, widespread subsidization, war crisis, and many more in this decade. Despite these difficulties, Asia continues to dominate the global shipbuilding industry, followed by Europe and America, which hold smaller niche markets. Since the post-WWII era, Asian countries—particularly China, South Korea, and Japan—have maintained their leadership in shipbuilding due to several inherent advantages [23]. These advantages include relatively low labour costs, strong governmental support, stable and

sustainable policies, favourable political environments, robust economic conditions, and extensive forward and backward linkage industries. The vision of the Fourth Industrial Revolution (4IR) and smart shipbuilding focuses on developing intelligent shipyards characterised by adaptability, resource efficiency, ergonomic design, and close integration among all stakeholders [67]. For the local shipbuilding industry to achieve substantial growth, it requires a balanced approach that includes strategic investments, government backing, adoption of smart technologies, and development of a skilled workforce to address future challenges. This analytical study evaluates both local and global shipbuilding trends, assesses the future of the domestic industry based on potential and challenge analysis, technological advancement, and market predictions. The research draws from primary data and secondary sources, incorporating insights from relevant stakeholders, literature, and academic journals.

2. Shipbuilding History and Global Trend

Historically, shipbuilding has faced challenges due to the lack of global regulation and a tendency for over-investment, as shipyards encompass various technologies, employ enormous numbers of workers, and generate income in a globally interconnected market. Shipbuilding has always been profoundly supported by the state, often benefiting from government subsidies, making it an appealing sector for developing nations [30]. Following WWII, Japan utilised shipbuilding during the 1950s and 1960s to reconstruct its industrial base. Subsequently, South Korea made shipbuilding a strategic industry in the 1970s, and later, China adopted similar approaches by implementing large-scale state-supported investments in shipbuilding. Since WWII, shipbuilding has grown into a significant and strategic global industry, especially in certain South Asian countries [18]. Currently, the global shipbuilding market is challenged by inflation, geopolitical tensions, excess capacity, low profit margins, market distortions, and persistent subsidization. Reviewing the global industry trend reveals that Japan dominated shipbuilding in the 1960s but slowly lost its edge to South Korea, which has benefited from lower wages, strong government support, and a weaker currency, and overtaking Japan in ship production by 2003. From 2009 onwards, China emerged as the global leader in shipbuilding, surpassing both Korea and Japan due to robust state support and favourable government policies [18].

The middle-class populations of Asia and Africa are growing rapidly in the 21st century. Concurrently, labour costs in China's shipbuilding sector have increased significantly in recent years. As a result, China is expected to reduce its market share in small and medium-sized container ships, cargo vessels, tankers, and multi-purpose ships within this decade. This shift creates opportunities

for emerging shipbuilding nations such as Vietnam, the Philippines, India, Bangladesh, Brazil, and Turkey [31]. Notably, indigenous shipbuilding in this region has a rich and illustrious history. Bengal is recognized as an early centre for shipbuilding, rooted in its traditional boat construction practices [2]. The renowned traveler IbneBatuta visited Bengal in the 14th century and returned with a wooden ship built at a shipyard in Sonargoan, Dhaka, and some of his ships are still preserved in European museums. European traveler Mr. Caesar Frederick observed that Chottogram was a major hub for constructing ocean-going ships in the mid-15th century (Hossain et al., 2010). During the 17th century, a fleet of ships was built in Chottogram for the Sultan of Turkey. Under Mughal rule, Chottogram produced numerous warships for the Mughal naval forces. Furthermore, the British Navy deployed wooden-hull warships built in Chottogram, including those used successfully in the Battle of Trafalgar in 1805. In 1818, the wooden-hull frigate Deutschland (1000 dwt) was constructed in Chottogram for the German Navy [18]. However, modern shipbuilding is a highly capital-intensive sector, producing costly individual units rather than mass-produced items like ready-made garments. Therefore, its growth and survival in the competitive global market depend on consistent and appropriate government policies, strategic management, and political stability. Additionally, ensuring safety standards and maintaining global benchmarks are essential for remaining competitive [28, 29].

3. Global Shipbuilding Demand and Market

Ship is the major mode of transport of good due to its minimum cost and versatility. One of the key factors influencing vessel disposal is the average operational lifespan of ships, alongside various other determinants. These include policy-related aspects such as environmental regulations, bunker fuel costs, technological obsolescence, freight rates, newbuilding prices, prices of end-of-life (EOL) or second-hand ships, and demolition prices [19]. Typically, ships are scrapped after 25 to 30 years of service, with minor variations depending on ship type and region. In Figure 1 below future vessel demolition trends are estimated based on survival rates by ship type and age, as illustrated in the Figure. The data indicates that tankers generally have higher survival rates compared to bulk carriers and container ships (double-hull tankers maintain a survival rate even 40 years). In Figure 2 presents the trends in World GDP, Global Seaborne Trade, and Global Active Fleet Growth [10, 51, 61]. Figure 3 below illustrates seaborne trade projections up to 2035 as estimated by ITF, Sea Europe, and SAJ. According to ITF's network model, seaborne trade is expected to reach 20.8 billion tons by 2035. In contrast, Europe and SAJ forecast a slightly lower Figure, predicting seaborne trade to reach approximately 16.2 billion tons by the same year [50, 54, 55].

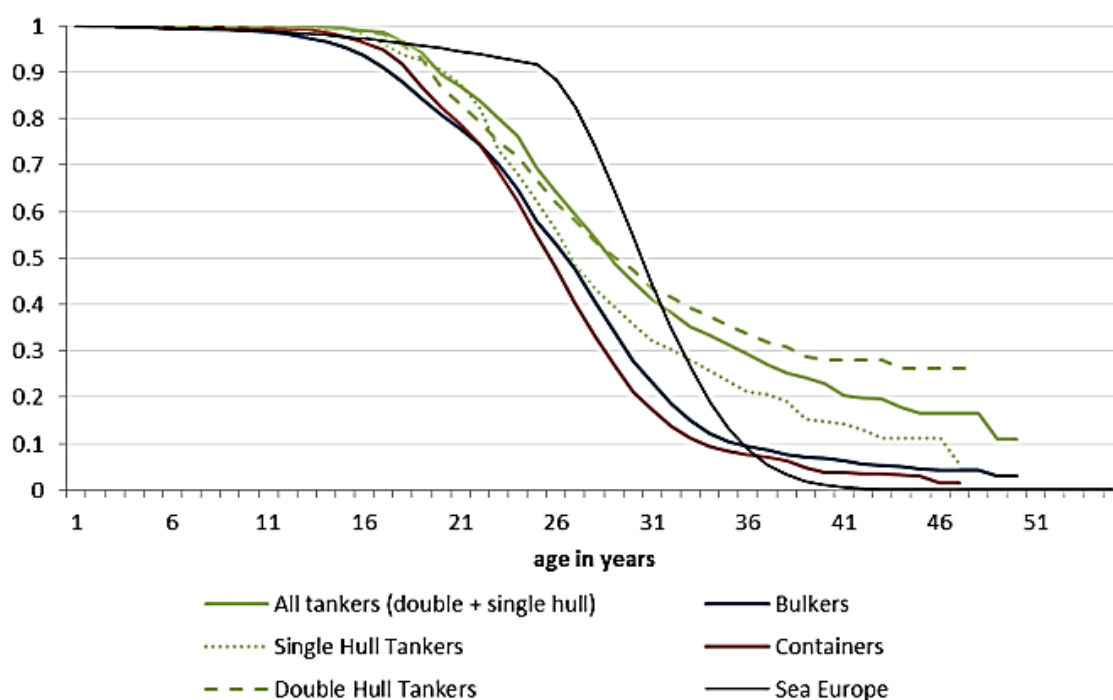


Figure 1. Survival rate by ship age (HIS Sea web 2016, OECD 2020).

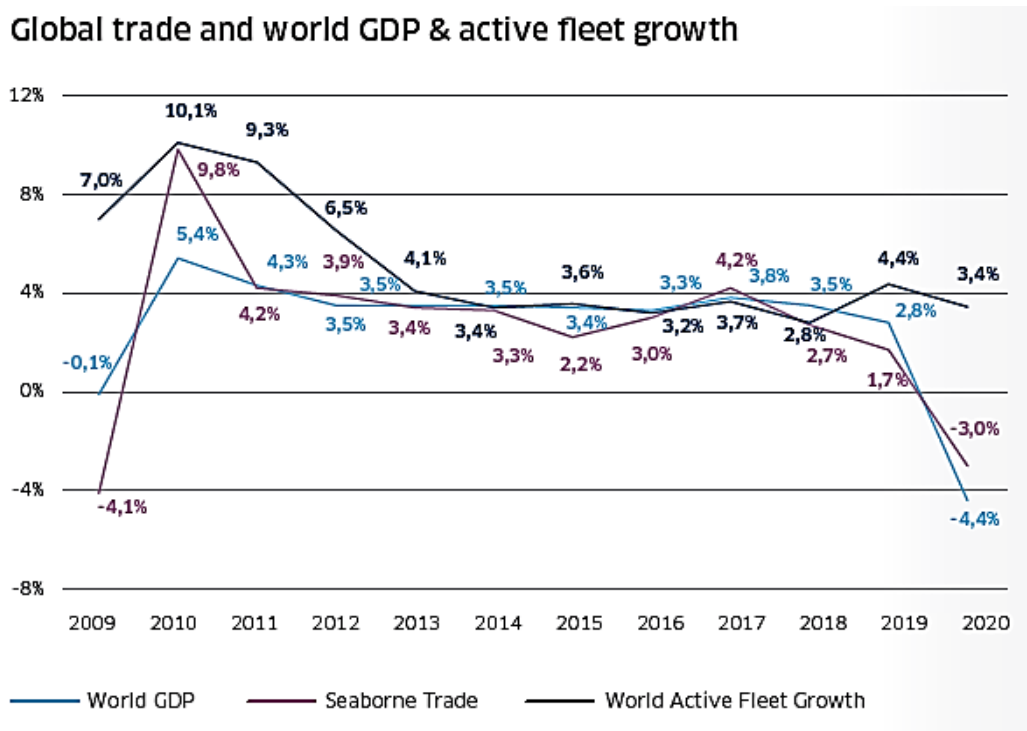


Figure 2. World GDP, Global Seaborne Trade and Global Active Fleet Growth.

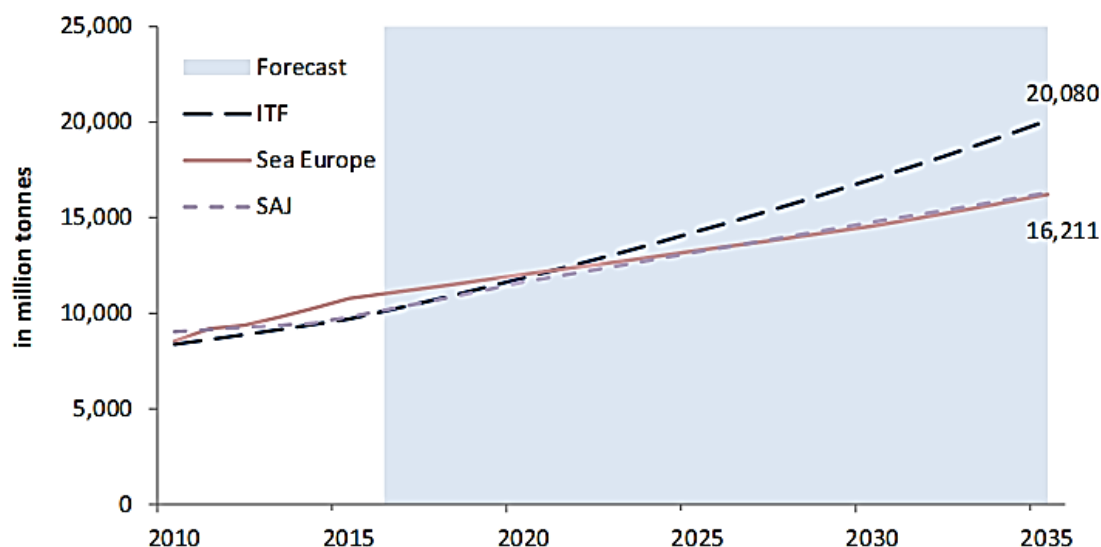


Figure 3. Forecast of Seaborne Trade From 2010-2035 by IFT, Sea Europe, SAJ, OECD (ITF 2015, Sea Europe 2015, SAJ Forecast 2015, and OECD 2017).

This industry needs own/government investment for its survival as shown in Figure 4 below which depicts the trend of domestic investment in own shipbuilding by different countries [21]. In Figure 5 shown below, future vessel requirements by ship type, associated with ship disposals, have been estimated using demolition rates and historical completion levels from previous years, as depicted for the period between 2016 and 2035. Additionally, the global population stood at

around 6.83 billion in July 2010 and is projected to rise to 9.08 billion by 2050 [48]. The urban population worldwide is also growing at a faster rate than the overall population growth, with over half of the world's population now residing in urban areas [48]. This trend is expected to positively influence seaborne trade, as a larger urban population not only creates a strong domestic market for goods and services but also stimulates economic growth and innovation.

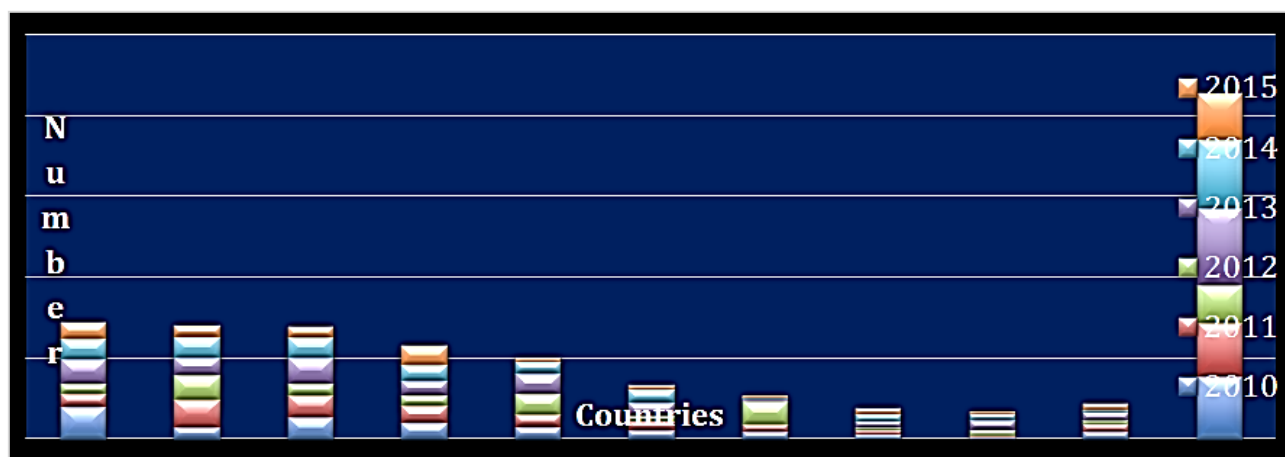


Figure 4. Trend of investment in local shipbuilding by own countries in 2010-2015(Hossain,2018).

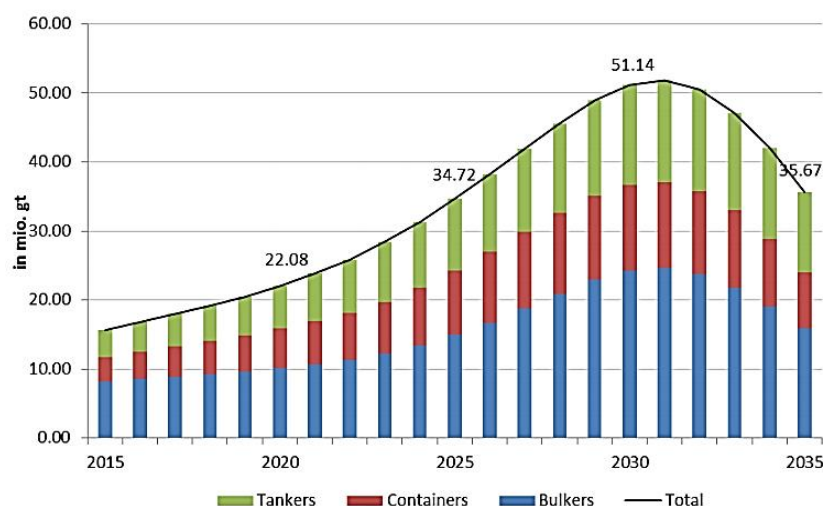


Figure 5. Forecast Of Future Ship Requirements From 2015 To 2035 (HIS Maritime & Trade).

4. Global Shipbuilding Market Forecast

Ships remain the primary mode of transportation, making shipbuilding an essential component of national development for many countries. According to Zakaria [65], “R&D collaborations across business lines are driving the creation of innovative solutions and services that can be leveraged by other units or groups.” Designing and constructing modern specialized ships today involves high levels of technology and complexity. For example, nuclear-powered aircraft carriers function like mobile airports, capable of carrying hundreds of aircraft and operating globally for decades without refueling. Similarly, nuclear submarines can remain submerged for up to six months and launch attacks from deep within the sea while remaining undetected [31]. Contemporary cruise ships, oil tankers, and bulk carriers are so massive that they resemble floating cities. Key factors propelling the growth of the global shipbuilding market include GDP expansion, overall eco-

nomie growth, rising global seaborne trade, increasing demand for cargo transportation by sea, trade agreements, technological advancements, market trends related to end-of-life (EOL) ships, marine regulations, and the growing trend of automation within the maritime transport sector [23]. However, the industry faces potential setbacks due to fluctuations in transportation and inventory costs, environmental concerns, and global crises such as the COVID-19 pandemic, the Russia-Ukraine war, or the Israel-Iran conflict, all of which can significantly impact market growth [24].

In Figure 6, projected global shipbuilding market, encompassing both commercial and military sectors, has been illustrated. It is anticipated that the market will grow to USD 176.1 billion by 2027, with an average compound annual growth rate (CAGR) of 3.4% over the forecast period from 2017 to 2027. The key drivers behind this growth include the expansion of seaborne trade, increasing demand for cargo transport, growing trade agreements, technological advancements in ship design, and increased automation. In contrast, Research

and Market (2022) estimated the value of the global shipbuilding market at USD 241.5 billion in 2021. According to their projections, the market is expected to reach USD 271.4 billion by 2026, reflecting a CAGR of 2.4%, as depicted in Figure 7. Furthermore, new shipbuilding orders are anticipated to rise, supported by the rollout of large-scale LNG

projects (Hossain K, 2023a). Demand for new container vessels is also projected to grow, fueled by a stronger VLCC (Very Large Crude Carrier) market, stricter environmental regulations, the need to replace older ships, and efforts to enhance vessel efficiency [52].

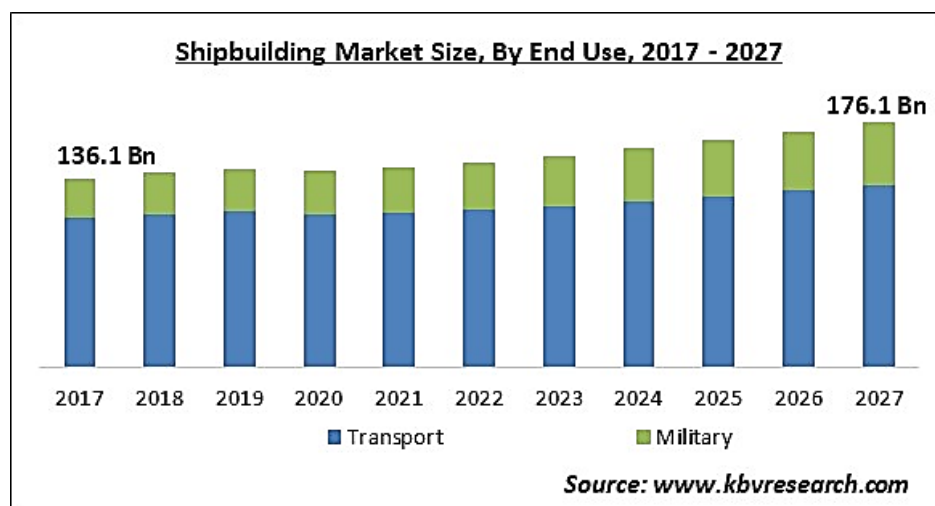


Figure 6. Forecast global shipbuilding market (commercial and military) in billion USD (KBV Research, 2022).

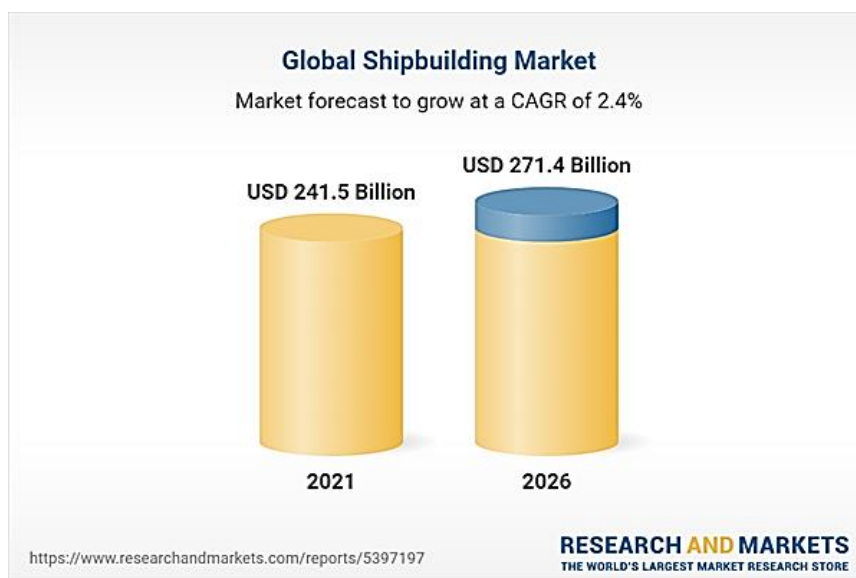


Figure 7. Forecast of global shipbuilding with CAGR (Research and Market, 2022).

5. Smart Shipping and Shipbuilding

Today, the concept of smart cities is gaining increasing popularity today, driven by rapid technological advancements and urban growth. Within this context, smart ports are emerging as technologically sophisticated seaports that leverage digitalization, automation, and data-driven technologies to enhance logistics, boost operational efficiency, strengthen

security, and minimize environmental impact [5]. Smart ports play a critical role not only in facilitating global trade but also in shaping the future of sustainable and interconnected urban systems. These ports utilize advanced digital tools to optimize resource usage, reduce ecological footprints, and streamline port activities. Technologies such as blockchain, artificial intelligence (AI), machine learning (ML), deep learning (DL), and Internet of Things (IoT) sensors are among the innovations being integrated into port operations [29]. Automated

ports, in particular, are adopting digital solutions like smart sensors and data analytics to improve their infrastructure and day-to-day operations. These include real-time tracking of cargo, monitoring of port facilities, and vessel movement coordination. Technologies involved in these efforts may include predictive analytics, communication systems, cybersecurity tools, supply chain integration, interoperability solutions, digital twin technology, as well as augmented and vir-

tual reality applications, among others [34]. In this digital transformation, AI stands out as a versatile, general-purpose technology with wide-ranging applications—including automation, robotics, language translation, image processing, decision-making, online banking, digital healthcare, credit evaluation, e-commerce, smart agriculture, and many more [46]. Future ship, shipbuilding and shipping business will be related with AI and smart technology [28].



Figure 8. AI transforming shipping sector (Andre, 2024) and future port operation (All-Forward, 2024).

Today in this sector production line, shipyards management, material, machinery are highly collaborated with advanced technology. Like the steam engine, internal combustion engine, electricity, or computers, AI is now widely applied across both industry and academia [13, 28]. Today ML, DL, ANN or DS are using in ship/port operations and shipbuilding industry to improve efficiency, reduce costs, and enhance overall performance. These technologies enable data-driven decision-making, predictive analytics, and automation, leading to significant advancements in various aspects of port management [32, 57]. In modern shipbuilding, AI and related technologies are being used to create smart or automated shipyard infrastructure to meet contemporary needs. Beyond construction and maintenance, smart shipyards also place strong emphasis on enhancing security. Digitalization is playing a transformative role in shipyard facility management. Innovations such as collaborative platforms, and safe and quick production by using smart technology will ensure safety, profit and on time delivery. To optimize shipbuilding production and profit, smart shipyards employ digital tools like automation, sensors, data analytics, and the Internet of Things (IoT), AI, DL.

Smart asset and logistics management systems further support this transformation by monitoring the location, condition, and performance of essential shipyard and material assets like cranes, vehicles, machinery, and infrastructure [34]. These smart systems help extend the lifespan of critical equipment, enable proactive maintenance, and improve overall asset utilization. Predictive maintenance techniques are also being adopted, where algorithms analyze sensor data, maintenance histories, and operational performance to forecast potential equipment failures and schedule repairs in advance. This approach not only increases the reliability and

safety of shipyards operations and management but also minimizes downtime and reduces maintenance costs. Today, big data analytics, AI, and IoT sensors allow real-time monitoring and evaluation of shipyard infrastructure and equipment. Additionally, ML or DL algorithms can analyze historical trends to forecast future ship demand, helping shipyards make informed decisions on inventory control, workforce management, logistic allocation, work schedule completion, and resource distribution [33].

Digital technologies and IoT are poised to play a key role in the future of AI integration within the shipping sector. IoT and AI devices will deliver real-time information and market data. AI algorithms can process to optimize production, operations and management [29]. AI will also support the maritime industry's sustainability efforts by helping optimize fuel consumption, minimize emissions, and improve supply chain efficiency. AI-driven solutions will enable shipping companies and ship-owner to comply with environmental regulations and work toward achieving their sustainability objectives. Looking ahead, AI is expected to fuel the development of more sophisticated predictive analytics tools. These tools will provide valuable insights into market dynamics, empowering industry stakeholders to make informed, data-driven decisions and maintain a competitive edge. However, adopting AI, ML, DL, data science, and other smart technologies demands substantial investment in hardware, software, and skilled human resources. These high initial costs may pose challenges for small and medium-sized shipping and shipbuilding industry. Additionally, the integration of such technologies involves the collection and processing of large volumes of data, raising concerns related to data privacy, cybersecurity, and overall safety.



Figure 9. An automated port (Togo-port, 2024) and their smart activities (Manik, 2024).

6. Capacity and Capability of Local Shipyards

There are hundreds of indigenous private shipbuilding and ship repair yards located across the country along sides of many rivers, and which build and maintain almost all inland and coastal water transport vessels. Some of these yards boast a long history and strong reputation in shipbuilding. For instance, High-Speed Shipyard Ltd (HSSL) has been operating for over 60 years in this sector. In recent years, several private shipyards have reached international standards, producing small and medium-sized ships for export markets. A few have even developed the capacity to manufacture merchant ships of up to 10,000 DWT. Notably, shipyards such as Annada Shipyard and Slipway Ltd (ASSL), Western Marine Shipyard Ltd (WMSL), Khulna Shipyard Ltd (KSYL), and Karnaphuli Shipyards and Slipway Ltd (KSSL) have received orders from foreign ship-owners in countries including Germany, Japan, Denmark, the Netherlands, the European Community, Mozambique, India, and Nigeria. These promising yards have already delivered dozens of ships to international clients. Moreover, other local shipyards are continuously enhancing their capabilities. This progress has created new opportunities for attracting foreign direct investment (FDI) into Bangladesh's shipbuilding sector [18, 25].

Country has a long and distinguished history in shipbuilding and maritime activities, which continues to inspire both local entrepreneurs and foreign investors to engage in this sector. Currently, approximately 40,000 inland and coastal ships, along with around 100,000 mechanized country boats, operate throughout the country. These vessels transport more than 85% of oil products, 65% of cargo, and 25% of passengers nationwide. All of these ships and boats are manufactured and maintained by local shipyards. There are around 100 indigenous shipyards in Bangladesh. Among them, four shipyards possess the capability to construct classed and ex-

port-standard ships up to 10,000 DWT, while several others are upgrading their facilities and capacity with the aim of entering the export market. The shipbuilding industry employs approximately 200,000 skilled, semi-skilled, and casual workers, while nearly two million people are directly or indirectly associated with this sector. As of 2009, the productivity of Bangladeshi shipbuilding labour was 11.43, with an average hourly wage of only USD 1.00, as shown in Table 2 and Figure 11 below. Moreover, the relative labour wage index was merely 0.45 in 2009, the lowest in the world, as presented in Table 3 and Figure 11. Although average hourly wages increased by 2021, they remain comparatively the lowest globally, maintaining Bangladesh's advantageous position in terms of cheap labour in shipbuilding. However, despite low labour costs, the sector continues to face challenges in terms of productivity and safety standards within shipyards. To address these challenges and remain competitive, the adoption of smart technologies in shipbuilding has become imperative. This includes implementing modular construction concepts alongside extensive digitization, robotics, artificial intelligence (AI), machine learning (ML), deep learning (DL), and data science [28, 33].

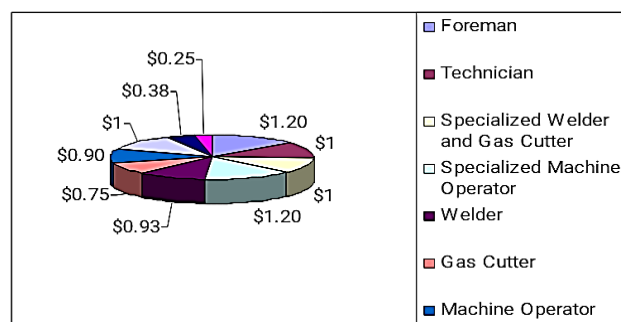


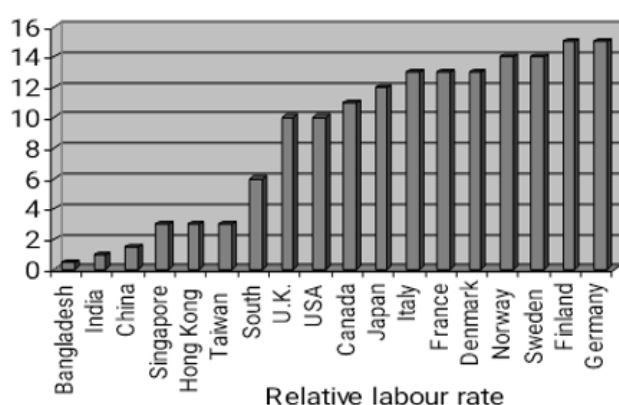
Figure 10. Average labor wage for class shipbuilding local shipyards in 2009 (Hossain et al 2017).

Table 1. Ship building labor productivity of different nations in 2009(MSC Thesis 2010, Hossain et al 2010).

Country	Formula for Labor Productivity = Man-Years/Unit Output (in CGT)	Productivity
Japan	Using basic formula	1
European countries	Same	2
United States	Same	4
China	Same	6
India	Same	10
Bangladesh	Same	11.43

Table 2. Relative labor wage for different nations in 2009 (Hossain et al2010).

Country	Relative Labor Wage	Country	Relative Wage
Bangladesh	0.45	Canada	11
India	1	Japan	12
China	1 to 2	Italy	13
Singapore	3	France	13
Hong Kong	3	Denmark	13
Taiwan	3	Norway	14
South Korea	6	Sweden	14
U.K.	10	Finland	15
USA	10	Germany	15

**Figure 11.** Relative labor rate of different nations (MSC Thesis 2010, Hossain et al 2010).

In Bangladesh a wide range of ships and vessels are constructed in local shipyards around the country. The types of vessels built include multipurpose vessels, coasters, dry cargo vessels, cargo coasters, passenger vessels or ferries (including

lunch-type vessels), double-decker passenger vessels, tankers, container vessels, landing crafts, tugs, dump barges, supply barges, deck loading barges, self-propelled barges, dredging barges, research vessels, survey ships, hospital ships, tourist ships, inspection vessels, pleasure crafts, yachts, Ro-Ro ferries, crane boats, speed boats, hydrographic survey boats, work boats, pilot boats, water taxis, pontoons, catamaran vessels, sand carriers, troop-carrying vessels, fast patrol boats, offshore patrol vessels (OPVs), patrol crafts (PCs), light patrol crafts (LPCs), landing crafts vehicle (LCVs), landing craft tanks (LCTs), deep sea trawlers, among others. Currently, approximately 40,000 inland vessels operate in the country's rivers and along its sea coast, with about half of these registered under the Department of Shipping (DOS). Additionally, there are more than 100,000 mechanized and manually operated country boats that remain outside formal registration and organized statistical records. Over 500 coastal ships are registered with the Mercantile Marine Department (MMD). Therefore, the actual number of vessels built by local shipyards is significantly higher than those registered with either DOS or MMD. The principal data - including length (L), breadth (B), draft (d), deadweight tonnage (DWT), and other

particulars - of the most common types and sizes of ships built locally for inland and coastal operations are presented in

Table 3 below [15, 43].

Table 3. Principal data of common types and sizes of ships built locally for in land water.

Types of Vessels	Dwt or no of passenger	Length in Meter	Breadth in Meter	Draught in Meter	Usually Ply
Multipurpose ship or Coaster	1500-4000	60-120	10-16	3.5-6.0	Coastal
Cargo	1000-3500	50-100	10-15	3.0-5.0	Inland & Coastal
Passenger ship or Launch	300-1500 Passenger	60-110	10-20	3.0-4.0	Inland
Tanker	1000-4000	50-120	10-16	3.0-6.0	Inland & Coastal
Sand Carrier	200-500	20-40	5-10	2.0-3.0	Inland
Barge	200-1000	20-60	6-14	2.5-3.5	Inland
Dredger	30-100	10-30	4-8	2.0-3.0	Inland

7. Suitable Market for Local Shipbuilding

Bangladesh has enough potential and opportunity, both domestic and export oriented product mainly in mass or heavy industry like shipbuilding, garments, food, etc. Internally, the need for inland and coastal ships for cargo, passenger, container, and oil transport is insignificant, with a big existing local inland fleet requiring maintenance and replacement. Export markets as well are also emerging, particularly for small or medium ocean-going vessels and specific types of ships. In the global point of view the middle-class societies of Asia and Africa are expanding rapidly in the 21st century. Simultaneously, shipbuilding labour costs in China have increased significantly in recent years, leading to a likely reduction in China's market share of small and medium-sized container ships, cargo vessels, tankers, and multipurpose ships in the near future [19-21, 30]. This shift has created opportunities for emerging commercial shipbuilding nations such as Vietnam, the Philippines, India, Bangladesh, Myanmar, Australia, Turkey, and others. Shipbuilding in this region has a rich and illustrious history. To identify suitable target markets for Bangladesh, empirical research has been conducted using both quantitative and qualitative data collection methods, including Focus Group Discussions (FGDs) with seafarers serving on various merchant ships worldwide and professionals working at leading shipping companies in Bangladesh. Experts suggest that Bangladesh is well-positioned to cater to the niche market of small-sized container ships, tankers, cargo vessels, multipurpose ships, and special-purpose ships within the 3,000-10,000 DWT range. This segment is often overlooked by large global

shipyards, enabling countries like Bangladesh to compete with advantageous pricing.

In addition, other experts propose that Bangladesh can also target the small and medium-sized ship market, particularly vessels within the 3,000-10,000 DWT and 12,000-20,000 DWT ranges, including multipurpose, container, tanker, and cargo ships. These niche markets are expected to remain viable in the coming years. Additionally, to sustain Bangladesh's export and import operations in cargo, energy, and other goods, it is imperative to develop the country's own merchant fleet, creating another promising local market. The maritime area of Bangladesh, covering approximately 118,813 sq. km, is of immense strategic importance as it serves as the only direct link to the rest of the world in times of regional crises [25]. Ensuring constant naval and coast guard presence is crucial for safeguarding sea lanes, maintaining sovereign rights, and securing economic benefits. To counter both traditional and non-traditional security threats, the Bangladesh Navy (BN) and Bangladesh Coast Guard (BCG) must remain vigilant by deploying various ships at sea. Moreover, troop transportation in coastal areas necessitates landing crafts for both the navy and army. Consequently, there is a consistent demand for military vessels for operational readiness in both peacetime and wartime. This represents a promising niche market for BN-operated private shipyards alongside the substantial local inland and coastal commercial fleet.

Today, the global shipbuilding market is valued at around USD 200 billion, with the small shipbuilding segment accounting for around USD 20 billion. There is a significant and increasing global demand for container ships across all sizes. Reports from UNCTAD, the World Bank, WTO, and OECD project a sustained rise in the

need for container vessels in the coming years. The small niche shipbuilding market is particularly suitable for local shipbuilders in countries like Bangladesh. In the near future, the world is expected to require several thousand new vessels, predominantly small to medium-sized. Furthermore, under IMO regulations, the existing global fleet of old single-hull tankers will soon need to be completely and urgently replaced, driving additional demand for new builds in this category. Previously, China dominated the shipbuilding sector due to its low costs. However, with the rise in living standards and increased labour wages in China, the competitive advantage has shifted. Bangladesh now holds a favourable position with its lower labour costs and growing technical capabilities. Analysts predict that China will gradually relinquish a portion of its small and medium-sized shipbuilding market share, opening up new opportunities for countries like Bangladesh. Since 2009, Bangladesh's shipbuilding industry has been exporting small and medium-sized ships and boats to more than a dozen countries. With its current potential and capacity, Bangladesh is projected to capture at least 2% of the global shipbuilding market by 2030, which would translate to an annual export value of approximately USD 4 billion [24]. By developing a skilled workforce, ensuring strategic government investment, and adopting meticulous planning, Bangladesh can generate USD 2 to 4 billion per annum from this promising sector. Technological advancements such as digitization, robotics, IoT, AI, machine learning (ML), deep learning (DL), and data science have significantly enhanced productivity and operational efficiency in shipbuilding. Therefore, improving labour productivity and building a highly skilled workforce are essential for sustaining the growth of this industry [33]. Moreover, maintaining safety standards and global compliance remains paramount to remain competitive in international markets [28, 29]. For substantial growth in the 21st century, strategic investments, strong government support, and continuous development of skilled human resources are vital to ensure Bangladesh's shipbuilding sector meets emerging challenges and secures its rightful place in the global market.

8. Challenges of Local Shipbuilding Industry

The shipbuilding industry of Bangladesh has struggled to maintain pace and consistency in its development due to a lack of coordinated initiatives from the government, stakeholders, along with common initiative both in public and in private sector. This has resulted in slow progress and an inability to effectively penetrate the global shipbuilding market. The key challenges are described below:

Despite its rich heritage in shipbuilding, Bangladesh has struggled to maintain pace and consistency with global

technological advancements. Due to the abundance of cheap labour, many shipyard owners remain reluctant to adopt advanced technologies. Local shipyards lag significantly in embracing smart and modern technologies for ship design and construction. Consequently, their quality assurance processes and product standards often fall short of international benchmarks.

There exists a clear gap between industrial requirements and the curricula of mainstream educational institutions. Greater emphasis is needed on technical and vocational education to bridge this divide. Universities and technical institutes have largely failed to develop a skilled workforce and sustainable human resources due to inadequate training facilities, outdated curricula, insufficient research infrastructure, and prevailing attitudinal barriers.

Policy planners, bureaucrats, bankers, and other key stakeholders often lack awareness of the shipbuilding sector's potential. For meaningful progress, this industry must receive the same nurturing support as the Ready-Made Garments (RMG) sector.

The major local shipyards are situated in and around Dhaka, far from coastal areas, thereby restricting their capacity to produce larger ships. Additionally, high bank interest rates and service charges remain a major obstacle to developing the shipbuilding industry. Additionally, international buyers often require bank guarantees, but local banks need counter-guarantees from foreign banks, incurring further costs and reducing competitiveness.

Bangladesh does not manufacture class-approved mild steel plates, frames, girders, stiffeners, longitudinals, machinery, fittings, and other essential shipbuilding materials and equipment required for the growth of export-oriented shipbuilding. There is poor backward linkage to support the industry. Bangladesh's shipbuilding industry is heavily dependent on imports for prime raw materials and resulting in increased production costs and vulnerability to global market fluctuations.

The sector suffers from an image crisis and challenges related to Ease of Doing Business (EODB), deterring Foreign Direct Investment (FDI). There is a lack of proactive information dissemination, motivation, and business promotion to prospective foreign buyers. Bangladeshi ambassadors abroad should actively promote the industry, while attitudes within the shipbuilding community must also improve.

Local shipyards lack technical expertise in modern technologies and receive insufficient government financial support to adapt to the Fourth Industrial Revolution (4IR) and integrate smart technologies. This technological gap remains a significant barrier to the sector's sustainable development [33].

One of the fundamental weaknesses is the prevalence of unethical practices within the industry, including dishonesty and attempts to gain illegal profits. Such behaviour creates mistrust and hampers the development of goodwill in international markets.

Private shipyards often lack a professional corporate culture, as management and key appointments are usually dominated by family members. This creates an unhealthy work environment marked by mistrust and lack of confidence, undermining employees' sense of belonging to the organization. Moreover, family industrial legacies, which are critical in capitalist societies, remain rare in Bangladesh.

The technology currently used in local shipyards is still rudimentary, leading to inefficiencies and low productivity. There is a significant shortage of advanced shipbuilding tools, machinery, and expert operators, particularly those skilled in digital and AI-enabled systems [28]. Furthermore, Bangladesh still depends heavily on foreign expertise for ship design.

The sector also suffers from inadequate government support in raising capital and managing financial emergencies, both of which are critical for the growth and sustainability of heavy industries in any nation. Additional costs incurred from import LC commissions, counter bank guarantees, and other banking mark-ups make Bangladesh's export-oriented shipbuilding less competitive compared to countries such as China, South Korea, Japan, Vietnam, the Philippines, India, and Brazil.

Countries such as Vietnam, the Philippines, Indonesia, India, Brazil, and others are actively working to capture the surplus and niche shipbuilding markets. This presents a significant threat and challenges to Bangladesh's shipbuilding sector. Opportunities do not wait indefinitely; local industry requires courage, clear vision, strategic direction, timely action, and political stability to be realized.

Market analyses indicate that the global demand for new ships, measured by the Compound Annual Growth Rate (CAGR), is increasing at approximately 4%. This growth, while presenting opportunities, also implies formidable risks and heightened competition for new entrants and local investors.

Insufficient infrastructure, unreliable energy supply, insufficient industrial land, and a poor Ease of Doing Business (EODB) environment are major obstacles to the rapid development of shipbuilding in Bangladesh. Moreover, few issues like image crisis, issues of integrity, bureaucratic challenges, and the attitudes of some local investors pose threats to the overall credibility of Bangladesh's shipbuilding sector. These factors undermine the ability to maintain goodwill and build confidence among foreign buyers.

Poor management practices in local shipyards lead to low employee motivation and job satisfaction. Consequently, indiscipline, high absenteeism, and poor retention rates of skilled manpower are common challenges in the sector. Additionally, there is an ongoing brain drain (like naval architects and engineers, managers, etc) including skilled manpower drain, from Bangladesh's shipbuilding industry to foreign industries, weakening the local talent pool.

The global economic recession triggered by the post-COVID-19 situation, coupled with severe geopolitical crises such as the Russia-Ukraine war and Israel-Iran tensions,

have negatively impacted the global shipping and shipbuilding markets, leading to order cancellations and a general slowdown in business.

The shallow draught of Bangladeshi rivers (maximum ~4 metres) limits the size of ships that can be built and launched from local shipyards. Maintaining navigable draughts is further challenged by heavy siltation. Additionally, bridges and overhead cables impose air draught restrictions, with a minimum clearance of 22 metres above high water levels (monsoon) required for major rivers, further constraining ship size and design.

There is a lack of comprehensive and supportive government policies and strategic frameworks for the shipbuilding sector. The absence of effective formulation, implementation, monitoring, and regular updating of export-oriented shipbuilding policies and strategies continues to hinder the sustainable growth of this industry.

9. Major Findings and Way Forward

Shipbuilding has traditionally been a labour-intensive, low-tech heavy industry. Since the 1950s, however, the introduction of high tensile and tough steel with superior physical and chemical properties has transformed ship construction (Stopford, 2009). Modern shipbuilding incorporates superb aesthetic finishes and work precision. Significant automation, advanced technologies, and line production manufacturing processes are now integrated, supported by a skilled workforce. Today's shipyards extensively adopt block or module construction, where large multi-deck segments are prefabricated elsewhere, transported to the building dock or slipway, and assembled to complete fabrication [19-21]. These modules are pre-fitted with equipment, pipes, electrical cables, and other systems to reduce installation efforts post-assembly. Ship design and naval architecture are further supported by model testing in towing tanks or basins. The incoming 4IR is poised to transform the maritime sector further, including shipbuilding. Bangladesh has a long and glorious maritime and shipbuilding history, which encourages both local entrepreneurs and foreign investors, enabling the nation to earn significant foreign currency from this sector.

The government has drafted a shipbuilding policy to improve the sector. However, its implementation must ensure proper evaluation and uniform priority so that both public and private shipyards benefit equally. The sector remains vulnerable and requires significant interventions to achieve sustainable development and international standards. If supported with facilities similar to the RMG sector, shipbuilding could generate greater net benefits. Government allocation for waterways and water transport under the Annual Development Programme (ADP) is below 5%, while roads receive over 70%. Weak state diplomacy, poor country branding, and insufficient promotional activities hinder export shipbuilding growth. Local shipbuilding costs are 10-20% higher than competitors such as China, Korea, Japan, India, and Vietnam

due different bank, tax, charges and import cost. High prices, coupled with inconsistent electricity and gas supply and inadequate infrastructure, obstruct smooth industrial development. Local shipyards often demonstrate reluctance towards improving Quality, Health, Safety, and Environmental (QHSE) standards. Government pressure, foreign buyer requirements, and awareness and training programmes are needed to elevate these standards to international levels.

Export-oriented shipbuilding is inherently a global industry. Bangladeshi-built ships, constructed to international standards, are approximately 10%-30% less costly compared to similar ships built in Japan, Korea, China, Vietnam, or India [19-21]. However, sustaining this advantage requires technological adaptation. The impact of the Fourth Industrial Revolution (4IR) has become a defining discourse in the maritime and manufacturing sectors. The first industrial revolution introduced water and steam-powered mechanical manufacturing; the second brought electrically powered mass production; the third integrated electronics and IT for automation (Wikipedia, 2022). In contrast, 4IR integrates digitization with physical manufacturing through technologies such as AI, ML, DL, Blockchain, Digital Twin, IoT, Big Data Analytics, Cloud Computing, Virtual and Augmented Reality, Simulation, Human-Machine Interaction, 3D Printing, and Advanced Materials Technology. Therefore, cheap labour and a abundance young population are no longer sufficient drivers for industrial development. Productivity and a skilled workforce are paramount requirements. If Bangladesh fails to develop its young population into a skilled human resource pool, it risks missing this critical opportunity for economic advancement and falling behind on the global development trajectory.

The concept of 6th Generation Ports (6GP), capable of handling megaships carrying up to 50,000 TEUs with a 20-meter draft and utilizing advanced automation alongside strong hinterland connectivity, is set to become operational in the near future. The entire maritime sector - encompassing ships, shipping, and shipbuilding - is on the verge of becoming far more advanced and smarter. The core objective of the 4IR in shipbuilding is to develop intelligent shipyards, which are not only adaptive, resource-efficient, and ergonomic but also ensure close integration among ship-owners, shipbuilders, suppliers, and all other stakeholders within business and value chains [47]. Without incorporating smart technologies and advanced ship design and construction processes, Bangladesh will struggle to produce globally competitive ships that guarantee safety, quality, and customer satisfaction in an increasingly competitive market. For substantial growth and capturing a significant share of the global market, this sector requires a balanced and strategic approach. This includes viable strategies and feasible planning, Continuous government backing and appropriate capital injection, strict operational discipline, Development of a skilled workforce and Integration of smart technologies to meet future challenges. The global shipbuilding market is estimated at approximately

USD 200 billion, with the small ship segment valued at USD 20 billion. To tap into this potential, the local shipbuilding industry must be properly guided and balanced. Achieving sustainable development and gaining global market share will depend on coordinated efforts, strategic investments, technological upgrades, and human resource development.

Cheap labour alone cannot ensure the sustainable development of the shipbuilding industry. While historically low labour costs have provided a competitive edge, the integration of advanced technologies is now crucial for cost efficiency and global competitiveness. Overreliance on cheap labour risks eroding Bangladesh's position in the global market, especially as other shipbuilding nations continue to adopt automation and smart technologies. Bangladesh possesses immense potential for economic progress through the proper nurturing and utilization of its export-oriented shipbuilding industry. Entrepreneurs remain confident about the promising future of local shipbuilding, leveraging the nation's long maritime heritage, favourable geographical location, and availability of a large workforce. However, private shipyards generally lack corporate management culture. Management remains family-dominated, hindering professional development, as seen in ASSL and other, which struggled to sustain its export success due to family-centric management practices. A prevailing mindset of "getting rich quickly" undermines sustainable growth. For example, WMSL failed to continue its export success due to diversions of investment focus. Poor job satisfaction prevails in shipyards. Workers do not receive industrial benefits like production bonuses, fringe benefits, or welfare facilities (medical, pension, travel allowance, and compensation). Owners neglect employee welfare due to abundant cheap labour, resulting in skilled graduates and trained personnel leaving for overseas jobs. Productivity of the workforce is low despite the lowest relative labour wage globally due to cheap hourly rates.

Approximately 40,000 inland and coastal ships, alongside around 100,000 mechanized country boats and trawlers, operate nationwide, carrying over 85% of oil products, 75% of cargo, and 25% of passengers. All these vessels are constructed and maintained by local shipyards. There are around 100 indigenous shipyards employing more than 200,000 skilled and unskilled workers. Approximately 2 million people are directly and indirectly engaged in shipbuilding activities. Few local shipyards can construct small to medium export-quality ships (up to 10,000 dwt), and several others are upgrading to enter the export market. Rising labour wages in China due to improved living standards are expected to shift some small and medium shipbuilding market share away from China, presenting an opportunity for Bangladesh. Recent FDI opportunities have emerged, with countries like China, Turkey, and the Netherlands showing interest. Establishing export shipyard zones could promote healthy growth. Bangladesh is suitable for constructing small to medium-sized container ships, tankers, cargo vessels, multipurpose ships, and specialized ships (3000-10000 dwt), and it has the potential to

capture this niche market competitively. The global shipbuilding market is approximately USD 200 billion, with the small ship segment accounting for USD 20 billion. Thousands of ships, particularly small to medium-sized, will be required in the coming years, driven by IMO regulations replacing old single-hull tankers and increasing container ship demands. By 2030, Bangladesh could achieve 2% of the global shipbuilding market share, valued at approximately USD 4 billion.

10. Conclusion

Ship and Shipbuilding is an important sector to transport goods around the globe. It is a comprehensive sector encompassing shipyards, marine equipment manufacturers, technical workforces, knowledge networks, service providers, and related stakeholders. Bangladesh has glorious shipbuilding history. Local shipbuilding possesses immense potential to emerge as a competitive player in the global shipbuilding market, which is expected to reach around USD 200 billion by 2030. With focused development of a skilled workforce, strategic government investment, and effective planning, the nation can realistically earn around USD 4 billion annually from this sector. The current positive trajectory, combined with rising export opportunities and foreign investment interests from countries like China, Turkey, and the Netherlands, further strengthens this prospect. Establishing dedicated export shipyard zones and adopting smart, viable strategies will be critical. By leveraging its geographical advantage, maritime heritage, and competitive pricing in small and medium ship segments (3000-10000+ DWT), Bangladesh can successfully capture this niche market and achieve sustainable industrial growth in the coming decades. The global shipbuilding market is typically categorized by ship type, end use, and region. Historically, the industry has suffered from a lack of global regulatory control and a tendency toward over-investment. This is due to its involvement of diverse technologies, its role in supporting numerous ancillary industries, its capacity to generate significant employment, and its inherently global nature. These trends have been common among all leading shipbuilding nations.

The global shipbuilding market at present faces multiple challenges, including inflation, overcapacity, depressed prices, geopolitical instability, war-crisis, low profit margins, trade distortions, widespread subsidization, financial crises, the impacts of the COVID-19 pandemic, volatile geopolitical situations, and trade imbalances. As a result, shipbuilding remains a slow-moving industry, vulnerable to unsteady market growth, as well as economic and environmental shifts. In Bangladesh, the government has taken initial steps and drafted a primary shipbuilding policy to strengthen both the shipping and shipbuilding sectors. However, before its implementation, proper evaluation and prioritization are essential to ensure that both public and private shipyards benefit equally. Additionally, the government must support this promising sector with appropriate capital injections and stra-

tegic interventions to unlock its full potential and ensure sustainable growth. Global shipbuilding industry increasingly leverages smart technologies, including advanced fifth and sixth-generation mega-ports and smart shipping systems, to ensure effective, sustainable, and market-driven shipbuilding that optimizes profits and supports long-term growth.

Considering the glorious tradition, present opportunities, future challenges, and the suggested measures highlighted in this research, Bangladesh's shipbuilding sector should formulate viable policies (the means) and develop effective strategies (the ways) to capture suitable market segments while optimizing production capacity. This approach could sustainably revitalize the nation's lost glorious shipbuilding heritage. Advanced technologies such as digitization; robotics, IoT, AI, machine learning, deep learning, and data science have significantly transformed the global shipbuilding landscape. Therefore, enhancing labour productivity and developing a skilled workforce is essential to sustaining growth in this sector. Simultaneously, ensuring safety and adherence to global standards is paramount to remain competitive in the international market. For substantial growth, the sector requires a balanced approach, including strategic investments, continuous government support, and focused human resource development to meet future challenges effectively. By addressing critical issues such as productivity, technological adoption, and safety standards, Bangladesh's shipbuilding industry can enhance its global competitiveness and contribute meaningfully to sustainable economic growth and national development.

Abbreviations

AI	Artificial Intelligence
BCGM	Bangladesh Coast Guard Medal
BIMSTEC	Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation
BMU	Bangladesh Maritime University
CSR	Corporate Social Responsibility
DL	Deep Learning
ESD	Education for Sustainable Development
GDP	Gross Domestic Product
ICT	Information and Communication Technology
IMO	International Maritime Organization
IoT	Internet of Things
ML	Machine Learning
MoU	Memorandum of Understanding
NGO	Non-Governmental Organization
OECD	Organisation for Economic Co-operation and Development
SDG	Sustainable Development Goal
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environment Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific

WTO World Trade Organization

Author Contributions

Hossain Khandakar Akhter is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

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