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A STUDY ON THE FINANCIAL FEASIBILITY OF COMPLIANT SHIP RECYCLING YARDS IN BANGLADESH

Shaumik Sharif Dipto[1*], Hafizur Rahman[2], Nafisa Mehtaj[3], Muhammad Sirazul Mawla[4], N.M. Golam Zakaria[5], Arun Kr Dev[6]

[1]Department of Naval Architecture and Marine Engineering, Bangladesh University of Engineering & Technology (BUET), Dhaka, Bangladesh, Email: *dipto9721@gmail.com
[2]Department of Naval Architecture and Marine Engineering, Bangladesh University of Engineering & Technology (BUET), Dhaka, Bangladesh, Email: hafiz.hafizurrahman@gmail.com
[3]Department of Naval Architecture and Marine Engineering, Bangladesh University of Engineering & Technology (BUET), Dhaka, Bangladesh, Email: nafisamehtaj@gmail.com
[4]Chief Operating Officer, Capella Consulting Services, E-mail: cpt.mawla@gmail.com
[5]Department of Naval Architecture and Marine Engineering, Bangladesh University of Engineering & Technology (BUET), Dhaka, Bangladesh, Email: gzakaria@name.buet.ac.bd
[6] Newcastle Research & Innovation Institute (NewRIIS), Newcastle University in Singapore, Email: a.k.dev@newcastle.ac.uk

Abstract:

Ship recycling is one of the most promising industries for Bangladesh. A significant amount of local steel demand is fulfilled by scrap metals from ship recycling yards. Bangladesh has been maintaining a competitive position in the ship recycling sector along with China, India, and Pakistan. But, in the absence of substantial workplace safety and infrastructure development and for not following international regulations, Bangladesh may lose its market share to other countries in this sector. This paper presents a financial analysis to establish compliant ship recycling facilities that will fulfill the Hong Kong Convention (HKC) requirements. This analysis has considered all the facilities of a compliant ship-recycling yard, including impermeable floors, mechanized systems, oily water separators, firefighting systems, and other special features. The worthiness, scalability, and sustainability of investing in the development of compliant ship recycling facilities have been assessed from Bangladesh's perspective and the benefits over the conventional ones have been discussed. Also, the challenges for ship recyclers and their prevalent perspective toward establishing compliant ship recycling facilities have been depicted. Lastly, recommendations have been suggested to assist the ship recyclers in Bangladesh by encouraging them to invest and enable HKC-compliant ship recycling to harness long-term economic rewards.

Keywords: Compliant ship recycling, financial feasibility, payback period, net present value, internal rate of return, profitability index.

1. Introduction

Ship recycling is the process of dismantling obsolete vessels to recover valuable steel and reusable materials. The need for breaking and recycling a ship arises under two conditions. Firstly, when the cost of operation of the ship becomes greater than the revenue it can generate, and secondly when the age or market conditions make a ship not profitable to operate for the owner, Hiremath *et al* (2016). The scrapping of ships is sustainable from an economic context, as it reduces the dependency on iron-ore mining, lowers the need to import steel from foreign markets, and generates suitable labor opportunities. Before the 1960s, this practice was confined to some industrialized countries like the United States, the United Kingdom, Germany, and Italy. Afterwards, in the next decade, this industry migrated to a few semi-industrialized countries such as Korea, Spain, Turkey, and Taiwan due to the availability of low-cost labor. Since the 1980s, ship recycling was introduced in the scrap yards of India, Pakistan, and Bangladesh to enhance the monetary benefits of the industries. The potential reasons for the migration of shipbreaking activities into these underdeveloped nations during that time were the availability of cheap labor and nominal health, safety, and environmental standards. Across the Indian subcontinent, multiple ship recycling yards operate in India, Bangladesh, and Pakistan. India is one of the world's largest ship recycling nations. Alang, located along the west coast of Gujarat, presently has nearly 120 active recycling yards dismantling end-of-life ships to extract various types of scraps and equipment for recycling and reusing, Singh (2021). Bangladesh has around 150 ship recycling yards, Illius (2020) but the number of active yards is nearly 50. According to World Bank studies and YPSA (Young Power in Social Action, an NGO), 22,000 to 50,000 workers are employed directly at the shipbreaking yards in Bangladesh whereas the number is around 100,000 to 200,000 indirectly, Hossain and Islam (2006) and Sarraf *et al* (2009).

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According to many reports, the ship-breaking industry in Bangladesh has an estimated annual turnover of around 1.5 billion dollars on average. Currently, it has become a profitable industry for the nation. The advantages for Bangladeshi shipbreaking yards may be obvious in terms of short-term economic gain. Still, unfortunately, these yards are currently lagging behind in terms of long-term initiatives for sustainable development compared to their competitor yards across India, China, and Turkey. Being a heavy industry, ship recycling has been a concern for the international community considering the generation of hazardous wastes posing severe effects on human lives and the environment. Over the years, ship recycling has resulted in unwary mishaps and accidents. The hazards linked to shipbreaking broadly fall into two categories: intoxication by dangerous substances, and accidents on the plots, Mehtaj *et al* (2022). Due to the occurrence of these hazards and the negligence of the South-Asian scrap yards to offer a risk-free working environment, multiple international concerns have been raised over the past years. These issues regarding the lax occupational safety standards of workers engaged in the ship recycling yards led to several amendments and the adoption of a safe ship recycling charter, the Hong Kong Convention (HKC) in 2009 (The Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, International Maritime Organization, IMO, 2009).

According to the HKC, responsible and sustainable shipbreaking activity ensuring zero harm to the environment and workforce is called a compliant ship recycling process. As per the HKC, for a ship recycling facility to be compliant, the availability of relevant technology, equipment, and facilities must be ensured along with the amenities to train the workforce and safeguard the recycling facility's occupational environment, health, and safety standards. In the ship recycling sector in Bangladesh, the issue of workplace safety in non-compliant yards is not appropriately practiced. Many owners emphasize the commercial aspects of shipbreaking more than the issues of a risk-free workplace and workers' safety. Already, recycling nations like India, China, and Turkey has advanced in this sector by establishing compliant recycling yards, highly mechanized and equipped with all the necessary infrastructure. Within the next couple of years, there is a high possibility that Bangladesh will ratify the HKC and once the HKC is put into effect, the ship recycling yard owners in Bangladesh will face difficulties in sustaining this business unless compliant recycling yards come into operation. As per the HKC guidelines, all ship recycling yards must be enabled with a standardized safety setup to ensure a productive and accident-free workplace culture. And for that to happen, the ship recycling yard owners must make heavy investments. Few researchers have previously conducted feasibility studies to develop compliant and green ship recycling facilities. Sunaryo *et.al* (2020) conducted a feasibility study on two different models, respectively a service provider model and a 3-in-1 model green ship recycling facility in Indonesia. Still, the study did not indicate the data collection methods and relied on simulated financial assumptions. In another study of designing a green ship recycling yard, Sunaryo and Pahalatua (2015), the facilities, layout, and design aspects were discussed, but a financial analysis was not conducted. Also, research has not been conducted based on the projection of financial parameters and evaluation of the feasibility of implementing compliant ship recycling facilities across the South-Asian countries. Hence, this study reflects on the financial feasibility of establishing compliant ship recycling facilities in Bangladesh. From the findings of economic estimates (secondary data), Sarraf *et al* (2009) and Ahammad and Sujauddin (2017), and primary data obtained from field visits to ship recycling facilities, the financial feasibility of compliant ship recycling has been assessed in this research.

2. Methodology

2.1 Data collection

The data collected for this study is based on the KII (Key Informant Interviews) method, where an in-depth qualitative interview of 12 respondents has been carried out. Initially, a set of semi-structured questions was prepared related to the capital and variable costs associated with the entire ship recycling process in Bangladesh, and thereafter, 12 individuals with thorough and unique knowledge of the scrap market and financial particulars of the ship recycling operations were chosen for the interviews. Of these participants, 3 of them represented banks and financial institutions, and the rest were finance managers from 9 ship recycling yards. From August 2022 to September 2022, visits to financial institutions and recycling yards were performed to obtain cost-based findings through the interviews.

The data collected for this study contains all segments of fixed capital and variable expenses of the yards and annual sales price of all items recovered from recycled ships which have been calculated and projected for assessing the financial feasibility. The projection was conducted based on a study of three different cases. As the input parameters of combined fixed and variables costs, the following components have been taken into consideration for this study:

(a) Fixed Capital Costs (Land acquisition, Investments for Infrastructure development, and other costs associated with depreciation, business insurance, etc.)
(b) Annual Government Charges, Taxes, and Duties
(c) Annual Costs for Environmental Clearance, Audit, Compliance, and administrative purposes
(d) Annual Ship Purchase Costs (Letter of Credit Payments along with interest rates)
(e) Annual Working Capital Costs (including bank loan payments, if any)
(f) Annual Sales (Earnings from the sale of metal, non-metal, scrap, and other recoverable and reusable materials)

Component (a) has been speculated based on financial projections for long-term capital investment projects. Components (b) and (c) have been calculated from the secondary data source mentioned in section 1 and components (d), (e), and (f) have been projected based on the KIIs.

2.2 Financial evaluation

Among multiple criteria for assessing the feasibility or worthiness of capital projects, the following 4 parameters have been used for this study:

(a) Payback Period (PBP) – PBP is the time that is required to recover the costs of an investment and is regarded as one of the most used and accepted methods for determining the economic desirability of any investment. If PBPs for capital investments are compared, then an investment with a shorter payback period and a higher degree of liquidity are more desirable than an investment having a longer payback period, Thuesen and Fabrycky (2000). For stable annual cashflows, the payback period is calculated as:

PBP = Investment/ (Annual Cashflow) x 1 Year (1)

(b) Net Present Value (*NPV*) – This method is used to obtain the current value of all the future cash flows generated by any project, which also includes the initial capital investment, Jagerson (https://www.investopedia.com/ask/answers/032615/what-,formula-calculating-net-present-value-npv.asp, accessed on 17 October 2022) [12]. For analyzing long-term projects with multiple cashflows, the *NPV* is calculated as follows:

$$NPV = \sum_{t=0}^{n} \frac{Rt}{(1+i)^t} \quad (2)$$

In the world of finance, the *NPV* method is regarded as a highly important benchmarking tool as it considers both the time value of money and provides concrete numerical values through which decision-makers can compare initial outlays of cashflows to the present values of return.

(c) Profitability Index (PI) – PI measures the ratio between the present value of future cash flows and the initial investment. This metric is essential in ranking project investments. If PI > 1, then the project is deemed worthwhile, and the investment is acceptable, CFI (https://corporatefinanceinstitute.com/resources/knowledge/accounting/profitability-index/, accessed on 17 October 2022). PI is calculated as follows:

PI = (Present Value of Future Cash flows) / (Initial Investment) (3)

(d) Internal Rate of Return (IRR) – The IRR is a discount rate that makes the net present value (NPV) of all the cash flows equated to zero in a discounted cash flow analysis. In financial assessment, the organizations or projects use IRR to find whether the project is worth investing in or not based on the estimated percentage return offered by the project. Practically, the higher the internal rate of return in contrast to the interest rate at which the amount of money is borrowed from financial institutions, the more desirable the investment, Fernando (https://www.investopedia.com/terms/i/irr.asp, accessed on 17 October 2022). If C_t is the net cash inflow during the period t, Co is the total initial investment costs, IRR is the internal rate of return and t is the number of periods, then,

$$0 = NPV = \sum_{t=1}^{T} \frac{Ct}{(1+IRR)^t} - \text{Co} \quad (4)$$

3. Case Study

This research is based on the assessment of the development of compliant ship recycling yards in Bangladesh in terms of financial aspects. To obtain the findings from this research, a case study has been designed considering three different categories of ship recycling yards. These categories have been chosen based on the existing ship recycling practices and the infrastructural capacities of the currently operating ship recycling yards in Bangladesh. The three categories chosen for this research are:

(a) Category 1 – Developing a completely new compliant ship recycling yard (A)
(b) Category 2 – Upgrading an existing non-compliant ship recycling yard with considerable infrastructure (B) into a compliant yard (A)
(c) Category 3 – Upgrading an existing non-compliant ship recycling yard with little infrastructure (C) into a compliant yard (A)

Generally, any compliant ship-recycling yard as per the HKC framework should be well equipped with all the standard amenities. The major entities that differentiate a compliant ship-recycling yard from other non-compliant yards include the existence of an adequate and organized infrastructural setup. These components include concrete impermeable floors, well-

maintained drainage, and bilge/rain/wastewater systems, separately earmarked cutting and material stacking zones, comprehensive fire-fighting systems, medical and training centers, a mechanized system of operations with adequate equipment and machinery setup, HAZMAT storage areas with asbestos containment units, and proper health and sanitation facilities. These features have been considered for this study, which represents a compliant ship-recycling yard (A). However, most of Bangladesh's actively operating ship recycling facilities fall short of compliance as they lack certain amenities.

Yard (B) considered for this study notably represents around 10-15 ship recycling facilities acknowledged as promising contributors to this industry. These recycling yards have adequate facilities, satisfactory mechanization, moderate operational excellence, and health-safety practices but require further upgradation to be enlisted as HKC-compliant yards.

Most recycling yards (C) are underperforming as these yards do not contain adequate or satisfactory infrastructure and mechanization. Also, in terms of health-safety maintenance and operational excellence, these yards do not reflect compliance. Fig. 1 shows the identified components and categorical differences for yards A, B, and C. A few more hypothetical aspects have been taken into consideration for this study. These aspects are depicted in Table 1.

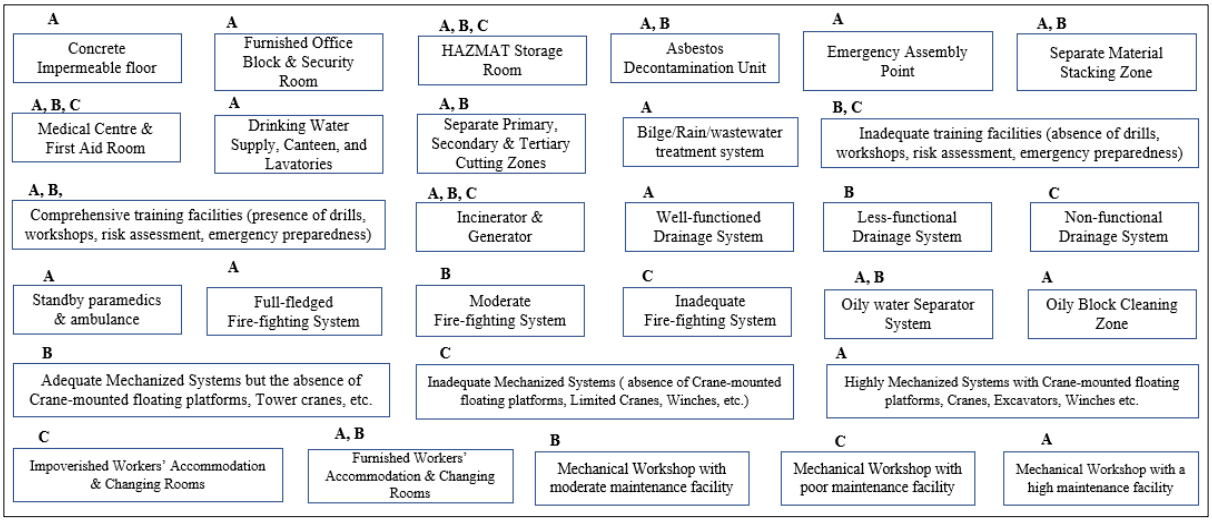

Fig. 1: Categorical Differences for Yards A, B, and C

Table 1: Case Study (Points of financial estimation)

Total Area for all categories	**Average Number of Ships Scrapped (Annually)**	**Average Annual Generation of LDTs**
Yard (A) – 25,000 square meters	Yard (A) – 3 to 5 ships yearly	Yard (A) – 65,000 LDTs
Yard (B) – 25,000 square meters	Yard (B) – 3 to 5 ships yearly	Yard (B) – 65,000 LDTs
Yard (C) – 25,000 square meters	Yard (C) – 3 to 5 ships yearly	Yard (C) – 65,000 LDTs
Total LDTs generated after 20 years – 12,35,000		Total Years of Operation – 20 Years

3.1 Data projection

The comparative costing for the three ship recycling yards stated in section 3 has been calculated for 20 years. Fig. 2 shows the comparison of investments for all three yards. The difference in the initial fixed costing for all these yards varies as per the requirement of infrastructural construction. The costs for all three categories have been projected for the establishment of compliant recycling yards. Yards B and C are already in business, but yard A is the new entrant in this market and hence will face initial liabilities for heavy investment for the development of a compliant ship recycling facility.

In Bangladesh, ship recycling yards bear variable expenses in the form of cost components like costs for purchasing EOL (end-of-life) ships, working capital for scrapping, government fees (environmental clearance and certification costs, audit, administrative, and other associated business costs), and the annual depreciation values. The discounted factor for this analysis is estimated to be 9%, which is the current Bangladesh Bank-approved interest rate at which capital industries can borrow principal sums as loans for financing. Hypothetically, all three model yards have been assumed to have identical costs related

to the purchase of EOL ships, working capital, and other costs involving government duties, taxes, certification costs, and auditing. Only, the depreciated values for the three model yards are different due to the difference in the fixed costs.

Fig. 3 illustrates the combined proportional segregation of typical variable costs associated with category A, B, and C recycling facilities. The highest costs incurred for any ship recycling yard lie in the purchases of ships from the demolition market and the working capital costs are the second highest among the variable expenses. The ship purchase costs have been projected based on the international demolition market pricing, Go Shipping (https://www.go-shipping.net/demolition-market, accessed on 17 October 2022). The costs associated with government fees, audits, environmental clearance, compliance, and depreciation are quite less compared to the working capital and ship purchase costs and are not burdensome for recyclers. These variable costs have been aggregated to evaluate the findings for the assessment of financial feasibilities for all the 3 categories of ship recycling yards considered for this study. Apart from evaluating 4 parameters stated in section 2.2 to estimate the worthiness of investments, the average sales rate for resalable and reusable scrap and other recovered ferrous, non-ferrous, and non-metal materials has been estimated by taking a sample oil tanker ship of 21,900 LDTs as the basis. Fig. 4 presents the quantitative allocation of recoverable materials for the basis ship considered for this study.

4. Results and Discussion

The yearly average cash flows have been obtained from the projections of all fixed and variable expenses and combined sales. With the net cash flows being calculated, and discounted factor being considered, the findings were speculated to attain Net Present Values (NPVs) for all 3 model yards. The NPVs for 20 years of the operational period are demonstrated in Fig. 5. The results from Fig. 5 indicate that all three categories of yards upon development and operation as a standard or compliant ship recycling facility will have consistent and sustainable Net Present Values, thus signifying the worthiness of capital investments. The already existing ship recycling yard (B) will generate the highest amount of NPVs upon development as a compliant recycling yard. The reason can be ascertained from the difference in capital investment for category B with categories A and C. An existing yard with sufficient financial strength will generate higher NPVs compared to a fresh entrant and another existing yard lagging in infrastructure and operational excellence. Both yards A and C will require hefty capital investments and banking finance to develop and operate the compliant recycling yards. Thus, Category A and C yards will obtain considerable leverage in generating suitable NPVs, but the highest share will be achieved by Category B recycling yards. The yearly earnings (cash flow) for all 3 model yards are demonstrated in Fig. 6. The results indicate sustainable and sufficient annual incomes over 20 years.

The profitability indices (Fig. 7) signify the worthiness of investments for all 3 model yards. Since the PIs for all 3 model yards are higher than 1, all 3 investments are feasible and profitable. Yard B has the highest PI, due to the least amount of capital investment and Yard A has the lowest PI owing to the highest capital expenses. Yard C is nearly 1.66 times as profitable as Yard A, and Yard B is nearly 3 times as profitable as Yard A as per calculation. Ideally, all categories of yards are profitable, which gives a positive impression for owners to consider developing existing ship recycling yards as compliant yards.

The internal rates of return for all 3 categories of yards are illustrated in Fig. 8. As stated in section 4, the borrowing rate for capital financing from financial institutions as per the approved government rule in Bangladesh is 9%. The IRRs obtained from the projections indicate higher returns on investment for all the 3 model yards. Ideally, as per financial analyses, an IRR of nearly 20% is considered a good fit, but it may vary depending on the costs of capital. Since all 3 IRR values are higher than the borrowing rate of 9%, the investments for all 3 recycling yards categories are deemed desirable.

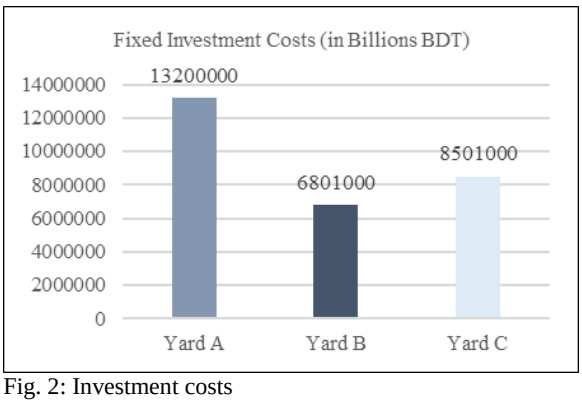

Fig. 2: Investment costs

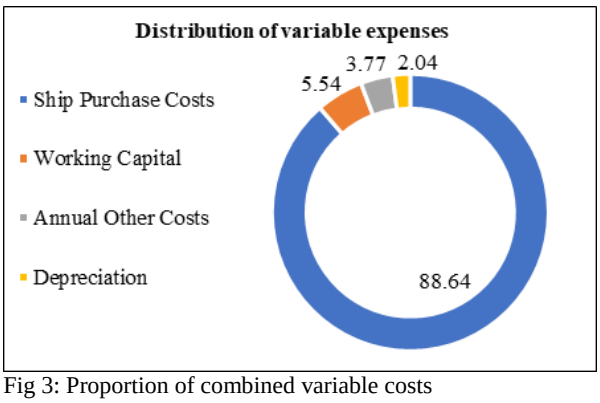

Fig 3: Proportion of combined variable costs

Finally, Fig. 9 shows the payback periods for all three model yards. As a fresh entrant, Yard A will require around 3.6 years to recover the investment costs considering its challenges as a new recycler in the industry. Yard B will reap the maximum benefits of recovering the investments at the earliest, in nearly 2.3 years. And Yard C will take around 3.1 years to retrieve its investments. All investments are desirable in this context but on a comparative assessment, both the existing yards (B) and (C), will surely achieve higher liquidity compared to the yard (A). This research highlights the advantages of compliance in

ship recycling for Bangladesh irrespective of all three yards assumed for this study in the following section. The recyclers shall gain a competitive advantage and a dominant scrap business leverage within the industry if they reconstruct and apply the strategic methods of developing their yards as HKC compliant.

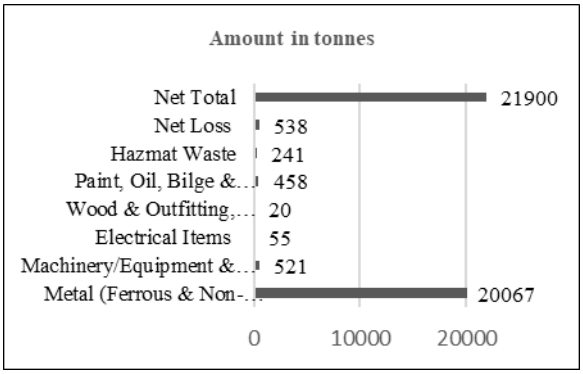

Fig 4: Proportion of recoverable items (for 21,900 LDT Oil Tanker Ship)

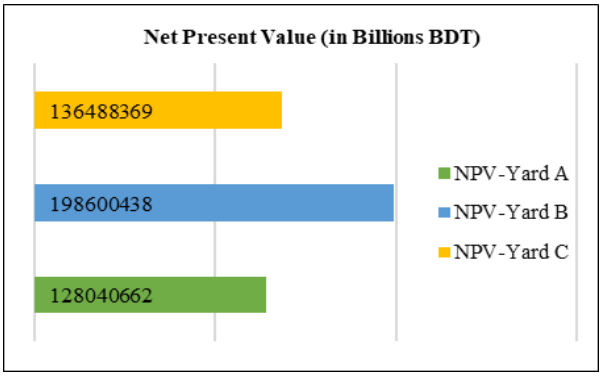

Fig 5: NPVs after 20 years of operation

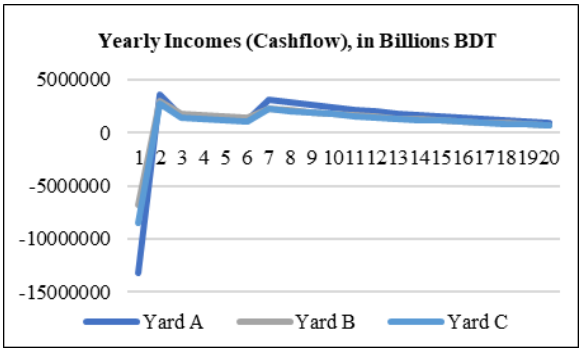

Fig 6: Annual Income for yards A, B, and C

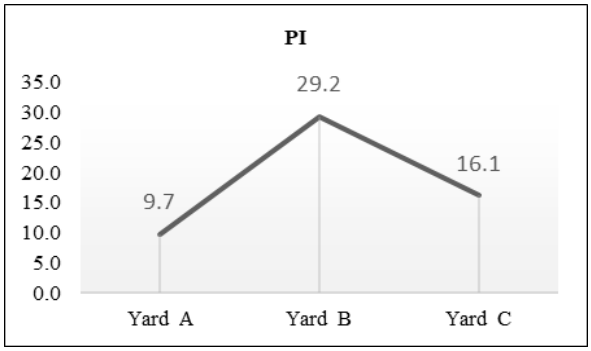

Fig 7: Profitability Indices

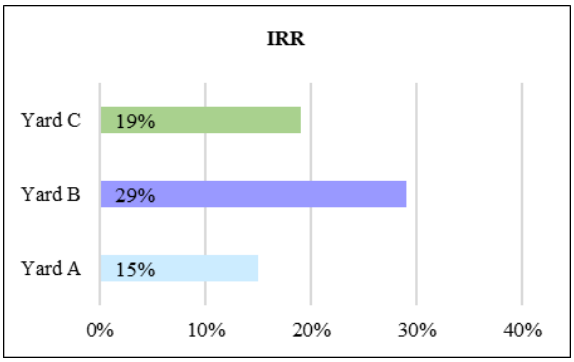

Fig 8: Internal Rates of Return

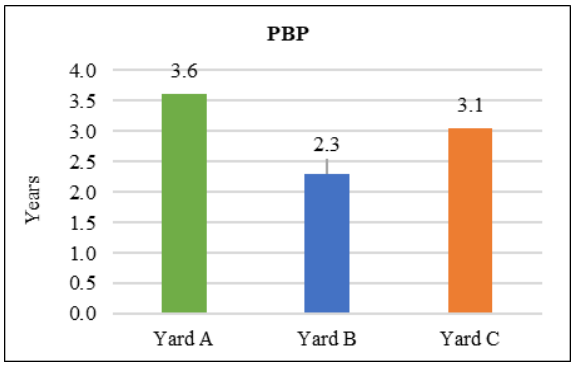

Fig 9: Payback Periods

4.1 Advantages of compliant ship recycling yards in Bangladesh

The findings from this study clearly show that developing the existing yards as compliant yards or establishing a new standard yard will cater to positive outcomes for local ship recyclers in Bangladesh. Being one of the largest ship recycling destinations in the world, Bangladesh can surely reap the long-term benefits of compliant ship recycling in the following ways:

(a) Enrichment of business goodwill and national image
(b) Ease of doing business (leverage in purchasing green ships at lower costs) and seeking flexible financial support from local and government banks
(c) Cleaner production of secondary steel

(d) Efficiency in the production process (faster cutting) due to enhanced mechanization
(e) Compliant and safe workplace
(f) Reducing manual labor
(g) Attracting more cash buyers and international investments and funding assistance
(h) Stable, sustainable, faster, and higher economic growth

4.2 Challenges for ship recycling facility owners

Although the findings of this study illustrate the desirability and worthiness of compliant ship recycling in Bangladesh as highly competitive and profitable, nonetheless the scrap business and recycling yard owners will still face some inevitable challenges such as:

(a) Initial liability of massive capital investment
(b) Increased working capital or operating expenses at the initial stages of steel cutting
(c) Sole proprietors or organizations that are not vertically integrated and have subsidiary business units in other sectors will feel tremendous pressure for capital financing unless they have sufficient stock of raw capital or stable mortgage valuation
(d) Fear of bankruptcy or lack of financial support from banks and other finance-based institutions
(e) Initial loss of business growth to other competitors in the national and South-Asian market
(f) Buying EOL ships at remarkably soaring prices owing to inflation and price fluctuation within the international scrap market

5. Recommendations

To enact safe and sustainable ship recycling in Bangladesh as per the HKC guidelines, the first and foremost issue is to understand and empathize with the mindset of the ship recycling yard owners in Bangladesh. As observed by the authors, it can be stated that there is a disparity among the stakeholders. The top market leaders and organizations that are involved with scrap-linkage businesses in Bangladesh are willing to change for the better. With only two active HKC-compliant ship recycling facilities operating in the country, the others, notably amongst the top ten highest shareholders of the ship recycling market are already investing in their ship recycling units to set up advanced facilities. These recyclers are aiming to obtain the internationally recognized and Class-Certified Statement of Compliance (SoC) within the next 2-4 years. This is indeed a positive reflection for the industry. But around 50-60% of the small-scale yards with less experience and financial goodwill are still lagging behind in terms of compliance. These recyclers are uncertain regarding their future as it may seem burdensome to make massive investments with high risks involved, as stated in section 4.2. Hence, considering the overall scenario and the nature of ship recyclers in Bangladesh, this study recommends the following:

(a) Financial and legal institutions involved with ship recyclers may provide flexibility in terms of legal, administrative, and financial issues concerning customs and rummage clearance, and ease of repayment of loans. In that case, the recyclers will be encouraged to invest in the establishment of compliant ship recycling facilities.

(b) The government agencies involved with the ship recycling industry should ensure fast-forward initiatives for capacity building of the recyclers and implementation of the TSDF (Treatment, Storage, and Disposal Facility) for the safe and effective management of hazardous substances emitted from the ship recycling facilities. Assistance from the government will work as moral support for ship recyclers in considering the expansion of compliant ship recycling practices in Bangladesh.

(c) Seeking international funding to aid the greater portion of staggering recyclers who are at risk of losing their potential business to the top players in the market. If international donor agencies or financers like JICA, NORAD, etc. come forward to assist the government of Bangladesh in promoting the lagging behind ship recycling yards to improve as HKC-compliant yards, then the industry would get a competitive edge to carry on with this business.

(d) The Bangladesh Ship Breakers and Recyclers Association (BSBRA) should employ safe and risk-free amenities for the workforce in congregation with all the industry stakeholders and prepare a national safety training guideline or framework to be mandatorily followed by recyclers for ensuring workplace and environmental safety and health.

6. Conclusions

This study elaborated on the financial feasibility of incorporating compliant-ship recycling facilities in Bangladesh. The findings from the feasibility study have shown encouraging results and the acceptability of capital financing for establishing compliant-ship recycling yards. It is anticipated that the commercial mindset and oblivious thinking of the majority of ship recyclers in Bangladesh to develop and promote compliant ship recycling may be changed to cater to the sustainability and significance of ship recycling in the days to come. However, this research was limited to key informant interviews. Also, financial information is to some extent confidential, as a result of which, few cost parameters have been assumed based on generalized market conditions. Only one basis ship has been considered for forecasting the sales of recoverable materials from obsolete ships. Also, as access to a few small and non-operable ship recycling yards could not be managed, this study was conducted with limited data.

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References

Hiremath, A.M., Pandey, S.K., Asolekar, S.R. (2016): Development of ship-specific recycling plan to improve health safety and environment in ship recycling yards; Journal of Cleaner Production 116 279-298, 2016. https://doi.org/10.1016/j.jclepro.2016.01.006

CFI Team, May 01, (2022) Profitability Index, CFI, October 17, 2022, https://corporatefinanceinstitute.com/resources/knowledge/accounting/profitability-index/

Thuesen, G. J. and Fabrycky, W.J. (2000): Engineering Economy, Pearson, 9th Edition

Go Shipping (2022): https://www.go-shipping.net/demolition-market. October 17

Ahammad, H. and Sujauddin, M. Contributions of Ship Recycling in Bangladesh: An Economic Assessment. IMO-NORAD SENSREC Project, IMO, London, UK, 2017

Fernando, J. (2022): What Is Internal Rate of Return (IRR)?, Investopedia, October 17, 2022, https://www.investopedia.com/terms/i/irr.asp.

Jagerson, J. (2022): How to Calculate Net Present Value (NPV), Investopedia, October 17, 2022, https://www.investopedia.com/ask/answers/032615/what-formula-calculating-net-present-value-npv.asp.

Hossain, M.M.M. and Islam, M.M. (2006): Ship Breaking Activities and its Impact on the Coastal Zone of Chittagong, Bangladesh: Towards Sustainable Management, https://www.ypsa.org/publications/Impact.pdf.

Sarraf, M., Stuer-Lauridsen, F., Dyoulgerov, M. Bloch, R. Wingfield, S. Watkinson, R. (2009): The ship breaking and recycling industry in Bangladesh and Pakistan; World Bank Report.

Mehtaj, N., Dipto, S.S., Zakaria, N.M.G., Awal, Z.I., Hannan, M.A., Dev, A.K. (2022): A techno-economic study on ship recycling practices in bangladesh: from safety perspective; Proceedings of the 3rd International Conference on the Decommissioning of Offshore & Subsea Structures, DECOM-2022.

Singh, R., (2022): Doubling ship recycling capacity by 2024: Are we ready? Down to Earth, October 17. https://www.downtoearth.org.in/blog/environment/doubling-ship-recycling-capacity-by-2024-are-we-ready-75494.

Illius, S., (2022): Green ship-breaking yards still a far cry, The Business Standard, October 17. https://www.tbsnews.net/economy/industry/green-ship-breaking-yards-still-far-cry-120394.

Sunaryo, S. and Pahalatua, D. (2015): Green ship recycle yard design, Journal of Naval Architecture and Marine Engineering, 12(1). https://doi.org/10.3329/jname.v12i1.20450

Sunaryo, Hanura, A. R. and Hussein, F. (2020): Feasibility study on the financial aspects of green ship recycling yard business model; AIP Conference Proceedings. https://doi.org/10.1063/5.0001072

IMO (2009): The Hong Kong International Convention for The Safe and Environmentally Sound Recycling of Ships.