AN ECONOMIC ANALYSIS OF SHIP RECYCLING INDUSTRY OF PAKISTAN: EXPLORING PRICE FORMATION AND POLICY OPTIONS FOR RETAINING COMPETITIVE ADVANTAGE

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CERTIFICATE

This is to certify that this thesis entitled **"An Economic Analysis of Ship Recycling Industry of Pakistan: Exploring Price Formation and Policy Options for Retaining Competitive Advantage"** submitted by **Ms. Aqsa Gull** is accepted in its present form by the School of Economics, Pakistan Institute of Development Economics (PIDE), Islamabad as satisfying the requirements for partial fulfillment of the degree in Master of Philosophy in Economics.

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Author's Declaration

I Aqsa Gull hereby state that my MPhil thesis titled An Economic Analysis of Ship Recycling industry of Pakistan: Exploring Price Formation and Policy options for Retaining competitive Advantage is my own work and has not been submitted previously by me for taking any degree from Pakistan Institute of development economics or anywhere else in the country or world at any time. If my statement is found to be incorrect even after my graduation the university has the right to withdraw my MPhil degree.

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DEDICATION

Dedicated to my beloved parents

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All praises to Almighty Allah, the most Beneficent, and the Most Merciful.

I am immensely grateful to Almighty Allah, for granting me the strength and guidance to complete this task using the abilities bestowed upon me.

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ABSTRACT

This study presents an economic analysis of the ship recycling industry in Pakistan, focusing on market structure and conditions, as well as the formation and forecasting of demolition prices. The study also aims to conduct a policy gap analysis to identify areas for improvement in order to retain Pakistan's competitive advantage in the ship recycling industry.

Using a mixed methods approach encompassing both qualitative and quantitative research, primary data was collected through observation and in-depth interviews. Thematic analysis was employed to analyze the qualitative data, which served as the basis for formulating a theoretical model, supplemented by theoretical foundations derived from the relevant literature.

Empirical investigation of the relationships among ship scrapping prices (the demolition prices), steel scrap prices, exchange rates, and international oil prices was carried out using the Gregory Hansen Procedure for testing Cointegration in the presence of structural breaks. The analysis revealed the existence of a long-term relationship among the variables, with steel scrap prices demonstrating a dominant and significant role in determining ship demolition prices in Pakistan.

Additionally, a comprehensive policy gap analysis was conducted to identify and highlight areas of improvement in the ship recycling industry's policies and regulations in Pakistan. The findings suggest that Pakistan can only retain its competitive position in the industry by ratifying Hong Kong Convention (HKC) and complying to other international regulations as is done by India and Bangladesh. Furthermore, safeguarding domestic demand for ship steel, establishing a clear administrative jurisdiction for development of dedicated regulatory framework coupled with grant of industry status, capacity building through investments in infrastructure and R&D are requisites for the maintenance of Pakistan's competitive advantage in ship recycling.

This study contributes to the understanding of the economic dynamics and policy landscape of the ship recycling industry in Pakistan. The findings provide valuable insights for industry stakeholders, policymakers, and researchers, aiding in the formulation of effective strategies and policies to enhance the industry's competitiveness and sustainable growth.

Keywords: Ship Recycling Industry, Demolition Prices, Gregory Hansen Cointegration, Structural Break, Policy Gap Analysis.

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LIST OF ACRONYMS

ADF	Augmented Dickey Fuller
AIC	Akaike Information Criterion
ARIMA	Autoregressive Integrated Moving Average
BD	Bangladesh
BEPA	Balochistan Environmental Protection Agency
BDA	Balochistan Development Authority
BSRB	Bangladesh-Ship-Reprocessing-Board
CUSUM	Cumulative Sum
CUSUMSQ	Cumulative Sum Square
DF	Dickey Fuller
EIA	Impact Assessments
ECM	Error Correction Model
EOL	End-of-life
EPA	Environmental Protection Agency
EU	SRR European Union Ship Recycling Regulation
GH	Gregory Hansen
HKC	Hong Kong Convention
HQ	Hannan-Quinn
ILO	International Labor Organization
IMO	International Maritime Organization
IHM	Inventory of Hazardous Materials
LC's	Letters of Credit
LDT	Light Displacement Ton
MAE	Mean Absolute Error
ME	Mean Error

M & E	Monitoring and Evaluation
MoA	Memorandum of Agreement
MoCC	Ministry of Climate Change
MoMA	Ministry of Maritime Affairs
NIMA	National Institute of Maritime Affairs
OECD	Organization for Economic Cooperation and Development
OHS	Occupational health and safety
PACRA	The Pakistan Credit Rating Agency Limited
PEPA	Pakistan Environmental Protection Act
PSBA	Pakistan Ship Breakers Association
PIDE	Pakistan Institute of Development Economics
RMSE	Root Mean Squared Error
SC	Schwarz Criterion
SENSREC	Safe and Environmentally Sound Ship Recycling
SECP	Securities and Exchange Commission of Pakistan
SRI	Ship Recycling Industry
SRF	Ship Recycling Facility
SRFP	Ship Recycling Facility Plan
TS	Tracking Signals
UNEP	The United Nations Environment Programme
UNCTAD	United Nations Conference on Trade and Development
VAR	Vector Autoregression
VECM	Vector Error Correction Model
VIF	Variance Inflation Factor
ZA	Zivot-Andrews Test

List of Symbols

PD	Demolition Prices
BC	Bulk Carrier Demolition Prices
TKR	Tanker Demolition Prices
ER	Exchange Rate
CO	Crude Oil
SS	Steel Scrap
TR	Tax Revenue

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CHAPTER 1

INTRODUCTION

1.1. Background

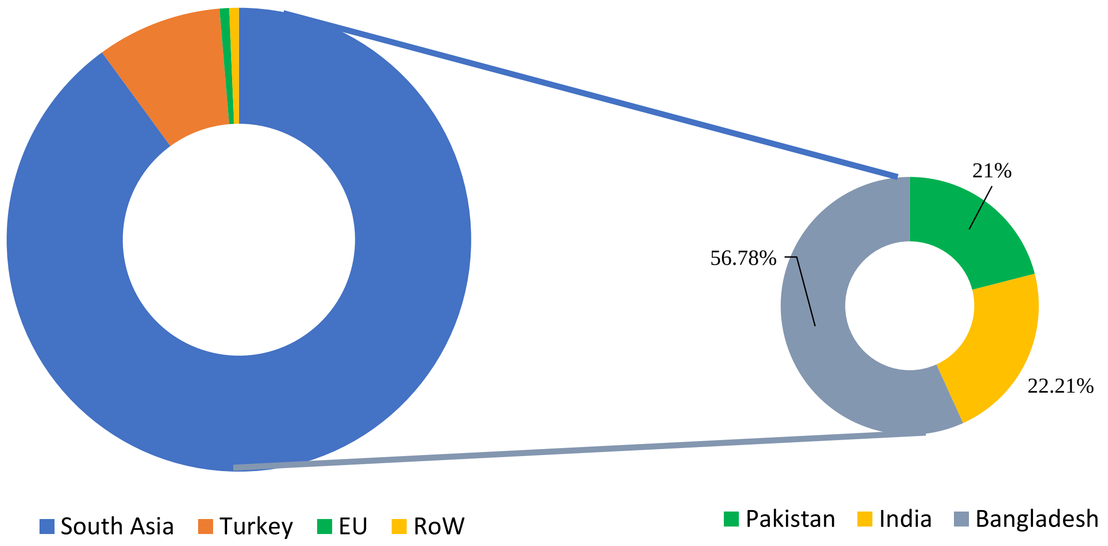
Ship recycling industry (SRI) is a recourse to recycling huge amounts of metal resources, which otherwise would result in sheer wastage of resources. End of life sea vessels are recycled to recover the metal from hull, which is either re-rolled into bars and rods or melted in mills to make new steel. In addition to the ship steel, practically every other item is removed and resold for more money in secondary markets. It is, therefore, a valuable sector for developing economies because it serves as a major supplier of materials to steel sector (Wang et al., 2014); requires minimal investment and is a labor-intensive industry, thus providing employment to millions (Pour et al., 2012a). It is therefore a cheap and easy source of crude steel production in steel scarce countries. Apart from being the balancing lever for shipping sector, SRI contributes to the economic development of the countries in which it is centered (Jugović et al., 2015; Mikelis, 2013a; Sarraf et al., 2010a; Terao, 2011).

The relocation of SRI from industrialized countries to developing countries of South Asia happened in 1970's in pursuit of lower labor expenditures and strong local steel demand; as a result, the activity is now restricted to emerging economies where the aforementioned requirements are satisfied (Stopford 2009). A closer look at the global tonnage recycled in recent years, specifically year 2021[1], reveals that shipbreaking industry is, concentrated in a limited number of countries, primarily centered in South Asian region as Bangladesh, Pakistan and India constitute 90% of the total gross tonnage scrapped worldwide. Pakistan is among the top three players dismantling 21% of the total beached tonnage (See Figure 1.1).

Lately, Türkiye is also emerging as a significant ship breaking center, though with far less capacity and lesser recycled volume than other players. China is the fifth player in this industry accounting for most of the rest tonnage dismantled, however the footprint of ship breaking activity is dwindling fast in china owing to international environmental considerations. The

[1] Year 2022 was not chosen to showcase the current ship recycling volumes due to a substantial decrease in global ship scrapping activity in 2022, which has been unprecedented in more than ten years, and thus is not representative of the true market scenario of this industry. However, the global ship recycling activity's performance in the year 2022 has been analyzed later in the next sections. It is important to note that the decline in the number of ships scrapped in 2022 has been attributed to various regional and global factors, including elevated ocean freight rates that incentivized the continued operation of older ships and limitations in banks' provision of letters of credit to companies for the acquisition of end-of-life assets, which were identified as the primary influencing factors.

total share of the top five actors (top three + Turkey and China) is 99.33% of the total tonnage scrapped worldwide.



Source: NGO Shipbreaking Platform.

Figure 1.1: *Shipbreaking Records 2021 (Gross Tonnage)*

In Pakistan, shipbreaking yards are located in Gadani, a district situated 40 km south of Karachi, in the west coast of Balochistan. Gadani shipbreaking yard spanning 10 km long beach with 68 operational plots is among the largest ship recycling yards of the world. Shipbreaking is the main source of steel in Pakistan as one third of the total steel production comes from SRI in Pakistan[2]. Still, it is not acknowledged as a formal industry in Pakistan. Because it is conspicuously visible, thus it is politically contentious one especially in Balochistan. In the last several years, shipbreaking activity in Pakistan has seen many ups and downs owing to a number of socio-economic factors as well as pressure from international environmental regulations.

Despite being a neglected industry, the industry possesses vast economic potential given the ever-increasing domestic steel demand. Pakistan can recycle 100-120 large tankers annually and considerably caters to the needs of country's steel demand with an annual average output of 500,000 tons, which makes up 15% of total steel production in Pakistan (Iqbal et al., 2021). In addition to supplying steel and other goods to the regional economy without depleting natural resources, the SRI also directly or indirectly employs an estimated 850,000 people

[2] PSBA, 2023; PACRA 2022.

(Iqbal et al., 2021). Furthermore, the tax payments by ship breakers contribute approximately Rs. 6 billion annually to national exchequer[3]. Thus, to realize economic potential and to address the concerns of shipbreaking stakeholders regarding the neglect by the government, better understanding of the dynamics of SRI is required. Consequently, a detailed analysis of the economics of this sector is an important policy discourse that needs to be explored.

1.2. Research Problem

There has been little research to study the economics and competitiveness of the SRI. Most research has concentrated on the shipbreaking processes, methods and its socio-environmental repercussions. Profitability in SRI has been presumed to be the result of supply-side considerations; and employment in SRI, through its multiplier effect, is considered to be the only indicator of economic significance. Until now, little research has been done on the down-stream market of SRI outputs (Sarraf et al., 2010b). Thus, details about the industry's economics have always been skipped or explored in a generic and superficial manner.

Ship breakers offer prices to attract end-of-life ships and these prices vary for different countries depending upon the pricing strategy of relevant country. Only a few studies have analyzed the ship demolition prices but none has studied the formation of prices in a country-specific scenario. No incentive for capacity building, a lack of government support, and hefty taxation has deteriorated the purchasing power of Pakistani ship breakers. Thereby, annual ship-recycling tonnage in the country is thus declining in contrast to that of regional competitors. Furthermore, the International Maritime Organization (IMO) and other international bodies are advocating environment friendly practices for ship recycling through HKC. India and Turkiye already being parties to the HKC, Bangladesh is also set to adopt it. As a result, ship owners' focus has shifted to other regional players i.e. Bangladesh and India who make attractive pricing offers to ship suppliers. The implementation of the HKC may bring changes to the shipbreaking market, which could potentially affect Pakistan's economic advantage.

With this background and problem in mind, this study aims to explore the economic dynamics of SRI in Pakistan, specifically, tracing the determinants of demolition prices thus providing important signals to decision makers so that Pakistan can retain its competitive advantage in the region.

[3] Pakistan Shipbreakers Association (PSBA).

1.3. Research Questions

Primary research question: How can Pakistan retain its competitive advantage through available information flows and informed decision making in pricing? This question can be operationalized into following questions:

Q. 1: What is the structure of demolition market as assessed by the degree of competition and degree of formalization in SRI in Pakistan?

Q. 2: How demolition prices are determined internally in Pakistan?

Q. 3: What should be the policy options for Pakistan to sustain its competitive advantage?

1.4. Objectives of the Study

Prices are the signals to which decision makers respond in SRI (N. D. Kagkarakis, Merikas, Merika, et al., 2016). In order to track the formation of prices, this study aims to explore the economic dynamics of SRI in Pakistan, specifically, tracing the determinants of demolition prices, analyzing market structure, demand and supply conditions prevalent in the industry, identifying challenges and proposing market-based solutions for these issues. Since, the primary objective of this study is to provide an economic analysis of Shipbreaking industry in Pakistan for informed decision making. Key research objectives in consonance with research questions are stated below:

Primary objective

- To study the market structure and conditions of SRI in Pakistan
- To trace out formation of demolition prices in Pakistan on the basis of supply-demand determinants and forecast demolition prices

Secondary objective

- To conduct a policy gap analysis for retaining Pakistan's competitive advantage in SRI

1.5. Significance of the Study

This study addresses a significant gap in the existing literature by conducting a comprehensive analysis of the downstream market of SRI outputs in Pakistan. Previous research on SRI has primarily focused on upstream factors such as determinants of supply and price at the regional level, lacking a comprehensive country-level assessment of the economic dynamics of the SRI in Pakistan. Therefore, this study makes a valuable contribution to the subject by offering the first formal economic analysis of the SRI in Pakistan, providing insights into the inter-linkages between various factors affecting price formation. The many contributions of this research can be categorized as follows:

1.5.1. Theoretical Contribution

In addition to the empirical analysis conducted, this study has made a significant theoretical contribution to the literature by developing a rigorous theoretical framework for understanding the price formation in the ship recycling industry in Pakistan. This framework was developed through a meticulous analysis of the existing literature on the subject, which involved examining relevant economic theories, empirical models from previous research, and concepts from the broader fields of economics, environmental sustainability, and maritime economics. Moreover, to enhance the theoretical framework's applicability to the specific context of the ship recycling industry in Pakistan, direct qualitative analysis of primary data was undertaken. The study extensively observed shipbreaking practices and conducted interviews with various industry stakeholders. These primary data collection and analysis efforts were crucial in gaining firsthand insights into the industry's dynamics, challenges, and factors influencing price formation.

Drawing upon the findings of the qualitative analysis and the extensive literature review, this study successfully developed an industry-specific theoretical model for demolition prices in the ship recycling sector in Pakistan. This theoretical model takes into account the unique characteristics, market forces, and regulatory aspects of the industry, providing a valuable contribution to the understanding of price dynamics in this specific context. By incorporating industry-specific factors and insights derived from primary data, the developed theoretical framework enhances the accuracy and relevance of analyzing and predicting demolition prices in the ship recycling industry in Pakistan.

Furthermore, the findings of this study have important policy implications for the ship recycling industry in Pakistan. By identifying the major causes of the declining share of beached tonnage in the country, the study sheds light on the market-level dynamics, including the behavior of firms and internal competition among ship breakers. Additionally, the analysis explores the external influences of prices in other countries, providing insights into the market dynamics from a policy reformation perspective. This information can be instrumental in devising policies that promote the competitiveness, sustainability, and profitability of the SRI in Pakistan.

In summary, this study fills a crucial gap in the literature by offering a country-level assessment of the economic dynamics of the SRI in Pakistan. By utilizing reliable data sources and applying robust econometric techniques, this study provides an objective and comprehensive analysis of the inter-linkages between various factors affecting price formation. The findings contribute to both theoretical understanding and practical policy implications, facilitating informed decision-making and potential reforms in the ship recycling industry in Pakistan.

1.5.2. Methodological Contribution

This study holds significant methodological value as it pioneers econometric research in the field of Ship Recycling Industry in Pakistan. The utilization of a mixed methods approach, combining both quantitative and qualitative methods to provide a comprehensive analysis of the industry sets this study apart.

One of the key contributions of this study is its departure from partisan and unreliable sources often found in existing research reports. By employing robust econometric methods and utilizing reliable statistical sources and estimates, this study ensures a rigorous and objective analysis of the SRI in Pakistan. This shift towards a more empirical and unbiased approach enhances the credibility and reliability of the findings, enabling a better understanding of the economic dynamics of the SRI in the country.

From an econometric perspective, this study addresses a critical aspect often overlooked in previous research on ship demolition prices conducted by Açık & Başer (2017), Kagkarakis et al. (2016), Pettersén & Direnzo (2021), Tunc (2019). Specifically, it accounts for the presence of structural breaks in the dataset, which is an essential consideration for accurate long-term econometric analysis. By incorporating suitable econometric techniques that accommodate structural breaks, such as the Zivot Andrews Test and the Gregory Hansen Test of Cointegration, this study adds to the existing econometric literature on shipbreaking.

Moreover, this study extends beyond quantitative analysis by incorporating qualitative methods for policy analysis, examining firm behavior, and assessing the market situation in the Ship Recycling Industry in Pakistan. This integrated approach adds depth and richness to the findings, allowing for a more comprehensive understanding of the industry dynamics.

Overall, this study's unique contribution lies in its combination of quantitative and qualitative methods, the development of a rigorous theoretical model for demolition price formation in Pakistan, its consideration of structural breaks in econometric analysis, and its comprehensive examination of the Ship Recycling Industry in Pakistan. By addressing these aspects, this research fills important gaps in the existing literature and provides valuable insights for policymakers, industry stakeholders, and researchers interested in the field of shipbreaking.

1.6. Limitations of the Study

The primary constraint of this study revolves around restricted data accessibility. As common practice dictates, data sharing within the maritime sector is predominantly facilitated through commercial platforms. Unfortunately, this circumstance places an adverse impact on research carried out by students with limited financial resources. Nonetheless, despite the constrained possibilities, the study is believed to have provided a valuable addition to the prevailing maritime literature. Subsequent investigations possess the potential to enhance the clarity of this relationship through the utilization of broader maritime data sets such as *Clarkson's* maritime timeseries data, and diverse econometric methodologies.

1.7. Organization of the Study

The remainder of this thesis is structured as follows. Chapter 2 provides a comprehensive review of the relevant literature, highlighting key studies and theories in the field. This literature review serves as the foundation for the subsequent chapters. In Chapter 3, the detailed methodology and research design are presented. This section outlines the research approach, data collection methods, and analytical techniques employed in the study.

Following the methodology and research design, results are presented in next three chapters. Chapter 4 presents the qualitative results obtained from thematic analysis and cover the comprehensive economic analysis of SRI in Pakistan. Chapter 5 discusses results of econometric analysis. The findings are presented in a clear and organized manner, accompanied by appropriate visual representations such as tables, graphs and charts. Chapter 6 presents the results obtained from policy gap analysis and gives recommendation for future action.

Finally, Chapter 7 concludes the thesis. This section summarizes the main findings, discusses their implications, and offers recommendations for future research. The conclusion serves as a comprehensive synthesis of the study, providing a cohesive ending to the research journey.

Chapter 2

Literature Review

2.1. Introduction

This section presents a brief review of literature available on the subject of ship breaking and recycling activity. Extensive research has been done on the social, safety, and environmental repercussions of ship recycling. However, the literature on purely economic aspects of this industry is scarce. The review of existing literature on shipbreaking activity reveals that the industry has been studied from industrial engineering or environmental sustainability and ecological resource management perspectives. In general, the majority of researches are concentrated on the shipbreaking processes and its socio-ecological repercussions. There is only a small amount of literature on the economic analysis of the sector and the factors influencing demolition activity (Karlis et al., 2016a). This section summarizes those few econometric studies on ship breaking market.

2.2. Literature Relevant to Supply and Demand Determinants

One of the earliest studies on the fundamentals of ship breaking market was done by Buxton (1991). He pointed out that the reasons for scrapping a ship are either technical deterioration or economic unfeasibility due to rising operating costs, and that the latter is significantly impacted by both the pace of the introduction of more efficient ships and the levels of the predicted freight market. He also proposed that demolition price offered by shipbreaker depends upon the realizable worth of the materials inside a ship and the cost of demolition. The cost conditions and domestic demand for steel in the relevant demolition country are also important confounding factors that have significant impact on both.

The first attempt for the statistical analysis of the ship-demolition market was done by Mikelis (2007) which provided useful background information for the development of Hong Kong International Convention. In addition to highlighting some of the most important economic relationships in the ship recycling market, such as the correlation between freight rates and ship recycling prices, Mikelis (2007) provided a timely and extremely informative statistical overview of ship recycling. He emphasized the industry's cyclical character and asserted that the differences in labour and environmental costs among recycling markets, as well as the internal demand for steel, are major factors in determining the demolition price disparity among ship-recyclers. There are only a few econometric analyses of ship breaking market. The first econometric study was done by (Knapp et al., 2008a). They studied the impact of various factors on the probability of a ship to be demolished in five major shipbreaking countries using the logistic regression. By estimating a separate model for each of the five main demolition countries i.e. India, Bangladesh, Pakistan, China, and Turkey, they calculated the probability of demolishing a vessel. The data set covered the years 1978 to 2007 and included data on 51,112 ships and 748,621 incidents. They confirmed the postulate that increasing revenue of shipowner reduces the possibility of recycling a ship. Moreover, tankers and older ships tend to choose Bangladesh as a destination while Turkey is an important destination for European registries.

The insights of Knapp et al. (2008) were explored by Alizadeh & Nomikos (2009), who showed a connection between vessel revenues, the remaining worth of the vessel (expressed as the resale price or disposal value), and fleet pricing. For valuing the vessels, they used the conventional dividend discount approach. The choice to include ship secondhand costs in the forecasting technique used in this thesis was informed by these findings. They emphasised that while selecting either to operate, layup, sell, or dismantle their vessels, vessel owners should take into account a variety of considerations, including shipping costs (current and expected), resale rates, and disposal prices. It was deemed reasonable to incorporate vessel secondhand rates in the model for forecasting of this study since both resale prices and disposal rates have an effect on the total worth of the vessel.

Another analysis exploring the factors affecting supply and demand in ship building as well as in shipbreaking markets was done by (Pour et al., 2012a). They delved into the economic factors that affect supply and demand in shipbuilding and ship scrapping industries. In addition to discussing productivity, labour costs, currency exchange rates, and the competitive advantage resulting from material availability, they also discussed the issue of defining capacity in the shipbuilding sector. To explain why shipbreaking is concentrated in developing nations with cheap labour costs, they used economic principles in their examination of the shipbreaking business.

The importance of shipbreaking for domestic steel production and economic growth in five major demolition countries has also been confirmed in another statistical analysis (Mikelis, 2013b). The impact of the ship-demolition industry on the production of steel globally and in the then-top five ship-demolition hubs of the globe (India, China, Bangladesh, Pakistan, and Turkey) was examined using statistical data. Nevertheless, from a global standpoint, this is not valid as ship-scrap is comparatively negligible in weight in comparison to the world's steel demands and cannot, thus, have an impact on the international production of steel. The author claimed that the business is crucial for local steel production in addition to the commercial growth of the five countries. As part of their closing remarks, they also provided the most recent information and projected concerns regarding the growth and impact that the Hong Kong International Convention (HKIC).

Karlis et al. (2016) built further insights into dynamics of SRI by investigating the factors affecting the decision to demolish a ship. They hypothesized that shipbreakers' bids for ship scrap are influenced by currency exchange rates. Using regression analysis, they tested the hypothesis and evaluated the linkage between currency rates and ship recycling rates. They regressed the ship scrap prices against number of ships demolished, freight rates and exchange rate to US dollars and found that despite various differences in vessel sizes, the regression results show a robust relationship between ship scrap prices and currency exchange rates of the major demolition countries.

To discover the interrelationship between impact of supply side variables on ship demolition Kagkarakis (2017) once again used the VAR framework. The age of the fleet and freight market conditions are the main determinants of ship supply for demolition. The findings showed that the supply side's influence on the industry's price formation, which is predominantly influenced by the demand for the commodity steel scrap, is minimal.

(Açık & Başer, 2017) conducted correlation and regression analyses to study the impact of freight rates on the number ships discarded for demolition. The findings support the idea that decision of vessel disposal is negatively correlated with freight revenues. Açik & Başer, (2018) studied the relationship between freight rate and demolition prices in India using the same analysis techniques. The results of both, regression and correlation analyses confirm the positive significant relationship between the variables. In yet another study Açik & Başer, (2018) tested the Efficient Markets Hypothesis in all the five major shipbreaking yards. This is crucial for understanding how prices are determined since it indicates whether they are produced independently or are impacted by other variables. They concluded that the EMH in the weak form is invalid for all demolition prices as a result of analyses done for the prices using the BDS test. These findings indicate that since prices are impacted by other factors, they are predictable, based on historical values, and can be manipulated.

Yin & Fan (2018) examined the ship demolition decisions made by individual shipowners using survival analysis models. By applying the Cox proportional hazards regression, they empirically estimate the factors influencing these demolition choices and uncover distinct patterns based on different shipping market cycles. Their research findings reveal that ship demolition activities among owners from developing countries have increased notably in the aftermath of the financial crisis. Moreover, the analysis highlights that older and less efficient vessels have been dismantled since 2008 due to the challenges posed by high bunker consumption, particularly affecting larger shipowners.

Furthermore, the study employs the survival distribution function to illustrate how different factors influence demolition behavior across diverse market conditions. This approach allows for a comprehensive understanding of the various factors at play and their impact on ship demolition choices made by individual shipowners. Tunç & Açık (2019) performed a bootstrap panel granger causality analysis to study the causal relationship between vessel scrapping prices and steel prices. And to assess if there is heterogeneity and cross-sectional dependence in price formation among five demolition centers. The latest econometric contribution to shipbreaking literature focuses on exploring hierarchical price movements using an integrated approach to study causality in variance along with Interpretive Structural Modeling techniques (Açik, 2021).

A latest study reveals a significant and bidirectional long-term association between the housing market and the ship demolition market in Turkey. The authors propose that this relationship could be attributed to the shared influence of macroeconomic factors, such as interest rates and inflation, on both markets (Efes, 2021**.** It shows that ship recycling industry can have cross industry linkages through product flow and domestic conditions.

2.3.Literature on Forecasting Analysis

The second set of literature revolves around studies that specifically address the prediction of ship demolition prices. (Kagkarakis et al., 2016; Merikas et al., 2015) were among the pioneering authors who formally constructed econometric models for forecasting ship demolition prices. They conducted a comparative analysis of different models to assess their forecasting performance. The models examined included VAR, ARMA, random walk, and linear trend models. The variables used in their analysis comprised steel rates, vessel scrapping rates, crude oil prices, and the exchange rate between Indian rupees and US dollars (INR/USD).

Merikas et al. (2015) explored determinants of demolition prices in India, Pakistan, Bangladesh, China and Turkey using monthly time series. They developed *Error Correction*

Modeling (ECMs) for three distinct markets yet interrelated markets in ship demolition i.e. tanker, product and bulker markets. They discovered that the scrap value i.e. the demolition price, together with the GDP growth of China, the currency rate, and an index measuring shipping profits, take the lead in all three markets. They concluded that these four factors work together to signal making of prices in the SRI.

As a first attempt to model the demand and explore price formation in SRI, Kagkarakis et al. (2016) forecasted the prices in shipbreaking market using a vector autoregressive (VAR) model. They used impulse response analysis and Granger causality analysis to investigate the connection between ship destruction costs and global scrap prices. The study used a demand-side industry model to show that the price of steel scrap exported from developed nations (the US and EU) to Southeast Asia leads the market for ship destruction and has a major impact on price discovery in the industry. They discovered unidirectional causality from steel rates to the price of ship dismantling. The results indicated that the latter price responds favorably to one-unit shocks originating from the former. The findings also suggest that these shocks cannot be ignored for an extended period of time. They explained the lead-lag effect by two factors: the volume of imported steel scrap, which is greater than that produced by ship demolition, and the length of time needed to transfer the steel scrap abroad. They concluded that scrap prices have little influence because there is a relatively small percentage of steel obtained from ship demolition compared to steel obtained from other sources.

The research conducted by Andrikopoulos et al. (2020), Kagkarakis et al. (2016) and Merikas et al. (2015) had a significant impact on the forecasting analysis in this thesis. Their study provided valuable economic insights regarding the selection of variables for forecasting purposes and offered guidance on suitable econometric methodologies for ship demolition forecasting. However, one aspect that was not addressed in Kagkarakis et al. (2016) work was the possibility of cointegration among the signs used in the predictive model. This thesis explicitly considers this relationship by employing an Error Correction Model (ECM) and Vector Error Correction Model (VECM), which account for long-run relationships among the forecasting variables.

Andrikopoulos et al. (2020) built upon the previous models introduced by Kagkarakis et al. (2016). Their research aimed to examine the relationship between macroeconomic variables and ship demolition prices. To accomplish this, Andrikopoulos et al. (2020) employed steel rates for scrap metal including nickel prices, crude oil prices, different indicators of marine trade, and vessel size-specific demolition prices. A Vector Error Correction Model (VECM) was utilized to evaluate the predictive capability of these variables in estimating ship demolition prices.

The findings of Andrikopoulos et al. (2020) revealed the existence of many relationships between the explanatory variables and ship demolition prices. The authors argued that the metals in the study play a crucial role in the development of countries where ship dismantling takes place, particularly in developing nations. Notably, the study by Andrikopoulos et al. (2020) made noteworthy contributions by documenting the relationship between nickel and ship demolition prices through a Granger causality test. Furthermore, they applied the VECM to account for the cointegrating relationships between the variables, which adds to the novelty of their research.

2.4. Research Gap

The review of existing literature on ship recycling reveals that the industry has been studied from industrial engineering or environmental sustainability and ecological resource management perspectives. In general, the majority of research on the ship recycling processes and its repercussions. There has been little research to study the economics and competitiveness of the SRI. Only a few studies have analyzed the ship demolition prices, (N. D. Kagkarakis, Merikas, & Merika, 2016a; Merikas et al., 2015a), but none has studied the formation of prices in a country-specific scenario. The econometric analyses of SRI conducted so far are mainly concerned with assessing the decision to demolish a ship or studying the relationship of demolition prices with other relevant variables.

Anther gap was identified in econometric literature is that the critical aspect of structural breaks in data was often overlooked in previous research on ship demolition prices conducted by Açık & Başer (2017), Kagkarakis et al. (2016), Pettersén & Direnzo (2021), Tunc (2019).

Until now, little research has been done on the down-stream market of SRI outputs in Pakistan (Sarraf et al., 2010b). Thus, details about the industry's economics have always been skipped or explored in a generic and superficial manner. Profitability in SRI is presumed to be the result of supply-side considerations, and employment through its multiplier effect is considered to be the only indicator of economic significance. A systematic review of literature showed that Ship recycling literature mainly concerns the environmental and safety management other than economic aspects (Rahman, 2020). Research on purely economic aspect of SRI is scant while in case of Pakistan is non-existent. The ship recycling industry in Pakistan, particularly in the Gadani yard, lacks research on market conditions, market structure, competitiveness. it is also noteworthy that no study was found that could present a qualitative analysis of this industry in Pakistan. There is a need for comprehensive studies that explore these aspects to inform policymaking and industry development strategies. Therefore, the current study is aimed to fill these gaps.

2.5. Theoretical Framework

Ship scrapping price also known as demolition prices play a crucial role in the ship recycling industry, as they are determined by various factors and have implications for industry dynamics and decision-making. This section presents the theoretical framework that guides this study on understanding the determinants of ship demolition prices in Pakistan. This section serves as the foundation for the research by integrating relevant economic theory, previous empirical research, and conceptual definitions.

The theoretical framework helps in identifying and defining the key variables and relationships that will be considered in the study (Ngulube et al., 2015). By presenting a comprehensive overview of the determinants of shipbreaking prices, it paves the way for empirical analysis and hypothesis testing.

2.5.1. Conceptual Definitions

Before proceeding to the underlying economic theory and the analysis of ship recycling industry, it is pertinent to explain some commonly used concepts and technical terms related to ship recycling industry. Following table explains the key terms and concepts related to ship recycling industry that are used in this study:

Table 2.1: Terminology and Concepts

Key Terms	Explanation and Context
	(a) Concepts
	Following are the most widely used concepts related to ship recycling industry:
Ship Breakers	Ship breakers refer to entities (firms) involved in the dismantling and recycling of ships. They are responsible for the process of breaking down ships into smaller components and recycling or disposing of the materials.

Ship Demolition Prices	Ship demolition prices represent the prices offered by ship breakers to shipowners for importing ships for demolition. These prices are determined based on various factors, including market conditions, supply and demand dynamics, and the characteristics of the ship being demolished.
Ship Scrap Market	The ship scrap market encompasses the global market for ship recycling, which is concentrated in a limited number of countries. It involves the buying, selling, and recycling of decommissioned ships for their scrap value. The market is influenced by factors such as international regulations, steel prices, and demand for recyclable resources.
Beneficial Owner (BO)	The beneficial owner refers to the person or entity that enjoys the benefits and rights of ownership over a ship, even if the legal ownership may be held by another party. The beneficial owner has the power to control and make decisions regarding the ship's operations and disposal.
Cash Buyer	A cash buyer is an entity that purchases ships for scrapping or recycling purposes. They typically acquire ships from shipowners or shipyards and sell them to ship breakers. Cash buyers play a significant role in the shipbreaking industry by facilitating the transaction process.
Shipbroker	A shipbroker is a person or company that acts as an intermediary in the shipping industry. They negotiate deals on behalf of shipowners or shippers for the transportation of cargo at an agreed price. Shipbrokers also assist in the buying and selling of ships, both second-hand tonnage and newbuilding contracts.

(b) Measurement Units

In the context of shipbreaking, the following units are commonly used:

Gross Tonnage (GT)	Gross tonnage is a measure of the total internal volume of a ship, including all enclosed spaces, calculated in accordance with international regulations. It provides an indication of the ship's size and capacity.

Light Displacement Tonnage (LTD)	Light displacement tonnage refers to the weight of a ship when it is in light condition, without cargo, fuel, or other supplies. It represents the weight of the ship's structure and equipment.
Deadweight tonnage (Dwt)	Deadweight tonnage is a measure of a ship's carrying capacity, including bunker oil, fresh water, crew, and provisions. It represents the total weight that a ship can transport, including cargo and fuel.
Freight Rate	Freight rate refers to the charge or cost for the carriage of cargo, typically expressed per ton of cargo or as a lump sum. It represents the price agreed upon between the shipper and the carrier for transporting goods from one location to another. Freight rates are influenced by factors such as market conditions, supply and demand, and the nature of the cargo being transported.

2.5.2. Theoretical Foundations

The theoretical foundation of a study refers to the underlying theories, concepts, and existing research that provide the basis for understanding and investigating the research problem. It serves as a framework for analyzing and interpreting the data and findings of the study. In the context of this study, the theoretical foundation encompasses several key elements. In this section, a brief overview of some of the theories that inform our understanding of the factors influencing ship demolition prices is presented.

2.5.2.1.Market Structure and Competition

The study acknowledges that ship demolition prices are influenced by various factors including the structure of the market. The market for ship recycling is concentrated in a limited number of countries, creating a competitive environment akin to an oligopoly or monopolistic competition. In economic theory and practice, these market structures do influence price determination mechanism.

The theory of market structure and competition provides insights into how the structure of the ship scrap market influences ship demolition prices. In an oligopoly market, a small number of firms dominate the industry and their pricing decisions can have a significant impact on market outcomes (Bain, 1949; Baumol, 1958; Friedman, 1982; Shapiro, 1989; Stigler, 1964). Ship breakers, as key players in the industry, are influenced by the pricing strategies of their competitors. They closely follow competitor prices and adjust their own prices accordingly to remain competitive. This behavior can lead to price coordination or price leadership within the market.

In a monopolistic competition setting, firms differentiate their products or services to gain a competitive edge (Chamberlin, 1951). In the context of ship demolition, ship breakers may differentiate themselves based on factors such as their expertise through labor training, advanced technological infrastructure and adoption of international conventions and sustainability protocols. However, they still face competitive pressures and tend to consider competitor prices in their pricing decisions.

Based on these theoretical foundations, and due to limited market size and competition in the global ship recycling market, this study recognizes the potential interdependence between ship demolition prices in different countries. Previous research by Açık & Tunc (2019) has demonstrated the existence of price spillovers from Turkish demolition prices to other countries' prices, as well as from Pakistani tanker demolition prices to those in Bangladesh and India. This highlights the interconnectedness of ship breakers and the influence of competitor prices on local prices.

2.5.2.2.Supply and Demand

The principles of supply and demand play a crucial role in understanding the dynamics of the shipbreaking industry. In the ship recycling industry, both the supply of ships for scrap and the demand for recyclable resources, primarily scrap steel, play crucial roles in price determination. Drawing from the empirical evidence, this study considers the supply and demand dynamics to explain the determinants of ship demolition prices. These determinants can be broadly divided into supply side factors as well as demand side factors.

The supply of ships for demolition is influenced by factors such as freight rates, ship type and age, and operating costs (Buxton, 1991; Knapp et al., 2008b; Merikas et al., 2015c). The study acknowledges the inelasticity of ship supply in the short term and the impact of freight rates on the supply of ships for demolition (Koopmans, 1939).

On the demand side, the study recognizes that the demand for ship demolition is derived from domestic steel demand. It is influenced by factors such as imported scrap steel prices as well as domestic steel prices, the costs associated with the shipbreaking process, and the availability of recyclable resources. This understanding aligns with the concept of derived demand in economics (Mundlak, 1968; Whitaker, 2017).

The theoretical foundation of this study also draws on previous literature suggests that the determination of ship demolition prices involves a range of factors on both the demand and supply sides. These factors include international steel prices, as studied by Açık & Tunc (2019) and Merikas et al. (2015); exchange rates, examined by Karlis et al. (2016) and Kagkarakis et al. (2016); freight rates, analyzed by Açık & Başer (2017a, 2017b); international oil prices, explored by (Kagkarakis et al. (2016); and domestic steel demand, as highlighted by Mikelis (2013). Other factors, such as those highlighted by Kagkarakis (2017), Knapp et al. (2008), Mikelis (2007) and Pour et al. (2012) have also been considered because these factors impact the cost structures and profitability of ship breakers, thereby influencing their pricing decisions.

2.5.2.3.International Trade and Exchange Rates

International trade theories, such as comparative advantage, highlight the importance of trade flows in determining prices. Exchange rates also play a significant role as they affect the competitiveness of ship demolition prices in different countries. The presence of price spillovers from one country's ship demolition prices to others suggests the existence of cross-country interdependence. This aligns with theories of price transmission and interdependence in interconnected markets. Further Tunç & Açık (2019) have shown that demolition prices in top four centers are likely to be influenced by shocks in each other's whereby confirming the presence of cross sectional interdependence. In other words, shocks in these countries are likely to be transferred to each other. This, however, not necessarily confirms that demolition prices in Pakistan are influenced by across the countries shocks.

2.5.3. Determinants of Ship Demolition Prices

The demolition price (PD), nonetheless, is determined internally by the ship breakers. And the internal dynamics of each country are different; such as labor costs, local steel demand, environmental taxes etc. and have strong impact on the demolition prices in that country. The price determination in any market is dependent on interaction of market forces. The interaction of these market forces for SRI is rather complicated. The supply of vessels sent for scrap to the SRI and the internal requirement (domestic demand) for the industry's recycled resources, primarily scrap metal of steel, are both influenced by broad global, regional, and international economic circumstances at any one time.

The determinants of ship demolition prices can be categorized into supply-side factors, demand-side factors, and factors associated with market structure and conditions. Supply side factors are largely identified in literature, while demand side factors are identified by market survey and in-depth interviews with industry experts.

2.5.3.1.Supply-side factors

- Freight rates: Fluctuations in freight rates impact the supply of ships for demolition, with high freight rates discouraging shipowners from sending vessels for dismantling (Açık & Başer, 2017; Buxton, 1991).
- Ship characteristics: Factors such as the age, type, and condition of the ship influence its suitability for recycling and, therefore, the demolition price (Knapp et al., 2008b; Merikas et al., 2015a).
- International regulations: Compliance with international regulations and requirements for environmentally sound recycling practices can affect the supply as well as the demand for ships for demolition (Legaspi, 2000; Sheikh, 2021).
- Global economic factors: These include indicators such as global economic outlook, international financial environment, oil price shocks, international steel price fluctuations, exchange rate fluctuations and other international economic indicators.

2.5.3.2.Demand-side factors

- Domestic steel demand: Ship demolition prices are influenced by the demand for recyclable resources, particularly scrap steel, which is driven by domestic steel industry requirements.
- Steel prices: Changes in international steel prices can influence the demand for ship recycling and, consequently, impact ship demolition prices.
- Labor and other Costs: The market demand for scrapping ships is a direct function of steel prices and scrapping industry costs, including expenditures involved with the breaking process in relation to expected revenue (Stuer-lauridsen et al., 2010). These costs also include the taxes levied on ship imports as well as on recycled output.
- Demolition Capacity: apart from demand stimulating factors, installed capacity at the recycling yards for handling imported tonnage at a given time is an important limiting factor that shapes demand for end of life ships.
- Market Share: Information extracted from in-depth interviews of the industry experts reveals that the total market share of each player, in terms of total tonnage imported and dismantled, does impact the position and power of those players in setting the price of end of life vessels. For example, Bangladesh has consistently been capturing a major market share in terms of output demolished annually, both in terms of number of ships

dismantled and the total gross tonnage demolished. This dominant market share gives some degree of advantage in attracting shipowners and influencing other market players for making price offers.

2.5.3.3. Market structure factors:

- Competitor country prices: The prices of ship demolition in competitor countries can have an interdependent relationship with local prices, as ship breakers may consider competitor prices when determining their own prices.
- Geographic proximity: The geographic proximity between salvaging centers, like the south east Asian countries, can lead to price spillovers and cross-sectional interdependence.

2.5.4. Proposed Theoretical Model

Based on the above determinants, the following model is proposed to explain that the ship demolition prices are determined by international steel scrap prices, exchange rate, freight rates, the labor and other operational costs, the domestic steel demand, the total installed capacity of the shipbreaking yards, the total output demolished serving as a proxy for market share and competitor country demolition prices.

$$PD_t = \beta_0 + \beta_1 CO_t + \beta_2 SSt + \beta_3 ERt + \beta_4 FR_t + \beta_5 LCt + \beta_6 OD_t + \beta_7 P_t comp + u_t \quad (2.1)$$

Where PD represents the ship demolition prices for tankers

SS denotes the international steel scrap price.

CO represents the exchange rate of Pakistani Rupee for US Dollars.

FR depicts the freight rates

LC represents the labor costs.

OD refers to the domestic steel demand.

SD represents the total output demolished, serving as a proxy for market share.

Pcomp represents competitor country demolition prices.

This study aims to enhance the current understanding of pricing dynamics within the SRI by examining the factors identified in the theoretical framework. Subsequently, the operationalization and analysis of these variables was conducted using empirical data to evaluate the proposed relationships outlined in the framework. However, it is important to note that due to the limitations of scope and data availability, this study focused on a scaled-down version of the proposed model for empirical analysis. This scaled down version of the original model is given below which will be used for econometric analysis:

$$PD_t = \beta_0 + \beta_1 CO_t + \beta_2 SS_t + \beta_3 ER_t + u_t \quad (2.2)$$

These limitations necessitate a careful selection of variables to ensure a robust and comprehensive analysis within the given constraints. The demand and supply side factors identified in literature are shown in Figure 2.1.

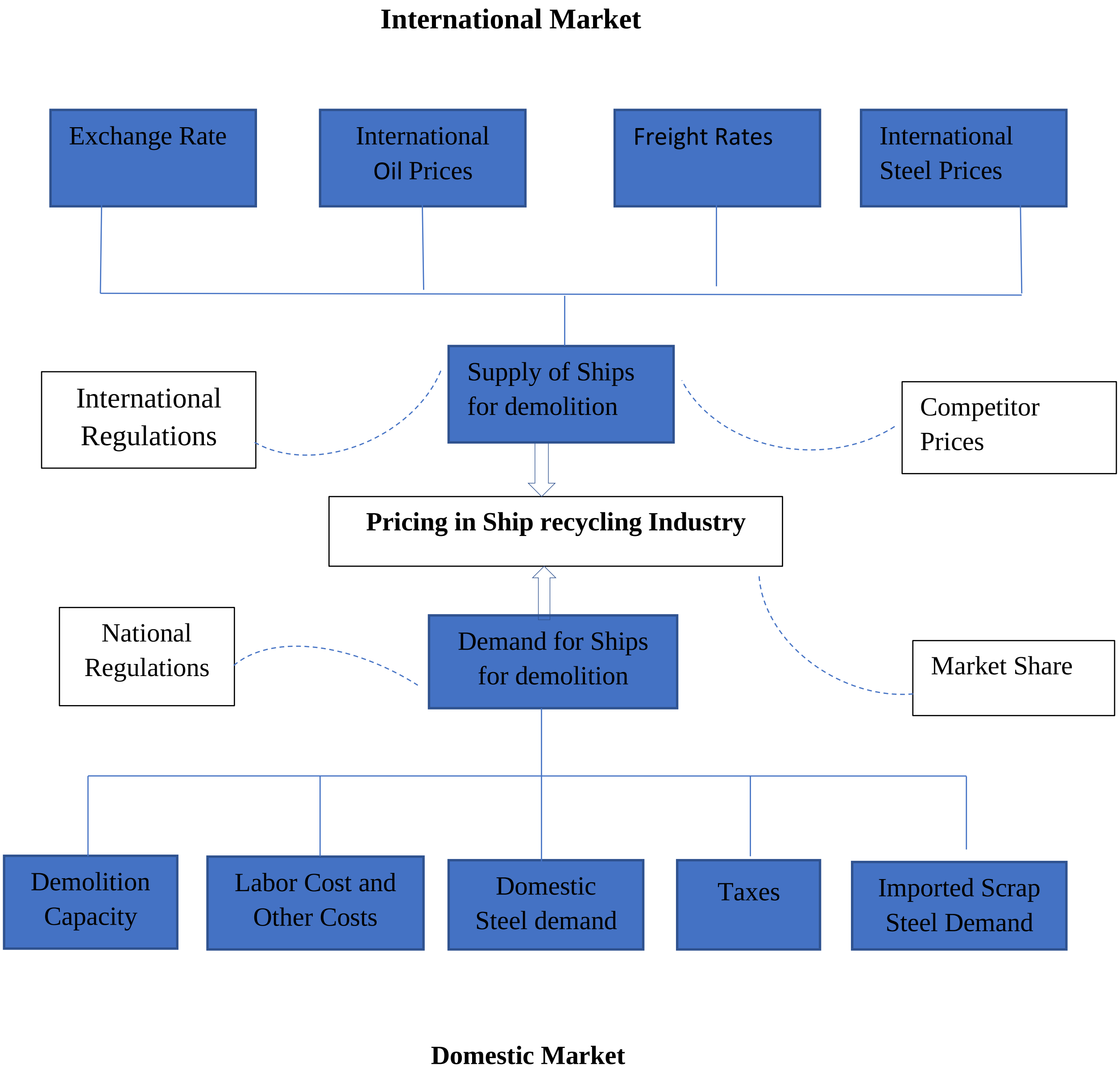


Figure 2.4: Demand-Supply Framework of SRI

CHAPTER 3

METHODOLOGY AND DATA

This chapter contains sections on research design and research framework followed to conduct qualitative and quantitative analyses. The nature of data used, variable description and data collection methods and also explained in the subsections. Further it also explains the methods of analyses employed for investigation.

3.1.Research Design

Research design refers to the overall strategy or plan that a researcher develops to answer the research questions or hypotheses. It involves identifying the data collection methods, the type of data to be collected, the sampling strategy, and the data analysis techniques to be used (Creswell & Creswell, 2017). The design of research is determined by how researchers choose a strategy to answer to a collection of questions that best addresses the subject under investigation. Each research design includes a road map outlining the investigation's objectives (Patton, 2002).

This study chose the exploratory design with mixed methods; which involves the steps shown below in figure. The chosen research design for this study was based on Creswell & Clark's (2007) discussion on conducting mixed methods research.

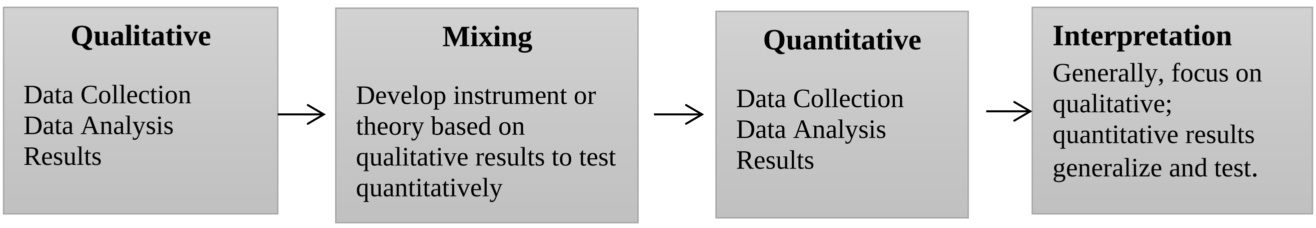


Figure 3.1: Exploratory Design

3.1.1. Mixed methods research design

According to Johnson et al. (2007) mixed methods research is recognized as one of the three primary research paradigms alongside quantitative research and qualitative research. Mixed methods research outcomes are 'superior', as demonstrated by this approach's ability to combine different research approaches (Johnson & Onwuegbuzie, 2004).

In a mixed methods study, researchers engage in the collection and analysis of both qualitative and quantitative data within a single research endeavor (Creswell et al., 2003; Leech & Onwuegbuzie, 2009). This approach involves the simultaneous or sequential gathering of data, with equal importance placed on both types of data. The integration of data occurs at various stages of the research process, enabling a comprehensive understanding of the phenomenon under investigation. (Creswell et al., 2003).

3.1.2. Point of Integration

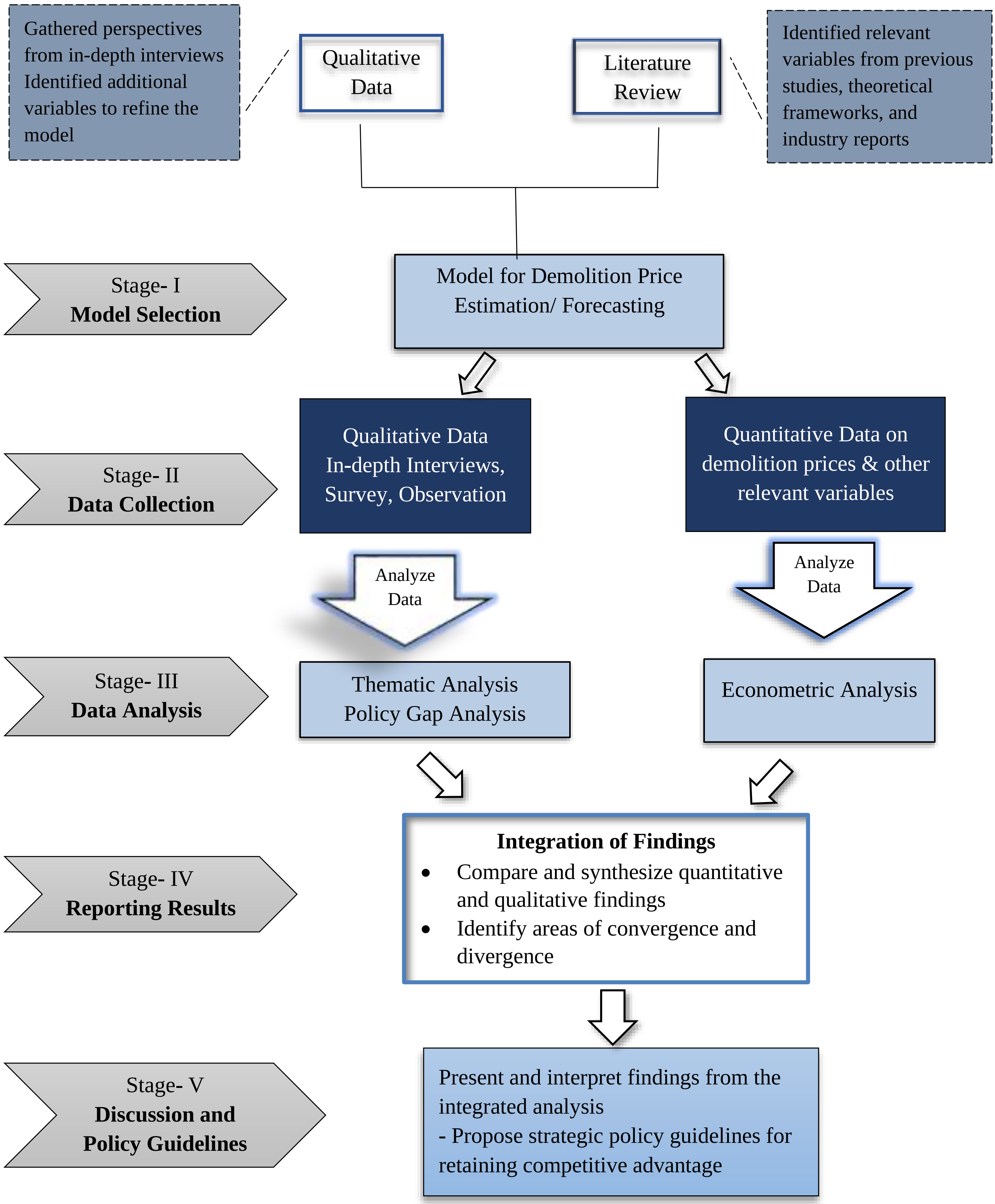
In every genuine mixed methods study, there exists a critical juncture known as the "point of integration" (Schoonenboom & Johnson, 2017). It is at this juncture that the qualitative and quantitative components of the study are harmoniously combined. In a mixed methods research design, the point of integration refers to the stage where the quantitative and qualitative components of the study are combined and synthesized to gain a comprehensive understanding of the research topic. There could be potentially two points of mixing as described by Morse (2016), namely the 'Results' point of integration and the 'Analytical' point of integration, which can be utilized in mixed methods research designs. This thesis employed both approaches of mixing i.e. mixing at the analysis stage and mixing at the stage of writing results. It is worth noting that in this thesis, mixing would occur at different stages throughout the research process. The following flowchart for research framework illustrates the stages of mixing methods.

3.2. Research Framework

To outline the systematic approach undertaken to investigate the determinants of ship demolition prices in Pakistan, a research framework was developed. This framework provides a roadmap for the research process and ensures a structured and logical flow of activities. Particularly, due to mixed methods approach, it was important to highlight the mixing and points of integration of the methods. Therefore, framework is presented in the form of a flowchart in figure 4.2.

It begins with the selection of an appropriate model for price estimation and forecasting, employing both, the quantitative and qualitative methods. As explained earlier, this study is exploratory with focus on exploring the market situation and structure. Therefore, to begin with, the qualitative methods were employed to gather information about nature of competition among ship breakers, the number of competitors, entry and exit conditions into and from the market, the market size and degree of formalization. This information was crucial for assessing price determination process in the market and it provided basis for choosing relevant economic theory.

Figure 3.2: Research Framework of the Study



In addition to that, the price determination and forecasting variables were selected following the economic rationale of (Andrikopoulos et al., 2020; N. Kagkarakis, 2017b; N. D. Kagkarakis et al., 2016; Merikas et al., 2015; Tunc, 2019). This approach allowed to demonstrate the integration of both components right from the beginning of this study.

In the next stage, to enhance the depth of analysis, qualitative data was gathered through in-depth interviews with industry experts. This qualitative insight complemented the quantitative data collected during the data collection phase, which includes ship demolition prices, market conditions, and other relevant variables. Stage IV again highlights the mixing of methods at the time of reporting results.

3.3. Data

This section describes the nature and collection process of both types of data used in this study. First it specifies the relevant quantitative variables and indicators used in this study and outlines the sources of quantitative data. Later, this section describes the qualitative data collection process of conducting in-depth interviews with key stakeholders in the SRI for the purpose of gathering qualitative data. It outlines the selection criteria for participants, explains the measures taken to ensure diverse perspectives and representation, discusses the interview protocol or guide used to structure the interviews, and addresses ethical considerations related to informed consent and participant confidentiality.

3.3.1. Quantitative Data

This section describes the quantitative data collection process of relevant variables and indicators in the ship recycling industry. Quantitative data was collected for the period (2004-2022)[4]. The dataset utilized in this research spans from July 4, 2004, to December 25, 2022, comprising of a total of 965 weekly observations. The variables under investigation are described in the following sections.

3.3.1.1. Operationalization of Variables

(i) Demolition Prices (PD)

Ship demolition prices refer to the monetary value at which ships are sold for scrapping or recycling purposes. These prices are a key indicator of the economic dynamics of the ship recycling industry. The data for ship demolition prices for the period 2004-2022 was sourced from Baltic Exchange[5] which is widely recognized as the sole independent provider of

[4] The rationale for choosing 2004 as the starting year is that Baltic exchange maintains records not earlier than 2004 which is the year of inception for Baltic exchange.
[5] Baltic Exchange (2023). https://www.balticexchange.com/en/index.html

comprehensive maritime market information globally. The dataset for this period consisted of weekly observations.

The demolition prices are measured in million $US per LDT. Demolition prices differ for different maritime vessels. We collected data on demolition prices of tankers and bulk carriers because these two types of vessels are imported preferably by Pakistan.

(ii) Exchange rate:

The exchange rate represents the value of one currency relative to another. In the context of this study, the exchange rate is important as it influences the pricing dynamics of shipbreaking activities in Pakistan. Fluctuations in the exchange rate can impact the competitiveness of the industry and affect the pricing decisions of market participants. Exchange rate data for the period 2004-2022 was obtained from open source online portal Investing.com.

(iii) Crude Oil Prices:

Crude oil prices are a crucial factor that influences the shipbreaking industry. As shipbreaking involves the recycling of steel and other materials from decommissioned ships, the prices of crude oil can affect the demand and supply of raw materials, subsequently impacting ship demolition prices. Data on crude oil prices for the period 2004-2022 was sourced from open source research platform MacroTrends®.

(iv) International Steel Scrap Prices:

International steel scrap prices play a significant role in determining the economic viability of shipbreaking activities. As ship recycling involves the extraction of steel scrap, the prevailing international prices for steel scrap directly influence the profitability and pricing decisions within the shipbreaking industry. Data on international steel scrap prices for the period 2004-2022 was collected from China Iron and Steel Association (CISA)[6] which is Chinese steel industry's national organization.

The steel price utilized in this study specifically pertains to the cost of hot rolled steel in China. Due to data constraints, it was not feasible to obtain a global steel price. Nevertheless, this is not a concern as noted by Giuliodori and Rodriguez (2015) due to the following reasons:

(i) China's economy holds substantial weight in the global economy,

(ii) it significantly influences the world steel market, and

[6]China Iron and Steel Association (CISA): http://english.chinaisa.org.cn/do/cn.org.chinaisa.view.Column.d?column=0

(iii) it sets the benchmark prices for the market.

(v) Annual Tonnage Dismantled

Annual Tonnage Dismantled refers to the total weight or tonnage of ships that are recycled within a given year. It represents the amount of ship material, such as steel and other components, that is processed and recycled through dismantling activities. The unit to measure this weight is referred as Gross tonnage (GT). Gross tonnage is the measure of the total internal volume of a ship, including all enclosed spaces, calculated in accordance with international regulations. It provides an indication of the ship's size and capacity. The Annual Tonnage Dismantled is a key metric in SRI as it provides an indication of the scale and volume of ships being recycled in a specific time period.

The following tables specifies the variables used for collecting data.

Table 3.1: Variables of the study

Variable	Symbol	Source
Ship Demolition Prices (Pakistan)		Baltic Exchange
i. **Bulk Carrier**	BC	
ii. **Tanker**	TKR	
Exchange Rate	ER	Trading Economics
Crude Oil Prices	CO	Investing.com
International Steel Scrap Prices	SS	CISA
Tax Revenue	TR	PSBA
No. of ships dismantled		NGO Shipbreaking platform
Annual tonnage dismantled		NGO Shipbreaking platform

3.3.2. Qualitative Data

The primary data was collected through semi-structured interviews, and observations. The interviews were conducted with key stakeholders in the ship recycling industry of Pakistan, such as industry experts, CEOs of domestic shipbreaking firms, policymakers, and representatives from relevant government agencies. The interviews focused on understanding their perspectives on price determination, policy issues, and factors influencing competitiveness. Observations were made by making field visits to understand the physical infrastructure and operations at the shipbreaking yards.

For policy gap analysis we used government documents such as Balochistan Ship Breaking Industry Rules 1979; Special Procedures for Ship Breaking Industry Rules, 1997; Provisions of the Hong Kong International Convention, Basal Conventions and ILO regulations.

3.3.2.1. The process of conducting in-depth interviews

In this study, a purposive sampling technique was employed to select participants who could provide valuable insights into the price formation and market conditions of the shipbreaking industry in Pakistan. The sampling strategy was guided by the research objectives and focused on individuals directly engaged in shipbreaking business in any capacity.

i. Selection Criteria of Participants:

Participants were selected based on specific criteria, including their business expertise, direct involvement in the shipbreaking industry, knowledge of real-time market fluctuations, and their roles in policy development in Pakistan. To ensure a diverse range of perspectives, participants were drawn from various sectors of the industry. These included shipbreaking firms, international cash buyers, officials from the maritime affairs division of the Planning Commission of Pakistan, and academics with expertise in shipbreaking.

Furthermore, interviews were conducted with relevant researchers from international organizations such as the International Maritime Organization (IMO) and the NGO Shipbreaking Platform, which is a global coalition of organizations working to address the environmental and human rights issues associated with shipbreaking. It is important to note that the selection criteria focused primarily on individuals with direct involvement in the industry and expertise in market dynamics.

However, it is important to acknowledge that certain stakeholders, such as environmental advocacy groups and organizations, as well as those focused on human safety concerns, were not included in the sampling frame. This exclusion was due to the specific focus of this study on price formation and market conditions, while intentionally excluding discussions on environmental hazards and human safety concerns associated with shipbreaking.

ii. Sampling Strategy for Diverse Perspectives and Representation

To ensure diverse perspectives and representation, a purposive sampling strategy was employed. This approach allowed for selecting participants who possess the necessary knowledge and experience to provide valuable insights into the research questions. Care was taken to include participants from different backgrounds, sectors, and geographical regions to capture a wide range of viewpoints and perspectives.

iii. Sampling Frame

The sampling frame for this study was constructed using multiple sources, including the professional network of the research supervisor and international organizations associated with the shipbreaking industry. These sources provided access to a wide range of potential participants who met the selection criteria. The professional network of the research supervisor facilitated connections with industry stakeholders in Pakistan, while international organizations offered valuable insights into global perspectives on shipbreaking.

A list of interviewees with their particulars is attached in Appendix A.

iv. Interview Protocol

An interview protocol or guide was developed to structure the in-depth interviews. The guide included a series of open-ended questions and prompts that addressed the research objectives and explored the participants' perspectives on policy analysis and market-based solutions. The questions were designed to elicit detailed information on the participants' experiences, opinions, and suggestions related to ship recycling industry dynamics, policy challenges, pricing mechanisms, and sustainability considerations.

The interview guide is given in the appendix A.

3.4. Methods of Analysis

3.4.1. Econometric Analysis

To investigate the determinants of demolition price in Pakistan, this study aimed to estimate the price function for the demolition prices in case of Pakistan. To empirically test the proposed model of demolition price determination presented in the theoretical framework, a scaled down version of that model was used. The specification of the scaled down version can be written as:

$$PD_t = \beta_0 + \beta_1 CO_t + \beta_2 SS_t + \beta_3 ER_t + u_t \qquad (2.2)$$

Where PD represents the ship demolition prices for tankers
SS denotes the international steel scrap price.
CO represents the exchange rate of Pakistani Rupee for US Dollars.
ER refers to the currency exchange rates

To test the relationships between variables, the following econometric techniques were employed:

3.4.1.1. Stationarity tests

Stationarity is an essential assumption in time series analysis (Chatfield & Xing, 2019). The initial step in time series analysis involves assessing the stationarity of the time series data, which serves as the fundamental basis for conducting reliable analyses (Jalil & Rao, 2019). As a result, prominent textbooks on time series analysis commonly emphasize the concept of stationarity as a starting point. Understanding and ensuring stationarity is of utmost significance in constructing econometric models that are both accurate and effective (Jalil & Rao, 2019). Two commonly used stationarity tests, Augmented Dickey Fuller (ADF) test and Zivot & Andrews (1992) Test for Structural Breaks, were applied in this study.

- ***Augmented Dickey Fuller (ADF) Test***

To test the stationarity, of the series, ADF test by (Dickey & Fuller, 1979) was performed both at level and at first differences. The null hypothesis of the ADF test is that the variable under consideration possesses a unit root and is non-stationary. The alternative hypothesis, on the other hand, suggests that the variable is stationary. The test statistic is compared to critical values from the Dickey-Fuller distribution to determine the rejection or acceptance of the null hypothesis (Harris, 1992).

If the test statistic is less than the critical value, the null hypothesis is rejected, indicating that the variable is stationary and does not possess a unit root. Conversely, if the test statistic is greater than the critical value, the null hypothesis is not rejected, suggesting that the variable is non-stationary and likely contains a unit root (Cheung & Lai, 1998).

ADF test takes into account higher-order correlation by incorporating a parametric correction. The test assumes that the series follows an autoregressive (AR) process and includes lagged difference terms of the dependent variable in the regression equation. The ADF test equation can be represented as:

$$\Delta y_t = c + \alpha y_{t-1} + \sum_{q=1}^{k} d_q \Delta y_{t-q} + \varepsilon_t \qquad (3.1)$$

$$\Delta y_t = c + \alpha y_{t-1} + \beta t + \sum_{q=1}^{k} d_q \Delta y_{t-q} + \varepsilon_t \qquad (3.2)$$

where Δyt represents the differenced series, c is a constant term, α is the coefficient of the lagged dependent variable, d represents the coefficient of the lagged differenced variable, and

εt is the error term. By estimating these coefficients and testing the null hypothesis of a unit root, the ADF test helps determine the stationarity of the series.

- ***Structural Break Test: Zivot Andrews Test***

Along with the conventional unit root test, the Zivot & Andrews (1992) structural break test was used to test stationarity of the series. Because recent studies suggest that the conventional tests may have low power in detecting unit roots when there are structural breaks or changes in the underlying data. Failing to account for structural breaks can lead to misleading results and incorrect inferences (Jalil & Rao, 2019). The graphical display of the data series depicted a structural break in the financial time series under consideration in this study. Therefore, it is necessary to incorporate structural breaks when conducting unit root tests.

The purpose of conducting a structural break test is to determine if there is evidence of a significant change in the behavior or characteristics of the data, such as a sudden shift in the mean or trend (Altinay & Karagol, 2004; Kum, 2012). This is important because it helps to identify periods of stability or instability in the time series, which can have implications for model specification, forecasting, and policy analysis.

The Zivot-Andrews test extends the ADF test by allowing for a single unknown structural break in the series. The test involves estimating a regression model with a structural break indicator variable and conducting an ADF test on the residuals. The null hypothesis is that there is no structural break, while the alternative hypothesis is that a structural break exists. The critical values for the test are obtained from Monte Carlo simulations (Harvie et al., 2006).

Specifically, three different models were proposed by Zivot & Andrews (1992).

$$\Delta y_t = c + \alpha y_{t-1} + \beta t + \theta DU_t + \sum_{q=1}^{k} d_q \Delta y_{t-q} + \varepsilon_t \quad (3.3)$$

$$\Delta y_t = c + \alpha y_{t-1} + \beta t + \theta DT_t + \sum_{q=1}^{k} d_q \Delta y_{t-q} + \varepsilon_t \quad (3.4)$$

$$\Delta y_t = c + \alpha y_{t-1} + \beta t + + \theta DU_t + \gamma DT_t + \sum_{q=1}^{k} d_q \Delta y_{t-q} + \varepsilon_t \quad (3.5)$$

Δyt represents the differenced series, c is a constant term, α is the coefficient of the lagged dependent variable, βt represents the coefficient of the time trend, γ and θ are coefficients related to structural breaks, DUt is an indicator dummy variable for a mean shift, DTt is the corresponding trend shift variable, d is the coefficient of the lagged differenced variable, and εt is the error term. These models are used to test structural break in intercept term, in trend, and in both intercept and trend respectively.

3.4.1.2. Information Criteria

Information criteria are used to strike a balance between model fit and complexity by penalizing models that are too complex. After ensuring the fulfillment of stationarity requirements, the next step is the selection of an appropriate lag length. This step involves utilizing a constrained VAR approach to determine the optimal number of lags for the model. Akaike information criterion (AIC) was used to determine the optimal lag length. The AIC takes into account both the goodness of fit of the model and the number of parameters used in the model. It penalizes models that have a larger number of parameters, thus avoiding overfitting, which can lead to poor generalization to new data (Wagenmakers & Farrell, 2004).

When selecting a model using AIC, the general rule is to choose the model with the lowest AIC value. This indicates a better trade-off between model fit and complexity. A lower AIC suggests that the model explains the data well while using a relatively small number of parameters (Akaike, 1998; Bozdogan, 1987).

3.4.1.3. Further Pre-estimation Diagnostic Testing: *Autocorrelation Test*

If the present period residuals are correlated with previous residuals, then this refers to the problem of autocorrelation. Brooks (2019).emphasized that ignoring autocorrelation can lead to inefficiency in coefficient estimates obtained through Ordinary Least Squares (OLS), making them unbiased but not Best Linear Unbiased Estimates (BLUE), especially in large sample sizes. Consequently, the standard error estimates may be incorrect. This study utilizes the Ljung-Box Q test to detect autocorrelation.

A predetermined number of residual lags are chosen to test autocorrelation using the Ljung & Box (1978), according to which the alternative hypothesis proposes the existence of autocorrelation among the lags, whereas the null hypothesis presupposes the absence of autocorrelation in the residuals.

As stated by the null hypothesis assumes no autocorrelation in the residuals, while the alternative hypothesis suggests the presence of autocorrelation among the lags. The test statistic for this diagnostic test is presented in Equation (4.6).

$$Q^{*} = \mathrm{T}(\mathrm{T} + 2) \sum_{k=1}^{m} \frac{\hat{\tau}_k^2}{T-k} \quad (3.6)$$

Here, $\hat{\tau}k$ represents the autocorrelation coefficient at lag k, T denotes the sample size, and m signifies the maximum number of lags. The test statistic is compared against a critical value obtained from the Chi-squared distribution.

3.4.1.4. Cointegration Analysis (Gregory Hansen Cointegration Procedure)

If all data series are integrated at the same level, that is, integrated at the first level, then we apply Johansen-Juselius cointegration test in the multivariate case without structural break. Since we have tested for the presence of structural break in the data generating process of our under-consideration series, we employed Gregory & Hansen (1996) cointegration test to account for structural breaks in data series.

The Gregory and Hansen Cointegration Procedure expands upon the Engel-Granger cointegration test and allows the model to endogenously determine the presence of structural breaks (Jalil & Rao, 2019). This approach offers several advantages compared to traditional cointegration tests when considering structural breaks. It focuses on the residuals and proposes an alternative hypothesis for a single jump in the cointegrating variables.

Similar to the Zivot & Andrews (1992) unit root test, Gregory & Hansen (1996) introduce three cases: a shift in level, a shift in trend, and a shift in regime. In all three cases, the null hypothesis states that there is no cointegration. It is important to highlight that this cointegration test is specifically suitable to detect an unknown endogenous structural break in the data (Doguwa et al., 2014; Mumba & Ziramba, 2021).

The G-H method builds upon the Augmented Dickey-Fuller and Z test of cointegration; however, it does not give specific knowledge about the time period when break happens (Gregory & Hansen, 1996). The general form for the cointegration including a trend and no structural change is given as:

$$y_{1t} = \mu + \beta_t + \alpha_t y_2^T + \varepsilon_t \quad t= 1,\dots, n \qquad (3.7)$$

This framework allows for a general structural change that permits alterations in the contant term (μ) or the slope (β) but not the time trend. To put this in the form of a model, a dummy variable is introduced. This dummy is defined below:

denoted as [O, 1], where O is the unknown change point and [ ] represents the integer part.

$$D_{Tb} = \begin{cases} 0, & if\ t \leq Tb \\ 1, & if\ t > Tb \end{cases}$$

Here, b denoted as [O, 1], is the unknown point and [ ] represents the integer part. Within the Gregory-Hansen (G-H) methodology, three equations represented as models are employed to capture different types of structural changes. Model 3.8 represents a level shift, Model 3.9 corresponds to shift in level with a trend, and Model 3.10 describes a change in regime. Each model is defined by an equation with the inclusion of a break dummy variable (D).

$$y_{1t} = \alpha_0 + \alpha_1 D_{Tb} + \beta_1^T y_{2t} + \beta_2^T y_{3t} + \varepsilon_t \qquad \text{t= 1,…, n} \qquad (3.8)$$

$$y_{1t} = \alpha_0 + \alpha_1 D_{Tb} + \gamma_t + \beta_1^T y_{2t} + \beta_2^T y_{3t} + \varepsilon_t \qquad \text{t= 1,…, n} \qquad (3.9)$$

$$y_{1t} = \alpha_0 + \alpha_1 D_{Tb} + \gamma_t + \beta_1^T y_{2t} + \beta_2^T y_{3t} + \beta_3^T \gamma_t D_{Tb} + \varepsilon_t \qquad \text{t= 1,…, n} \qquad (3.10)$$

The G-H procedure uses three statistics presented by (3.11), (3.12), and (3.13). Significantly small values of these Zt statistics provides grounds for the rejection of null hypothesis.

$$Z_\alpha^* = \inf_{b \in T} Z_\alpha(b) \qquad (3.11)$$

$$Z_t^* = \inf_{b \in T} Z_t(b) \qquad (3.12)$$

$$ADF = \inf_{b \in T} ADF(b) \qquad (3.13)$$

Gregory & Hansen (1996) emphasize the use of simulation to calculate these test statistics, (MacKinnon, 1991). If the null hypothesis is not rejected, the next step would be to conduct a Granger causality test specifically designed for cases involving structural breaks (Jalil & Rao, 2019). On the other hand, if the null hypothesis is rejected, the estimation of long-run estimates for the model becomes necessary. In the presence of cointegration, the recommended approaches for calculating short-run and long-run estimates are Dynamic Ordinary Least Squares (DOLS) and Fully Modified Ordinary Least Squares (FMOLS) (Cho et al., 2014).

The G-H Cointegration equation implied for our model is expressed as:

$$PD_t = \alpha_0 + \alpha_1 d_t + \beta_1 lnCO_t + \beta_2 lnSS_t + \beta_3 lnER_t + u_t \quad \text{t= 1,…, n} \qquad (3.14)$$

$$PD_t = \alpha_0 + \alpha_1 d_t + \gamma_t + \beta_1 lnCO_t + \beta_2 lnSS_t + \beta_3 lnER_t + u_t \qquad (3.15)$$

$$PD_t = \alpha_0 + \alpha_1 d_t + \gamma_t + \beta_1 lnCO_t + \beta_{11} lnCO_t\, d_t + \beta_2 lnSS_t + \beta_{22} lnSS_t d_t + \beta_3\, lnER_t + \beta_{33}\, lnER_t\, d_t + u_t \quad (3.16)$$

Where, β_1, β_2 and β_3 are the slope coefficients before structural change and β_{11}, β_{22} and β_{33} are the coefficients after structural change. PD_t is the price of vessels brought in for demolition. This study looked at the prices of tankers (TKR) and prices of bulk carriers (BC) for analysis. After conducting the test, the selected model was used to estimate ECM through the residuals if the evidence of cointegration was found. General-to-Specific (GETS) technique of Hendry was applied to derive a parsimonious model for the ECM. To examine the stability of the chosen model, the CUSUM and CUSUMSQ tests were employed. These tests are used to assess whether the model remains stable over time.

3.4.1.5. Post estimation diagnostics: Parameter Stability Tests

After conducting the estimations as outlined above, the stability of the parameters was verified through the utilization of the Cumulative Sum (CUSUM) test. The CUSUM test, initially developed by Brown et al. (1975) is employed to assess the residuals from a subset of the data. It begins at the start of the data and progressively adds observations, repeating the test. (Brooks (2019) notes that the CUSUM test serves to normalize the cumulative sum and establish upper and lower bounds determined by critical values. The null hypothesis assumes parameter stability, while the alternative hypothesis suggests parameter instability, indicating the existence of a breakpoint. Graphical representation of the CUSUM test aids academics in pinpointing the time of break. In the presence of a breakpoint and unstable parameters, a determination is made regarding the appropriate truncation point of the dataset to exclude data preceding the breakpoint.

3.4.1.6. Forecasting Analysis

Forecasting analysis involves predicting future values of the dependent variable(s) based on the estimated model. Various econometric techniques can be used for forecasting, such as autoregressive integrated moving average (ARIMA) models, Vector Autoregression (VAR) models, or the forecast function of the VECM. Econometric forecasting is fundamentally a decision problem and emphasizes the importance of considering the underlying economics and loss functions. The process involves selecting a forecasting model, estimating its parameters, and evaluating the precision of the model's forecasts (Elliott & Timmermann, 2016).

The objective of this study was to forecast demolition prices for future periods after estimation, to provide shipbreakers important signals regarding price movement. Therefore, the analysis proceeded to test if one or more variables under consideration had predictive power to forecast the other variables of interest. For instance, in our case we are interested to see in Equation (2.2) if the stated determinants are capable of forecasting the tanker demolition prices. The forecasting techniques used to predict future demolition prices included using autoregressive integrated moving average (ARIMA) models, and ECM framework to forecast demolition prices based on historical price data and relevant economic indicators. The best forecasting model is selected by comparing the predicted values for in-sample and out-of-sample periods based on Root Mean Squared Error (RMS).

The estimated model was used to forecast ship demolition prices. First, static ex-post forecasts of the ship-demolition prices are calculated on the basis of the estimated cointegration equation and the results are benchmarked with simpler models like univariate autoregressive integrated moving average (ARIMA) model in order to evaluate the historical fit. ARMA models are time series models in the following form:

The ARIMA(1,1,1) model for estimating tanker demolition prices can be presented as follows:

$$\left(1 - \emptyset_1 B - \emptyset_2 B^2 \dots - \emptyset_p B^p\right)(1 - B)^d PD_t = c + \left(1 + \theta_1 B + \theta_2 B^2 + \cdots + \theta_q B^q\right)\varepsilon_t \quad (3.17)$$

Where:

PD_t represents the demolition prices at time t.

B is the backshift operator.

p is the order of the autoregressive (AR) component.

d is the degree of differencing applied to achieve stationarity.

q is the order of the moving average (MA) component.

Φ's are the coefficients of the autoregressive terms

θ' s are the coefficients of the moving average terms.

ε_t represents the white noise error term at time

The $(1 - B)^d$ term represents the differencing operation applied d times to achieve stationarity. The $\left(1 - \emptyset_1 B - \emptyset_2 B^2 \dots - \emptyset_p B^p\right)$ represents the AR component and the $\left(1 + \theta_1 B + \theta_2 B^2 + \cdots + \theta_q B^q\right)$ represents the MA component.

The approach of moving from a general model to a specific one was utilized to determine the most parsimonious ARMA (Autoregressive Moving Average) model, which served as a benchmark for forecasting analysis. These forecasting models were compared on the basis of the root mean square error (RMSE) of the forecast and the Theil coefficient. Then an out-of-sample forecast was made on the basis of cointegration equation. And its predictive power was tested. The RMSE and Theil coefficient criteria were again utilized in order to measure the accuracy of the forecast.

3.4.2. Qualitative Analysis:

3.4.3. Thematic analysis

The data collected through interviews and observations was transcribed and analyzed using a thematic analysis approach. Thematic analysis is a qualitative data analysis technique that identifies patterns and themes within the data (Braun & Clarke, 2012). The data was coded into themes and sub-themes and then was analyzed to identify patterns and relationships. For that we transcribed the interview data to identify common themes and patterns related to policy options for ship recycling in Pakistan, the nature of competition among the ship breakers, profit motive and the degree of formalization in the market, challenges, and market-based solutions. Then, the qualitative data was analyzed to gain insights into the perspectives of stakeholders and potential policy implications. The results obtained from the analysis are presented in chapter 6.

3.4.4. Policy Gap Analysis

To highlight the gaps between the current and desired policy situations and to propose a strategic policy directive maintaining competitive advantage, this study employed the Policy Gap Analysis method. To conduct policy gap analysis the five step procedure followed by (Gomm, 2009) was used.

Policy Gap Analysis

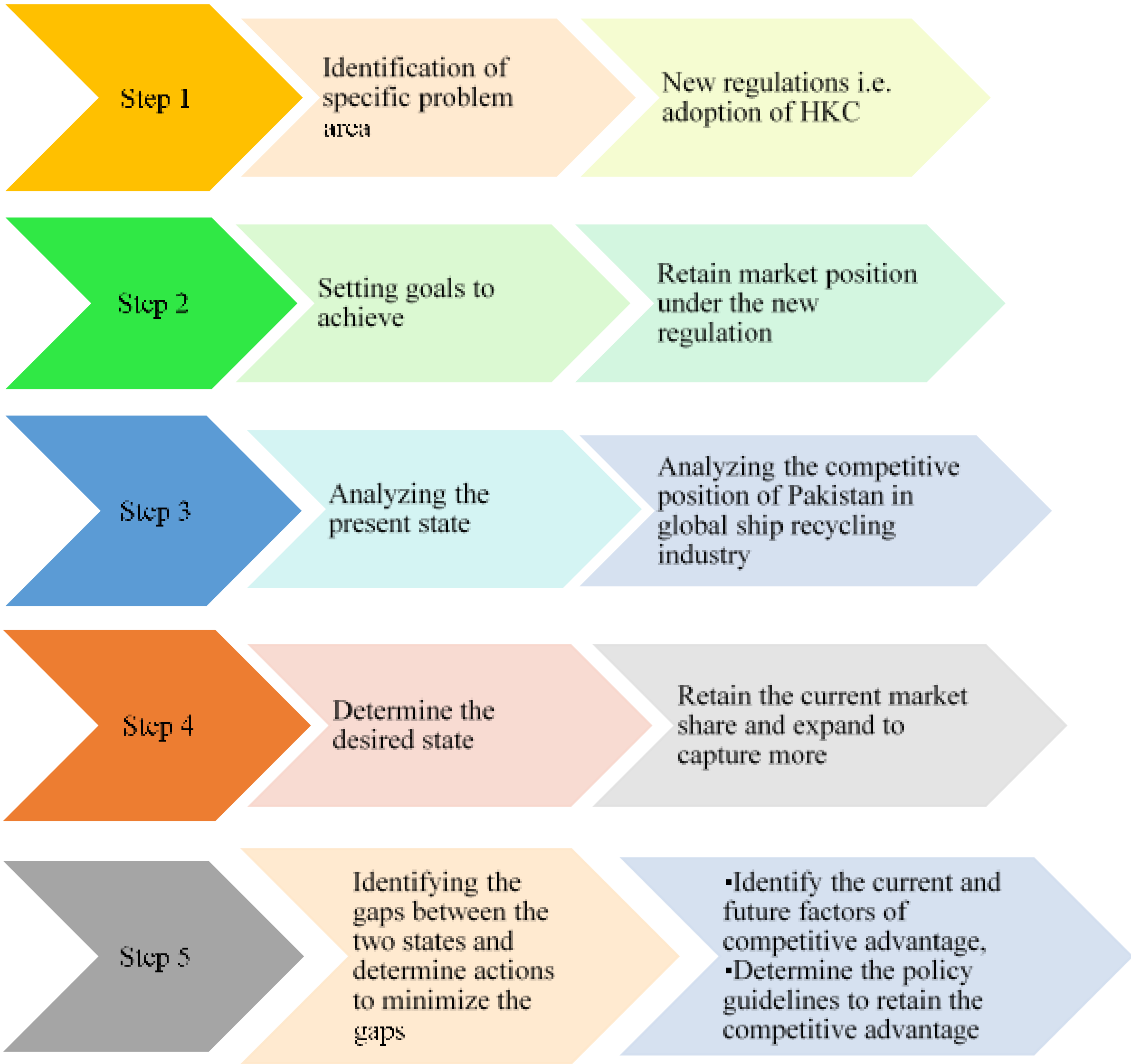


Figure 3.3 Policy Gap Analysis

3.5. Triangulation and Integration:

After completing data analysis, the findings from both the quantitative and qualitative analyses were compared and triangulated, identified areas of convergence or divergence between the results and sought to integrate the insights gained from both approaches. This helped to provide a comprehensive understanding of the economic dynamics of the ship recycling industry in Pakistan.

Convergence: the areas of convergence, where the results from both approaches aligned or supported each other. For example, I found that exchange rate and steel price fluctuations influencing price formation identified in the quantitative analysis were also mentioned by stakeholders in the qualitative interviews.

Divergence: attention was also paid to any areas of divergence or differences between the quantitative and qualitative findings. These differences, discussed in the coming sections, revealed nuanced perspectives and enriched the overall understanding of the policy options for ship recycling in Pakistan.

Synthesis: Based on the convergence and divergence identified, the findings from both the quantitative and qualitative components were synthesizes. This synthesis, which created a holistic picture of the economic dynamics of the SRI in Pakistan, is discussed in the next following section.

3.6. Validity and Reliability

To ensure the validity of the qualitative analysis, the researcher employed triangulation, member checking, and peer debriefing.

3.6.1. Triangulation

Triangulation involves utilizing two or more theoretical perspectives, data sources, methodological approaches, investigators, or data analysis methods. The goal of employing triangulation is to address, minimize, or balance the limitations of a single approach, thereby improving the interpretability of the results (Thurmond, 2001). Chapter 7 of this study pertains to triangulation explaining how the findings from qualitative and quantitative sources and from different methodological approaches were integrated.

3.6.2. Member checking

Member checking involves verifying the findings with the participants to ensure that they accurately reflect their experiences. Member checking is defined as a validation technique in qualitative research where the research participants are given the opportunity to review the collected data or results to confirm the accuracy and authenticity of the findings based on their own experiences (Birt et al., 2016). This technique was used to enhance the credibility and trustworthiness of the research by ensuring that the participants' perspectives were adequately represented in the final analysis.

3.6.3. Peer debriefing

Peer debriefing is a qualitative research technique where an external researcher or a colleague is brought in to review and provide feedback on the research process, analysis, and interpretation of results. According to Lincoln & Guba (1985), peer debriefing involves "exposing the entire research process, including its underlying assumptions, procedures, and products, to the critical scrutiny of a knowledgeable, interested, and independent third party." This technique was used to increase the credibility and rigor of the research by having an objective and knowledgeable peer review of the research process and results. It was done by sharing the findings with other researchers to ensure that the interpretation is unbiased and rigorous.

Chapter 4

Econometric Analysis and Results

This chapter presents the econometric analysis conducted on the data collected for ship demolition prices in Pakistan. It begins with data visualization, providing a visual representation of the time series data. Descriptive statistics offer key insights into the characteristics of the data. Pre-estimation diagnostics, including stationarity tests and cointegration analysis, ensure the reliability of the econometric model. The short-term parameters are then estimated to capture short-term dynamics, followed by parameter stability tests. Finally, forecasting analysis provides future projections. The chapter's findings contribute to a comprehensive understanding of the determinants and dynamics of ship demolition prices in Pakistan, informing subsequent discussions on policy implications and strategic guidelines for the industry.

4.1. Data Visualizations

This section presents the time series plots for the variables under investigation, spanning a period of 18 years from 2004 to 2022. The time plots provide a visual representation of the data patterns and trends over time. The graphical display of series offers insights into the behavior and dynamics of each variable over the specified timeframe. Observing the time plots allows for the identification of patterns, trends, seasonality, and potential structural breaks. Figure 4.1 displays the time series plot for each variable. When visualizing time series data, we looked for visual evidence of:

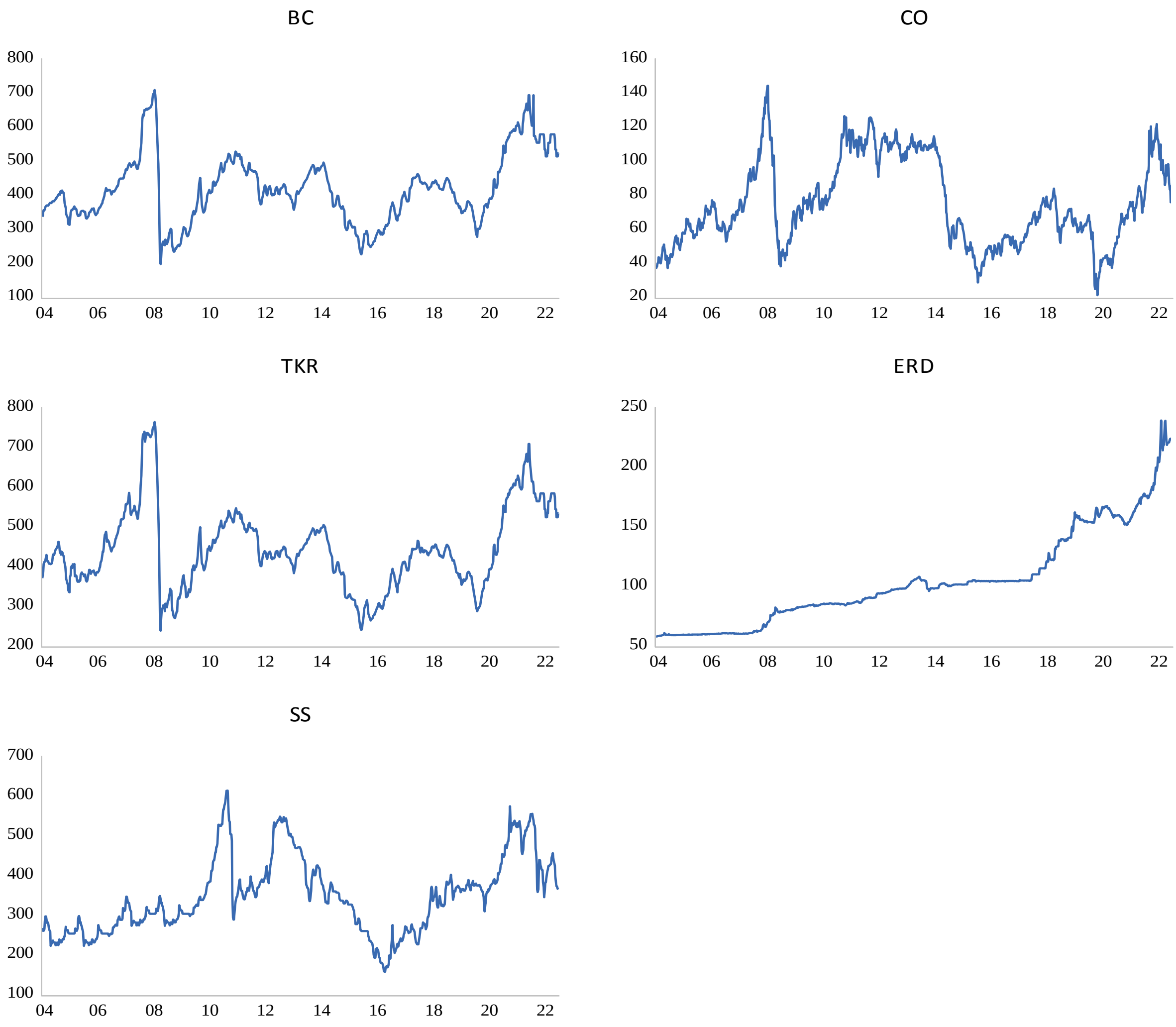
i. The co-movements between variables.
ii. The presence of deterministic components such as constants and time trends.
iii. Potential structural breaks

In the case of Bulk Carrier Prices (BC) and Tanker Prices (TKR), the graph illustrates the co-movements and same fluctuation of prices of both type of vessels over time, indicating an obvious structural break in the year 2008.

The time series plot of Steel Scrap Prices (SS) showcases that scrap steel prices follow the movement and trend of tanker and bulk carrier prices with a time lag, throughout the years, revealing a long-term relationship between these variables. it can be observed that the prices of scrap consistently remain lower than the tanker demolition prices, except for the instances of extreme values in 2008. This phenomenon can be attributed to the fact that steel scrap exported from developed countries is typically traded at a discounted rate compared to scrap obtained from ship recycling. This discount is implemented to account for the higher transportation costs involved in exporting scrap from these countries. The time series plot of Crude Oil Prices also indicates a potential structural break in the trend of oil prices, during the months leading to global financial crisis of 2008.

By examining the time series plots, we gained a visual understanding of the variables' behavior over time. These plots served as an initial exploration and provided insights into the data patterns and potential relationships between variables. Subsequent analyses were guided by the observations and patterns identified in the time series plots.

Figure 4.1: Display of Raw Variables Over Time



Note: The time series plots are based on weekly data obtained from Baltic Exchange, MacroMicro, CISA and Investing.com. for the period 2004 to 2022. For further details on data sources see Table 4.1.

4.2. Descriptive Statistics

This section presents the descriptive statistics of the key variables in the study, providing insights into their central tendency, variability, skewness, kurtosis, and normality. Table 4.1 summarizes the descriptive statistics for the variables: Bulk Carrier Prices (BC), Tanker Prices (TKR), Steel Scrap Prices, Exchange Rate, and Crude Oil Prices.

Table 4.1 Summary Statistics of Key Variables

	LNTKR	**LNSS**	**LNCO**	**LNERD**
Mean	6.069	5.814	4.264	4.589
Median	6.071	5.823	4.251	4.592
Maximum	6.639	6.422	4.973	5.479
Minimum	5.477	5.063	3.065	4.064
Std. Dev.	0.225	0.269	0.342	0.354
Skewness	0.039	0.003	-0.172	0.321
Kurtosis	2.929	2.566	2.387	2.407
Jarque-Bera	0.456	7.556	19.844	30.666
Probability	0.796	0.023	0.000	0.000
Sum Sq. Dev.	48.739	70.186	112.84	120.92
Observations	965	965	965	965

Note: Based on Author's calculations

The table displays the mean, median, standard deviation (SD), minimum, maximum, 1st quartile, and 3rd quartile for each variable. Skewness and kurtosis coefficients are also reported, indicating the distribution's asymmetry and peakedness. Additionally, the Jarque-Bera (JB) test statistics and associated probabilities are provided to assess the normality assumption. The number of observations for each variable is consistent, with a total of 965 observations available. The mean represents the average value of each variable, providing an estimate of their typical magnitude. The median represents the middle value when the data is sorted, reflecting the central tendency of the distribution. Standard deviation (SD) measures the dispersion or variability around the mean, with higher values indicating greater variability. The minimum and maximum values depict the range of observations captured within the dataset, highlighting the lower and upper bounds.

Skewness measures the symmetry of the distribution. Positive skewness indicates a longer right tail, while negative skewness indicates a longer left tail. Kurtosis assesses the peakedness or flatness of the distribution, with higher values suggesting a sharper peak or heavier tails compared to a normal distribution. The Jarque-Bera (JB) test statistics and associated probabilities assess the departure from normality. Lower probabilities indicate a higher likelihood of deviations from the normal distribution assumption.

Table 4.2: Correlation Matrix

	lnCO	**lnTKR**	**lnSS**	**lnERD**
lnCO	1	0.606	0.527	-0.004
lnTKR	0.606	1	0.462	0.094
lnSS	0.528	0.462	1	0.478
lnERD	-0.004	0.095	0.478	1

Note: Based on Author's calculations

Table 4.2 displays the correlation between the variables. According to Kagkarakis et al. (2016) a strong correlation relationship exists between ship demolition prices and international steel scrap prices. It can be seen that the correlation coefficient between steel scrap prices and tanker demolition prices is 0.46 while between steel scrap prices and bulk carrier prices is 0.50 which suggest high positive correlation. The descriptive statistics provide a comprehensive overview of the variables' characteristics, enabling a better understanding of their central tendencies, variabilities, shapes, and potential departures from normality. These insights are valuable for subsequent analyses and interpretation of the study's findings.

4.3.Stationarity Tests

To ensure suitability for long term econometric analysis and forecasting analysis, it is essential for the series to exhibit stationarity. Converting original time series into log series is a common practice in time series econometric analysis for several reasons. Therefore, original data series were transformed into log series, potentially rendering them stationary. Transforming financial series into return series or log series before econometric analysis helps address issues related to stationarity, normality assumptions, comparability, and interpretability, enhancing the reliability and validity of the subsequent analysis.

However, conducting unit root tests is still necessary to establish a conclusive determination. To this end, the augmented Dickey-Fuller test by Dickey & Fuller (1979) was initially employed on all the series, and the outcomes are presented in Table 4. Based on the obtained results, it is evident that all variables contain a unit root at the level but the first differences of all variables are of I (1). The significance of test statistic for TKR at level is nothing but spurious result due to presence of structural break. The results of the ADF test show all variables to be non-stationary at level while first differences of all series are stationary.

Table 4.3: Augmented Dickey-Fuller (ADF) Test

Series name	**Level**		**First Difference**	
	C	**C & T**	**C**	**C & T**
lnERD	1.363	0.019	-27.974*	23.760*
lnCO	-2.658	-2.691	-30.489*	-21.505 *
lnTKR	-3.099*	-3.004	-11.983*	-13.493*
lnSS	-2.417	-2.85	-18.652*	-18.574*

Critical values: 1%, 5% and 10% level of significance are: -3.436913, -2.864326, -2.568306
Critical values for first differences are -3.967597, -3.414482, -3.129378.
Note: *denotes the rejection of null hypothesis at the 5% level.

Recent studies suggest that the conventional tests may have low power in detecting unit roots when there are structural breaks or changes in the underlying data. Failing to account for structural breaks can lead to misleading results and incorrect inferences (Jalil & Rao, 2019). The graphical display of the data series depicted a structural break in the financial time series under consideration in this study. Therefore, it is necessary to incorporate structural breaks when conducting unit root tests.

Since, the results of the ADF test cannot be relied on therefore the Zivot-Andrews unit root test with a single unknown structural break was also employed to examine the stationarity in the presence of structural breaks. The results are presented in table 5 which shows that all the series are I (1). It means that first differences of all the variables are stationary. While structural breaks were found in all variables for mid-2008 except SS which exhibited break period pertaining to 2011. The Zivot Andrews test was performed for equation 3.3 and 3.5.

Table 4.4. Zivot-Andrews Structural Break Unit Root Test

Variable	**Level**		**1st Difference**	
	Intercept	**C&T**	**Intercept**	**C&T**

lnERD	2.709	-0.673	-27.249*	-6.259*
Time Break	10/19/2008	10/19/2008	10/19/2008	10/19/2008
lnCO	-3.244	-2.945	-30.554*	-31.737*
Time Break	6/15/2014	7/06/2008	7/06/2008	4/19/2020
lnTKR	-3.352	-4.395	-11.919*	-12.191*
Time Break	7/13/2008	7/13/2008	2/10/2008	1/26/2020
lnSS	-2.282	-2.639	-10.437*	-10.679*
Time Break	3/31/2013	2/13/2011	02/13/2011	4/26/2020

Note: *denotes the rejection of null hypothesis at the 5% level.
Model 4.3: Critical values at Level for 1%, 5% and 10% level of significance are -4.734858, -4.193627, -3.863839. for trend and intercept: -5.282189, -4.616123, -4.275401.
Model 4.5: Critical Values at level are: -5.282189, -4.616123, -4.275401.

4.4. Gregory Hansen Cointegration Procedure:

The Gregory and Hansen residual-based test was employed for cointegration analysis. The Gregory Hansen test examines the null hypothesis of no cointegration for the 1(1) series considering the presence of a structural break. The decision for the rejection of null hypothesis depends on the absolute value of Z_t statistic. If the calculated value of Zt statistic is greater than the critical value at 5% level of significance, null hypothesis is rejected. The table 4.5 presents the results of this test. The test statistics were calculated for equations 3.14 to 3.16 as shown in Table 4.5.

Table 4.5 a: Gregory Hansen Cointegration Test

Model	**ADF**	**Break Date**	Z_t	**Break Date**	$Z\alpha$	**Break Date**	**AIC**
Level Shift	-5.88*	11/02/2008	-4.97*	10/19/2008	-49.419*	10/19/2008	11.188
Intercept Shift with Trend	-6.39*	11/02/2008	-5.52*	10/19/2008	-60.168*	1/26/2020	11.180
Intercept and Regime Shift	-6.77*	06/15/2008	-5.77*	07/06/2008	-65.681*	06/08/2008	11.050

Note: *Represents rejection of null hypothesis at 5% level.

Table 4.5 b: Critical Values Extracted from Gregory & Hansen (1996)

Model	Critical Values			
	ADF, Zt		Zα	
	5%,	10%	5%	10%
Level Shift	-4.61	-4.34	-40.48	-36.19
Intercept Shift with Trend	-4.99	-4.74	-47.96	-43.22
Intercept and Regime Shift	-4.95	-4.68	-47.04	-41.85

Critical Values are given according to Table 1 of Gregory & Hansen (1996)

The table 4.5 confirms that long run relationship exists among tanker prices, steel scrap prices, exchange rate, and crude oil prices. It also indicates that cointegration is established under the assumption of shifts in both the level and the slope. The results point out that break happens in year 2008. The largest actual value of the ADF test score is used to calculate the break date (Mumba & Ziramba, 2021). The break date identified by GH test represents the shocks caused by global financial crisis of 2008. Therefore, we introduced structural dummy (dt=0) for period 04/07/2004 to 10/01/2008 and 02/01/2009 to 25/12/2022. while dt=1 for period of global financial crisis i.e. 11/02/2008 to 25/12/2008. Hence, the estimated coefficients of the Gregory and Hansen equation are presented in Table 4.6.

Table 4.6: The GH Cointegration Equations

Variable (Break Date)	GH-1* (2008)	GH-2 (2008)	GH-3 (2008)
C	2.428*	4.023*	-25.347*
Trend	-	0.0006*	27.513
lnSS	0.398*	0.254*	0.643*
lnCO	0.264*	0.397*	-0.041
lnERD	-0.329*	-0.253*	6.839
D_2008	2.428*	-0.357*	
lnSS_2008			-0.489*
lnCO_2008			-6.566

lnERD_2008	0.436

The model 1, 2 and 3 are the estimations of equations (3.14) to (3.16). The coefficient of trend is insignificant for model 3 which is the estimation of equation 3.16. the same coefficient for model 2 is significant but exhibits a negligible magnitude. Therefore model 1 is selected with break date 2008 which implies a level shift in the series.

As shown in table above, the GH-1 estimates reported steel scrap prices has a positive and significant relationship with tanker prices, which means that tanker prices are significantly elastic to changes in steel scrap rates. The main effects that is the lnSS and lnERD depict correct signs as anticipated. The interaction term of the lnSS is significant at 5% level after the break and in line with a priori expectations. This implies that structural break should be taken into account when modeling long run relationship of tanker demolition prices in Pakistan.

While the coefficient of exchange rate at -0.328 implies that, in the long run, a one-unit increase in lnERD leads to a 0.32 percent decrease in the current tanker prices. This finding is important and in line with the economic rationale of exchange rate fluctuations disrupting the national markets.

Table 4.7 Short-run results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.003	0.002	1.996	0.046
D(LNSS)	0.038	0.027	1.406	0.015
D(LNSS(-1))	0.034	0.121	3.019	0.007
D(LNSS(-2))	0.064	0.122	2.207	0.039
D(LNCO)	-0.016	0.016	-0.996	0.031
D(LNCO(-1))	-0.178	0.004	-3.864	0.0010
D(LNCO(-2))	-0.017	0.004	1.015	0.322
D(LNERD)	0.033	0.084	0.386	0.039
D(LNERD(-2))	0.034	0.259	1.204	0.242
D(LNERD(-1))	0.029	0.002	-0.211	0.835

ECM(-1)	-0.235	0.005	-0.135	0.000

Diagnostics:

R-squared	0.7
Adjusted R-squared	0.71
Akaike info criterion	-4.565
Serial Correlation LM Test	13.024*
ARCH LM Test	18.98*

The ECM (Error Correction Model) was estimated using the aforementioned method i.e. general-to-specific (GETS) technique, which helps identify the significant factors that influence tanker demolition prices. The results from the short-run regression analysis in Table 5.7 indicate that steel scrap prices, international crude oil prices, and exchange rate dynamics play a role in determining tanker demolition prices. One key finding is that the coefficient of the Error Correction Term (ECT) is negative and highly significant. This suggests that there is a long-term relationship between tanker demolition prices and their determinants, both before and after the financial crisis. In other words, changes in the determinants of tanker demolition prices have a significant impact on the prices themselves, and there is a tendency for any disequilibrium to converge back to the long-run equilibrium at a rate of approximately 23.5 percent per year.

To validate the robustness of the results, diagnostic tests were conducted. The CUSUM and CUSUM Square tests, shown in Figures 5.2 and 5.3 respectively, provide additional evidence in support of the findings. These tests help assess whether the estimated model adequately captures the relationship between the variables and whether any structural breaks or deviations from the model occur over time. The results of these tests further support the conclusions drawn from the regression analysis, strengthening the overall reliability of the findings in this study.

4.5. Post-estimation diagnostic test results.: The Parameter Stability Tests

The CUSUM and CUSUMSQ tests developed by Brown et al. (1975) were employed to assess the stability of the money demand function in Nigeria throughout the study period. These tests examine whether the estimated residuals of the money demand function fall within the critical boundaries. Any deviations outside these boundaries indicate potential parameter instability during that specific period. Figure 4.2 illustrates the results of the CUSUM test, indicating overall stability in the tanker demolition price function. However, the CUSUMSQ test reveals parameter instability specifically during the global financial crisis, while the parameters remain stable in the pre- and post-crisis periods. There is further some slight instability visible in the post COVID-19 pandemic era as shown in the figure 4.3 below.

Figure 4.2 CUSUM Stability Test

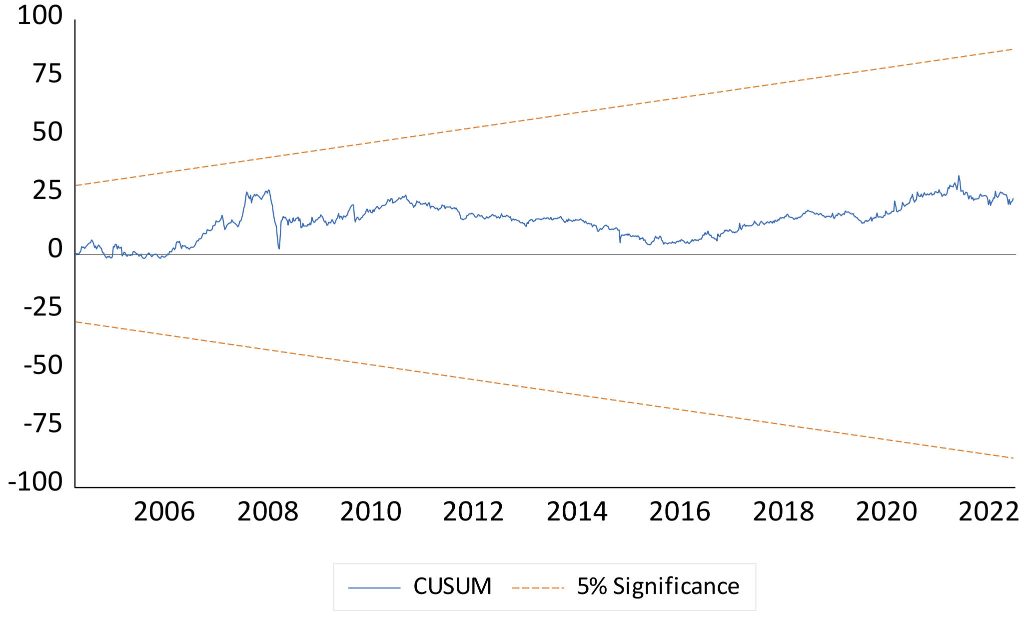
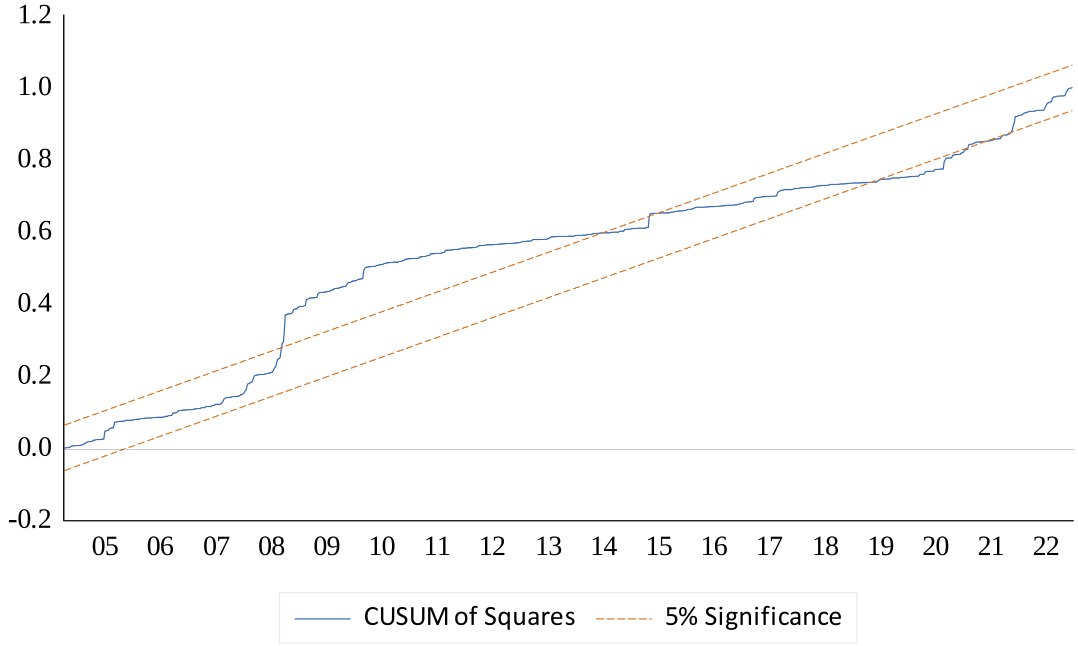


Figure 4.3 CUSUMQ Stability Test



4.6. Demolition Price Forecasting

In this section, we will assess the forecast accuracy of the estimated models, utilizing the estimation results presented in the previous section. The performance of each model was evaluated through Root Mean Squared Error (RMSE) and Theil Coefficient. By comparing these metrics, we can gauge the accuracy of the in-sample and out-of-sample forecasts for each model. Before moving forward an ARIMA (1,1,1) model was estimated whose results are presented below. To prevent spurious regressions, the demolition price time series, represented by TKR_t – δt, was detrended prior to conducting the regression analysis. The regression equation based on this procedure, is as follows:

$$\Delta TKRt = \theta + \gamma\, TKRt - 1 + ut + \delta\, ut\text{-}1 \qquad (4.1)$$

$$\underset{(0.001682)}{\Delta TKRt = 0.000406} + \underset{(0.015017)}{0.5703\, TKRt_{-1}} - \underset{(0.026419)}{0.033965\, u_{t-1}} \qquad (4.2)$$

The numbers in parenthesis represent the relevant standard errors (SE). It is clear from the results of the ARIMA model estimation that the moving average (MA) and autoregressive (AR) variables are both statistically significant at the 1% level. In addition, the value of the coefficient of the autoregressive component shows that this term can account for a sizeable amount of the detrended price changes at time t.

First, a within-sample forecast over the whole of the estimated period is performed, whereby the models produce one-step ahead static forecasts in order to confirm their historical fit. With reference to the proper ARIMA (p,d,q) model selection (Equation (4.1)), the employed methodology 'general to specific' indicates that an ARIMA (1,1,1) is the most parsimonious. According to the results which are presented in Table 4.8 and Figure 4.4(a) 4.4(b), the ECM based forecasting model has the lowest forecasting errors and outperforms the forecast based on other models; thus, the findings from the previous analysis that the ship-demolition prices are highly affected by the international steel-scrap prices are validated further.

Table 4.8: Ex-post forecasting results – Theil and RMSE criteria

	Models	
Criteria	**Coint. Eq.**	**ARIMA (1,1,1)**
RMSE	22.221*	27.223
Theil	0.027*	0.033

Note: * shows the model with smallest forecasting errors.

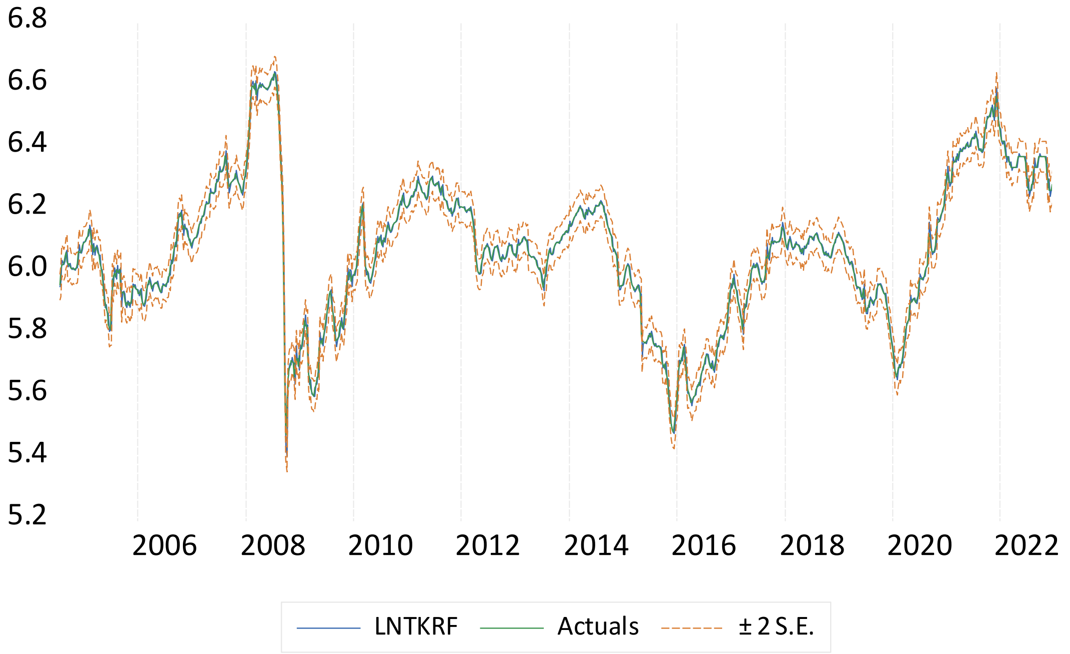


Figure 4.4(a): ARIMA based Ex-post Forecast

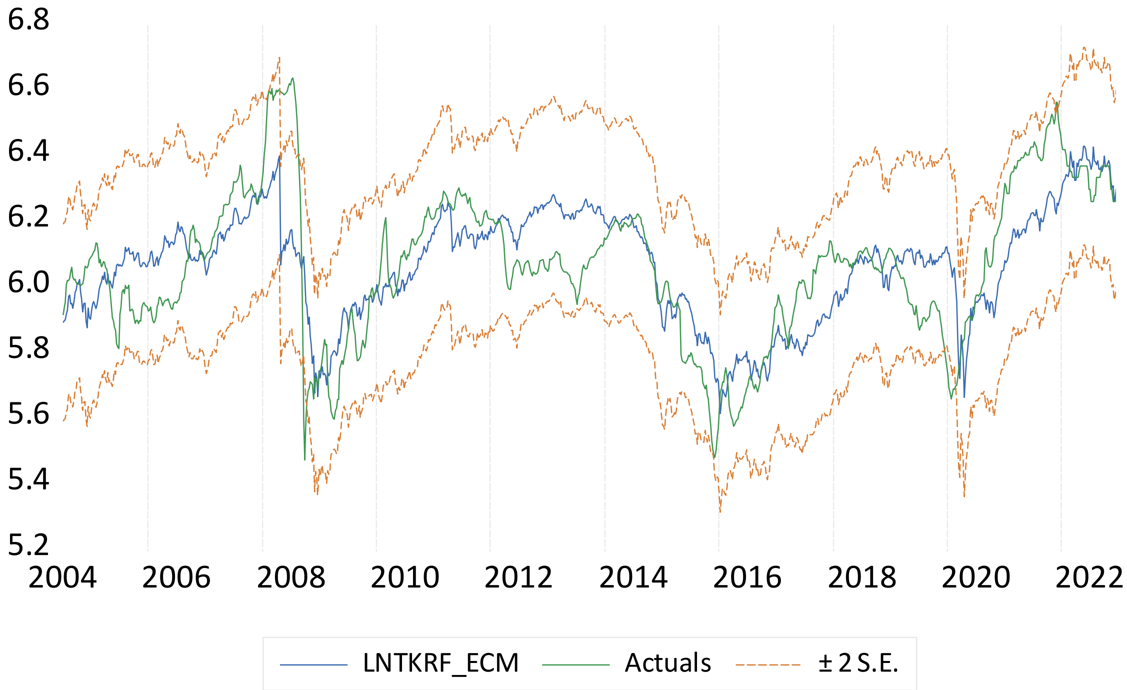


Figure 4.4(b): ECM based Ex-post Forecast

To test the out-of-sample predictive ability of our cointegrating equation, we estimate it within July 2004 and December 2021, with the remaining sample (January 2022–December2022) left out for prediction purposes. The accuracy of the model was tested by comparing the forecasted values to the actual ones. The results of the procedure are presented in Figure 4.5, and indicate a high forecasting accuracy with low RMSE and Theil coefficient. The Root Mean Squared Error (RMSE) is the standard deviation of the forecast errors. The Theil Coefficient lies between 0 and 1, with 0 indicating a perfect fit.

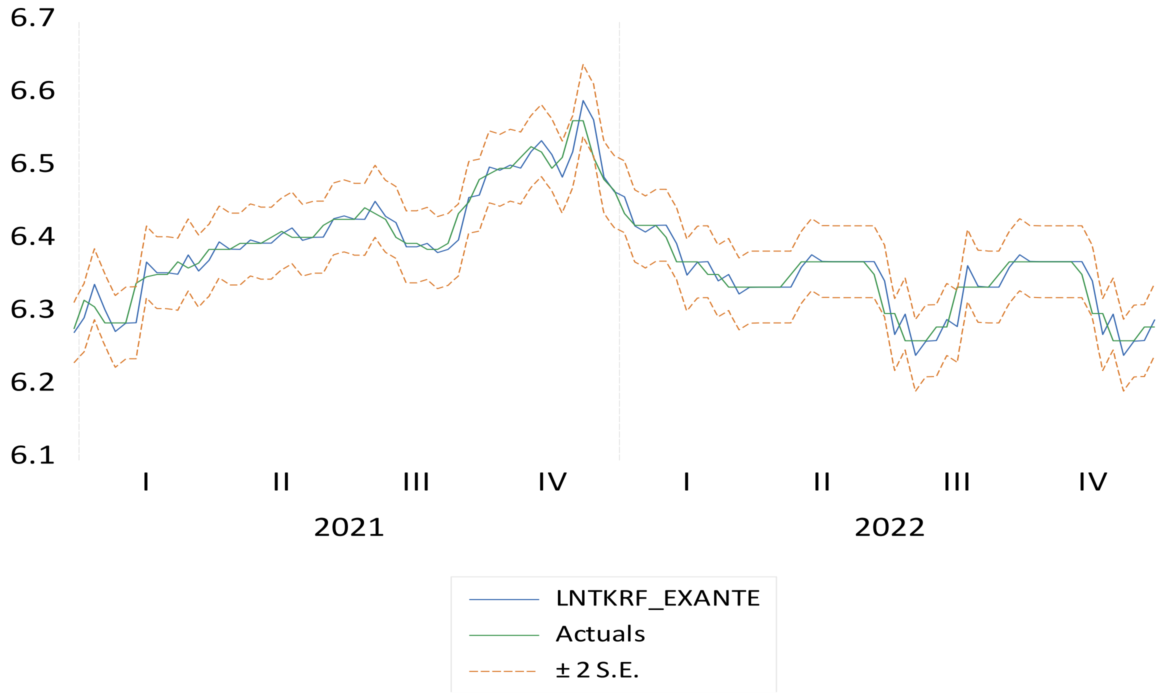


Figure 4.5: ARIMA based out-of-sample Ex-ante Forecast

Overall, the prediction for the future trend of demolition prices is that tanker demolition prices are forecast to go up steadily for the year 2023 and beyond. It is common practice that high demolition prices are offered when freight earnings are high as well, to lure shipowners into selling their old vessels (Merikas et al., 2015a). According to the Knapp et al. (2008) high freight earnings have negative effects on sending ship to the demolition. This situation leads to an increase in scrap prices, because the number of ships sent to the demolition market decreases and economic activities are buoyant. This evidence supports our forecast which shows higher demolition prices for year 2023 through 2024. This result is in line with consistent hike in freight rates all over the world which has caused reduction in demolition tonnage in the year

2022[7][8], prompting shipowners to carry on operations with their old vessels due to increased profitability.

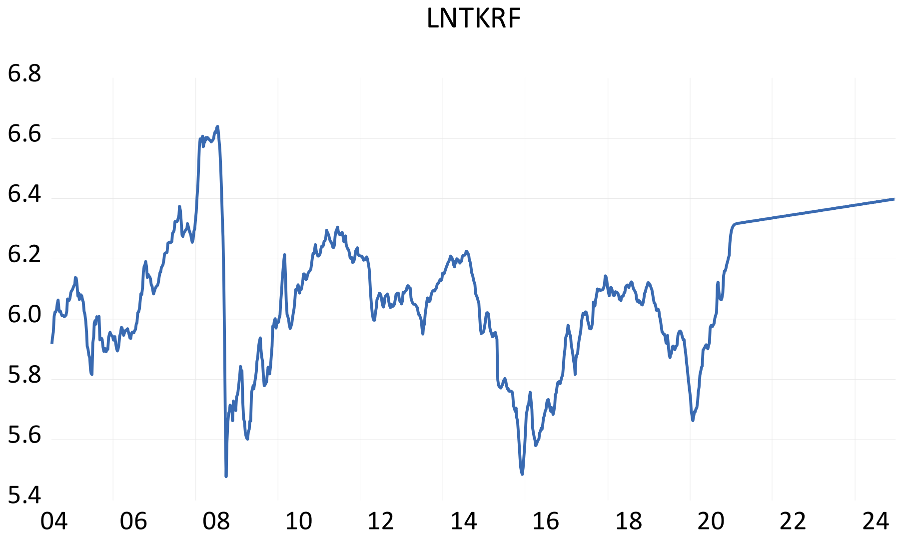


Figure 4.6: Demolition Price Forecast

4.7. Discussion of Results and Conclusion

According to the research model obtained from the theoretical framework of this study, demolition prices are a function of the steel scrap price, international oil prices and exchange rate, among other variables. And freight rates indirectly affect the demolition prices via EOL ship supply. Thus, when economic activities are bullish, freight rates tend to rise. Therefore, even the old and inefficient vessels are able to make profit on the market by meeting their high operational expenses.

In this context, the aim of this study was to estimate the relationship of tanker demolition prices with its determinants as proposed in the theoretical model. As a result of our study, a positive relationship is found between demolition prices and two of the three explanatory variables (steel prices and international oil prices).

[7] Throughout 2021, demand and supply conditions in the container shipping freight market were unusual. On the one hand, there was an 11 per cent increase in global containerized trade volumes, – a rebound that put additional pressures on carriers and ports. At the same time there was an increase in freight prices – a consequence of low growth in fleet supply and disruptions in supply chains, caused mainly by COVID-19, with greater port congestion and landside problems that reduced global container and logistics capacities.

[8] UNCTAD. (2022). Review of Maritime Transport: Navigating stormy waters. United Nations. https://unctad.org/system/files/official-document/rmt2022_en.pdf

Firstly, logarithmic data are checked for stationarity and are converted to stationary series if they have unit roots. The time plots of the variables revealed that there is a structural break in data in the year 2008 due to global financial crisis. Therefore, instead of relying on the results of conventional unit root tests, Zivot-Andrews unit root test with a single unknown structural break was also employed to examine the stationarity in the presence of structural breaks. According to Zivot-Andrews unit root test, all the series are I (1). It means that first differences of all the variables are stationary. While structural breaks were found in all variables for mid-2008 except for steel scrap prices which exhibited break period pertaining to 2011.

Thirdly, Gregory Hansen cointegration residual-based test is conducted for cointegration analysis in the presence of structural breaks. The results of the cointegration test confirm that long run relationship exists among tanker prices, steel scrap prices, exchange rate, and crude oil prices. It also indicates that cointegration is established under the assumption of shifts in both the level and the slope. The results point out that break happens in year 2008.

Fourthly, to take into account the effect of this break, structural dummies were introduced to estimate the model. The empirical results of the estimated show that tanker demolition prices are influenced by steel prices, exchange rates and oil prices. Estimates reported steel scrap prices has a positive and significant relationship with tanker demolition prices, which means that tanker prices are significantly elastic to changes in steel scrap rates. These results are consistent with the theoretical framework of the maritime market and previous studies about this subject. Mikelis (2007) argued that demolition prices are affected by number of ships sent to the demolition and steel demand in the domestic country. Merikas et al. (2015) supported this view that fluctuations in steel industry affect the ship demolition prices because demolition market is one of the main suppliers of the steel industry in a given country.

In a similar analysis, Kagkarakis et al. (2016) have also affirmed that in the short run the international steel-scrap prices play an important role in incorporating new information to the ship-demolition price determination. The interesting information derived from this result is that; since Pakistan is also a leading steel scrap importing country, and the scrap obtained from the ship-recycling procedure covers only a portion of the total domestic demand; the quantity of the imported steel-scrap is greater compared to the steel-scrap obtained from recycling ships; hence, the prices offered by ship-recyclers are strongly affected by the price levels of the importing scrap.

Estimates show that, in the long run, exchange rate fluctuations, particularly the increase in exchange rate leads to push the current tanker prices downwards. This finding is important and is in line with findings of Merikas et al. (2015) and Kagkarakis et al. (2016) confirming the economic rationale of exchange rate fluctuations disrupting the national markets. Furthermore, the relationship between international oil prices and tanker demolition prices was found to be positive in the long run. The elasticity of international oil prices to tanker demolition prices was 0.2643, meaning that when international oil prices increase by one unit, tanker demolition prices go upward by around 26%. The implication of this result is that fluctuations in the international oil prices are an important determinant of change in tanker demolition prices offered by the ship recyclers.

The practical implications of this analysis lie in its potential to serve as a valuable decision-making tool for stakeholders in the shipping sector. Ship owners, cash buyer, who buy EOL ships for reselling them again after some time and end-buyers or ship recyclers who purchase vessels for recycling can derive strategic insights from the findings of this study. These insights can aid them in efficiently managing ship-demolition transactions and planning their strategic moves with precision. The signal shown by international steel-scrap prices to the ship-demolition market can be interpreted by industry professionals as follows: an upward trend in international steel-scrap prices may ignite optimistic sentiments among cash-buyers, anticipating a surge in future demolition prices. Consequently, they may expand their investments and inventory by procuring additional units, intending to sell them later to end-buyers at elevated prices. For ship owners, a similar signal would trigger expectations of imminent demolition price hikes, prompting them to potentially delay a sale in anticipation of more favorable pricing conditions.

CHAPTER 5

SHIP RECYCLING INDUSTRY IN PAKISTAN: AN ECONOMIC ANALYSIS

The primary objective of this study was to present an economic analysis of ship recycling industry in Pakistan. This section offers a detailed exploration of the ship recycling industry in Pakistan from an economic standpoint. To support the analysis and findings, the chapter draws upon information extracted through in-depth interviews conducted with industry experts, shipbreakers, policymakers, and relevant stakeholders. The detailed process of conducting interviews was explained in the section on data collection. These interviews were conducted keeping in view the following themes and key words:

> *the market conditions of SRI, market size, economic footprint or contribution, degree of competition, degree of formalization, profit motive, operations,* and the *pricing strategies* employed by shipbreakers.

The chapter presents an exploratory account of the industry, based on the thematic analysis of the interviews conducted along the above described keywords and themes. These insights provided valuable perspectives on the industry, enriching the exploratory account and contributing to a comprehensive understanding of the market conditions of ship recycling in Pakistan. This understanding served as a foundation for further analysis and discussion in subsequent chapters, providing a robust framework for informing policy recommendations.

5.1. An overview of the Shipbreaking Activity

The life cycle of a seaborne ship/vessel passes through four stages: the building or construction phase, the operation phase, the second hand sale and purchase and finally the demolition. Likewise the shipping industry comprises four sub-markets: the shipbuilding market, freight market, sale and purchase market and shipbreaking market (Stopford, 2009). Although all the four markets are characterized by different activities but all these markets are strongly interlinked. However, shipbreaking market plays the stabilizing role in shipping sector where the EOL vessels are converted into recyclable steel and other reusable objects. When ship supply exceeds demand, overall market freight levels fall leading to reduce the shipowner revenues. Resultantly, some vessels may become uneconomical for service, prompting shipowners to sell them for demolition or scrapping. Balance in shipping market is maintained when the excess ships are driven to the breaking yards at a faster rate than new ships join the market from shipbuilding yards.

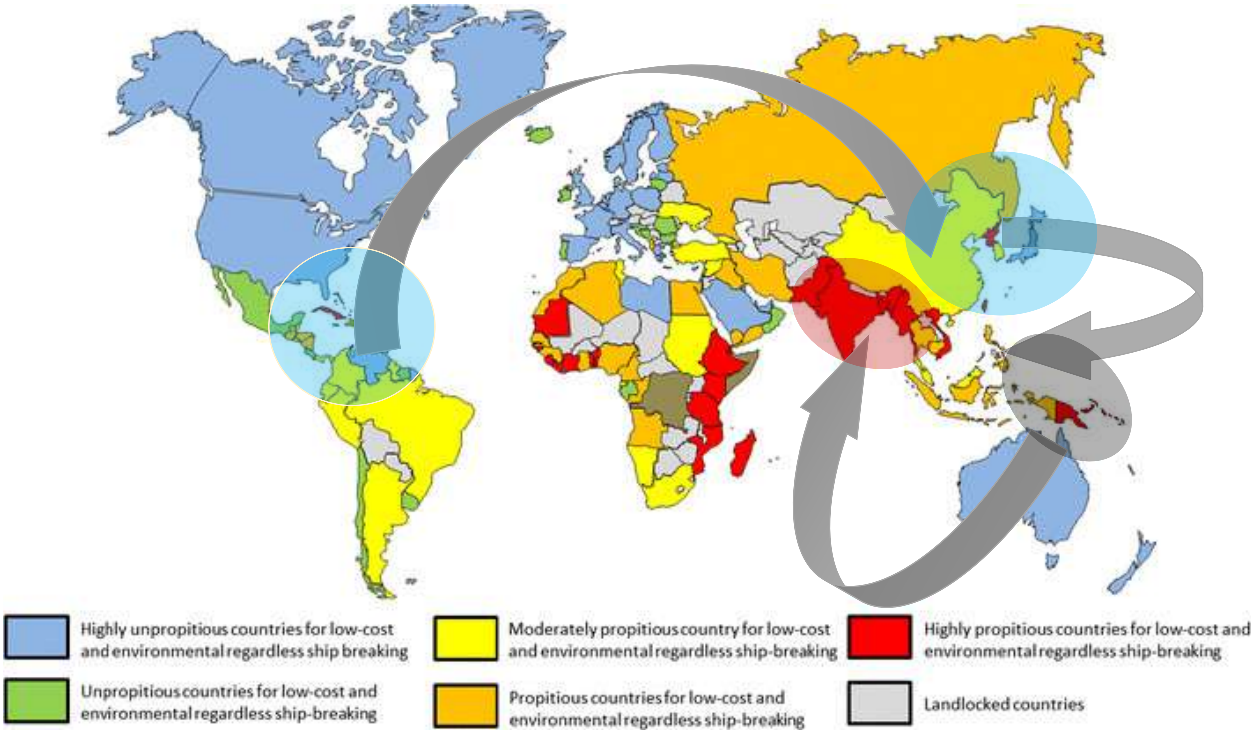
The ships targeted for demolition are usually – but not always – older ships that have become practically obsolete (Buxton, 1991). The decision to demolish a ship depends not only on the age of the ship but also on regulatory changes, technical obsolescence, earnings from the ship and the scrap prices among other factors (Knapp et al., 2008b). The life of a vessel spans 25–30 years but after 20 years, their maintenance costs keep on rising exponentially deeming their operation inefficient. As the decision to demolish a ship depends on its economic life, and the latter is determined by the earnings from freight rates throughout the ship's operational life (Strandenes, 2010). If the owner's earnings are declining despite cost-cutting efforts, the owner may consider demolition (Buxton, 1991; Karlis & Polemis, 2016; Knapp et al., 2008b). This is the reason freight rates are such strong determinant of supply for scrapping ships.

5.1.1. Physical Relocation of SRI

Ship Recycling industry has undergone geographical transitions driven by factors such as lower labor cost optimization and the demand for scrap steel (K. Jain & Pruijn, 2017). Initially, this industry emerged in industrially developed nations like the United Kingdom and the United States following World War II, primarily to dismantle war-damaged ships (N. D. Kagkarakis, Merikas, & Merika, 2016b). However, due to the detrimental environmental impact on coastal ecosystems, these countries discouraged the industry. Later on, due to the availability of cheap labour and the rising demand for re-rolled steel in those areas, the industry moved to semi-industrialized Asian and Mediterranean nations (Buxton, 1991; Stopford, 2009). In Figure 5.1, the relocation of SRI is depicted.

the industry shifted to semi-industrialized Asian and Mediterranean countries like Japan, Taiwan, South Korea, Spain, and China, driven by the availability of inexpensive labor and the increasing demand for re-rolled steel in those regions. The relocation of SRI has been shown in Figure 5.1.

A closer look at the global tonnage recycled in recent years reveals that shipbreaking industry, currently, is concentrated in a very limited number of countries, primarily centered in South Asian region as Bangladesh, Pakistan and India constitute 90% of the total gross tonnage scrapped worldwide (*NGO Shipbreaking Platform Impact Report*, 2021). Lately, Turkey is also emerging as a significant ship-demolition center, though with far less capacity and lesser recycled tonnage than its competitors. China is the fifth player in this industry accounting for most of the rest tonnage dismantled, however the footprint of ship breaking activity is dwindling fast in china owing to international environmental considerations. The total share of the top five actors (top three + Turkey and China) is 99.33% of the total tonnage scrapped worldwide.

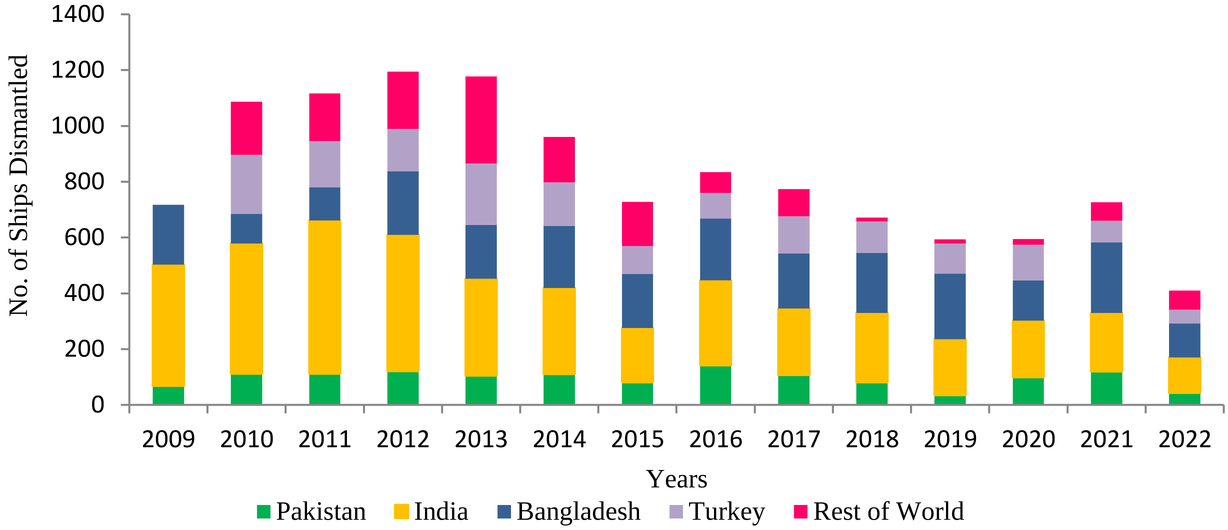


Source: Map adapted from (Devault et al., 2017)

Figure 5.1: Relocation of SRI around the world

Figure 5.2 shows the number of ships dismantled in top five shipbreaking centers since 2009. It can be seen that the numbers have not been consistent due to supply side fluctuations as well as internal challenges faced by the dismantlers. In 2021, 763 commercial ships were sold to scrap yards of which 583 huge tankers, bulkers, cargo and cruise ships were broken down on the shores of Bangladesh, India, and Pakistan, which amounts to approximately 90% of the global gross tonnage demolished. Pakistan dismantled 21% of the total tonnage beached in 2021[9].

[9] NGO Shipbreaking Platform, Annual Impact Report, 2020-2021. https://shipbreakingplatform.org/wp-content/uploads/2022/11/NGO-SBP-Annual-Report-2020_2021.pdf



Source: NGO Shipbreaking Platform.

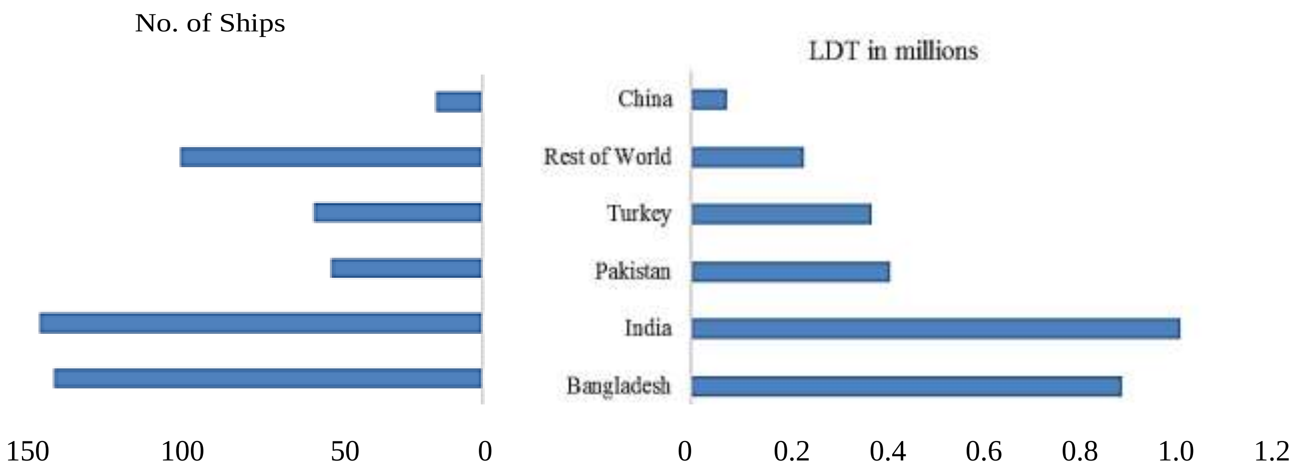
Figure 5.2: Number of Ships Dismantled Annually

5.1.2. Global Ship recycling Industry: Performance in 2022

Although the shipbreaking yards in South Asia witnessed a substantial decrease in ship scrapping activity in 2022, which has been unprecedented in more than ten years, they continued to be the preferred choice for decommissioned vessels, accounting for 80% of the global end-of-life gross tonnage. The decline in the number of ships scrapped in 2022 can be attributed to various factors, including elevated ocean freight rates that incentivized the continued operation of older ships and limitations in banks' provision of credits to companies for the acquisition of end-of-life assets, which were identified as the primary influencing factors[10].

According to data released by SteelMint, global ship recycling activities experienced a significant decline in 2022, plummeting by 49%, following a 14% increase in the previous year (SteelMint, 2023). The total tonnage scrapped in 2022 amounted to 3.19 million light displacement tonnage (LDT), a notable decrease from the 6.27 million LDT recorded in 2021. This sharp decline in output y-o-y basis reveals the volatility inherent in this industry.

[10] NGO Shipbreaking Platform, 2023. Press Release- Platform publishes list of ships dismantled worldwide in 2022
https://shipbreakingplatform.org/platform-publishes-list-2022/#:~:text=According%20to%20new%20data%20released,sold%20for%20scrapping%20in%202022.



Source: Steel Mint.com

Figure 5.3: Leading Ship Recycling Countries in 2022

Among the leading ship-recycling nations, Bangladesh and Pakistan witnessed the most significant decline in tonnage volumes compared to the previous year. Furthermore, India surpassed Bangladesh in 2022 to become the top ship-dismantling country. India concluded the year with a ship-breaking tonnage of 1.08 million LDT, surpassing Bangladesh's 0.95 million LDT. Pakistan secured the third position with a tonnage of 0.44 million LDT. Overall, Pakistan experienced a significant decline of 56% year-on-year from 1.00 million LDT.

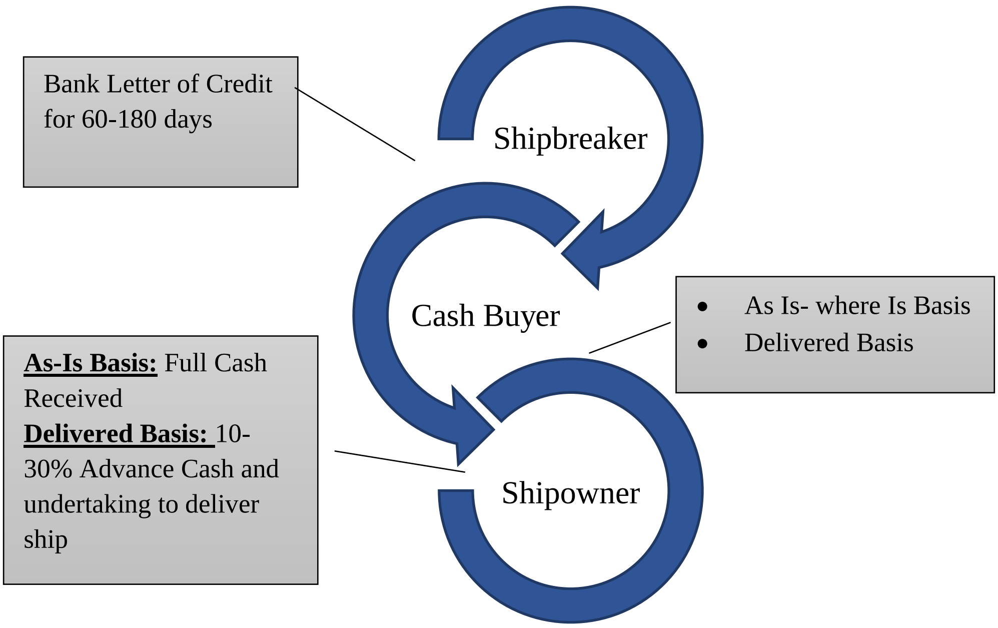
5.1.3. The Process of Sale of Ship for Demolition

The supply in SRI is determined by a mix of factors such as fuel prices, freight and charter rates, and the age of vessels, which decides whether the vessel can be kept in service or better be sold for demolition. The ship sale process involves a chain of stakeholders and the decision to sale is determined by technical as well as economic factors (Sarraf et al., 2010a). This chain of stakeholders is shown in figure 5.2. Ship breakers offer prices to attract end-of-life ships and these prices are determined by many factors. The ship sale may involve a direct arrangement between the shipbreaking firm and the shipowner. However, it usually involves a third party called *Cash Buyer*.

Figure 5.4: Stakeholders involved in material/ output flow

Shipbreaking firms normally offer minimal cash in advance with a 60-180-days letter of credit. The shipowner, on the other hand prefers cash payment. As a result, Cash Buyers are used in the majority of transactions who serve as intermediaries for the financial transaction (Mikelis, 2013a). Cash buyers can employ either of the two options for the purchase of the ship: (i) "As Is– Where Is" basis, (ii) "Delivered Basis". In the first approach, the Cash Buyer pays the full cash at once and becomes the ship's owner for a limited time. They next broker the ship's sale to the shipbreaking firms, which is normally secured by a bank letter of credit. In the second option, the Cash Buyer makes 10-30 percent cash payment to the shipowner in exchange for a Memorandum of Agreement (MOA) for the ship's delivery to the shipbreaking yard. The rest of the agreed-upon sum is paid to the shipowner after the ship is delivered (Mideast-shipping.com, 2016[11]).

Figure 5.5: Monetary Flow in Ship Sale Process



[11] http://www.mideast-shipping.com/

It is important to note that ship owner and ship recycler do no come into direct contact ever. Cash buyers make full payment to the ship owners and the transaction is done. In practice, the global ship breaking industry has only 8-10 cash buyers, among which top three lead the cartel market shares wise. They have enough risk appetite and sustained financial capacity to unceasingly keep buying everything at all prices. During an interview while probing the question of market share and influence the respondent stated that:

> *"The ship recycling market is characterized by a limited number of cash buyers, creating an oligopolistic structure with only a few major players dominating the industry. This oligopoly consists of approximately eight to ten cash buyers, with three large players and several smaller ones. Risk appetite and understanding of the industry are crucial in this market, making it unlikely for new entrants from unrelated sectors to become cash buyers. The concentration of cash buyers highlights the importance of industry expertise and the need for significant financial capacity to sustain continuous purchasing."*

5.2. Ship Recycling Industry in Pakistan

In Pakistan, Shipbreaking yards are located in Gadani, a district situated 40 km south of Karachi, in the west coast of Balochistan. Gadani shipbreaking yard spanning 10 km long beach with 68 operational plots is one of the largest ship breaking yards of the world. According to NGO Shipbreaking Platform, Gadani yard accommodates approximately 20,000 workers and an estimated 850,000 people depend directly or indirectly on this industry. Shipbreaking is the main source of steel in Pakistan as one third of the total steel production comes from SRI in Pakistan[12].

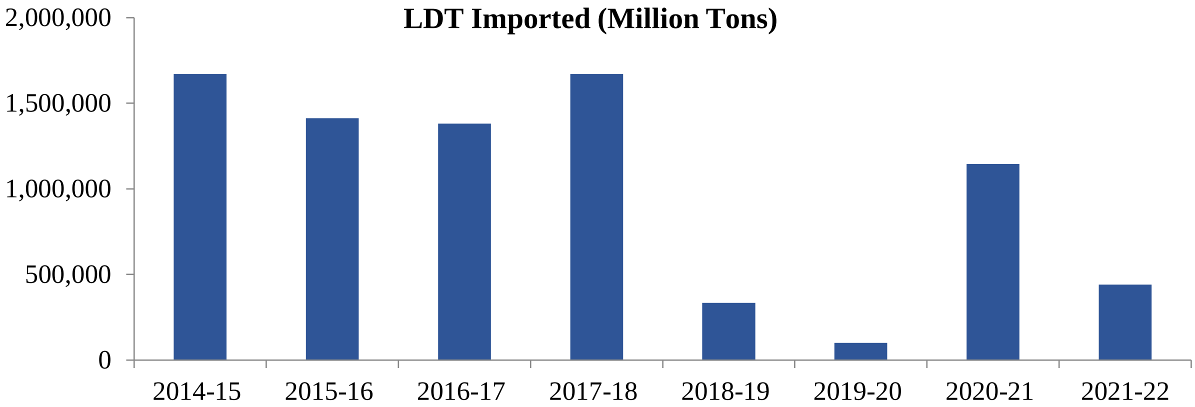
5.2.1. Historical Performance of Gadani Yards

From 1969 to 1983, in its heyday, Gadani was the world's largest ship-breaking facility. During that time, economy of Balochistan was thriving due to government's business friendly policies for the development of SRI. Infrastructure was built, import charges were reduced, and concerns of *Pakistan Ship-Breakers' Association (PSBA)* were heeded. All of this resulted in a minor economic boom for Balochistan, as the Balochistan Development Authority (BDA) extracted double revenue; by leasing out the beachfront at Gadani to shipbreakers on a case-by-case basis as well as by extracting tax revenue as per tonnage being broken. Even after the

[12] PSBA, 2021.

operations at Gadani have slowed dramatically, these streams of revenue for the impoverished region remain to this day.

The slowdown began in the late 1980s, when taxation and import restrictions increased, and competition from Bangladeshi and Indian yards eroded the business in Pakistan. The depreciation continued until 2001, when the yard generated only 160,000 tons of scrap metal, compared to millions in earlier decades. Furthermore, govt. negligence, lack of market regulation and capacity building led to pushing the Gadani yard down the ladder in south Asian region favoring regional competitors namely Alang, India and Chattogram in Bangladesh (Iqbal & Heidegger, 2013). However, resurgence occurred around the turn of the century, when the tax on shipbreaking was reduced from 15% to 10%.



Source: PSBA, Steel Mint[13]

Figure 5.6: Tonnage Demolished at Gadani

The minimal tonnage in the years 2018-19 and 2019-20 is explained by an 18-months long ban that was enforced by government on the import of end-of-life tankers in 2017 followed by a moratorium on all ship breaking activities at Gadani yards after two separate accidents in 2018[14]. However, 2021 showed healthy comeback as 119 ships and larger vessels were broken down in Gadani making up approximately 19% of the total tonnage scrapped.

In the last several years, shipbreaking activity in Pakistan has seen many ups and downs owing to a number of socio-economic factors as well as pressure from international environmental

[13] SteelMint, 2023. Global ship recycling tonnage falls by half in 2022, India emerges top dismantler: https://www.linkedin.com/pulse/global-ship-recycling-tonnage-falls-half-2022-india-emerges/

[14] Pakistan shuts Gadani ship breaking yards https://shipsandports.com.ng/pakistan-shuts-gadani-ship-breaking-yards-2/

regulations. The exchange rate fluctuation, adverse fiscal policies, with additional hefty taxation by Balochistan government has deteriorated the purchasing power of ship breakers in Pakistan. Moreover, the relatively lower tax rates for imported steel scrap by re-rolling mills has threatened the market share of the SRI in Pakistan.

5.2.2. Ownership and Land Rights at Gadani Yard

Gadani yard is comprised of 132 shipbreaking plots. Majority of these plots are on lease from private land owners and remaining are functioning on state/government owned land. Because Gadani yards lie within the provincial jurisdiction of Balochistan, therefore the Balochistan Development Authority (BDA) is in charge of maintaining physical infrastructure at the yards.

During an interview, a member of Pakistan Ship Breakers Association (PSBA) explained the land ownership situation at Gadani as:

> *"Out of the 132 plots at Gadani Yard, 75% (around 100 plots) are owned by private feudal, the Baloch Waderas. The remaining 32 plots are owned by the Balochistan Development Authority (BDA), which leases them to private shipbreaking firms. However, regardless of ownership, the BDA is responsible for ensuring the development of all plots, as they collect taxes from all operators at Gadani. Unfortunately, we are facing challenges like the limited availability of electricity, which restricts our operations to daylight hours. The government's investment in land development has been inadequate, and there is a noticeable divide between the waderas and the BDA. Therefore, no initiative reaches its completion. However, it's worth mentioning that the BDA has initiated a project to develop the industry and to develop allied facilities. also involves the development of landfill site for the sustainable disposal of ship waste. The project is under progress and for that land has already been acquired."*

5.2.3. Linkage with Other Industries

SRI contributes to the economic development of the countries in which it is centered (Jugović et al., 2015; Mikelis, 2013a; Sarraf et al., 2010a; Terao, 2011). Ship recycling industry is directly linked with steel and construction sector of Pakistan through output supply chain. It provides output in the form of steel plate (extracted from shift plate, the basic component of ship construction) which is a good quality steel product and can used as steel bar by simply cutting it suitable sizes or could be rolled by re-rolling mills

The industry is highly localized as the local metal rolling facilities in Pakistan rely significantly on ship steel (Rukhsar & Siddiqui, 2013). There are around eighty melting facilities (mostly) and more than 300 re-rolling units in Pakistan. The majority of re-rolling mills are centered in Punjab and Sindh (Maritime Study Forum, 2019). The re-rolling mills use approximately 75 percent of the ship steel to make steel bars. 20% of the salvaged ship steel is used by smelters and melter mills that use ship steel to make various steel products (Iqbal et al., 2021).

Table 5. 1 Distribution of Re-rolling Facilities in Pakistan

Location	No. of Re-rolling Mills
Lahore	250
Islamabad	16
Gujranwala	16
Karachi	52
Total	334
Scrap melting facilities	80

Source: (Maritime Study Forum, 2019).

5.2.4. Economic Footprint:

5.2.4.1. Market size and structure

Pakistan ship recycling industry is largely competitive with around 25- 30 active shipbreaking firms, which are mostly based in Karachi. These firms compete with each other as well as with international competitors on the basis of optimal cost structures and optimal capacity.

In practice, the global ship breaking industry has only 8-10 cash buyers, among which top three lead the market shares wise. It is true oligopolistic market type. The top players have enough risk appetite and sustained financial capacity to unceasingly keep buying everything at all prices. Due to high volatility associated with scrapping price trends and specific knowledge constraint of the industry, new entrants into the market are not possible. During an interview while probing the question of market share and competitiveness, an expert provided insights into this matter, stating:

"The ship recycling market is characterized by a limited number of cash buyers, creating an oligopolistic structure with only a few players dominating the industry. This oligopoly consists of approximately eight to ten cash buyers, with three large players and several smaller ones. Risk appetite and understanding of the industry are crucial in this market, making it unlikely for new entrants from

unrelated sectors to become cash buyers. The concentration of cash buyers highlights the importance of industry expertise and the need for significant financial capacity to sustain continuous purchasing."

5.2.4.2. **Competitiveness in SRI**

Shipbreakers face dual competition. On the local front, they compete with one another to secure vessels for breaking. Simultaneously, they also face competition from international counterparts, competing to secure higher bids.

5.2.4.3. Competition in International Market

The shipbreaking industry operates as a labor-intensive sector, devoid of costs related to advanced machinery and compliance with environmental sustainability protocols (Terao, 2011). Although, a recycling state can gain a competitive advantage through a less strict regulatory framework, which lowers recycling costs. Nonetheless, this does not provide a basis for attracting more shipowners by offering higher prices compared to international competitors. The ratification of international regulations, like Regulation 17.2 of HKC, can also provide an advantage. India, having over 80 yards compliant with the HKC, is better positioned than its regional competitors, giving it a competitive edge.

Despite that, India has competitive advantage only over Turkey because of labor cost differential. However, the challenge lies in the extent of reflagging. Reflagging is the practice of HKC party states to send for sale their vessels to those intermediaries who change the flag of the ships after purchase and sell them to countries such as Pakistan and Bangladesh who are not parties to HKC at higher prices. Thus, the advantage of ratifying environmental conventions depends on ship owners' willingness to accept lower amounts for recycling in environmentally friendly yards and the extent of reflagging. Precise statistical data on this matter is not available.

The decisive factor for competitiveness then comes down to lower costs via profitability. The axiom/ universal principle for profitability is minimization of costs and maximum profits. Profitability in this industry primarily stems from domestic demand for scrap steel, as well as the prices of scrap metal and other recoverable items. Profitable shipbreaking firms are those capable of bidding higher prices while being firmly established in the domestic steel market and are able to mitigate transportation costs. Because this makes them successfully resale all of their output in the local market at lucrative prices without incurring any additional costs. When there is a growing demand for steel and iron in the local economy, as witnessed in

Bangladesh and Pakistan in recent years, the shipbreaking business becomes lucrative. An expert provided insights into this matter, stating:

> *"... the idea is very simple, and very intelligent. The shipbreaker only wants to buy and scrap what it can sell locally without adding cost. And for that matter, the fastest moving for them is rolling steel and steel in our country."*

After the critical evaluation of the interview data and previous literature, following factors are attributed to the competitiveness of the industry:

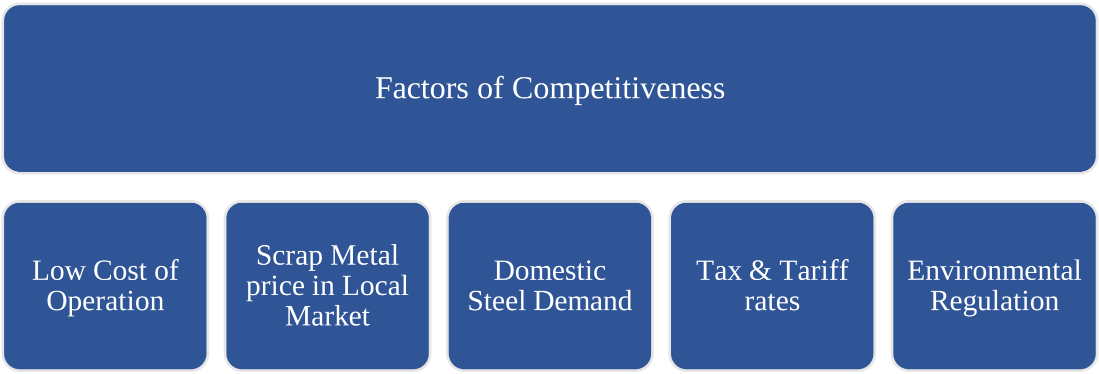


Figure 5.7: Factors of Profitability and Competitiveness

As far as the international competitiveness is concerned, the most important condition is a strong domestic demand for cheap iron and steel metals. However, if there is strong domestic demand for metals, but the tax and tariff rates are also higher, the shipbreakers won't be able to win higher bids. The competitiveness analysis done by Sheikh (2021) shows that Bangladesh has the lowest labor costs as well as the lowest tax and tariff rates compared to Pakistan and India. That is the reason recyclers from Bangladesh are able to offer higher prices and more bids than the rest. A comparison of major factors affecting competitiveness of each country is shown in Table A- Appendix 2.

5.2.4.4. Competition in Local Market

Since, the shipbreaking industry yields better quality steel and iron scrap than ordinary metal scrap, that too produced at minimal costs compared to the imported alternatives, the industry contributes to national competitiveness. Its recycled output is also readily usable after minimal processing. Thus, nationally the source of competition and higher profit is the ability of shipbreakers to optimize their costs compared to their competitors at the same time enhancing tonnage handling capacity and risk sustainability to readily offer competitive bids at all times.

5.3. **Market Dynamics and Pricing strategies**:

Bids offered for ship pricing are highly dependent on the vessel supply. When freight markets are strong, there is a decrease in the number of ships being scrapped, indicating an inelastic supply. Which, according to principles of market mechanism should push prices upwards. However, despite limited availability, paying higher prices is not sustainable as it is connected to the cost of scrap. An interviewee highlighted the competitiveness among shipbreakers when there was a limited number of vessels and multiple buyers, leading to a premium price but not an excessive increase. Here are the insights:

> *"... The supply is inelastic, but at the same time, you can't really just keep on paying more money when there's only one ship available. That's when breakers become really competitive. When you have, say, one vessel available, five buyers and your price comes to say $640. We may even sell it to $660 or $670. But that's it, you can look at $30 or $40 premium, instead of offering it at $900."*

Another crucial aspect to consider while analyzing pricing strategies is the high volatility of the SRI. Being a cash buyer involves intensive volume-based operations, with certain goods having lower margins and limited sales, while the shipping industry typically operates with margins between 1- 4%. significant fluctuation in values of end of life ships can be noted with movements of over 20 to 30 percent in a year. This volatility exposes shipbreakers to potential losses, making risk management crucial.

In such situation, the only strategies that works for businesses are the strategies of "consistent buying without break" and bring in economies of scale", hence, navigating risks and maintaining profitability through economies of scale. The strategy of consistent buying is used as a means to offset potential downsides by generate profits along the horizon. This strategy emphasizes the need for continuous production to avoid closing books and assessing losses, emphasizing the determination to keep the business running regardless of price fluctuations.

5.3.1. Contribution to steel demand

Despite being a neglected industry, the industry possesses vast economic potential given the ever-increasing domestic steel demand. Bangladesh meets 50% of their total steel demand domestically, from shipbreaking activity. Given the historical records of Gadani ship yards, Pakistan can recycle 100-120 large tankers annually[15]. It is a major provider to the country's

[15] PSBA.

steel demand (approximately 500,000 tons of annual average output), which makes up 15% of total steel production in Pakistan (Iqbal et al., 2021). In addition to supplying steel and other goods to the regional economy without depleting natural resources, the SRI also directly or indirectly employs an estimated 850,000 people (Iqbal et al., 2021). Furthermore, the tax payments by ship breakers contribute approximately Rs. 6 billion annually to national exchequer[16].

Table 5.1 Annual Demand and Supply of Steel

Steel Profile	**FY 2021**
Total steel demand in Pakistan	11.1 Million Tons
Annual steel consumption	59 Kg Per Capita
Local steel production	3.5-4 Million Tons
Steel imports (steel scrap + finished goods)	7.7 Million tons (2021)
Re-rollable steel from shipbreaking Industry	1.6 Million Tons
Percent contribution of SRI	14.4%

Source: PACRA[17]

5.3.2. Contribution to Employment

In addition to supplying a sustainable source of steel and other goods to the regional economy without depleting natural resources, the SRI also directly or indirectly employs an estimated 850,000 people thereby making a substantial contribution to the labor market (Iqbal et al., 2021). Direct employees include workers directly engaged in ship breaking activities, both corporate staff of the shipbreaking companies, who handle administrative and managerial tasks; and the field labors. On average, the estimated number of workers directly associated with this industry range from 15000-20,000 annually[18].

While the indirectly associated workforce includes workers dependents on ship recycling industry due to linkages of other related industries with SRI through supply chain of recycled output. This indirect workforce comprises individuals who are employed in other related

[16] Pakistan Shipbreakers Association (PSBA).
[17] PACRA, 2022. Steel Sector Study. The Pakistan Credit Rating Agency: https://www.pacra.com/sector_research/PACRA%20Research%20-%20Steel%20-%20Sep'22_1662124643.pdf
[18] Estimated by author based on interviews conducted with members of PSBA, study by (Iqbal et al., 2021) and confirmed by member checking and peer debriefing. Pakistan Shipbreakers Association (PSBA)

industries that have linkages with the SRI through the output supply chain. These industries may include steel melting and manufacturing, transportation, logistics, construction sector, and various service sectors that support the functioning of the ship recycling industry. The employment generated through these indirect linkages further expands the economic impact of the SRI and provides livelihoods for numerous individuals and their families.

5.3.3. Tax Revenues

The ship recycling industry faces a complex taxation structure, resulting in substantial tax revenues. According to the representatives from PSBA, shipbreakers encounter multiple layers of taxation, significantly impacting their operations and financials. These tax slabs include:

- Sales Tax: Ship breakers are subject to an 18% sales tax, which is applied to the value of the ships being recycled.
- Income Tax: At the import stage, ship breakers are required to pay a 2% income tax on the imported ships.
- Infrastructure CESS: A 1.15% Infrastructure CESS is imposed on ship breakers, contributing to the overall tax burden.
- Balochistan Development Authority (BDA) Fees: The BDA levies fees on ship breakers, with a rate of Rs. 1700 per ton. This fee is an additional financial obligation for ship recycling companies.

It is noteworthy that the ship recycling industry faces higher tax levies compared to other sectors in Pakistan, including the steel industry. These tax burdens have a significant impact on the financial operations and profitability of ship breakers. In contrast, countries like Bangladesh and India have implemented simplified tax regimes for their respective ship recycling industries. This streamlined approach aims to facilitate the growth and development of the industry while ensuring a favorable business environment.

Table 5.2 shows that the tax revenues generated from the SRI contribute to the overall revenue stream of the government. In the last decade, average tax revenue contributed to national exchequer has been Rs. 11.8 billion annually. In 2021, the tax payment by SRI were highest of all times reaching Rs. 23.108 billion. It is essential to strike a balance between taxation policies and the sustainable growth of the ship recycling sector to promote economic development while maintaining a competitive edge in the global market.

Table 5.2: Tax Revenue Generation by Ship Recycling Industry

Year	No. of Ships Imported	Tonnage Imported (LDT)	Customs Duty (000 Rs.)	Sales Tax (Rs. Millions)	Income Tax (Rs. Million)	FED (Rs. Million)	Tax Revenue (PKR bn)
2014-15	137	1,670,851	753.960	808783	3757.871	0.748	12.6
2015-16	117	1,412,864	1202.37	802.339	2037.307	2550	11.3
2016-17	118	1,380,947	1641.94	786.119	2126.576	4.204	11.6
2017-18	123	1,670,516	2503.106	1000.12	3724.542	0.742	16.3
2018-19	43	335,241	1476.37	231.545	1018.815	0.399	4.8
2019-20	29	100827.39	0.34	956.97	13.088	0.052	1.5339
2020-21	134	1146555	58.335	1146.6	1611.976	1.806	13.7309
2021-22	44	440314	28.16	887.74	2789.352	0.322	23.108

Source: PSBA, 2023.

5.4. Institutional Framework

The ship recycling industry in Pakistan operates informally, following an ad-hoc approach. Despite its name, this sector lacks legal recognition as an official 'industry' within Pakistan. The shipbreaking units are not registered as formal companies with the Securities and Exchange Commission of Pakistan (SECP) or any other relevant national entity. As a result, a specific regulatory policy and institutional framework are conspicuously absent. Nevertheless, some level of formalization exists, as shipbreakers must comply with customs clearance and environmental safety requirements stipulated by the relevant authorities. Additionally, shipbreakers are obligated to register with income tax and sales tax authorities, and membership in the Pakistan Ship Breakers Association (PSBA) is mandatory for all shipbreaking firms. However, the precise ministry or true *de jure* administrative authority responsible for overseeing this industry remains uncertain both legally and administratively.

Following the decentralization process in Pakistan, which commenced in 2011 through the implementation of the 18th amendment to the Constitution, there has been a transfer of certain labor and environmental responsibilities to provincial governments, while others continue to be managed at the federal level. In the shipbreaking sector, the Balochistan Environmental Protection Agency (BEPA) and the Balochistan Development Authority (BDA) share responsibilities at the provincial level. Additionally, various ministries at the federal level, including the Ministry of Labor and Manpower, the Ministry of Climate Change (MoCC), and the Ministry of Maritime Affairs (MoMA), are also involved in overseeing relevant matters.

Shipbreaking has been an established activity in Pakistan for a significant period of time, yet the absence of specific regulations and procedures is quite noticeable. At present, only basic requirements such as customs checks are obligatory, while the Balochistan Ship Breaking Industry Rules of 1979 primarily grant authority to the BDA for leasing shipbreaking plots.

The shipbreaking industry operates under general legal provisions, with constitutional guarantees for fundamental rights also applicable to the sector. Additionally, there are regulations in place to address hazardous waste management and environmental protection, such as the Hazardous Substances Rules (2003) under the Pakistan Environmental Protection Act (PEPA) (1997) and the Balochistan Environmental Protection Act 2012. These regulations play a role in ensuring the proper management of hazardous materials and safeguarding the environment.

Regarding occupational health and safety (OHS), there are several relevant laws in Pakistan; however, a comprehensive law specifically covering OHS in the shipbreaking sector is lacking. Enforcement of laws pertaining to environmental protection and health and safety is weak, and a monitoring system for compliance is absent. Furthermore, most workers are employed through *'contractors'* which deprives them of stable and direct employment relationships, undermining their labor rights.

Although there exist a range of laws and regulations that can be applied to the shipbreaking industry, it is evident that a comprehensive set of sector-specific policies and regulations is urgently required. These specific policies would address the unique challenges and concerns associated with shipbreaking, aiming to ensure decent working conditions and safe recycling practices that align with both national legislation and international obligations.

By implementing such sector-specific policies and regulations, significant progress can be made towards promoting clean and secure recycling operations in the shipbreaking industry. These measures would not only enhance environmental sustainability but also prioritize the protection of workers' rights. They would establish clear guidelines and standards for safe working conditions, efficient waste management, and proper handling of hazardous materials during the shipbreaking process.

Furthermore, the development of sector-specific policies and regulations would facilitate effective enforcement mechanisms, inspection procedures, and monitoring systems. This would enable regulatory bodies and relevant authorities to monitor compliance, enforce adherence to the established standards, and take necessary actions against any violations or non-compliance. Incorporating the principles of circular economy and sustainable development into these policies and regulations would encourage the adoption of environmentally friendly practices. This includes promoting the recycling and reuse of ship materials, minimizing waste generation, and implementing proper disposal techniques for hazardous substances. By doing so, the shipbreaking industry can play a crucial role in reducing its environmental footprint and contributing to global efforts to combat pollution and climate change

5.5. Challenges and Issues:

i. **Doing business issues:** Gadani yards in Pakistan faces significant obstacles in terms of a lack of support and incentives from the government, resulting in an unfair playing field. Unfortunately, this sector remains neglected by the government of Pakistan.

ii. **Lack of industry status:** The ship recycling industry does not enjoy the recognition of being an official industry. Consequently, it is excluded from the benefits and incentives provided to other industries in the national budget or the Public Sector Development Program (PSDP). Moreover, the absence of industry status limits the industry's involvement in economic affairs, as their concerns and requests often become entangled among various ministries due to unclear administrative jurisdiction.

iii. **Underdevelopment and lack of Investment:** Insufficient funds and the absence of government assistance hinder the development and upgradation of the ship recycling industry. Adequate physical infrastructure plays a crucial role in industry upgradation, but its realization depends on the government's commitment. Upgrading the industry requires substantial investments in physical infrastructure, such as modern and environment friendly recycling facilities. However, without the government's commitment to provide financial support and assistance, the industry struggles to overcome these barriers. Despite the fact that this sector pays hefty amount of taxes every year, govt. does not invest in physical infrastructure.

iv. **Poor enforcement of labor laws:** The ship recycling industry faces challenges in terms of labor laws enforcement. Workers are frequently hired on a contract basis, depriving them of permanent employment status and the associated benefits and privileges. Regarding occupational health and safety (OHS), there are several relevant laws in Pakistan; however, a comprehensive law specifically covering OHS in the shipbreaking sector is lacking. Enforcement of laws pertaining to environmental protection and health and safety is weak, and a monitoring system for compliance is absent. Furthermore, most workers are employed through "contractors," which deprives them of stable and direct employment relationships, undermining their labor rights. The lack of proper training and a prevalence of unskilled labor contribute to concerns regarding worker safety within the ship recycling industry.

v. **Environmental concerns:** The beaching method employed in ship recycling raises environmental concerns. The improper disposal and handling of hazardous materials during the dismantling process pose risks to the environment. Proper waste management and adherence to environmental regulations are crucial to mitigate these risks and ensure sustainable ship recycling practices.

CHAPTER 6

Policy Gap Analysis

6.1.Overview

Strategic policy recommendations for Pakistan have been created using the Policy gap-analysis approach. The existing situation and the predicted future scenario under the new regulatory structure are compared using this strategy. Gap analysis is an effective method for achieving objectives because it reveals differences or gaps between the situation as it is and what is expected to happen. Following the identification of these gaps, effective steps are recommended to close them or eliminate the discrepancies (Gomm, 2009). This study covers the ship recycling industry's current market and policy environments on both a national and worldwide scale. This policy gap analysis provides insightful findings and policy recommendations to assist Pakistan preserve its competitive edge in the sector.

6.2. Step 1: Selecting the specific problem area: the HKC accession

the International Maritime Organization (IMO) introduced the Hong Kong International Convention (HKC) in May 2009 to ensure safe and environmentally sound ship recycling. Various non-governmental organizations, ship-owner associations, and international environmental protection bodies are actively advocating for more environmentally friendly practices in the ship recycling industry (Hougee, 2013), leading the industry towards "Green ship recycling" (K. P. Jain, 2017; Urano, 2012). Although the convention has not yet come into force, it is nearing compliance requirements (Ali & Pearce, 2020). As India and Türkiye have already ratified it. While Bangladesh is all set to deposit accession instrument of the Hong Kong Convention shortly in 2023 as its parliament has already ratified it during June 2023. Earlier, the government of Bangladesh has passed and enacted the Bangladesh Ship Reprocessing Act-2018 to promote the sustainable growth of the industry. Further, it has launched a comprehensive project for safe and environmentally sound ship recycling, called (SENSREC[19]). If Bangladesh ratifies this convention, it will complete all its criteria for entry into force.

[19] IMO. (2017). Safe and Environmentally Sound Ship Recycling in Bangladesh—Phase I. https://www.imo.org/en/ourwork/partnershipsprojects/pages/ship-recycling.aspx

The implementation of the Hong Kong Convention (HKC) may bring changes to the shipbreaking market, which could potentially affect Pakistan's economic advantage. To safeguard its competitiveness in this evolving industrial landscape, Pakistan needs to develop and implement effective national-level policies and plans. The purpose of this analysis is to explore strategic policy recommendations that will enable Pakistan to maintain its competitive edge while adhering to the requirements of the HKC.

In simpler terms, with the introduction of the HKC, the way shipbreaking operates in Pakistan may change. This could impact Pakistan's economic advantage in the industry. To stay competitive, Pakistan needs to create and implement effective policies and plans at the national level. The aim of this analysis is to provide recommendations on strategic policies that will help Pakistan maintain its competitive position while following the rules of the HKC.

6.3. Step 2: Critical Analysis of International regulations

The importance of ship recycling in terms of its environmental impact cannot be overstated. With the global fleet expanding at an average annual rate of around 3.5% (UNCTAD, 2022), the urgency of addressing this issue becomes even greater. This section focuses on the primary legal framework that governs the ship recycling industry. Scholars such as Puthucherril (2010) and Molenda (2010) recognize the significance of the Basel Convention of 1989 and the Hong Kong Convention of 2009 as important legal instruments. Additionally, Mikelis (2013), Moncayo (2016) and Zarqa et al. (2021) include the EU Ship Recycling Regulation of 2013 in their analyses. In this study, particular attention is given to the Hong Kong Convention (HKC), which was specifically developed for the ship recycling sector.

In simpler terms, recycling ships has a significant impact on the environment and is becoming increasingly urgent as the global fleet continues to grow. This section discusses the main laws and regulations that govern the ship recycling industry. Scholars have recognized the importance of legal instruments such as the Basel Convention, the Hong Kong Convention, and the EU Ship Recycling Regulation. This study focuses specifically on the Hong Kong Convention, which was designed specifically for ship recycling.

This section examines the requirements for the entry into force, the actual situation, and the effects of various legal instruments on the industry using quantitative data from secondary sources. Our understanding of the dynamics of the market and industry rivalry, particularly in regard to these rules, particularly the HKC, is intended to be improved by the insights presented here.

6.3.1. Basal Convention, 1989

The Basel Convention (1989) aims to safeguard human health and the environment by curbing the movement of hazardous wastes from developed to underdeveloped countries. It entered into force on 5 May 1992 and currently has 188 party states, with 53 signatories (UNEP, 2021). Key obligations of the treaty include waste reduction at the source, managing waste domestically, minimizing transboundary movement of hazardous materials, controlling waste trade, and promoting environmentally friendly waste management practices. The Basel Ban Amendment, effective from 5 December 2019, prohibits OECD, EU member states, and Liechtenstein from exporting hazardous materials to developing nations. The shipping industry is particularly relevant to this convention as developed countries own around 90% of the world merchant fleet, while over 95% of ship recycling occurs in developing countries in Southeast Asia (UNCTAD, 2022).

The convention's use in the ship recycling sector does have some restrictions, though. Considering end-of-life (EOL) ships as garbage, their participation in transboundary movement, and both the exporting and importing countries being Basel Convention parties are essential components. The 188 party states include the majority of ship-owning and ship-recycling nations, which satisfy the third element. Transactions for the acquisition and selling of ships clearly display the second component. The major issue at hand is whether or not an EOL ship qualifies as "waste." The Basel Convention should apply to EOL ships that contain hazardous compounds when they are exported for recycling (Bhattacharjee, 2009; Moen, 2008; Zhou, 2013).

The treaty is ineffective in this sense due to the widespread ship recycling industry and the current practises of selling EOL ships for recycling. Due to the expensive nature of EOL ships, many ship owners want to avoid the convention (Bhattacharjee, 2009). The Basel Convention in ship recycling has two major obstacles, recognising the point at which a ship becomes waste and identifying the "country of export" as defined by the (Bhattacharjee, 2009; Moen, 2008; Zhou, 2013). These restrictions and difficulties made the creation of the Hong Kong Convention by the International Maritime Organisation (IMO) necessary in order to accommodate the specific needs of the ship recycling industry.

6.3.2. Hong Kong Convention, 2009

In 2005, the International Maritime Organization (IMO) initiated the development of a new global ship recycling regime. Subsequently, the ***International Convention for the Safe and***

Environmentally Sound Recycling of Ships was adopted during a diplomatic conference in Hong Kong in 2009. The IMO has also created guidelines to support this convention. At present, only Norway has ratified the convention, while shipbreaking nations in South Asia have not signed or ratified it. The NGO Shipbreaking Platform advocates for the integration of elements from both the Basel and Hong Kong Conventions, promoting their coexistence. While the Hong Kong Convention includes requirements for ships and ship recycling facilities, such as the implementation of an Inventory of Hazardous Materials (IHM) and a Ship Recycling Plan (SRFP), it lacks certain crucial aspects such as waste prevention, the polluter pays principle, and provisions for downstream waste management. Although the convention does not explicitly prohibit beaching, only a few Chinese ship recycling yards have declared compliance. If Pakistani yards aim to adhere to the Hong Kong Convention, they need to upgrade their facilities to meet the specified standards.

The primary goal of the convention is to make sure that end-of-life vessels do not pose unnecessary risks to the environment and human health and safety. To come into effect, the convention has three specific requirements outlined in Article 17. These requirements are as follows:

v. Ratification by a minimum of 15 states.
vi. The combined merchant fleet of these states should constitute at least 40% of the world merchant fleet in terms of gross tonnage.
vii. The combined maximum annual ship recycling volume of these states over the last 10 years should amount to no less than 3% of their combined merchant shipping fleet in gross tonnage.

To fulfill these requirements, it is necessary for not only the major flag states (such as Panama, Marshall Islands, and Liberia) but also the major ship recycling states (such as Bangladesh, India, Pakistan, Turkey, and China) to ratify the convention, as reported by (Sun, 2022). During the one-year signing period from September 1, 2009, to August 31, 2010, five countries signed the convention. Since then, the convention has remained open for ratification or accession. Despite more than 10 years since its adoption, the convention has not yet come into effect.

The recent ratifications by four countries [20]have given a fresh impetus to the convention, bringing it closer to meet its entry-into-force criteria. Second, the pact must be ratified by either

[20] India, Japan, Malta, and Germany

Liberia or the Marshall Islands, who together control around 23% of the world fleet. Any one of the three major recyclers—Bangladesh, Pakistan, or China—ratifying the third requirement would be adequate. The significance of ratification by one of the primary recycling states is highlighted by the fact that the combined representation of the rest of the globe, excluding Turkey and India, who have already ratified, amounts to only 0.6 million GT. The tables 8.1 and 8.2 in Appendix 2 illustrate the entry into force criteria and current status of HKC:

Unfortunately, Pakistan has not made significant progress in terms of ratification and compliance with the Hong Kong Convention (HKC). Factors such as higher taxation, a lower foreign exchange rate, and cheaper imports of billets from Iran have adversely affected Pakistan's ship recycling industry since 2019, resulting in a drastic decline in volume in 2019.

Building capability and creating the necessary infrastructure for HKC ratification has been made possible by the successful completion of the "***"Safe and Environmentally Sound Ship Recycling in Bangladesh"*** *-(SENSREC)* project, funded by Norad[21] and carried out by the IMO. Leading ship recycling business in Bangladesh, PHP Ship Breaking and Recycling Industries Limited, has previously been granted the Statement of Compliance (SoC) to the HKC by an IACS classification society, setting a standard for other yards. The Bangladeshi Ministry of Industries has stated that it intends to ratify the HKC by 2023, while yard owners' objectives will also be important to consider as significant stakeholders. It is critical to comprehend how the HKC's adoption will impact these yard owners' profit margins (Sheikh, 2021).

6.3.3. EU Regulations for Sustainable vessel recycling

The European Union (EU) is taking steps to build its own stringent legislative framework for sustainable ship recycling in light of the difficulties and shaky progress of the Hong Kong Convention. The EU established the EU Ship Recycling Regulation (SRR) in 2013, following the release of the EU Green Paper on Better Ship Dismantling in 2007. A list of approved shipyards capable of recycling vessels flying the EU's flag has been compiled under Article 16 of the EU SRR. The list, which was first released in 2016 with 18 European shipyards and an overall capacity of 1.1 million LDT, has since grown to include 43 yards with a recycling capacity of over 3 million LDT, making up the 7th edition.

[21] the Norwegian Agency for Development Cooperation.

Additionally, the EU has been stressing the necessity of designing and building ships sustainably for future recycling. The SRR's effectiveness is nevertheless constrained in spite of these efforts. According to the 7th edition list, the SRR principally consists of EU ship recycling yards with limited capacity, which account for less than 1% of the global capacity. Furthermore, the EU exports a lot of scrap steel to nations like India, Pakistan, China, Turkey, and Egypt, making it unprofitable to recycle large ships in Europe and then export the steel to those nations who specialise in ship recycling. Furthermore, recycling of huge ships cannot be handled by European yards.

Since 2010, Japan has been offering Indian ship recycling facilities technical and commercial support. As a result, almost 50% of Indian yards now have HKC compliance certificates, and India just ratified the convention. The majority of European ship-owning nations support Turkey, which accepted both the HKC and the EU SRR, providing them a competitive edge in recycling European-flagged ships. Bangladesh and Pakistan have a difficulty since China, which owns a substantial number of ships, has a recycling business that is self-sufficient. It is essential for Pakistan and Bangladesh to build resilience in the face of this threat.

6.4. Step 3: Review of Policy Framework in Pakistan

Although shipbreaking has been a longstanding practice in Pakistan, there is a significant absence of specific regulations or established procedures. Critical analysis of existing regulatory framework of SRI in Pakistan, as discussed in section 3.5 reveals that the ship recycling industry in Pakistan operates informally, following an ad-hoc approach. The shipbreaking units are not registered as formal companies with any relevant national entity. As a result, a specific regulatory policy and institutional framework are conspicuously absent. However, a few legal instruments exist which are listed below:

6.4.1. The Balochistan Ship Breaking Industry Rules, 1979

These rules were the earliest effort to formalize the industry under the jurisdiction of Balochistan Development Authority. Nonetheless, the existing rules were primarily designed to strengthen the authority of the BDA and are primarily focused on the leasing of government-owned plots specifically for ship breaking activities. It is imperative to undertake a comprehensive revision of these rules, encompassing all facets pertaining to the green ship recycling industry, and align them with international conventions and best practices.

6.4.2. Environmental protection

The shipbreaking industry is governed by general legal provisions. Constitutional guarantees for fundamental rights apply to the sector, and regulations such as the ***Hazardous Substances Rules (2003)*** under the ***Pakistan Environmental Protection Act (PEPA), 1997*** and the ***Balochistan Environmental Protection Act 2012*** address hazardous waste management and environmental protection. There is a need to bring these regulations in line with the provisions of HKC regarding environmentally sound ship recycling.

6.4.3. Labour Laws

In Pakistan, there are various labor laws that address occupational health and safety (OHS) concerns; however, there is a lack of a comprehensive law specifically focusing on OHS in the shipbreaking sector. The enforcement of existing health and safety regulations is ineffective, and there is a lack of monitoring mechanisms to ensure compliance. Additionally, the majority of workers are hired through contractors, resulting in unstable employment arrangements and compromising their labor rights.

To address these issues with a unified approach, the Ministry of Labour and Manpower formulated a draft act called the ***'Pakistan Occupational Health and Safety Act'*** in 2018. However, the draft has yet to be discussed and reach a consensus among relevant stakeholders.

6.5. Step 4: Identification of Policy Gaps

Based on the qualitative and econometric analysis conducted in this study, several gaps were identified in the existing policy framework related to ship recycling. These gaps include:

(i) **Absolute lack of sector-specific national policy:** Pakistan lacks a dedicated ship recycling policy that addresses the unique challenges and requirements of the industry. The absence of such a policy hinders the development of a comprehensive and coherent approach to ship recycling, including environmental and safety regulations.

(ii) **Outdated *Balochistan Ship Breaking Industry Rules, 1979*:** The existing rules governing ship breaking activities in Balochistan, particularly in Gadani, are outdated and insufficient. Originally designed to empower the Balochistan Development Authority (BDA) and regulate the leasing of government-owned plots for ship breaking, these rules fail to encompass crucial aspects related to green ship recycling practices. To address this gap, a complete revision of the rules is necessary, with a focus on incorporating all relevant aspects of environmentally friendly ship recycling and aligning them with international standards.

(iii) **Outdated general labor laws:** The general labor laws that are supposed to govern labor safety and social security in Pakistan are outdated and rooted in colonial-era legislation such as '*Factories Act of 1934'*, the *'Labourers Act of 1934'* and the '*Workmen Compensation Act of 1923'*. These laws may not adequately address the specific challenges and risks faced by workers in the ship recycling industry. There is a need for updated and comprehensive labor laws that specifically address occupational health and safety concerns in ship recycling yards.

(iv) **Inadequate waste management and environmental safety regulations:** The current waste management and environmental safety regulations in Pakistan do not align with the provisions of the Hong Kong Convention (HKC) concerning environmentally sound ship recycling. The HKC aims to ensure safe and environmentally friendly practices in ship recycling. To bridge this gap, it is crucial to revise and enhance waste management and environmental safety regulations in line with the requirements set forth by the HKC.

(v) **Absence of govt. assistance for development of SRI:** Another identified gap is the absence of government assistance for the development of the ship recycling industry (SRI). The Pakistan Ship Breakers Association (PSBA) has highlighted that the infrastructure in ship recycling yards has remained unchanged for the past 30 years. Despite paying taxes and rent to the Balochistan Development Authority (BDA), the industry contends that the government has not invested in improving the infrastructure. Industry representatives have expressed their willingness to pay higher rents if the government provides better infrastructure facilities.

Addressing these identified policy gaps is essential for the sustainable and responsible development of the ship recycling industry in Pakistan. The formulation and implementation of a sector-specific national policy, revision of outdated rules, enactment of updated labor laws, and alignment of waste management and environmental safety regulations with international standards will contribute to the establishment of a robust and environmentally conscious ship recycling framework in the country.

6.6. Step 5: Comparative Analysis

6.6.1. Comparative analysis of the policy frameworks of Bangladesh

The comparative analysis of the evolution of the legal and regulatory framework in Bangladesh provides an encouraging example which can be emulated by Pakistan. In Bangladesh, there was no clear regulatory structure created especially for the vessel recycling business prior to 2011. The Bangladesh Labour Act-2006[22]. was the only piece of legislation that applied. However, the government established the Ship Breaking and Recycling Rules-2011[23] in response to a crucial judgement from the Bangladeshi high court on March 18, 2009, directing it to address labour safety issues in the ship breaking business. These regulations, however, were not backed by any parent legislation. In light of the HKC's compliance obligations, the Bangladesh Ship Reprocessing Act-2018 was approved by Parliament to address environmental safety and workers' rights (Inp, 2020).

A multi-stakeholder organisation named the Bangladesh-Ship-Reprocessing-Board (BSRB) was required to be established in order to monitor the Act's implementation and control ship recycling activities. The BSRB was tasked with creating national regulations for the approval, registration, and inspection of recycling facilities in accordance with Regulations 7(2 &3) of the Act and the HKC. According to Regulation 7(1) of the Act, the BSRB will be the key legal organisation in charge of creating the policies necessary to guarantee the HKC-compliant long-term viability of the industry. According to Regulation 7(2), the Act specifies a 5-year window beginning in 2018 for capacity building in order to comply with the HKC. By doing this, Bangladesh declares its desire to ratify the HKC soon after 2023.

The establishment of BSRB) which included members from diverse stakeholders, was a major aspect of the Bangladesh Ship Reprocessing Act-2018. These stakeholders included the officials from the shipping sector, two officials from shipyard owners and an intermix of various relevant ministries such as the department of the Ministry of Industry, the Department of Environment and Forest, the Department of labour and Employment, the Department of Energy and Mineral Resources etc. Due to this multi-stakeholder organisation, the board was able to secure the industry's sustainable growth by incorporating policy suggestions from a

[22] *The Bangladesh Labor Act-2006.* (Government of Bangladesh. https://www.ilo.org/dyn/natlex/natlex4.detail?p_isn=76402&p_lang=en
[23] *Ship Breaking and Recycling Rules, 2011.* (Government of Bangladesh). https://moind.portal.gov.bd/sites/default/files/files/moind.portal.gov.bd/legislative_information/52017f63_a708_40d2_a95a_529a01e9bb7c/SBSBR2011.compressed%20(1).pdf

variety of stakeholders. Notably, the National Board of Revenue, the shipyard owners' organization, and members of the division of Industries all play important roles in maintaining industry competitiveness. As a result of this policy and regulatory reform, Bangladesh was able to successfully complete all the three phases of SENSREC Project.

Building capability and creating the necessary infrastructure for HKC ratification has been made possible by the successful completion of the ""Safe and Environmentally Sound Ship Recycling in Bangladesh"-(SENSREC) project, funded by Norad and carried out by the IMO. Leading ship recycling business in Bangladesh, PHP Ship Breaking and Recycling Industries Limited, has previously been granted the Statement of Compliance (SoC) to the HKC by an IACS classification society, setting a standard for other yards. The Bangladeshi Ministry of Industries has stated that it intends to ratify the HKC by 2023, while yard owners' objectives will also be important to consider as significant stakeholders. It is critical to comprehend how the HKC's adoption will impact these yard owners' profit margins (Sheikh, 2021).

As a result of all this legal and regulatory framework evolution, BD is in a better position to adopt this treaty, as the government recognizes the significance of this sector for the national economy while also being aware of its environmental impact. There are lessons in the example of BD that can be emulated by Pakistan for the safeguard of the interests of the shipbreaking business.

6.6.2. Potential Impact of HKC ratification

There are certain misconceptions regarding the economic implications of the convention among relevant stakeholders. One common perception is that once the convention is in effect, party states will be restricted from recycling ships belonging to non-party states. However, according to different articles[24] ship recycling facilities in party states can accept ships from both party and non-party states as long as they comply with the convention. Nonetheless, ensuring compliance will entail additional costs.

Economic Impact of HKC: A Ship Breaker's Point of view: This section presents the potential economic effects of the HKC on a given ship breaking unit based on the obligations outlined in Regulations 15-23 of the HKC. General needs and ship-specific requirements can be divided into two categories. The basic requirements primarily encompass the following:

[24] Article 3.4, Article 4.2, and Regulation 17.2

- The state's designated authority must grant approval to every SRF. Every five years, this approval is up for review and renewal.
- Only ships that comply with the HKC will be accepted by approved SRFs.
- SRFs are required to devise a dedicated plan for their facility that addresses issues such employee safety, training, and the preservation of the environment and public health. The renewal of the SRF approval will depend on how the SRFP[25] is implemented.

The basic requirements outlined above are anticipated to result in increased investment and labor costs for an SRF, as they will need to allocate more resources to implement the SRFP and ensure labor safety. On the other hand, ship-specific requirements include:

- Devising a Ship Recycling Plan (SRP) unique to each vessel before recycling is required. The shipowner's information[26] must be taken into account in this strategy. Before physically receiving the ship, the SRP must be given to the appropriate government together with ship facts[27].
- The relevant authority's approval of the SRP, which must be made accessible to the ship for its last survey. The ship can start the scheduled recycling once the SRF notifies the appropriate authority and receives the International Ready for Recycling Certificate (IRRC) from the flag state.
- At the end of the operations the SRF will issue a Statement of Completion to its designated authority, which will then forward this document to the true owner of vessel.

Shipbreakers are of the view that all these requisitions will contribute to push the ship breaker's costs upwards. It should be noted that preparing documents and obtaining permits may introduce bureaucratic processes, potentially leading to longer recycling periods. Prolonged time of breaking operations will further escalate underlying labor and other kinds of economic costs. costs.

6.7.Policy Recommendations

Based on the findings of the policy review, stakeholder perspectives, and comparative analysis, this section provides a set of policy recommendations to bridge the identified gaps and enhance the policy framework of the ship recycling industry in Pakistan. These suggestions can be used as guidelines for policy formulation for developing and building the required capacities for

[25] Ship Recycling Facility Plan
[26] including the Inventory of Hazardous Materials (IHM) and the International Certificate on Inventory of Hazardous Materials (ICIHM)
[27] Ship facts refer to the flag state, owner and company information, classification society, etc.

adopting the Hong Kong Convention (HKC) and initiating a gradual and phased approach to improve the competitive advantage of Pakistan's ship recycling industry while keeping up with international best practices.

(i) **Establish a National Task Force:** As a first step, there is a need of a dedicated National Task Force or Board at the federal level of govt. comprising representatives from relevant ministries, departments, and industry stakeholder. This task force should be responsible for formulating a sector specific policy and drafting legislation for the grant of industry status to ship recycling sector in the first place.

(ii) **Policy and Institutional Reforms:** Pakistan should develop and enforce a robust regulatory framework that is specific to the needs of ship recycling and aligns with international standards. This framework should address issues such as worker safety, environmental protection, waste management, and the use of environmentally friendly technologies. This is contingent upon the grant of industry status to this sector. Which should be followed by the formulation of ***Pakistan Ship Recycling Industry Policy*.** The policy should clearly define the administrative jurisdiction of the industry. It should be based on a comprehensive review of existing policies, regulations, and legislation related to ship recycling. Pakistan needs to completely revise the old and outdated rules and regulations by incorporating all aspects related to green ship recycling practices. Further, the policy should set short term targets to align the industry practices with HKC's requirements for the long-term goal of HKC adoption.

(iii) **Capacity Building Programs:** Bangladesh collaborated with IMO to launch the SENSREC Project which had three phases aimed at enhancing national capacities for safe and environmentally sound recycling of ships and to comply with the requirements of the HKC. Similarly, Pakistan needs to develop a gradual approach and implement capacity building programs tailored to the needs of different stakeholders, including shipyard workers, managers, and inspectors. For this purpose, we can collaborate with international organizations, such as the International Maritime Organization (IMO) and United Nations Environment Programme (UNEP), to provide training courses, workshops, and certifications as well as funding for safe and environmentally sound ship recycling practices.

(iv) **Infrastructure Development for Operational Efficiency:** Achieving sustainable ship recycling necessitates a higher level of mechanization. This transition to mechanization requires substantial investments in procuring advanced machinery and upgrading the existing ship recycling infrastructure. The longstanding concern of ship breakers in Pakistan is that govt. does not invest at all for the betterment of Gadani yards. Ministry of Maritime Affairs needs to work with relevant ministries, such as the Ministry of Industries and Production, Ministry of Planning, Development and Special Initiatives and Ministry of Climate Change to identify areas for infrastructure development in ship recycling yards which comply with environmental requirements. Govt. should make arrangements to invest in upgrading facilities, equipment, and waste management systems to meet the requirements of the HKC. Provide financial incentives or support mechanisms to encourage private sector participation in infrastructure development.

Govt. must introduce financial incentives, tax breaks, and support mechanisms to incentivize ship recycling yards to adopt environmentally friendly practices, upgrade infrastructure, and comply with international standards. It can be achieved by providing grants or low-interest and easily accessible loans for capacity building, infrastructure development, and research and development activities.

(v) **Support for retaining competitive advantage:** The competitive analysis discussed in the preceding chapter highlights that Pakistan's competitive advantage stems from its capacity to offer higher prices to ship owners. This ability, leading to increased profit margins, is primarily attributed to three key factors:

1. Cost-Effective Labor: The jurisdiction of Labour and Human Resource department oversees the low-cost labor force.
2. Favorable Taxation: The Federal Board of Revenue's purview ensures a low tax rate.
3. Robust Demand of Scrap Steel: The Ministry of Industries & Production’s domain underscores the nation's strong demand for scrap steel.

This study suggests recalibrating wage rates, revising tax rates, and incentivizing the utilization of ship-scraps in steel production. This will retain the existing competitive advantages of cheap labor, favorable taxation, and high scrap steel demand. Additionally, the study advocates cultivating a competitive edge in operational efficiency via two pivotal catalysts: digitalization and financial support.

(vi) **Compliance with International Conventions:** Pakistan needs to ratify Hong Kong Convention, which sets the global standards for safe and environmentally sound ship recycling. In addition to that Pakistan needs to implement clauses of ILO's C187 (2006)[28] and ratify it. There is no harm to ratify it along-with HKC as both will be complementing each-other

(vii) **Research and Development:** there is dearth of knowledge on ship recycling in Pakistan. Research on the economic aspect of ship recycling in Pakistan is no-existent. Therefore, this study suggests to allocate funds for research and development initiatives focused on sustainable ship recycling technologies and practices. Ministries or the relevant industrial board can collaborate with universities and research institutions such as Pakistan Institute of Development Economics (PIDE), National Institute of Maritime Affairs (NIMA), to explore innovative market-based solutions for waste management, pollution prevention, and worker social security. Knowledge sharing and technology transfer should be encouraged through partnerships with international organizations such IMO and NGO Shipbreaking Platform. Govt. must seek international cooperation and strengthen collaboration with international organizations, such as the IMO, UNEP, and the International Labour Organization (ILO), to exchange information, participate in capacity building initiatives, and share experiences on implementing the HKC. Seek technical assistance and support from international partners to overcome challenges and ensure effective implementation of policies.

(viii) **Industry Collaboration and Certification:** Pakistan Ship Recycling Industry Policy should foster collaboration between ship recycling yards, industry associations, and certification bodies. There must be provisions to encourage ship recycling yards to pursue certifications such as Statements of Compliance (SoC) under the HKC.

(ix) **Environmental Impact Assessment (EIA):** Pakistan Ship Recycling Industry Policy should introduce a mandatory EIA process for ship recycling activities. A specialized unit within the Environmental Protection Agency (EPA) should be established or a designated authority to conduct EIAs and ensure compliance with environmental regulations. The policy should also outline pre-defined guidelines

[28] (*Convention C187 - Promotional Framework for Occupational Safety and Health Convention, 2006 (No. 187)*, n.d.): https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO::P12100_ILO_CODE:C187

for conducting EIAs, monitoring environmental impacts, and implementing mitigation measures.

(x) **Monitoring and Evaluation:** the proposed Pakistan Ship Recycling Industry Policy must have a robust monitoring and evaluation framework to assess the progress of policy implementation, evaluation of short-term targets and monitoring mechanism for maintaining long term competitiveness. The policy should have guidelines for regular review and updates of projects based on monitoring results, stakeholder feedback, and changing international practices.

By adopting this comprehensive policy framework, Pakistan can gradually and strategically develop the necessary capacities, align with the HKC, and improve the competitive advantage of its ship recycling industry. This phased approach will ensure the industry's long-term sustainability while keeping pace with international best practices and standards.

6.8.Conclusion

The policy gap analysis has shed light on the existing shortcomings and areas for improvement in the ship breaking industry in Pakistan. Through a comprehensive examination of international conventions, regulations, and best practices, as well as an exploration of the specific context in Pakistan, several key findings have emerged.

Challenges are enormous. Economic perceptions regarding the HKC's impact need to be addressed, as there are misconceptions that it will restrict the recycling of non-party countries. Clear communication and awareness campaigns are necessary to ensure stakeholders understand that party states' ship recycling facilities can accept ships from both party and non-party states, provided they comply with the convention, albeit with additional costs.

The analysis has also highlighted the economic implications for ship recyclers, both in terms of general requirements and ship-specific obligations outlined in the HKC. Increased investment and labor costs are expected as recyclers need to meet the authorization and compliance requirements, develop comprehensive recycling plans, and ensure worker safety and environmental protection. It is essential for ship recyclers to adapt their operations and allocate resources accordingly to comply with these requirements.

To achieve long-term goals and enhance the competitive advantage of the ship recycling industry in Pakistan, a gradual and phased approach is recommended. This includes building the necessary capacities and expertise to adopt the HKC fully, establishing a robust infrastructure for ship recycling, and investing in training programs and technological advancements. Collaboration between relevant institutions, ministries, and industry stakeholders will be crucial in implementing these measures effectively.

In conclusion, the policy gap analysis has provided valuable insights into the current state of the ship recycling industry in Pakistan, identified areas where policies can be improved, and highlighted the steps needed to align with international best practices. By addressing the identified gaps, implementing the necessary measures, and fostering collaboration, Pakistan can enhance its competitive advantage, ensure sustainable ship recycling practices, and contribute to a safer and greener industry.

CHAPTER 7

CONCLUSION AND WAY FORWARD

This study provides a comprehensive analysis of the ship recycling industry in Pakistan, examining its economic aspects, conducting econometric analysis, and identifying policy gaps. The researchsheds light on the market conditions, industry performance trends, operations, and competitiveness of the industry. Additionally, it explores the policy framework, land ownership rights, economic footprint, market size, competitiveness, pricing strategies, and challenges faced by the industry. The findings have been further strengthened by conducting econometric analysis to determine the factors influencing ship demolition prices. The policy gap analysis highlights crucial gaps in the existing policy framework and provided recommendations for policy reforms.

The thesis employed various methods of data collection, including historical records, surveys, interviews, and literature review. These methods ensured a comprehensive understanding of the industry and provided reliable data for analysis. The econometric analysis utilized statistical techniques to examine the relationships between ship demolition prices, steel scrap prices, exchange rates, and international oil prices. These findings have contributed to a better understanding of the economic dynamics and market forces driving ship demolition prices in Pakistan.

This study provides an insight into demolition considerations that individual ship recyclers should keep in mind and is intended to help shipping companies, primarily smaller entities, to make profitable scrapping decisions. This study will also contribute to the ship owners' understanding of the volatility and correlation between ship demolition rates at the global level, helping them reap the benefits of more favorable demolition rates.

Since steel scrap prices are continuously growing post covid pandemic. And given the uncertain political and economic situation in Pakistan, the exchange rate is continuously depleting against dollar as well as oil prices are also increasing. All of this augurs well for high demolition rates being offered by Pakistani ship recyclers. Furthermore, the surge in freight rates post pandemic has restricted the vessel supply for demolition, which also has the potential to push the offered demolition rates further upwards. But the changing regulatory setup in the international ship recycling industry, particularly the adoption of HKC by Bangladesh and entry into force of the HKC might have the potential to offset these influences on demolition prices offered by Pakistani recyclers, if Pakistan does not adopt the HKC in time. Because in the aftermath of such events, Pakistani shipbreaking yards will be the least desirable option for ship owners. Therefore, this study concludes that Pakistan needs to adopt the HKC as soon as possible to maintain its market share in SRI and reap the benefits by attracting ship owners and keeping up the competition in the ship recycling industry in the region.

The policy gap analysis identified several gaps in the existing policy framework related to ship recycling. These gaps include the absence of a sector-specific national policy, outdated regulations, inadequate labor laws, insufficient waste management and environmental safety regulations, and the lack of government assistance. Addressing these gaps is crucial for the sustainable and responsible development of the industry.

Based on the findings from the economic analysis, econometric analysis, and policy gap analysis, the following way forward is recommended for the ship recycling industry in Pakistan:

First, establish a dedicated National Task Force or Board comprising relevant stakeholders to formulate industry-specific policies and legislation aligned with international standards, including the Hong Kong Convention and ILO’s C187 (2006). Second, design tailored capacity building programs in collaboration with international organizations to train various industry stakeholders in safe and eco-friendly ship recycling practices. Third, identify and develop environmentally compliant infrastructure within ship recycling yards through partnerships with relevant ministries. Financial incentives and support mechanisms should be introduced to encourage adoption of green practices and infrastructure upgrades. Ratifying the Hong Kong Convention and ILO’s C187 (2006) is crucial, along with research initiatives focused on sustainable technologies. Collaboration among industry entities, certification bodies, and adherence to comprehensive Environmental Impact Assessments will further bolster the sector's growth and environmental responsibility.In conclusion, the ship recycling industry in Pakistan has significant potential for economic growth, revenue generation, and employment opportunities. However, addressing the identified policy gaps and implementing the recommended measures are essential for the industry's sustainable development. By adopting environmentally friendly practices, complying with international standards, and fostering collaboration, Pakistan can establish itself as a responsible player in the global ship recycling market. This will not only enhance the industry's competitiveness but also contribute to environmental preservation and worker welfare.

APPENDICES

Appendix 1: Interview Guide

List of Questions

Situational Information about shipbreaking market

1. What is the size of market (industry) in terms of number of firms?
2. What are the Entry and exit conditions, regulations, capital threshold etc?
3. How many big players are there? If any. Or all firms have level playing field?
4. How shipbreakers compete with each other? Degree of Competitiveness.
5. Profit motive and profit margin: Profit motive (in terms of motivation for the business) and profit margin (in terms of the actual profit earned after bearing all costs).
6. Infrastructural capacity installed and actual capacity utilization. Is there optimal utilization of the capacity or there is idle capacity. Are you satisfied with current situation or you see any gaps between existing capacity and true potential? (Causes of under-utilization, measures to improve).
7. Are there any expansion plans for Gadani?
8. Contribution to steel sector and Revenue contribution to economy.

Governance Structure

9. Degree of formalization: How many firms are formally documented/registered and unregistered? Where do ship breakers register? Is it SECP or FBR or what else forum of national govt.? What is the documentation process?
10. What is the organizational hierarchy? Which ministerial domain /division does SBI fall? Is it federal ministry for maritime affairs or Balochistan development authority or both?
11. Regulatory framework and Taxing authority. What is the tax incidence on ship breakers?

Supply-Demand and Price Setting Mechanism

12. Internal (domestic) and External Determinants
13. Linkages between prices of all demolition centers (Pakistan, Bangladesh, India, Turkey)
14. Strategy of Pakistani breakers/buyers
15. What kind of competition do you face from imports of steel scrap?

16. Linkage with steel Prices, Exchange rate impact, recent currency devaluation impact. Oil Price shocks.etc. What has the impact of devaluation been on this business given that all ships are imported?
17. Between the higher taxes and lower RD imposed by the last budget, what has been the loss to the sector?
18. What major changes you expect in the near future that could impact international supply conditions?

Significance for Pakistan Economy

19. What is the contribution of the ship breaking sector to the steel industry as a whole?
20. Comment on the economic benefit of SBI in terms of chain effect
21. Do you think that shipbreaking industry is a valuable contributor to national economy? Should it be given the industry status?
22. What benefits SBI would get if it is given the formal industry status.

Policy Discussion

23. Comment on Green Industry vs. Yard of Garbage debate.
24. your views on Environmental Concerns and Sustainability Practices in Pakistan?
25. What are your views on Hong Kong Convention. Why Pakistan has not ratified it yet. Why is there reluctance in adopting it? What are the roadblocks for adopting HKC? Can Gadani yards adopt it's guidelines without Pakistan formally ratifying it.
26. Where Pakistan stands in its efforts to ratify and adopt HKC.
27. Shed some light on tax provisions for SBI. What measures would you suggest regarding taxation to improve the profitability in SBI?

Appendix -II

LIST OF INTERVIEWEES

Sr. No.	Name	Designation	Address
1.	Mr. Jawed Iqbal	CEO at Shoaib Shipping Agencies (Pvt) Ltd. Vice Chairman & Executive Committee Member Pakistan Ship Agents Association	Karachi
2.	Siddharth Jayesh Shah	(Cash Buyer) CEO Tristar Oceanic Inc.	India
3.	Dr Kanwar Javed Iqbal	Senior Researcher	NIMA, Islamabad
4.	Dr. Abdullah Açık	Associate Professor, Maritime Faculty, Dokuz Eylül University,	Turkiye
5.	Mr. Asif Ali Khan	Chairman PSBA	Karachi
6.	Mr. Sultan Madad	Second secretary SPR&S FBR HQr	Islamabad
7.	Vice Admiral (R) Abdul Aleem	Director General NIMA	NIMA, Islamabad
8.	Vice Admiral (R) Ahmed Saeed HI(M)	Director General NIMA	NIMA, Islamabad
9.	Dr. Syed Muhammad Anwar	President, Maritime Study Forum (MSF)	Islamabad
10.	Mr. Jun Sun	Technical Officer, IMO	IMO, UK
11.	Ingvild Jenssen	CEO, Shipbreaking Platform	Belgium
12.	Dr. Anil Sharma	Founder & CEO of GMS	GMS Leadership, YouTube: https://www.youtube.com/watch?v=do4RmAjtLmk

Appendix-III

Table A: Competitiveness Analysis of SRI

	India	Bangladesh	Pakistan
Local Steel Price			
Re-rollable/Scrap Steel	$472/ton	$496/ton	$420/ton
Labor Cost			
Unskilled	Unskilled- €59	Unskilled- €45	Unskilled- €80
Skilled	Skilled- €119	Skilled- €180	Skilled- €180
Taxes & Tariffs			
Approx. tax rate on per LDT price of scrap ship	22%	12%	18%
Demand of Scrap Steel			
Total national Steel Demand	~100MT	~6 MT	~11.1 MT[29]
Contribution of the SRI to the national demand	Around 7%	Around 60%	Around 14.4%

Source: Reproduced from (Sheikh, 2021).

Table B: Requirements for Entering into Force (From 2009 to June, 2021)

Criteria	**Minimum Requirements**	**Current Status**
Number of Parties	15	17
GT of World Merchant Fleet	40%	Approximately 27.72%
Recycling Tonnage in Last 10 Years	3%	Approximately 2.49%

Note: Reproduced from (Sun, 2022)

Table C: Current Status of the Requirements (From 2009 to June, 2021)

World Fleet	1,39,91,00,000
40% of World Fleet	55,96,40,000
3% of the 40%	1,67,89,200

[29] PACRA, 2022. Steel Sector Study. The Pakistan Credit Rating Agency: https://www.pacra.com/sector_research/PACRA%20Research%20-%20Steel%20-%20Sep'21_1630576235.pdf

SL.	Country	Signature	Accession/ Ratification	Fleet (GT)	Percentage (%) in World Fleet	Max. Annual Ship Recycling Volume in last 10 years
1	France	19-Nov-09	2-Jul-14	40,34,741	0.29%	5,102
2	Netherland	21-Apr-10	20-Feb-19	63,01,478	0.45%	11,288
3	Ghana	2-Aug-10		36,569	0.00%	8,714
4	Türkiye	26-Aug-10		48,77,268	0.35%	15,40,800
5	India	27-Aug-10	28-Nov-19	1,04,40,505	0.75%	1,22,10,082
6	Norway	26-Jun-13		29,50,336	0.21%	6,261
7	Congo	19-May-14		4,757	0.00%	0
8	Belgium	7-Mar-16		59,96,510	0.43%	36,441
9	Panama	19-Sep-16		23,03,75,579	16.47%	3,305
10	Denmark	14-Jun-17		1,38,024	0.01%	56,369
11	Malta	4-Mar-19		8,24,55,008	5.89%	947
12	Japan	27-Mar-19		2,92,33,552	2.09%	45,706
13	Germany	16-Jul-19		71,37,495	0.51%	1,534
14	Serbia	-		-	0.00%	0
15	Estonia	-		3,81,850	0.03%	3,593
16	Croatia	16-Feb-21		10,05,370	0.07%	2,814
17	Spain	3-Jun-21		24,38,287	0.17%	16,656
Total		**38,78,07,329**		**1,39,49,612**		
Total Percentage (%) of the World Fleet (1,39,91,00,000)					27.72%	
Required Rate-40%						
Maximum annual recycling volume (all the countries recycled their maximum amount of GT in 2012)			2.49%			
Required Rate- 3%						

Source: Adapted from (Sheikh, 2021).

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