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Port state control: banning: an analysis of banned ships from Paris MOU and its effect on other MOUs

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PORT STATE CONTROL: BANNING

AN ANALYSIS OF BANNED SHIPS FROM PARIS MOU AND ITS EFFECT ON OTHER MOUS

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A dissertation submitted to the World Maritime University in partial fulfillment of the requirements for the award of the degree of Master of Science in Maritime Affairs

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Declaration

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

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(Date): **25. Oct. 2023**

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Abstract

Title of Dissertation: **Port State Control: Banning – An analysis of banned ships from Paris MoU and its effect on other MoUs**

Degree: **Master of Science**

The pressing need for a more harmonized maritime strategy has become increasingly evident due to contrasting safety and operational standards among different Port State Control (PSC) Memorandums of Understandings (MoUs). Influenced by their individual circumstances, each MoU varies in its approach, creating a ripple effect that underscores the urgency for unified protocols to enhance maritime safety and facilitate consistent global compliance. Against this backdrop, this research offers a comprehensive exploration of maritime operations, focusing on ship inspections, banning patterns, and their intricate relationships within various MoUs.

The pivotal role of Port State Control Officers (PSCOs) emerges prominently, showcasing their imperative function in assuring vessels adhere to international safety and operational benchmarks. An in-depth analysis of banned ships, particularly within the context of the Paris MoU, exposes a nuanced trend: ships potentially navigating towards regions perceived as more lenient, challenging the rigor of existing MoUs, and highlighting the adaptability of ship operators within these regulatory frameworks.

Core insights from the study emphasize the fluidity of maritime standards, which adapt in response to shifts in technology and global landscapes. Notably, the migration pattern of banned ships reflects the global interconnectedness of maritime activities, indicating that actions in one region can resonate elsewhere, urging for research that spans beyond specific maritime events.

Looking forward, intriguing research areas encompass cross-MoU studies to understand disparities and identify best practices, the utilization of technological advancements for improved monitoring, and a deep dive into the motivations and decisions of ship operators. Overall, the research accentuates the importance of both rigorous enforcement and a holistic understanding of maritime dynamics, illuminating pathways to elevate global maritime standards.

KEYWORDS: Port State Control (PSC), Memorandum of Understanding (MoU), Paris MoU, Refusal of Access, Banning, Awareness, Global Cooperation

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List of Abbreviations

CIC	Concentrated Inspection Campaigns
EC	European Commission
ECA	Emission Control Area
EQUASIS	Electronic Quality Shipping Information System
EU	European Union
IMO	International Maritime Organization
MoU	Memorandum of Understanding
NIR	New Inspection Regime
PSC	Port State Control
PSCO	Port State Control Officer
RO	Recognized Organizations
SOLAS	International Convention for the Safety of Life at Sea
SRP	Ship Risk Profile
UNCLOS	United Nations Convention on the Law of the Sea
UNCTAD	United Nations Conference on Trade and Development
USCG	United States Coast Guard

Chapter 1 Introduction

1.1 Background

Port State Control (PSC), which ensures the safety of human life at sea, prevention of marine pollution, and a safe working environment for seafarers, is considered the most important safety measure in the maritime industry (IMO, 2019c). Various international maritime agreements, in addition to the United Nations Convention on the Law of the Sea (UNCLOS), include provisions that obligate port states to conduct inspections to verify compliance with international rules and regulations by foreign-flagged vessels arriving at their ports, thus ensuring the authority of port states. PSC inspections, designed as an alternative to inadequate safety management by flag states, have proven to be highly effective response measures (Demirci & Cicek, 2023). In order to further encourage and enhance cooperation among neighbouring countries, the International Maritime Organization (IMO) has adopted Resolution A.682(17) and continuously updates the PSC procedures through the implementation codes to harmonize PSC activities globally (IMO, 2019a).

The purpose of interregional cooperation is to provide member states' ports with fair competition opportunities. Regional agreements aim to reduce administrative costs by avoiding duplicate inspections on the same vessel and allow for more focused inspections on substandard ships, thus enabling more efficient implementation of ship inspections (Mehrotra, 2000). In other words, the goal of harmonizing PSC measures between regions is to inspect as many substandard ships as possible without subjecting safe vessels to redundant inspections (IMO, 2019c). Thanks to over 40 years of international attention, the number of countries joining regional regimes has significantly increased, and each country strives to inspect vessels entering their jurisdictional waters and detain substandard ships (Nippon Kaiji Kyokai, 2022;

Özçayir, 2009). Starting with the Paris MoU established in 1982, centered around Western European countries, there are currently ten PSC regimes operating in various regions, and some member states belong to more than one regime (Kulchytskyy, 2013). Each regime sets its own compliance standards and conducts ship inspections, taking into account the maritime environment and characteristics within their respective regions, in order to achieve common objectives (Knapp & Franses, 2008).

Shipping industry stakeholders pay significant attention to the PSC regimes of the regional Memorandum of Understandings (MoU) in which their vessels operate (Knapp & Van De Velden, 2010). Ship Risk Profile (SRP) is an indicator that determines how frequently a ship should undergo PSC inspections (Shen et al., 2021). This risk level is measured considering not only the characteristics of the ship itself but also the performance of the management company, classification society, and flag state (Xiao et al., 2020). Since 2011, the New Inspection Regime (NIR), which was newly implemented by the Paris MoU to select ships for inspection, has been recognized as the most effective and harmonized ship inspection system and has been adopted by other MoUs such as Tokyo-2014, Black Sea-2016, and Indian Ocean-2018 (Xiao et al., 2020).

However, each MoU applies it differently, considering the specific characteristics of the regional regime and changes in the shipping environment, gradually incorporating additional factors into the calculation (Fu et al., 2020). Through the agreed-upon methodology determined by each MoU, the risk level of a ship is determined by comprehensively considering the weighted factors, and higher-risk vessels are given priority in inspections (Rodríguez & Piniella, 2012). High-risk vessels undergo more intensive inspections, and vessels with numerous deficiencies or repeated detentions may be designated as substandard or subject to a prohibition of entry. Shipping companies strive to reduce the risk level of their vessels to ensure their smooth engagement in trade activities within the respective regions (Chuah et al., 2022). On the other hand, some are concerned about substandard ships moving to regions with less regulation and less active PSC activities (Farag, 2016; Plant, 1995).

After reviewing academic research on PSC, it has been noted that there is a significant body of literature addressing the positive impact of PSC (Yang et al., 2020; Fotteler et al., 2020) as well as its dissonance (Kara et al., 2019; Piniella et al., 2020), particularly focusing on specific regional regimes (Şanlıer, 2020) and SRP methods (Wu et al., 2021; Demirci & Cicek, 2023). Many scholars have provided empirical evidence through their studies that the concentrated inspections of high-risk ships determined by the current SRP methodology contribute to the expulsion of substandard ships and enhance maritime safety in the region (Xiao et al., 2021; Yang et al., 2020). Some scholars have also written papers specifically examining the impact of individual factors on risk assessment, while others have proposed new SRP methods.

Conversely, although there have been numerous studies analysing the detailed information of substandard ships identified through PSC activities of the regional MoUs (Chen et al., 2019) and demonstrating the effectiveness of expulsion measures, there is a lack of literature investigating the fate of expelled ships. The expulsion of substandard ships in one maritime region can pose a threat to safety in other areas, which is inconsistent with the goal of the international community to establish a globally safe maritime environment. In 2004, Efthimios E. Mitropoulos, the former Secretary-General of the IMO, mentioned during a joint ministerial conference on the Paris and Tokyo PSC conventions that a PSC regime, consistently and uniformly applied through global support, should be a common objective. He emphasized the need to encompass not only the US Coast Guard but all regional regimes and to harmonize and coordinate existing PSC activities to achieve this goal (Mitropoulos, 2004).

1.2 Problem Statement and Justification of the Research

The unity among the countries sharing the same maritime area has undoubtedly made a significant contribution to maritime safety within the agreed-upon region. However, ship activities are not limited to a single maritime area. Certain ship incidents can serve as strong triggers for new international maritime agreements, highlighting the international nature of the shipping industry and the essential need for global cooperation to achieve common goals. Nevertheless, the current regional regime has inherent inconsistencies with the collective objectives of the international community. Notably, the divergent ship inspection standards and the expulsion methods for substandard ships by different regional agreements create disharmony within the shipping industry's internationalization efforts.

Firstly, each regional agreement is a region-centric organization of port states dedicated to specific maritime areas, which means they have their own characteristics based on the overall shipping situation and interests of the member countries. For instance, the Paris MoU predominantly consists of European Union (EU) member states, and the policies of the EU have a strong influence on this regional regime. Recently, the EU designated all EU waters as Emission Control Areas (ECA) for sulphur emissions and announced a large-scale plan to reduce carbon emissions to achieve carbon neutrality by 2050, ahead of the IMO's plan (Urdahl, 2023). These ship regulations only apply to vessels entering the EU waters, excluding other areas. Therefore, the unique inspection approaches of each regional regime create an imbalance in common safety standards as they are only enforced within their respective regions.

The second mismatching element is the bias in safety caused by the banning of substandard or high-risk ships within regional regimes. PSC, enforced by port states' authority, allows them to issue detention or expulsion orders for ships that do not comply with the standards, based on their national laws, for ships entering their own ports. Regional agreements facilitate the sharing of such port state actions among member countries and collectively work towards eliminating factors that pose a threat to the community. However, since these ships can operate in other regions without significant sanctions or restrictions, they tend to move towards areas with less regulation and enforcement. Some studies have pointed out the movement of ships refused access in one regime to other regions (Kulchytskyy, 2013). This phenomenon, persisting until the ship is scrapped, ironically implies that the safety improvement in one regional regime diminishes the safety in other regional regimes.

One distinct feature that sets the Paris MoU apart from other regional agreements is its strong response to substandard ships, as mentioned earlier. In the annual performance lists published by the agreement, if a ship flying the flag of a country marked in the grey list has been detained twice or more within a period of 24 months, it will be refused access. If the ship's flag state is included in the blacklist, the calculation period extends to 36 months. The duration of the first refusal of access is 3 months, followed by 12 months for the second and 24 months for the third. If the number of refusals exceeds three, the flag state, recognized organization, and the ship's management company must all have received satisfactory evaluations for the order to be lifted. Failure to meet these conditions results in the permanent denial of access to all ports and anchorages within the Paris MoU region for the respective ship. Furthermore, this refusal of access measure also applies if the ship escapes without complying with detention orders or fails to call at the designated repair port (Paris MoU, 2023).

These circumstances demonstrate the need for improvement in achieving the global objectives pursued by the IMO through harmonious implementation of all PSC regimes. It is essential to gain a precise understanding of the differences in ship inspection systems among regional agreements and to examine the movement information of ships subject to access refusal measures for valuable insights.

1.3 Research Aim and Objectives

This document investigates vessels that have been banned from entering under the Paris MoU due to substandard criteria. Fundamentally, with the enforcement of Directive 2009/16/European Commission (EC), the European PSC system is mandatory, setting it apart from other MoUs. Therefore, it is implemented more stringently than other PSC MoUs, based on the research findings of Van Leeuwen (2015). Accordingly, the primary objective of this study is to analyse detailed data on banned ships to understand their characteristics, and secondly, to track their movement to other MoU regions and verify the inspection results.

Chapter 2 Literature Review

With the increasing importance of PSC inspections in preventing ship accidents worldwide, research on this topic has been actively conducted in recent years. Searching for articles on Google Scholar with the exact phrase "Port State Control" in the title or text reveals a total of over 11,500 documents. Approximately 5,000 documents were registered between the past and 2013, and within the last decade, from then until now, an additional 6,300 documents have been published, surpassing the number of existing documents within just a 10-year period.

Among these, an analysis of the literature related to PSC inspections reveals that they can be broadly categorized into the following three themes: 1) The impact and analysis of PSC inspections and their outcomes, 2) Inconsistencies in ship inspection systems, and 3) Enhancing and harmonizing PSC inspections. However, it is noteworthy that only a few documents solely focus on a single theme, while most articles propose the third theme based on the evidence from the first and/or second themes.

2.1 Impact and Result of PSC Inspection

Despite the global outbreak of Covid-19, it was reported in the United Nations Conference on Trade and Development (UNCTAD) (2021) Maritime Transport Review that over 80% of global cargo transportation was still carried out through maritime shipping in 2021. To sustain continuous and uninterrupted cargo transportation by ships at sea, it is crucial to maintain a safe and environmentally friendly approach to prevent accidents in advance. Maritime ship accidents can cause delays or disruptions in international cargo transportation and have serious implications for global trade as a whole (Demirci & Cicek, 2023). A recent example of such accidents is the grounding incident in the Suez Canal in 2021, which affected approximately 400 vessels and was estimated to incur a cost of around 2 billion dollars for accident handling (SAFETY4SEA, 2022).

Various stakeholders are involved in developing and implementing ship inspection systems to prevent accidents and improve safety. Flag states, insurance companies, classification societies, cargo owners, superintendents, shipowners, and port states all contribute individually or collaborate with other organizations to achieve their goals (Demirci & Cicek, 2023). Flag states primarily bear the overall responsibility to effectively control ships registered under their jurisdiction in accordance with their laws, while classification or Recognized Organizations (RO) conduct comprehensive inspections of ships in accordance with inspection guidelines on behalf of flag states and issue certificates. Shipowners and managers conduct internal audits or supervision based on company manuals, and cargo owners, in particular, establish inspection rules to verify the suitability of ships for cargo transportation. PSC plays the role of a "safety net" by identifying ships that do not meet international standards in addition to the various inspections conducted by stakeholders.

Since the implementation of PSC measures after the International Convention for the Safety of Life at Sea (SOLAS) in 1929, their necessity has progressively increased over the past few decades, especially after a series of major maritime accidents that occurred in the late 20th century, including the grounding of the Amoco Cadiz, which resulted in a spillage of over 200,000 tons of oil off the coast of France in 1978 (Soares, Cariou, et al., 2018). It was recognized that ships were not properly adapting to new environments and failing in self-regulation (Anderson, 1998; Bell, 1993; Mansell, 2009; Özçayır, 2004; Vorbach, 2001). As a response, the establishment of the Paris MoU in 1982, the first regional coordinated ship inspection regime among European countries to prevent the spread of substandard ships, further solidified the role of PSC as the final line of defence for ship safety (See table 1).

Table 1: Members of the Paris MoU and Date of Joining.

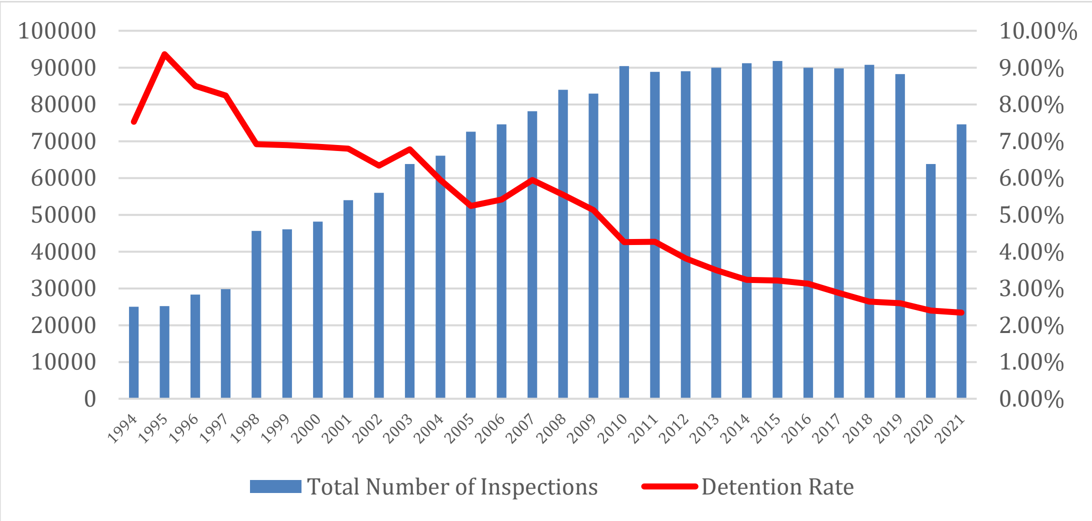
No.	Authority	Joining Year	No.	Authority	Joining Year
1	Belgium	1982	15	Poland	1992
2	Denmark	1982	16	Canada	1994
3	Finland	1982	17	Russian Federation	1996
4	France	1982	18	Croatia	1997
5	Germany	1982	19	Iceland	2000
6	Greece	1982	20	Slovenia	2003
7	Ireland	1982	21	Estonia	2005
8	Italy	1982	22	Latvia	2005
9	Netherlands	1982	23	Cyprus	2006
10	Norway	1982	24	Lithuania	2006
11	Portugal	1982	25	Malta	2006
12	Spain	1982	26	Bulgaria	2007
13	Sweden	1982	27	Romania	2007
14	United Kingdom of Great Britain and Northern Ireland	1982	28	Montenegro	2023

Source: Paris MoU (2023)

Bell (1993) highly evaluated the improvement in the compliance rate with international law due to the activities of PSC, and similarly, Payoyo (1994) supported the view that PSC is the most important factor in enforcing international conventions compared to flag states and classification societies. Furthermore, a study examining 20 years of PSC after the establishment of the Paris MoU concluded that PSC exerted significant pressure on the maritime industry, which resulted in ships being able to comply with international standards, despite the numerous efforts of flag states (Vorbach, 2001). Another scholar argues that PSC effectively narrowed the gap between ships and international standards that flag states were very slow in narrowing

(Van Leeuwen, 2015). Knapp and Franses (2008), analysing ship accident reports and 193,819 PSC inspection data, demonstrated that the activities of port states reduced accident probabilities and improved safety. The figure 1 illustrates that despite the increasing number of PSC inspections conducted by the total of 9 existing MoUs and the USCG, the detention rate continues to decrease. Numerous studies have clearly demonstrated the improvement in ship safety (Li & Zheng, 2008; Van Leeuwen, 2015), pollution prevention (Bang, 2008; Cuttler, 1995), as well as standards for protecting seafarer labour (Grbić et al., 2015; Fotteler et al., 2020) since the emergence of PSC.

Figure 1: Total Number of Inspections and Detention Rate among All PSC Regions from 1994 to 2021



Source: PSC Annual Report (2021)

Note. Abuja MoU Annual Report, 2010-2021; Acuerdo de Viña del Mar Annual Report, 2005-2021; Black Sea MoU Annual Report, 2003-2021; Caribbean MoU Annual Report, 2005-2021; Indian Ocean MoU Annual Report, 2001-2021; Mediterranean MoU Annual Report, 1998-2021; Paris MoU Annual Report,1994-2021; Riyadh MoU Annual Report, 2007-2021; Tokyo MoU Annual Report, 1994-2021; USCG Annual Report, 1998-2021

While PSC activities have undeniably contributed to enhanced maritime safety, literature remains scarce regarding the interrelation and influences between various regional MoUs. Existing research predominantly centers on the efficacy of regional MoUs in addressing substandard ships. However, nuanced discussions concerning the specifics of these substandard vessels and their subsequent movements are often glossed over, suggesting a gap in the current body of knowledge. As the complexity of maritime conventions grows and regional collaborative mechanisms intensify, there emerges a compelling research imperative to explore the decisions of ship owners, especially those with aging vessels that fail to meet contemporary standards.

2.2 Discrepancies in Ship Inspection Regime

Since the establishment of the Paris MoU, a total of nine regional MoUs for PSC have been formed, and the United States Coast Guard (USCG) is recognized as the tenth PSC regime (IMO, 2019c) (see table 2). Hare (1997) identified two factors driving regional cooperation: the need for intergovernmental sharing of ship safety information and the need to avoid repetitive ship inspections in the same region. The primary objective of regional MoUs is to ensure compliance with international conventions for ships through consistent procedures, from the designation of ships for inspection to the conduct of inspections and imposition of detainment (Soares et al., 2018). Similarly, applying common standards among cooperating countries reduces negative impacts on ports within the same MoU, reduces commercial incentives distortions (Molenaar, 2007), and decreases unilateral enforcement by member states that could distort the shipping market (Knapp & Franses, 2007).

Table 2: PSC Regimes in 2023

	Region	Name	Year	Member
1	Europe and north Atlantic	Paris MoU	1982	28
2	Latin America	Acuerdo de Viña del Mar	1992	16
3	Asia and the Pacific	Tokyo MoU	1993	22
4	Caribbean	Caribbean MoU	1996	18
5	Mediterranean	Mediterranean MoU	1997	11
6	Indian Ocean	Indian Ocean MoU	1998	22
7	West and Central Africa	Abuja MoU	1999	22
8	Black Sea region	Black Sea MoU	2000	6
9	Gulf Region	Riyadh MoU	2004	7

Source: PSC MoUs (2023)

Note. Abuja MoU, 2018; Acuerdo de Viña del Mar, 2020; Black Sea MoU, 2022; Caribbean MoU, 2020; Indian Ocean MoU, 2022; Mediterranean MoU, 2022; Paris MoU,2023; Riyadh MoU, 2015; Tokyo MoU, 2021

Table 3: Relevant Instruments of PSC Regimes in 2023

Instruments	Paris	Vina	Tokyo	Cari	Medi	Indian	Abuja	Black	Riyadh
LOAD LINES 66	√	√	√	√	√	√	√	√	√
LOAD LINES PROT 88	√	√	√	√	√	-	√	-	-
SOLAS 1974	√	√	√	√	√	√	√	√	√
SOLAS PROT 88	√	√	√	√	√	-	√	-	√
MARPOL 73	√	√	√	√	√	√	√	√	√
MARPOL PROT 78	√	√	√	√	√	√	√	√	√
MARPOL PROT 97	√	√	√	√	√	-	√	-	-
STCW 78	√	√	√	√	√	√	√	√	√
COLREG 72	√	√	√	√	√	√	√	√	√
TONNAGE 69	√	√	√	√	√	√	√	√	√
MLC 2006	√	√	√	√	√	√	√	√	-
CLC 69, PROT 1992	√	√	√	√	√	√	√	√	-
CLC PROT 1992	√	√	√	√	√	√	√	√	-
AFS 2001	√	√	√	√	√	√	√	√	-
Bunker 2001	√	-	-	√	√	√	√	√	-
BWM 2004	√	√	√	√	√	√	√	√	-
Nairobi WRC 2007	√	-	-	√	√	-	-	√	-

Note. The US Coast Guard operates under the PSC system of a single nation, rather than a cooperative framework shared by various countries in the same maritime area.

Source: PSC MoUs (2023)

Note. Abuja MoU, 2018; Acuerdo de Viña del Mar, 2020; Black Sea MoU, 2022; Caribbean MoU, 2020; Indian Ocean MoU, 2022; Mediterranean MoU, 2022; Paris MoU, 2023; Riyadh MoU, 2015; Tokyo MoU, 2021

However, criticism regarding the lack of consistency between regions and countries regarding PSC activities within the MoUs has emerged since the 1990s (Demirci & Cicek, 2023). Blanco-Bazán (2004) mentioned the scepticism surrounding the Paris MoU due to the perception that European countries enforce IMO conventions discriminately. Other scholars argue that the non-binding nature of regional MoUs poses significant challenges in achieving their original objectives (Bang, 2008; Bang & Jang, 2012; Molenaar, 2007; Molenaar & Pons, 1996). To overcome these challenges, ambitious goals of unifying enforcement standards within regions have been set (Ravira & Piniella, 2016). In contrast, despite their continuous efforts, numerous studies have proven that PSC is not consistently implemented (Anderson, 2002; Bloor et al., 2006; Cariou et al., 2009; Hjorth, 2015; Knapp and van de Velden, 2009; Knudsen and Hassler, 2011; Ravira and Piniella, 2016; Sampson and Bloor, 2007). Özçayır (2009) pointed out that PSC is applied differently in each regional MOU and even varies within the same MOU (refer to table 3). Furthermore, research has shown that the results of deficiencies and detainments vary depending on the background and number of inspectors implementing PSC within the same country (Soares, Cariou, et al., 2018).

The issue of inconsistency and lack of harmonization among regional MoUs has been consistently raised since the establishment of the first MoU. The primary research topics have focused on the legal basis of port state jurisdiction (Anderson, 1998; Bang, 2009; Bell, 1993; Keselj, 1999; Molenaar, 2007; Özçayır, 2004; Payoyo, 1994) and improvements in the selection of ships for inspection (Anderson, 2002; Cariou et al., 2009; Cariou and Wolff, 2015; Degré, 2007, 2008; Sage, 2005). Through interviews and field research with stakeholders from different countries belonging to different regional MoUs, Sampson and Bloor (2007) confirmed that the participants perceived that ship inspections were not uniformly conducted among regional MoUs. Similarly, Knapp and van de Velden (2009) and Knudsen and Hassler (2011) emphasized the differences in approaches since the establishment of PSC and concluded that it was premature to expect harmonization and uniformity among the regional MoUs. Unjustified detainment cases have also been studied in several papers (Kulchytskyy, 2012; Lindroos, 2019; Serafimov and Rudenko, 2018; Xiong, 2015; Zhanjun, 2016), with claims that the decisions for detainment were based on the subjective understanding of PSC officers (Zhanjun, 2016). This inconsistency in inspections among PSC regimes has a significant impact on the credibility of regional MoUs and overall compliance with international maritime conventions.

To date, research focusing on disparities between regional bodies has primarily been aligned with the authorities conducting PSC, notably the inspectors and administrative agencies, especially in relation to the SRP policies. However, there are limited studies addressing the differences in strategies of regional bodies towards substandard ships and the outcomes of these differences. By analysing the tangible issues stemming from these disparities, papers can raise awareness in the maritime industry and prompt action from policy-makers.

2.3 Improvement and Harmonization of PSC Inspection

The inspection of ships engaged in international navigation plays a crucial role in ensuring safety in maritime transportation. An effective way to enhance the efficiency of this important activity is to discover meaningful knowledge from the massive ship inspection data held by each regional MoU (Demirci & Cicek, 2023). The data primarily consists of ship attributes and deficiencies, and through the analysis of PSC inspection reports, it has been reported that factors such as the age of the ship, ship type, flag state, classification society, and inspection location influence detainment and deficiency counts (Xiao et al., 2020; Cariou et al., 2007; Cariou et al., 2009; Yang et al., 2018; Şanlıer, 2020). Following the development of discriminatory functions for estimating the likelihood of ship detainment by Itoh et al. (2005), Cariou et al. (2009) utilized Count Data Models, and Wang et al. (2021) employed Bayesian Network Models to uncover correlations between ship detentions and attributes. Furthermore, one study analysed ship accident reports using a Bayesian Network Model to identify the factors with the greatest impact on ship risk, which were identified as vessel age, ship type, and inspection level (Fan et al., 2019). Based on various measured key factors, many scholars are consistently conducting research to improve the precision of ship risk measurement and enhance the efficiency of ship inspections.

Recently, the most researched topic has been the measurement of risk in ship inspection systems. The pursuit of standardized measurement methods has been a major concern among scholars even before the emergence of the widely used NIR in many regional agreements. Xu et al. (2007) analysed ship inspection report data from the Tokyo MoU and demonstrated that new factors generated by defect records improve ship targeting systems. They proposed an improved system based on Support Vector Machine. Additionally, Gao et al. (2008) proposed a Bag of Words approach to extract new factors for enhancing the model proposed by Xu et al. Yang et al. (2018) integrated a game-theoretical model between port states and shipowners with a Bayesian network approach to propose an ideal PSC inspection system. Furthermore, Yan et al. (2021) proposed a classification model that combines Demirci et al.'s (2022) Fuzzy Rule-Based SRP Prediction Model with balanced random forest algorithms for ship detention prediction. Additionally, recent studies have focused on developing decision support systems using big data and artificial intelligence to maximize the efficiency of ship inspection (Demirci & Cicek, 2023) and considering the psychological behaviour of decision-makers and the uncertainty of PSC inspection results (Zhu et al., 2023).

Through continuous research from various perspectives in academia on PSC, progress is being made toward harmonized implementation globally. However, fundamental issues remain. The most significant drawback is the lack of synchronization among PSC regimes (Kulchytskyy, 2013). The improved ship risk measurement methods proposed by many scholars would greatly assist each MoU in identifying high-risk ships. However, a comprehensive database that facilitates such targeting systems does not currently exist. Unless there is close cooperation between regional regimes, substandard ships can exploit this loophole to escape detention or deficiency rectification orders and move to other regions. In order to prevent such misconduct by shipowners and utilize information sharing as a window to identify substandard ships, Electronic Quality Shipping Information System (EQUASIS) was established in 2000 under the leadership of the European Union Executive Agency and the French Maritime Authority. Currently, all regional MoUs except the Riyadh MOU share ship inspection reports, and classification societies, insurance companies, international organizations, and the shipping industry continually update the information

(EQUASIS, 2021) (see table 4). However, this innovative system is limited to verifying ship inspection information from other regional MoUs and does not have any influence on the calculation factors or weightings of the ship inspection systems of each regional MoU.

Table 4: EQUASIS Data-Providers

Data Provider Category	Data Provider	Scope of provided information	Since
Core Data	IHS Maritime	Ship's companies' characteristics	2000
PSC Regimes	Abuja MoU	Inspection data	2019
	Black Sea MoU		2017
	Caribbean MoU		2016
	Indian MoU		2008
	Vina del Mar MoU		2012
	Mediterranean MoU		2014
	Paris MoU		2000
	Tokyo MoU		2000
	US Coast Guard		2000
Other Provider: Classification Societies, P&I Clubs and Insurance Companies, Intergovernmental Organisations, Federations and National/EU Agencies, Private companies and Associations from the Maritime Industry			

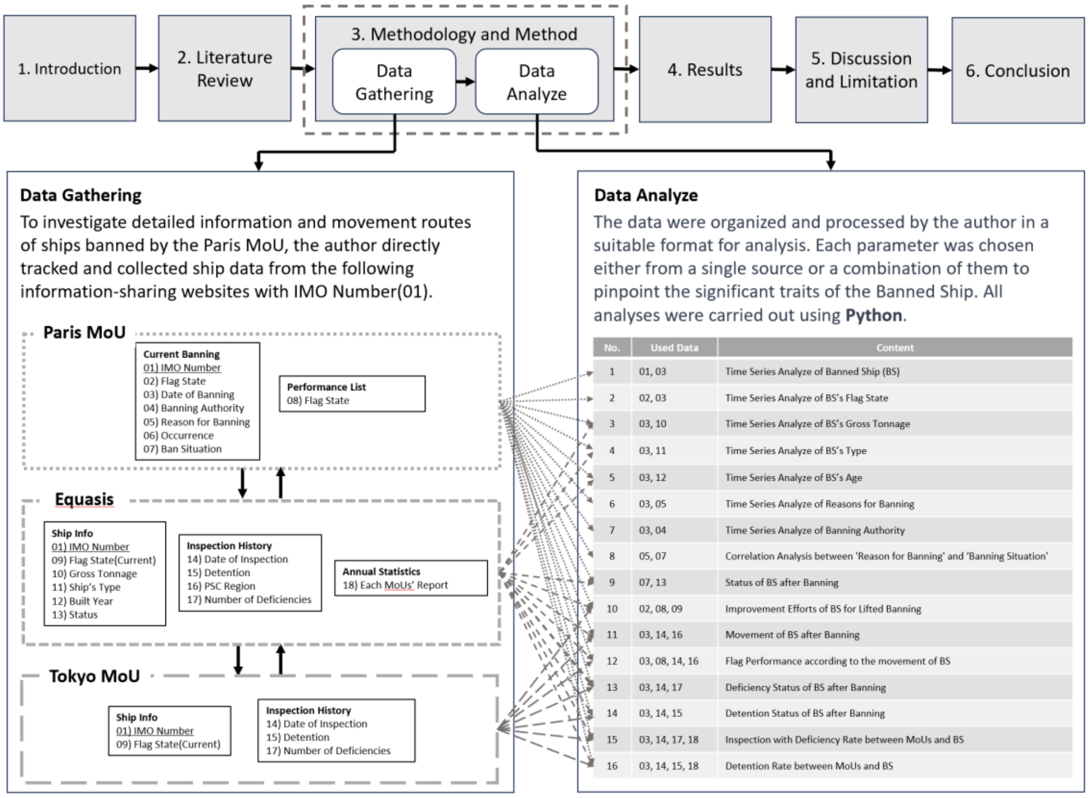
Source: EQUASIS (2021)

Despite the extensive efforts and collaborations within the international community, the disparity between regions persists and is not easily bridged. However, the plethora of scholarly papers on improvements and harmonization within this field indicates that ample opportunities for refinement remain, sending a positive signal. While the study and analysis of various theories for the enhancement of PSC regulations and policies are undoubtedly crucial, there is an equally pressing need to accurately identify and address the challenges arising from the existing differences. Concurrently, it is essential to raise awareness of these issues.

Chapter 3 Research Methodology

The purpose of this study is to ascertain information about substandard ships banned by a specific MoU and to explore their potential influence on other MoUs. To conduct this research, data was tracked and collected from various ship information systems, and Python programming was employed for analysis. To achieve this, the following research design in Figure 2 was established.

Figure 2: Research Design



3.1 Structure of the Dissertation

The thesis consists of six chapters: Introduction, Literature Review, Research Methodology, Results, Discussion, and Conclusion.

Chapter 1, "Introduction," provides the background for the issues surrounding PSC and regional MoUs. It describes the problems arising from differences in inspection standards and practices between regions. The rationale for this study is presented, along with the research objectives and goals.

Chapter 2, "Literature Review," focuses on understanding and discussing the problems of PSC and regional agreements by providing historical context and reviewing relevant literature. It introduces the significance and concept of PSC and examines the growth process and inspection systems of regional agreements. The chapter also reviews literature related to ship inspections proposed for harmonized activities and the disparities within regional agreements.

Chapter 3, "Research Methodology," introduces the methodology and data collection methods used in the study. It describes the use of the Python programming language for statistical analysis and provides an explanation of the key statistical techniques and analysis tools employed. Additionally, it includes the definition and explanation of variables and measurement indicators used in the research. This chapter plays a crucial role in ensuring the reliability and validity of the study.

Chapter 4, "Results of Analysis," presents the findings obtained through the methods employed in Chapter 3. It provides a detailed explanation and includes statistical analysis results and graphs generated using Python. The research findings offer specific information on expelled ships and their movement patterns, which assist in identifying potential solutions to the identified problems.

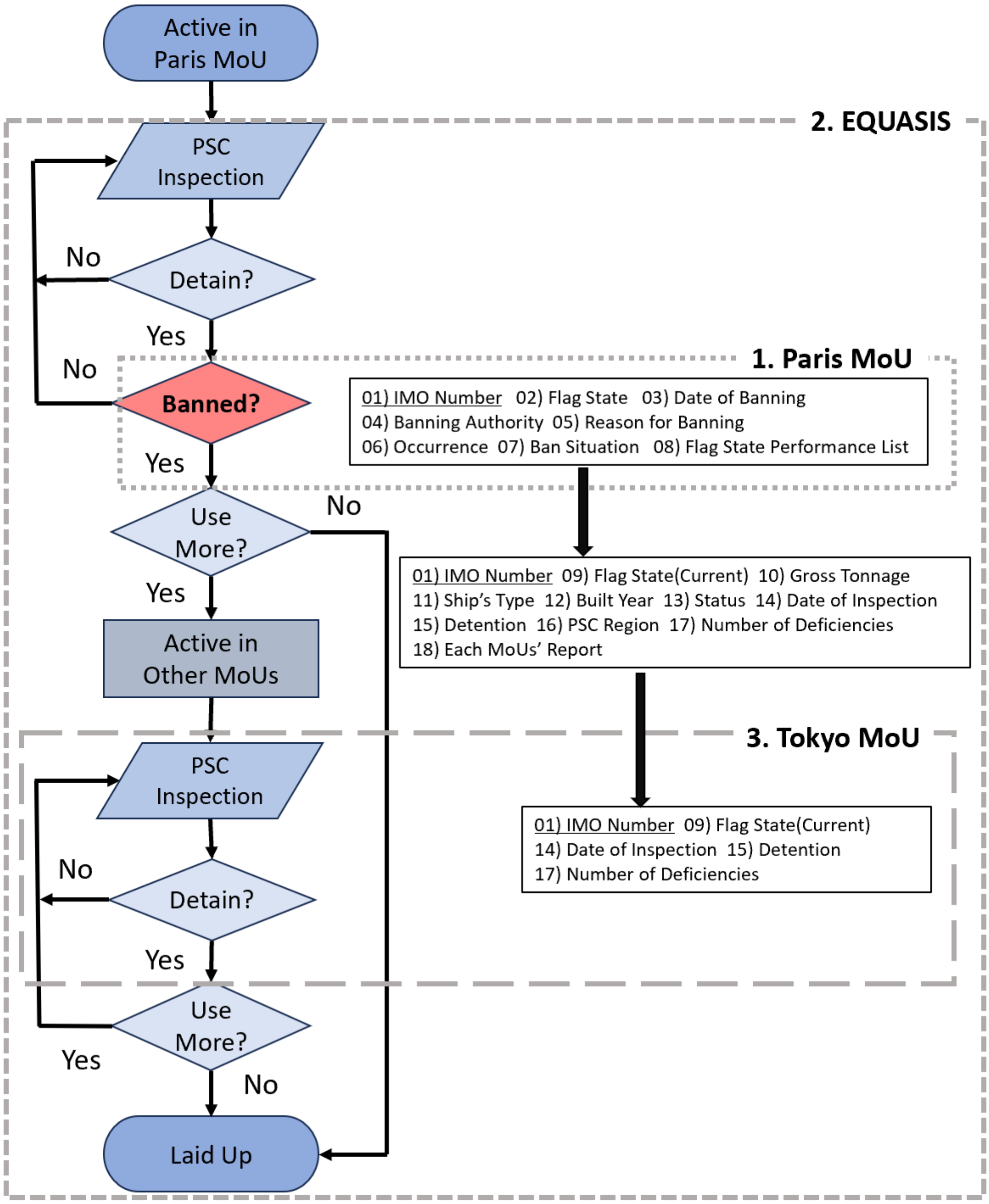
Chapter 5, "Discussion and Limitations," provides a discussion and interpretation of the research findings. It analyses the obtained results in comparison to theoretical aspects and research objectives and research goals. This chapter also discusses the significance and limitations of the results and provides suggestions for future research directions.

Chapter 6, "Conclusion," presents a summary and conclusion of the research. It evaluates the achievement of research objectives and provides a concise summary of the key conclusions and research outcomes. Additionally, it emphasizes the need for further research based on the limitations and proposed directions. This chapter delivers a succinct overview of the overall significance and outcomes of the research to the readers.

3.2 Data and Sources

The data for analysis was collected using the Banning List provided by the official website of the Paris MoU, along with ship information from the EQUASIS and Tokyo MoU's PSC databases. Initially, a total of 427 cases of entry bans implemented between November 28, 1996, and July 1, 2023, were identified from the Paris MoU. Basic information and reasons for the bans for these ships were collected from the same website. Subsequently, the unique ship identification numbers (IMO numbers) obtained from this list were used as identifiers to retrieve information about the ships' movements and inspection history from the EQUASIS database. Additionally, the ship inspection history within the Asia-Pacific region was further examined in greater detail using the Tokyo MoU's PSC database. The flow of information obtained from each database system, based on the ships' movement paths, is illustrated in Figure 3:

Figure 3: Flow Chart of Movement of Ship and Source of Data



3.3 Data Analysis Method

The ship-related data collected from various information sharing websites were stored and processed in Excel format before being analysed using Python. Python is an efficient programming language widely used for data analysis and statistical analysis, as well as visualization, machine learning, and other fields. Despite its relatively short history, this analysis tool has rapidly grown within the scientific and engineering communities, becoming practically a standard for computation-intensive scientific research (Millman & Aivazis, 2011). Vallat (2018) attributed Python's rapid growth worldwide to its user-friendly nature, quick learning curve, and the abundance of high-quality packages for data science and machine learning.

In this study, for data analysis and visualization, the following four analysis packages in table 5 were utilized: 'Pandas,' a library specialized in data processing and analysis, providing a data structure called Data Frame for handling tabular data with rows and columns. It is primarily used for reading, manipulating, and storing various data sources such as CSV, Excel, and SQL. 'NumPy,' a core library for numerical computations in Python, supports multidimensional arrays and matrix operations. When mathematical operations are required, NumPy arrays efficiently handle processing. 'Matplotlib,' a library for data visualization, is mainly used for creating 2D graphs. It supports various types of graphs such as line plots, scatter plots, and bar graphs. Matplotlib allows for quick and easy visualization of data patterns and distributions. 'Seaborn,' built upon Matplotlib, is specialized in creating statistical graphs, with well-defined default themes and styles that enable simpler and aesthetically pleasing visualizations.

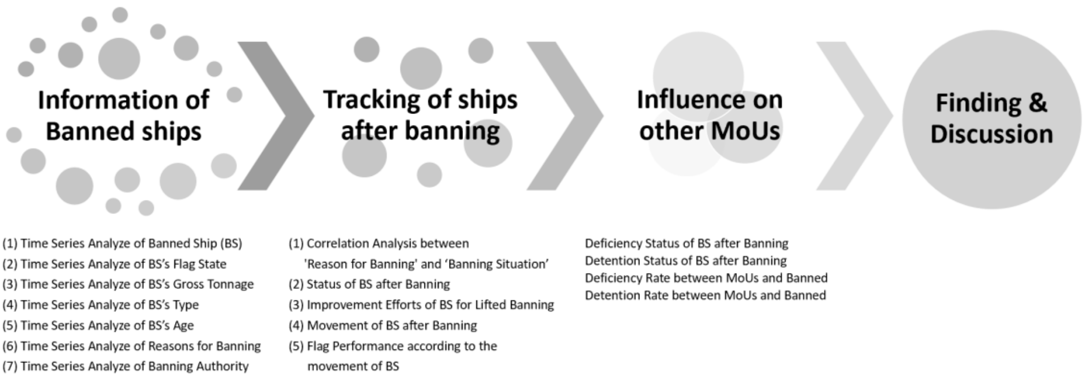
Table 5: Analyse Tool and Library

Python Library	Pandas – Processing and analysis of data in a tabular form with rows and columns.
	NumPy – Numerical computation supporting multi-dimensional arrays and matrix operations.
	Matplotlib – Data visualization including line plots, bar charts, scatter plots, etc.
	Seaborn – Specialization in statistical graphs based on Matplotlib.

3.4 Data Analysis

By applying above libraries, the data was analysed and categorized into three distinct categories based on characteristics: ‘Information of Banned Ships’, ‘Tracking of Ships after Banning, and ‘Influence on Other MoUs’. As specified in figure 4, the subsequent subsections provide detailed explanations on the criteria by which the data was analysed and the manner in which it was presented.

Figure 4: Analysis Sequences



3.4.1 Information of Banned Ships

(1) Time Series Analysis of Banned Ship (BS):

This graph displays the number of banned ship entries in Paris MoU ports. The X-axis represents the years from 1996 to 2023, spanning a total of 28 years, while the Y-axis indicates the frequency of occurrences. This graph allows for tracking the annual count and trends of banned ship entries.

(2) Time Series Analysis of BS’s Flag State:

This graph illustrates the flag state and performance indicators of ships banned from entering Paris MoU ports. The X-axis covers the years from 1996 to 2023, a span of 28 years, while the Y-axis represents the frequency of occurrences. The flag state performance indicators are categorized into 'White,' 'Grey,' 'Black,' and 'Not

Identified,' and are shown as a cumulative graph. This provides insight into the distribution and changes in flag state performance indicators of the banned ships.

(3) Time Series Analysis of BS's Gross Tonnage:

This graph showcases the total gross tonnage of ships banned from entering Paris MoU ports. The X-axis spans from 1996 to 2023, covering 28 years, and the Y-axis represents the magnitude of tonnage. Each red dot represents one ship, and the black line represents a linear regression line for all data points. The graph helps in understanding the distribution and trends in the total gross tonnage of the banned ships.

(4) Time Series Analysis of BS's Type:

This graph displays the types of ships banned from entering Paris MoU ports. The X-axis covers the years from 1996 to 2023, spanning 28 years, while the Y-axis indicates the frequency of occurrences. Considering the diversity of ship types, the top 5 most common types are categorized, and the rest are labelled as 'Other.' The graph offers insight into the distribution and trends in ship types of the banned vessels.

(5) Time Series Analysis of BS's Age:

This graph presents the age of ships banned from entering Paris MoU ports. The X-axis covers the years from 1996 to 2023, spanning 28 years, while the Y-axis represents the numerical values. Similar to previous graphs, each red dot signifies one ship, and the black line represents a linear regression line for all data points. The graph helps understand the distribution and trends in the age of the banned ships.

(6) Time Series Analysis of Reasons for Banning:

This graph reveals the reasons for banning ships from entering Paris MoU ports. The X-axis spans from 1996 to 2023, covering 28 years, and the Y-axis represents the frequency of occurrences. The reasons are categorized as 'Failed to call,' 'Multiple detentions,' 'Jumped detention,' and 'No valid ISM.' The graph allows for understanding the distribution and trends in reasons for banning.

(7) Time Series Analysis of Banning Authority:

This graph displays the countries that have banned ships from entering Paris MoU ports. The X-axis spans from 1996 to 2023, covering 28 years, and the Y-axis represents the frequency of occurrences. Similar to ship types, the top 5 most common countries are categorized, and the rest are labelled as 'Other.' The graph provides insights into the distribution and trends of the banning countries.

3.4.2 Tracking of Ships after Banning

(1) Correlation Analysis between 'Reason for Banning' and 'Banning Situation':

This graph illustrates the correlation between the reason for banning and the current banning situation (validated or lifted). The X-axis represents the banning situation, while the Y-axis represents the reasons (4 categories). The graph helps in understanding how different reasons for banning are correlated with the current situation.

(2) Status of BS after Banning:

This graph presents the correlation between the current banning situation (validated or lifted) and the current operational status of the ships. The X-axis represents the banning situation, and the Y-axis represents whether the ship is currently operational. The graph shows how many banned ships are still operating and whether they have lifted the ban even after being scrapped.

(3) Improvement Efforts of BS for Lifted Banning:

This graph illustrates the change in flag state performance indicators from the time of banning to the current or last recorded flag state indicators. The X-axis represents the flag state performance indicators, while the Y-axis represents the number of ships. The graph helps understand the efforts made by the ships to improve their indicators and lift the ban.

(4) Inspection History of BS after Banning (Including/Excluding Paris MoU):

These two graphs depict the inspection history of ships after their expulsion, both inclusive and exclusive of the Paris MoU. This paper investigates the impact of banned ships in regions excluding the Paris MoU. Therefore, subsequent analyses are based on the inspection histories outside of the Paris MoU after the ban. The X-axis represents a span of 28 years, from 1996 to 2023, while the Y-axis indicates the frequency of occurrences. Through the annual inspection records of the expelled ships, one can discern the primary regions these ships migrate to.

(5) Flag Performance according to the movement of BS:

This graph shows the flag state performance indicators of banned ships based on inspection history in other MoUs. The X-axis spans from 1999 to 2023.

3.4.3 Influence on Other MoUs

Deficiency Status of BS after Banning:

This graph provides insight into the deficiency status of banned ships based on their inspection history in other MoUs. The X-axis spans from 1999 to 2023, covering a total of 24 years, while the Y-axis represents the frequency of occurrences. The graph shows the yearly inspection history of banned ships, indicating their deficiency status. This allows for understanding the management status of these ships after the ban.

Detention Status of BS after Banning:

This graph illustrates the occurrence of ships' departure prohibitions based on their inspection history in other MoUs. The X-axis spans from 1999 to 2023, covering a total of 24 years, while the Y-axis represents the frequency of occurrences. By representing the inspection history of banned ships in terms of departure prohibitions, the graph indicates how well or poorly these ships are managed after the ban.

Deficiency Rate between MoUs and Banned:

This graph showcases the deficiency rate of banned ships after inspections in Paris MoU and compares it to the average deficiency rate of the MoUs where these ships are active. The X-axis spans from 1999 to 2022, covering 23 years, while the Y-axis represents percentiles. The graph enables a comparison between the deficiency rates of banned ships in Paris MoU inspections and the average deficiency rates in their operational MoUs, highlighting the impact of banned ships on other MoUs.

Detention Rate between MoUs and Banned:

This graph displays the detention rate of banned ships after inspections in Paris MoU and compares it to the average detention rate of the MoUs where these ships are active. The X-axis spans from 1999 to 2022, covering 23 years, while the Y-axis represents percentiles. Similar to the previous graph, this one compares the detention rates of banned ships in Paris MoU inspections with the average detention rates in their operational MoUs, shedding light on their impact on other MoUs.

As illustrated in figure 4, these graphs elucidate the issues associated with the PSC regional agreements highlighted in Ch.1 and 2. Ch.4 delves into these concerns, while Ch.5 interprets the underlying significance of the data and contemplates prospective research directions.

Chapter 4 Results of Analysis

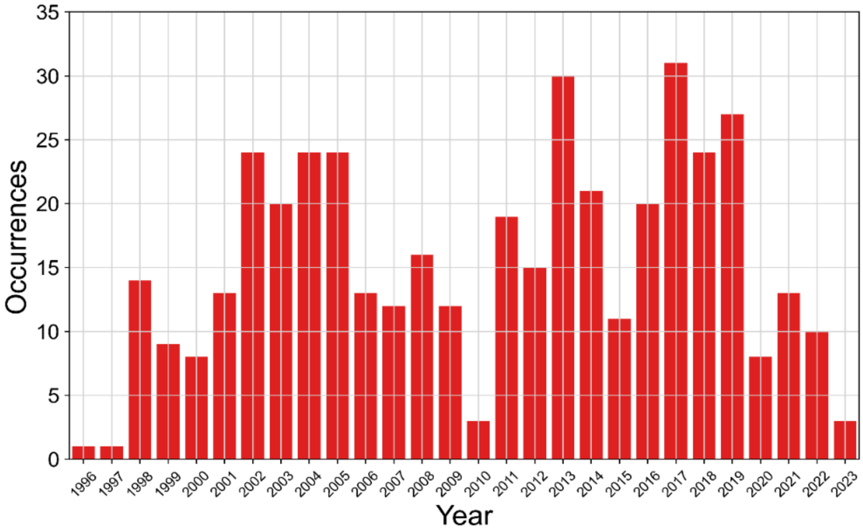
The process of data acquisition, preprocessing, and analysis required for the completion of this paper spanned over the course of one month. The data acquisition phase for this study was conducted over a two-week period from July 1st, 2023, to July 15th, 2023. During this period, the necessary data was collected and organized, followed by data preprocessing to ensure its suitability for Python-based analysis. Proficiency in data analysis techniques using the Python programming language was then acquired, and the subsequent analysis was conducted. This entire process extended for an additional two weeks.

4.1 Information of Banned Ships

Time Series Analysis of Banned Ship

The figure 5 delineates the occurrences of a BS from the year 1996 to 2023. In 1996 and 1997, there was a singular occurrence each year, denoting a low level of activity. The occurrences started to escalate from 1998, reaching 14 occurrences, an abrupt increase from the previous years. By 2002, the number had risen to 24, which was the highest figure until that date. This high of 24 occurrences was replicated in 2004 and 2005, suggesting a consistent period of heightened activity. The lowest point after the initial rise was in 2010, with just three occurrences, a significant drop when compared to preceding years. However, the occurrences once again amplified, peaking at 31 in 2017, the highest throughout the observed period. This peak was not sustained, as by 2020, the occurrences declined to eight, mirroring numbers close to those of 2000. A slight rebound happened in the subsequent years, reaching 13 and 10 in 2021 and 2022 respectively. Yet, as of 2023, the occurrences descended again to the low figure of three, equating the count of 2010. Over the span of 28 years, there have been fluctuations with both steep ascents and descents. The data points oscillate, with no discernible continuous growth or decline throughout the entire timeframe. From a broad perspective, the occurrences peaked around mid-2010s, especially in 2017. Post this year, there seems to be a declining trend, albeit with minor recoveries in between. The total number of occurrences over this period sums up to 396, with an average of about 14.14 occurrences annually.

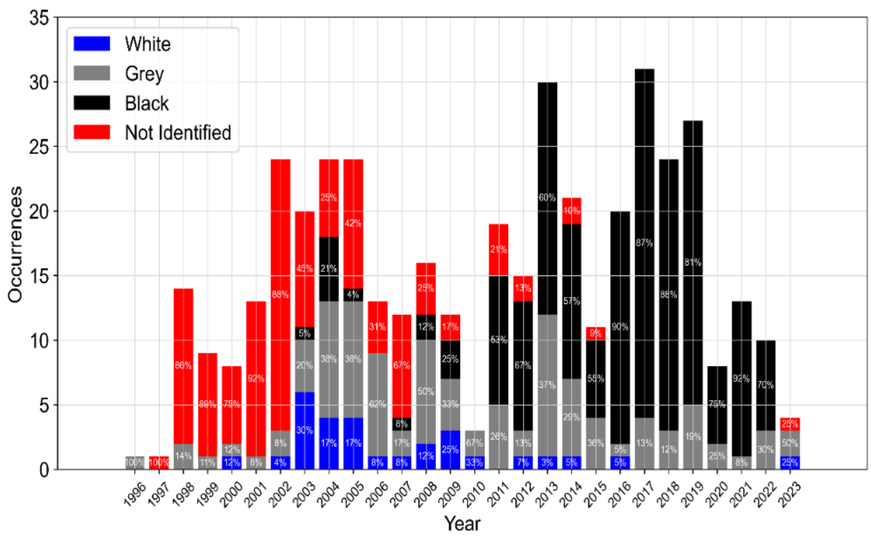
Figure 5: Time Series Analysis of Banned Ship



Time Series Analyse of Banned Ship's Flag State

The figure 6 displays the occurrences of different Flag State's performance categories - White, Grey, Black, and Not Identified - spanning from 1996 to 2023. In 1996, 100% of occurrences were categorized as Grey, while in 1997, 100% were categorized as Not Identified. The subsequent years, from 1998 to 2000, saw the majority of occurrences dominated by the Not Identified category, contributing between 75% to 88.9%. In 2001, the percentage of occurrences in this category increased further to 92.3%. However, 2003 marked a diversification in occurrences, where the distribution was 30% White, 20% Grey, 5% Black, and 45% Not Identified. In 2004, the distribution changed with the Grey category taking the lead at 37.5% and the Black category, for the first time, representing a significant portion at 20.8%. By 2010, both the White and Grey categories recorded a 33.3% occurrence, with the Not Identified category dropping to 0%. This trend was temporary as, in 2011, the Black category emerged as a dominant colour with 52.6%, and this dominance continued through the 2010s, often surpassing 60%. Notably, from 2016 to 2021, the Black category displayed an overwhelming dominance, reaching as high as 92.3% in 2021. In contrast, during these years, the White category consistently remained at a low, even recording 0% in many of the years. The Grey category, after its peak in the mid-2000s, also remained relatively lower, with occasional spikes like in 2020, where it represented 25% of occurrences. In 2023, there was a more even distribution among the categories with 25% White, 50% Grey, and 25% Not Identified, with Black recording 0% for that year. Throughout this period, the Not Identified category displayed significant fluctuations, starting from dominance in the late 1990s and early 2000s to minimal or no representation in many years of the 2010s and 2020s. Over the entire period, it's evident that each category had periods of dominance, with the Black category being the most dominant in the later years.

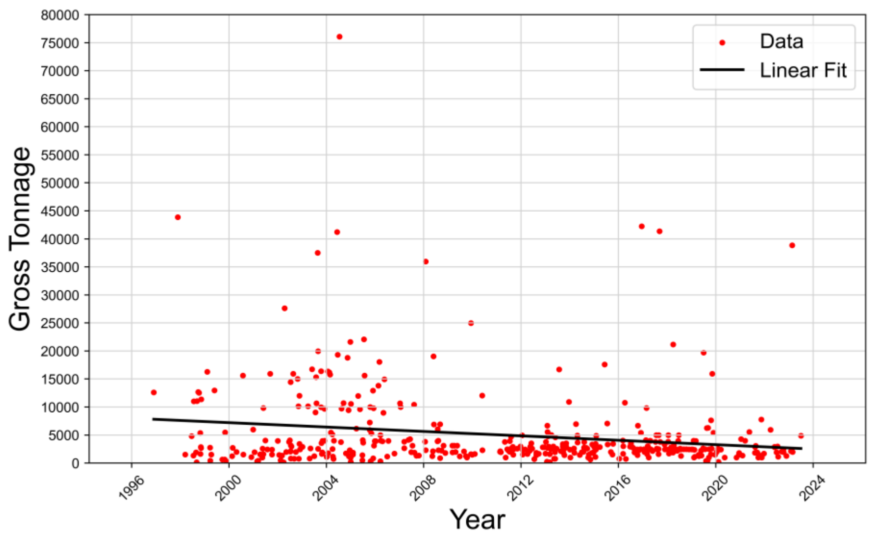
Figure 6: Time Series Analysis of Banned Ship's Flag State



Time Series Analysis of Banned Ship's Gross Tonnage

The figure 7 chronicles data from 1996 to 2023, categorizing values within specified numerical brackets ranging from 0-4999 up to 75000-79999. A broad observation reveals a dominant clustering within the 0-4999 bracket across the years, while the higher ranges, particularly those beyond 40000, are sparsely populated. Starting in 1996, there is limited activity with sporadic appearances in only a few categories. By 1998, the data becomes more diversified with 8 instances in the 0-4999 range, an indication of growing frequency. The period from 1999 to 2007 consistently shows the 0-4999 bracket leading in occurrences, suggesting a steady trend. A significant uptick is noticed in 2011, with the 0-4999 category reaching 19 occurrences, the highest until then. This momentum continues, with 2013 marking another high at 25 instances. Conversely, the years 2010 and 2023 display noticeable dips in the 0-4999 category, with only 2 and 3 entries respectively. The mid and late 2000s reflect a consistent behaviour, with the 0-4999 range persistently leading and occasional entries in the next two or three immediate categories. The higher numerical categories, notably those starting from 50000, remained virtually untouched throughout the observed years. In essence, while the majority of the data gravitates towards the 0-4999 range, other categories, especially those beyond 40000, have minimal to no occurrences. This distribution pattern suggests a consistent concentration in the initial range, with only infrequent divergences into the higher categories over the 28-year span.

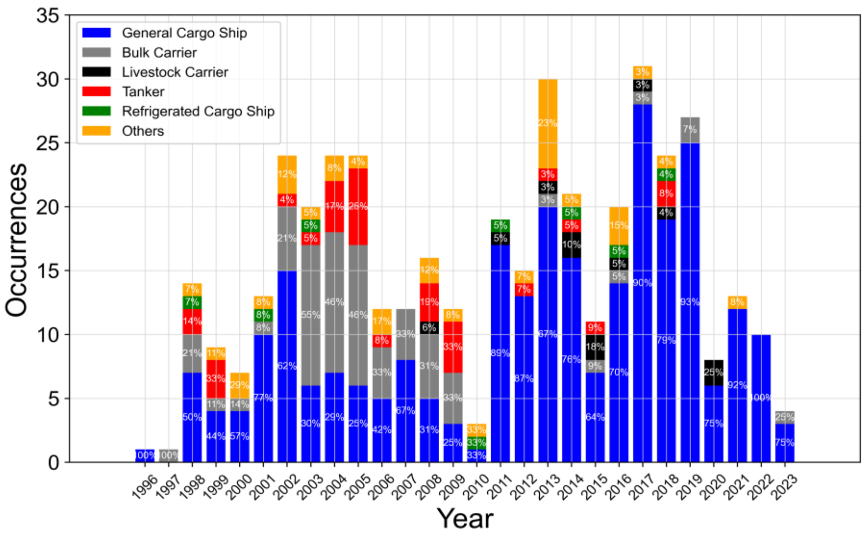
Figure 7: Time Series Analysis of Banned Ship's Gross Tonnage



Time Series Analysis of BS’s Type

The figure 8 presents a distribution of various ship types, specifically General Cargo, Bulk Carrier, Livestock Carrier, Tanker, Refrigerated Cargo, and Other, spanning from 1996 to 2023. Beginning with the General Cargo category, the data highlights a notable dominance in 1996, 2011, 2017, 2019, 2021, and 2022, with percentages ranging from 89.47% to 100%. The years 1997 and 2003 reveal the highest concentrations for Bulk Carrier at 100% and 55% respectively. While Livestock Carrier sees sparse data entries throughout, 2015 marks its peak at 18.18%. The Tanker category, on the other hand, fluctuates over the years but displays its strongest presence in 1999 and 2009, both at 33.33%. Refrigerated Cargo makes occasional appearances in the dataset, the earliest in 1998 at 7.14%, and notably in 2010 and 2018 both at 33.33% and 4.17% respectively. The "Other" category shows varied percentages across the years, with a significant spike in 2013 at 23.33%.

Figure 8: Time Series Analysis of Banned Ship’s Type



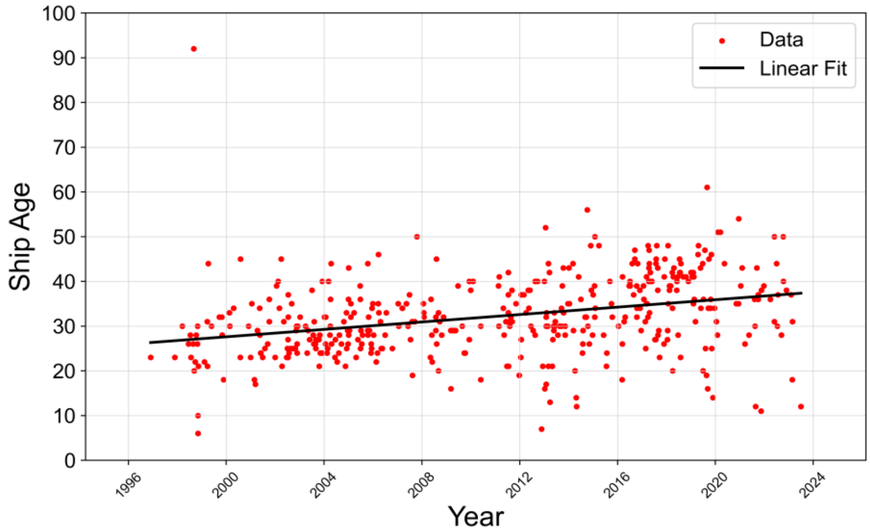
Furthermore, certain years like 2001, 2013, 2014, 2015, 2016, and 2017 feature values spread across multiple ship types, indicating a diversified distribution for those specific years. Conversely, years such as 1996, 1997, 2007, 2019, 2021, and 2022 reveal a more concentrated value within a single category, predominantly the General

Cargo, reaching up to 100%. In 2023, a shift is observed with 75% for General Cargo and 25% for Bulk Carrier, making it the only year after 2009 where Bulk Carrier exceeds 10%. Lastly, throughout the entire span of the dataset, Livestock Carrier never crosses the 25% mark, and in several years, some categories, like Livestock Carrier in 2022 and Refrigerated Cargo in 2016, have a complete absence, registering at 0%.

Time Series Analysis of Banned Ship's Age

The figure 9 depicts data spanning from 1996 to 2023, categorizing frequencies into ten age ranges, from 0-10 up to 91-100. The 21-30 range manifests the highest frequencies for most of the years, with notable peaks in 1998 with 9 occurrences, 2002 and 2005 both with 14, and 2003 and 2004 each recording 15. The subsequent age bracket, 31-40, also exhibits significant frequencies, particularly in 2011 with 13 occurrences, followed closely by 2013 with 15. Years such as 1996 and 1997 had a mere single entry in the 21-30 range and none elsewhere. The 41-50 range began gaining prominence from 2017 onwards, with 2017 showcasing 16 occurrences, 2018 with 13, and 2019 with 11. The 11-20 age range generally maintains a low count throughout the years, but the year 2013 is an exception, recording 3 occurrences. The 51-60 range remains mostly dormant until 2020, where it registers 3 occurrences, a number that is maintained in 2022. For the age ranges 61-70, 71-80, 81-90, and 91-100, the table shows minimal to no activity throughout the span of years, with a singular exception in 2019 for the 61-70 bracket, noting 1 occurrence. 2010 seems to be the year with the lowest total occurrences across all age ranges, having its highest in the 31-40 range with just one. Conversely, 2013 can be viewed as one of the years with a wider distribution, with occurrences in the 0-10 through to the 51-60 brackets, and a total count higher than many of the surrounding years. It's also noteworthy that by 2023, the occurrences have reduced substantially, with only the 11-20 and 31-40 ranges recording 2 entries each.

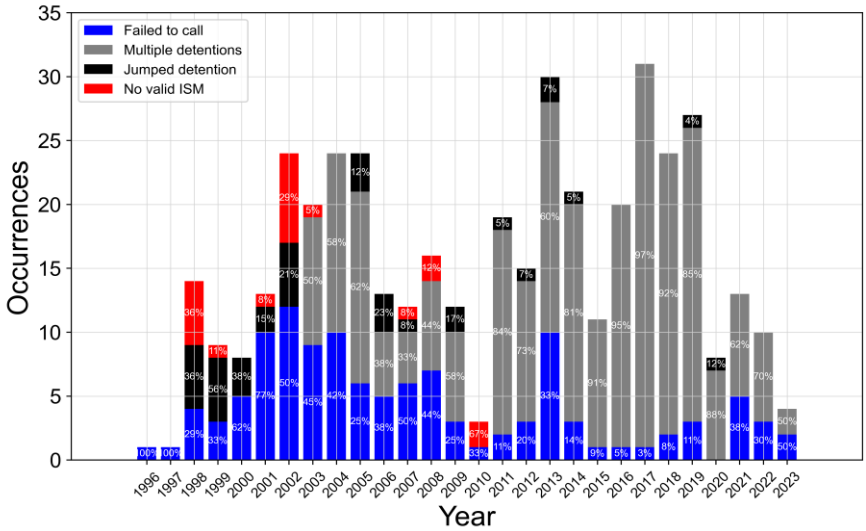
Figure 9: Time Series Analysis of Banned Ship's Age



Time Series Analysis of Reasons for Banning

The figure 10 represents a comprehensive breakdown of the reasons for vessel detentions under the Paris MoU over an extensive period, starting from 1996 to 2023. Ignoring the initial years of 1996 and 1997 due to sparse data, several evident trends emerge. From 1998 to 2023, there was a notable fluctuation in the "Failed to Call" category. The highest count was in 2002, with 12 incidents, while 2020 saw no such incidents. When observed in percentages, 1996 and 1997 both stood at a 100% rate, highlighting the fact that while the number of incidents was low, every incident in those years fell under this category. The "Multiple detentions" category witnessed a dramatic rise, especially from the mid-2000s onwards. In 2017, a staggering 96.77% of the detentions were attributed to this reason. The trend indicated a systemic issue with multiple detentions becoming a more prevalent cause for concern as the years progressed. Interestingly, the "Jumped detention" category was not a widespread cause for detentions. Peaks were observed in 1999 and 2013, with a majority of other years having minimal to zero cases. This suggests that skipping detentions wasn't a chronic problem across the years. Lastly, the "No valid ISM" category started with a significant spike in 1998 but saw a steady decline in later years, particularly after 2002. The data from 2015 onwards indicates almost a complete eradication of this issue. In conclusion, the table paints a nuanced picture of the challenges and trends associated with vessel detentions in the Paris MoU over a span of 27 years. The insights derived can serve as an invaluable resource for stakeholders in maritime affairs.

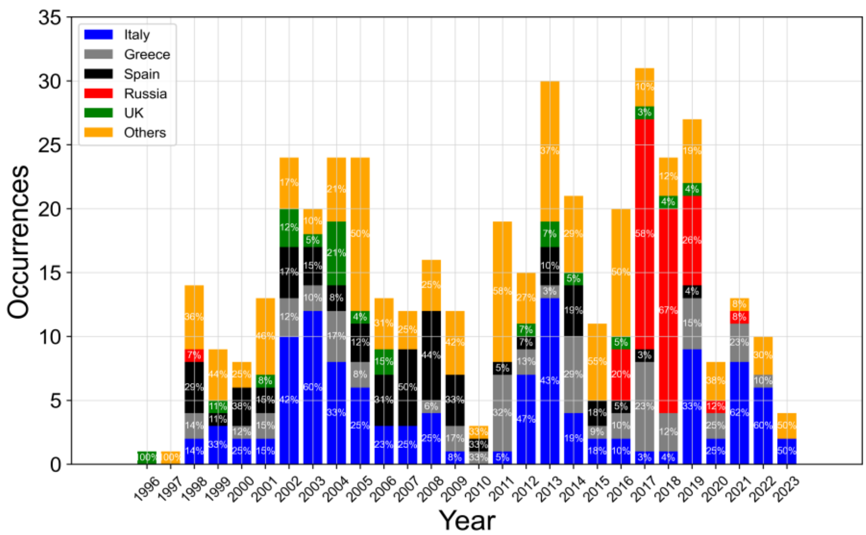
Figure 10: Time Series Analysis of Reasons for Banning



Time Series Analysis of Banning Authority

The figure 11 illustrates the annual contributions of several countries, namely Italy, Greece, Spain, Russia, the UK, and a category termed "Others" from the year 1996 to 2023. In 1996, the UK was the sole contributor with 100%, while every other country and the "Others" category recorded zero contributions. This dominance by the UK was short-lived, as by 1997, it dropped to zero, and the "Others" category took up the entirety of the contribution at 100%. From 1998 onwards, multiple countries began to contribute, with Spain leading at 29% that year, closely followed by Italy and Greece both at 14%, Russia at 7%, and the "Others" category having 36%. Italy witnessed its highest percentage contribution in 2021 at 62%, although it has fluctuated over the years. Greece's contributions varied, with its peak in 2011 at 32%. Spain’s contributions have also been inconsistent, its highest being 50% in 2007. Russia's contribution remained at 0% until 2016, after which there was a significant rise, peaking at 67% in 2018, marking the highest contribution percentage for Russia across all years. The UK's contributions after 1996 were sporadic, never surpassing the 11% mark recorded in 1999. The "Others" category, which could represent a combination of other countries or entities, saw significant variability throughout the years. It reached its highest contribution in 2011, accounting for 58%. Throughout the given period, no single country or the "Others" category consistently dominated in terms of percentage contributions. Each entity had times of both increased and decreased contributions, displaying a lack of a consistent leading contributor over the near three-decade span.

Figure 11: Time Series Analysis of Banning Authority

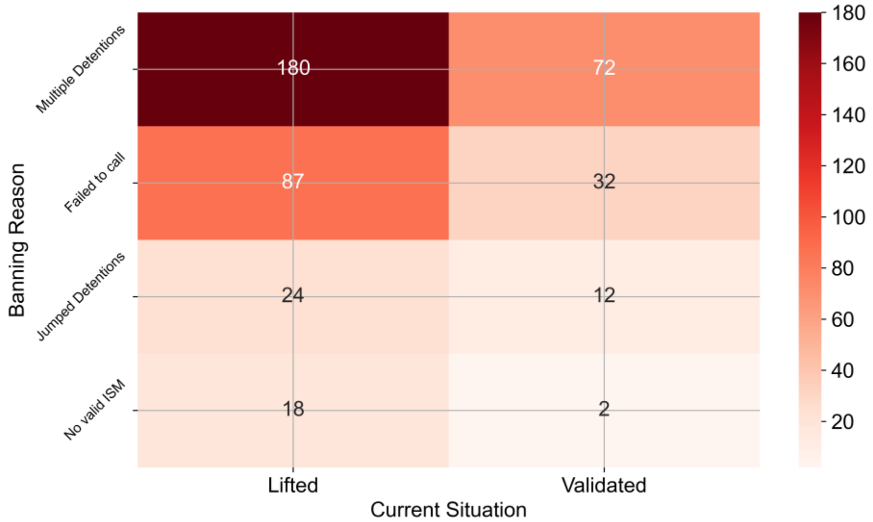


4.2 Tracking of the Ships after Banning

Correlation Analysis between 'Reason for Banning' and 'Banning Situation'

The figure 12 provides a breakdown of ships that have been prohibited from entry by the Paris MoU, categorized by the specific reason for their prohibition and their current status—either "Lifted" or "Validated." In total, 427 ships are detailed in the table. Of these, the most common reason for prohibition is "Multiple Detentions," accounting for 252 ships or approximately 59% of the total number. Out of the ships under this category, 180 have had their prohibitions lifted, while 72 remain validated. The second most prevalent cause is "Failed to call," encompassing 119 ships or about 28% of the total. From these, 87 ships have seen their prohibitions lifted, with the remaining 32 still being validated. The "Jumped Detentions" category includes 36 ships, making up around 8.4% of the overall number. 24 out of these have had their restrictions lifted, and 12 remain validated. The least common reason, "No valid ISM," represents 20 ships, which is roughly 4.7% of the total. Out of these, a significant majority, 18 ships, have had their bans lifted, leaving only 2 with validated restrictions. When we look at the overall status of all ships regardless of the reason, 309 ships or about 72.4% have had their prohibitions lifted, while 118 or approximately 27.6% are still under validated restrictions. In essence, this table offers a comprehensive overview of the prohibition status of ships by the Paris MoU, further dissected based on the particular cause for the ban.

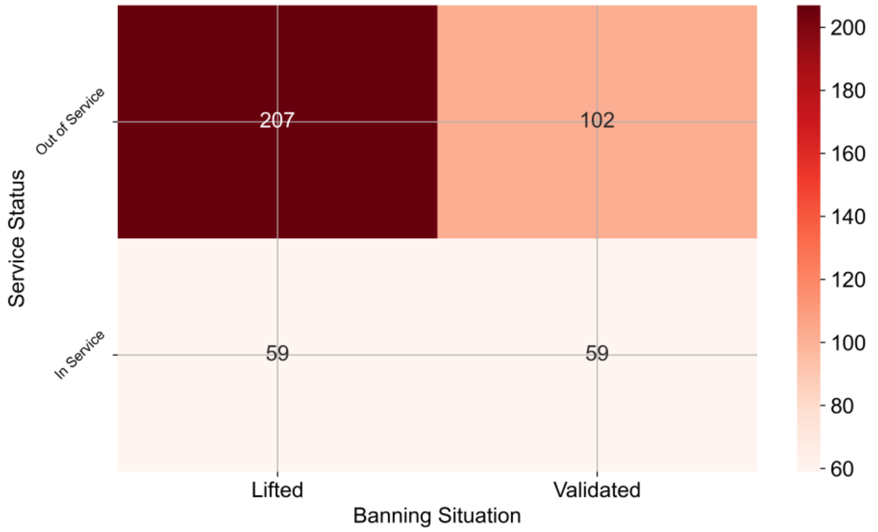
Figure 12: Correlation Analysis between 'Reason for Banning' and 'Banning Situation'



Status of Banned Ship after Banning

This figure 13 categorizes vessels that have faced entry bans by the Paris MoU based on the status of their sanctions (either "Lifted" or "Validated") and their operational condition ("Out of Service" or "In Service"). In total, there are 427 vessels listed. Out of these, 309 vessels are "Out of Service." Among the "Out of Service" vessels, 207 have had their sanctions lifted, whereas 102 remain validated. This indicates that approximately 67% of the ships that are no longer in operation have seen their bans lifted. The remaining 118 vessels are in the "In Service" category, and interestingly, the number of vessels with lifted and validated sanctions is equal at 59 each, signifying a 50% distribution for both lifted and validated sanctions among operating vessels. When we examine the aggregate data, 266 out of 427 vessels, or about 62.3%, have had their sanctions lifted. On the other hand, 161 vessels, approximately 37.7%, still have validated sanctions. This data suggests that a larger portion of vessels, irrespective of their operational status, have had their bans lifted compared to those whose sanctions remain in effect. The most prominent distinction between the two operational categories is that while "In Service" vessels have an equal distribution between lifted and validated sanctions, the "Out of Service" vessels have a higher proportion of lifted sanctions than validated ones. In essence, the table provides a comprehensive breakdown of vessels' operational status concerning the current condition of their Paris MoU sanctions.

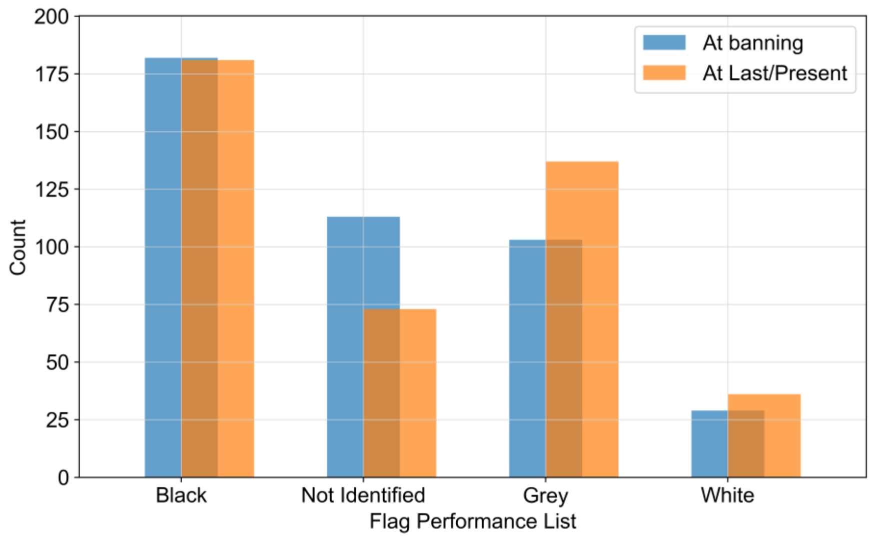
Figure 13: Status of Banned Ship after Banning



Improvement Efforts of BS for Lifted Banning

The figure 14 illustrates the Flag State Performance of vessels banned by Paris MoU, divided into four categories: Black, Grey, Not Identified, and White. It juxtaposes the numbers at the time of the ban ("At banning") against the most recent or last recorded figures ("At Last/Present"). A total of 427 vessels are represented in both columns. Initially, 182 vessels were categorized under the "Black" category, and this number saw a minor decrease to 181 in the latest figures. The "Grey" category observed a substantial increase from 103 vessels during the banning to 137 vessels in the most recent count. Contrarily, the "Not Identified" vessels dropped notably from 113 at the time of the ban to 73 in the present figures. Lastly, vessels in the "White" category showed growth, from 29 initially to 36 in the current data. This table essentially offers a snapshot of how the Flag State Performance of banned vessels has evolved from the time of their banishment to the most recent records.

Figure 14 Improvement Efforts of BS for Lifted Banning



Inspection History of BS after Banning (Including/Excluding Paris MoU)

The figure 15 presented provides an annual breakdown of ship inspections across various Memorandums of Understanding (MoUs) from the years 1998 to 2023. These inspections are specifically for vessels that had been barred from the Paris MoU. Spanning a 25-year period, the accumulated data displays a total of 3,143 ship inspections across the mentioned MoUs. Starting in 1998, only the Paris MoU recorded inspections, totalling 4. This trend continued into 1999 and 2000 with the

Paris MoU accounting for 11 inspections each year. In 1999, the US MoU also joined the fray with 3 inspections. The year 2001 marked a significant rise in the Paris MoU's inspections, reaching 29, accompanied by Tokyo with 3 and the US MoU with 2. 2002 saw a broadening with the Indian Ocean MoU registering 2 inspections while the Paris MoU, Tokyo, and the US MoU tallied 39, 7, and 3 inspections respectively. By 2004, a significant spike is observed with the Paris MoU, which recorded 107 inspections. Concurrently, the Tokyo and the US MoUs posted 23 and 4 inspections, respectively. This upward trajectory persisted, and by 2007, the Paris MoU peaked with 101 inspections, closely trailed by Tokyo's 31 inspections, marking a combined total of 148 inspections that year when including other MoUs. Interestingly, the Mediterranean MoU began its documentation in 2012 with 44 inspections, which saw a consecutive rise over the years, culminating at 84 inspections in 2019. Likewise, the Black Sea MoU made its prominent debut in 2017, registering 65 inspections, and reached its zenith with 82 inspections in 2021. The Caribbean MoU had minimal numbers with single inspections in 2015, 2018, and 2019, while Abuja's most active year was 2021 with 8 inspections. The Vina Del Mar MoU, which began with 3 inspections in 1999, registered a total of 26 inspections over the 25-year period. Notably, 2017 witnessed the highest annual total inspections across MoUs with 221, with significant contributions from the Black Sea, Mediterranean, Paris, and Tokyo MoUs. The subsequent years continued to exhibit fluctuating figures with 2018 and 2019 having 238 and 254 total inspections respectively, whereas 2020 observed a dip with 201 inspections. This trend continued into 2021 and 2022 with 217 and 225 total inspections, but saw a decline in 2023, which registered only 117 inspections. In the grand tally over the 25 years, the Paris MoU overwhelmingly dominated with 1,562 inspections, followed by the Mediterranean MoU at 743, and the Black Sea MoU with 481 inspections. The Tokyo MoU also had a significant count with 229 inspections, while the others, namely Abuja, Caribbean, Indian Ocean, US, and Vina Del Mar MoUs, had comparatively fewer inspections, each registering 22, 5, 49, 26, and 26 inspections respectively. The figure 16 is a graph that omits the Paris MoU data, and subsequent analyses are based on this representation.

Figure 15 Inspection History of BS after Banning (Including Paris MoU)

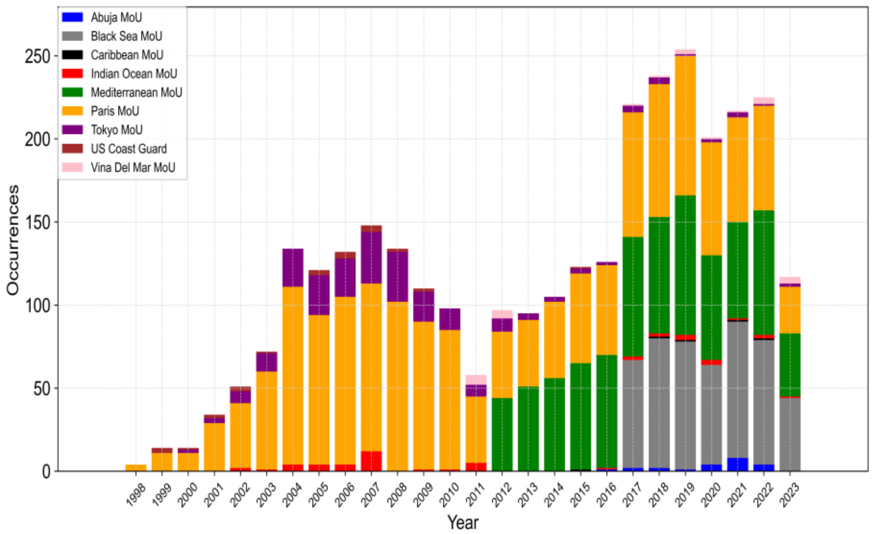
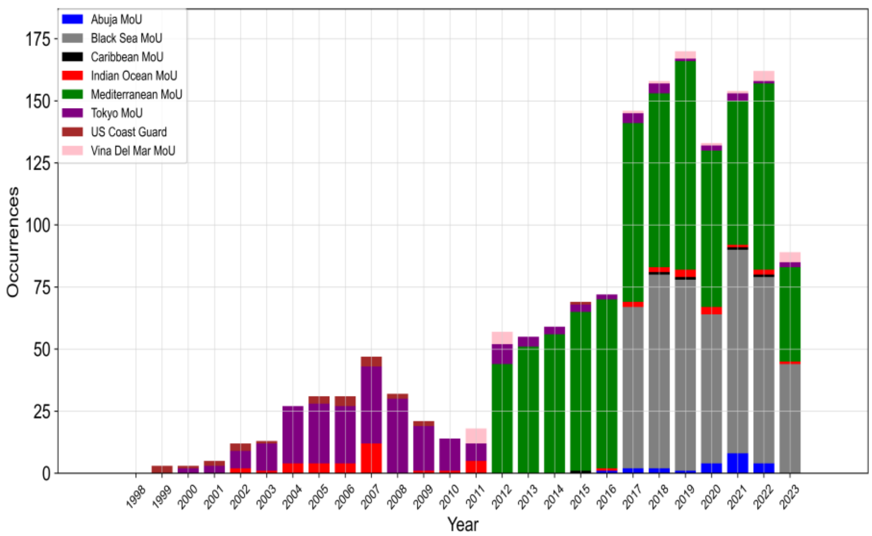


Figure 16 Inspection History of BS after Banning (Excluding Paris MoU)

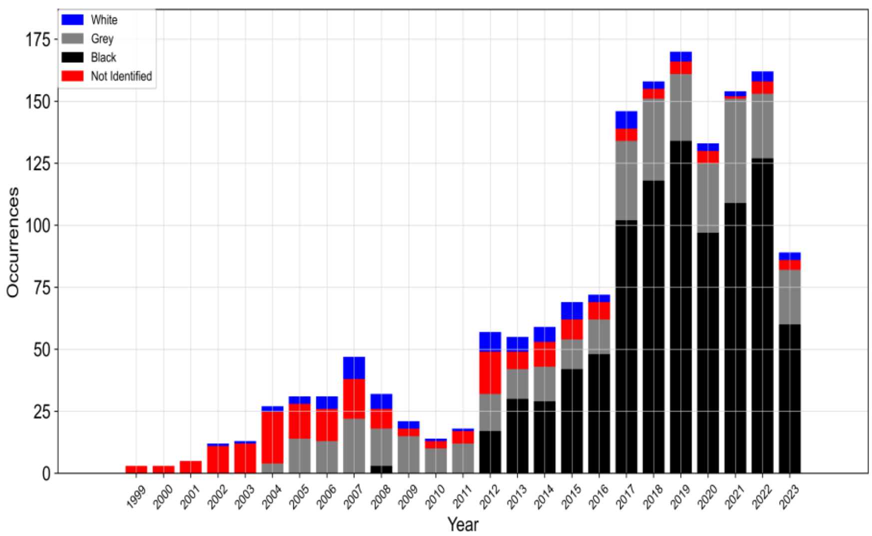


Flag Performance according to the movement of Banned Ship

The figure 17 provides a detailed breakdown of the performance indicators (White, Black, Grey, Not Identified) based on ship inspection records in different MoUs, specifically for ships that were prohibited from entering the Paris MoU, spanning the years 1999 to 2023. Over this 25-year period, a total of 1,581 indicators were recorded.

Beginning in 1999 and extending to 2002, ships were predominantly labelled as 'Not Identified' with counts of 3, 3, 5, and 11, respectively. The year 2002 marks the first appearance of the 'White' classification with a single count, and this classification witnessed a gradual increase reaching up to 9 by 2007. The 'Grey' classification made its debut in 2004 with 4 counts and saw a noticeable increase, particularly from 2005 onwards, where the count was 14 and reached up to 42 by 2021. The 'Black' classification began in 2008 with 3 counts, then dramatically increased year by year, marking a notable peak with 134 in 2019. The highest count for 'Black' was 134 in 2019, for 'Grey' was 42 in 2021, for 'Not Identified' was 21 in 2004, and for 'White' was 9 in 2007. The year 2017 recorded a substantial rise in the 'Black' classification with 102 counts, almost doubling the previous year's 48, and it continued to be over 100 until 2021. By contrast, the 'Not Identified' classification declined over the years, reaching its lowest count of 1 in 2021. In the recent year of 2023, there was a noticeable drop in the 'Black' category to 60, whereas the other categories remained relatively consistent with their previous year's numbers. Cumulatively, over the entire span, 'Black' had the highest total with 916 counts, followed by 'Grey' with 382, 'Not Identified' with 195, and 'White' with 88.

Figure 17 Flag Performance according to the Movement of Banned Ship

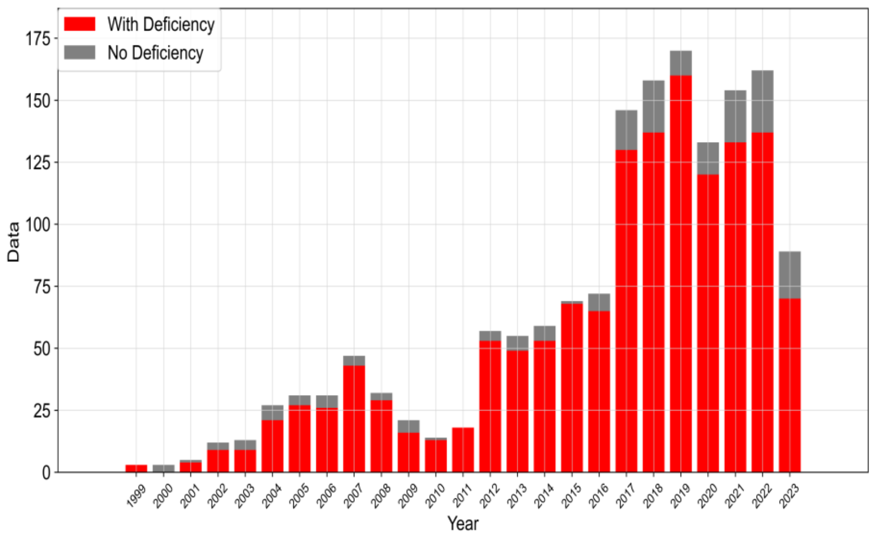


4.3 Influence on Other MoUs

Deficiency Status of Banned Ship after Banning

The figure 18 presents a yearly breakdown, spanning from 1999 to 2023, of vessels that were barred from entry by the Paris MoU and subsequently inspected under different MoUs. The data specifically divides the inspected vessels into two categories: those with deficiencies (With Deficiency) and those without deficiencies (Without Deficiency). Over this 25-year period, a total of 1,581 inspections were conducted, with 1,393 of them resulting in vessels having deficiencies and 188 inspections concluding without any deficiencies.

Figure 18 Deficiency Status of Banned Ship after Banning

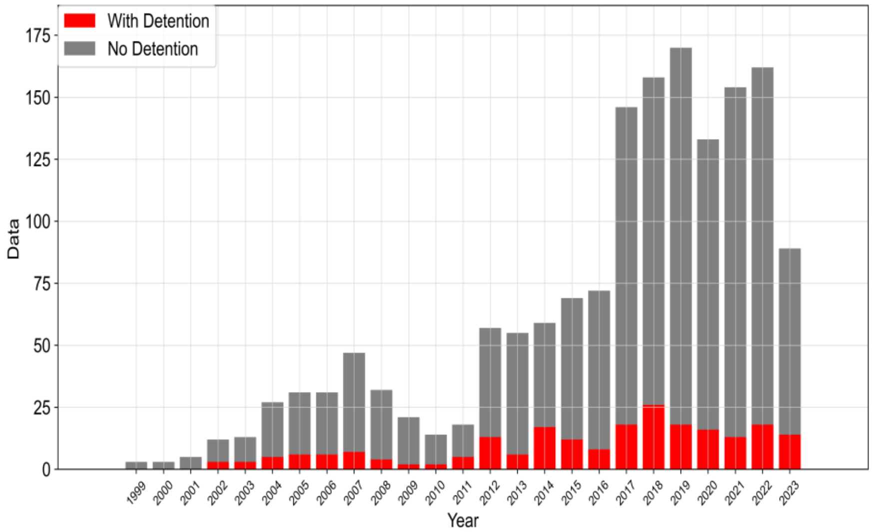


Starting in 1999, three vessels were found with deficiencies, while none were found without. The subsequent year, 2000, saw a reversal with no vessels having deficiencies and three vessels without any deficiencies. The trend from 2001 to 2004 showed an increasing number of vessels with deficiencies, escalating from four in 2001 to 21 by 2004. In 2005, vessels with deficiencies peaked at 27, but the number of vessels without deficiencies dropped to four. This trend of a higher number of vessels with deficiencies continued until 2008 when it decreased to 29, yet it surged again in the subsequent years. By 2019, vessels with deficiencies reached their zenith at 160, while only 10 vessels were inspected without any deficiencies. Conversely, 2020 saw a decline in vessels with deficiencies to 120, but a slight increase in vessels without deficiencies to 13. The year 2017 saw a marked increase in the number of vessels with deficiencies, numbering 130. This trend continued in the subsequent years with 137 in both 2018 and 2022. The most recent data from 2023 indicates a decrease in vessels with deficiencies to 70, with 19 vessels inspected without deficiencies. Over the entire 25-year span, the vast majority of inspections resulted in deficiencies being identified, solidifying the trend of most vessels being found with deficiencies post-sanction by the Paris MoU.

Detention Status of Banned Ship after Banning

The figure 19 delineates the number of vessels that were inspected after being prohibited from entering ports by the Paris MoU from the year 1999 to 2023. Over the course of these 25 years, a total of 1,581 vessels were inspected. Out of these, 222 vessels were detained, which signifies they were found with substantial deficiencies, while a significant majority, 1,359 vessels, were not detained. In the early years from 1999 to 2001, all the inspected vessels, 3 in both 1999 and 2000 and 5 in 2001, were not detained. The first recorded detentions started in 2002 with 3 out of 12 vessels. As the years progressed, the number of inspections and the corresponding detentions fluctuated. For instance, in 2007, out of 47 inspected vessels, 40 were not detained and only 7 were. A notable year is 2019, where the highest number of vessels, 170, were inspected within this timeframe. Out of these, 152 were not detained, and 18 were detained. The most recent data from 2023 shows that 14 out of 89 inspected vessels were detained. When observing the total counts over this quarter-century, it's evident that the number of vessels not detained significantly surpasses those that were detained, with the latter forming a minor fraction of the total inspections. This numerical analysis provides a foundational understanding of the inspection outcomes of vessels post their prohibition by the Paris MoU.

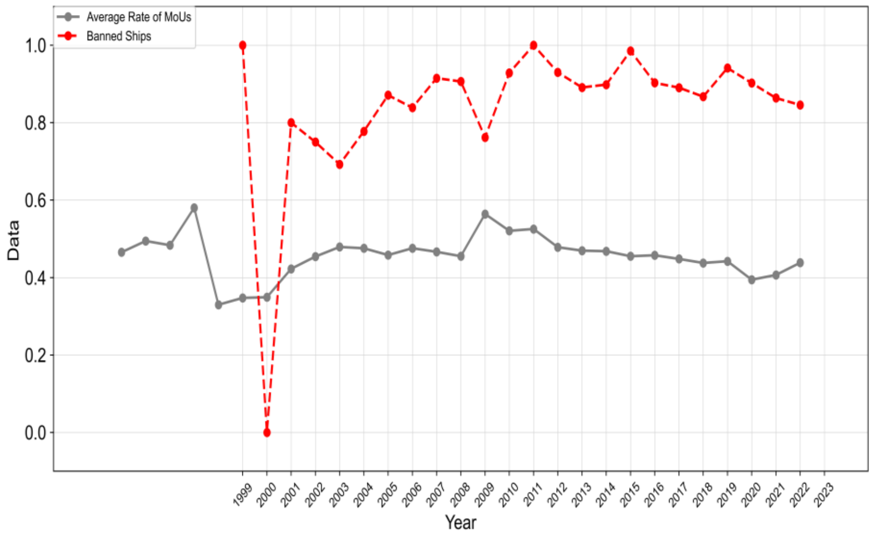
Figure 19 Detention Status of Banned Ship after Banning



Deficiency Rate between MoUs and Banned Ship

The figure 20 showcases the annual percentages from 1994 to 2022, reflecting the rate at which ships under MoUs and the Banned Ships category received defect remarks upon inspection. In 1994, the percentage of ships under MoUs that received defect remarks stood at 47%. This figure saw an ascent, reaching its zenith in 1997 at 58% before making a sharp descent to 33% in 1998. From the onset of data collection for Banned Ships in 1999, this category marked a stark 100% defect rate. It's important to underscore that 1999 and 2000 present particular data peculiarities for Banned Ships with rates of 100% and 0% respectively, suggesting limited representation during these years. Subsequent years post-2000 consistently illustrate defect percentages for Banned Ships that seldom dip below 69%. A comparative glance between MoUs and Banned Ships reveals a notable trend: Banned Ships typically have a higher defect rate. For instance, in 2010, while the defect percentage for ships under MoUs was 52%, the Banned Ships category was significantly higher at 93%. 2011 reiterated a 100% defect rate for Banned Ships, contrasting with the 53% of ships under MoUs. Across the duration, MoUs' defect rates undulate, moving between the mid-30s to mid-50s. On the contrary, Banned Ships exhibit a consistent upward trend, with the lowest being around 69%. The most recent year, 2022, records a defect rate of 44% for MoUs, juxtaposed against 85% for Banned Ships. To encapsulate, over this 28-year period, while ships under MoUs display oscillating defect rates, Banned Ships persistently hover at markedly higher levels.

Figure 20 Inspection with Deficiency Rate between MoUs and Banned Ship

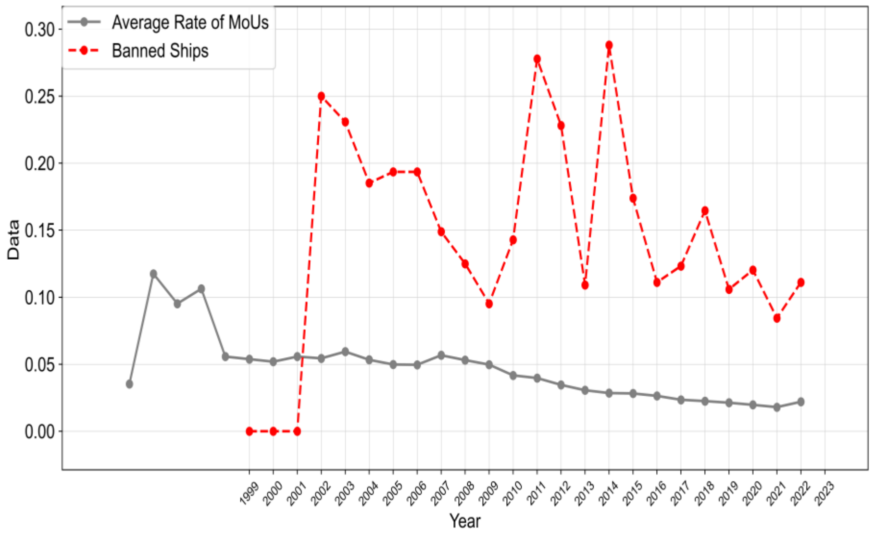


Note. The data was sourced from reports that accurately capture the Deficiency Rate. Abuja MoU Annual Report, 2010-2021; Acuerdo de Viña del Mar Annual Report, 2009-2022; Black Sea MoU Annual Report, 2003-2022; Caribbean MoU Annual Report, 2011-2022; Indian Ocean MoU Annual Report, 2001-2022; Mediterranean MoU Annual Report, 2005-2021; Riyadh MoU Annual Report, 2007-2021; Tokyo MoU Annual Report, 1994-2022; USCG Annual Report, 2009-2022

Detention Rate between MoUs and Banned Ship

The figure 21 presented spans from 1994 to 2022 and illustrates two specific data sets: the detention rate (presented as a percentage) of ships under various MoUs, excluding the Paris MoU, and the detention rate of ships banned by the Paris MoU when inspected by other MoUs. Starting in 1994, the detention rate for various MoUs stood at 3.53%. This rate saw its peak in 1995 at 11.75% and gradually declined over the years, with minor fluctuations, reaching its lowest at 1.8% in 2021 before slightly increasing to 2.2% in 2022. For the ships banned by the Paris MoU, data commences from 1999, where there's a recorded detention rate of 0%. This suggests that ships banned in that year didn't face any detention in other MoUs. It's worth noting that the detention rate for banned ships in 1999 and 2000 was 0%, possibly due to a limited sample size or fewer inspections of these banned ships. Subsequently, in 2002, the detention rate for these ships rose to 25%. From there, the rate experienced fluctuations: peaking at 28.81% in 2014 and dropping to its lowest at 8.44% in 2021. Interestingly, in certain years like 2011 and 2014, the detention rates for banned ships (27.78% and 28.81% respectively) were significantly higher than the average detention rates for ships under various MoUs. To put this in perspective, while the average detention rates for ships under various MoUs steadily decreased over the span of nearly three decades, the detention rates for ships banned by the Paris MoU displayed higher volatility. Additionally, there were moments when the detention rate of banned ships significantly surpassed the average detention rate of ships under various MoUs. This observation underscores the varying levels of scrutiny and outcomes ships might encounter depending on their previous records and the MoUs they operate under.

Figure 21 Detention Rate between MoUs and Banned Ship



Note. The data was sourced from reports that accurately capture the Detention Rate. Abuja MoU Annual Report, 2010-2021; Acuerdo de Viña del Mar Annual Report, 2005-2022; Black Sea MoU Annual Report, 2003-2022; Caribbean MoU Annual Report, 2005-2022; Indian Ocean MoU Annual Report, 2005-2022; Mediterranean MoU Annual Report, 1998-2021; Riyadh MoU Annual Report, 2007-2021; Tokyo MoU Annual Report, 1994-2022; USCG Annual Report, 1998-2022

Chapter 5 Discussion and Limitation

The graphics provided in Chapter 4 offer a lucid visual interpretation of ships that have been banned from the Paris MoU, while also deepening our comprehension of their intricate dynamics. These visual tools act as a bridge, translating raw data into actionable insights essential for port states to identify potential high-risk vessels. Referring to Figure 4, this chapter discusses the underlying significance and limitations of each graph.

5.1 Discussion

5.1.1 Banned Ships and Banning Countries

The data variations observed in Figure 5 can be attributed to both internal and external factors concerning the Paris MoU. Internally, the inclusion of new member countries (refer to table 1) and their active participation might influence the recorded figures. Externally, as delineated in Table 6, the introduction of novel maritime conventions by the IMO or amendments to existing ones could contribute to variations. With the implementation of new regulations, it is expected that PSCOs intensify their scrutiny, conducting thorough inspections to ensure vessel compliance. These inspections often materialize through Concentrated Inspection Campaigns (CIC), aimed at promoting adherence to maritime standards (Lai et al., 2023). To circumvent such scrutiny, shipowners might redirect their vessels to other regions or even decommission them. Notably, post-2017, there is a discernible decline in banned vessels, suggesting an improvement in ship management practices. Building upon this, as supported by Figure 6, countries previously unregistered with the Paris MoU but now categorized under the Black List points towards the MoU's endeavour to consolidate and exercise better control over their data. The movement of nations to the White and Grey Lists is commendable as it illustrates the nations' commitment to improving ship management and safety standards.

Table 6: Adoption and Effective Date of IMO Conventions from 2000 to 2020

Convention	Adoption	Entered into Force
ISPS Code (SOLAS Ch.XI)	2002.12.13	2004.07.01
MARPOL Annex VI: Air Pollution	1997	2005.05.19
OPRC-HNS Protocol	2000.03.15	2007.06.14
Anti-Fouling Systems	2001.10.05	2008.09.17
Bunker Convention	2001.03.23	2008.11.21
ISM Code (SOLAS Ch.IX) Amendment: Resolution 273(85) company's responsibility for shipboard operation, specific intervals of certificate	2008.12.04	2010.07.01
STCW 2010 Manila Amendments	2010.06.25	2012.01.01
SOLAS Ch.II-1: Goal Based Ship Construction Standards for Bulk carriers and Oil Tankers	2010.05	2012.01.01
MARPOL Annex VI Amendments: Energy Efficiency Regulation	2011.07.15	2013.01.01
Maritime Labour Convention	2006.02.23	2013.08.20
Nairobi Convention (Removal of Wrecks)	2007.05.18	2015.04.14
Ballast Water Management Convention	2004.02.13	2017.09.08
Hong Kong Convention (Recycling of Ship)	2009.05.15	Not Yet
HNS 2010 Protocol	2010.04.30	Not Yet

Source: IMO (2019b)

Figures 7 to 10 provide detailed insights into the distinct characteristics of the vessels in question. As illustrated in Figure 7, the observed trend suggests enhanced safety measures for larger vessels. Yet, it concurrently underscores the immediate necessity for stringent inspections of smaller vessels, which are seemingly associated with increased risks. Corroborating this, Figure 8 demonstrates that general cargo ships, due to their inherent vulnerabilities, should be subject to more frequent inspections. Furthermore, the safety management of Bulk Carriers and Tankers has displayed notable improvements, inferred from thorough checks such as the Lightship or Major Inspection. Figure 9 captures the broadening age spectrum of vessels, potentially pointing to advancements in shipbuilding techniques. Nonetheless, this aging fleet brings forth concerns, hinting that older vessels could be prone to bans from outdated systems or gradual deterioration. A pivotal enhancement in the maritime domain, as depicted in Figure 10, is the decline in issues pertaining to the lack of ISM certificates after 2010. This development mirrors the cohesive endeavours of maritime entities to align with global benchmarks. In addition, the decline in data for both the 'Jumped Detention' and 'Failed to call' categories can be interpreted as evidence of shipowners' growing respect for the MoU cooperative system.

However, while progress has been significant, challenges persist. Some ship operators, unfortunately, continue to bypass their commitments. This is especially evident in cases where ships are mandated to dock at specified ports for rectification but fail to do so. Companies should exercise heightened caution, particularly when entering in countries like Italy, known for its rigorous inspection regime and higher ban rates according to figure 11.

5.1.2 Information of the Ships after Banning

Figures 12 to 17 focus on the trajectories of ships after they've been banned. This analysis illuminates the broader implications of the bans, particularly in terms of ship conditions (as depicted in Figures 12, 13, and 14) and movements between different MoU regions (as shown in Figures 15, 16, and 17). The graphs in this section clearly illustrate the correlation between lifting port bans and other influencing factors. These relationships offer valuable insights that might influence the inspection strategies of port authorities.

In Figures 12 and 13, there are concerning observations. Some ship owners and management companies appear sluggish in addressing issues that have led to port bans. Figure 12 reveals that numerous ships remain under active bans, suggesting immediate threats to both the environment and human safety. The findings from Figure 13 intensify these concerns. The fact that over a hundred ships have not exhibited efforts to rectify their infringements implies that the Paris MoU's measures alone might not suffice to effectively manage non-compliant vessels. Such a trend strongly hints at these ships possibly moving strategically to regions with potentially lenient regulations (Kulchytskyy, 2013). Furthermore, as evident from Figure 14, the commitment to enhancing ship management among shipowners appears lacking.

The data underscores the importance of fostering robust collaboration mechanisms among various MoU entities. Enhanced collaboration not only streamlines the inspection process but also ensures a more harmonized and consistent response post-ban across different MoUs. Research indicates that, as of July 1, 2023, a significant number of ships continue to face bans. While there could be numerous reasons for this phenomenon, one plausible explanation centers on the rising instances of multiple detentions, accentuating the challenges in maritime regulatory compliance.

Results from Figures 16 and 17 emphasize the significance of monitoring ships operating beyond the confines of the Paris MoU. This holds especially true considering that a considerable portion of these vessels continues to operate unimpeded despite active bans. The diminishing data trend from the Tokyo MoU region is both intriguing and alarming, suggesting that ships prohibited by the Paris MoU might be venturing into proximate areas to evade stringent inspections. Fortunately, since 2017, EQUASIS has introduced a detailed ship movement tracking feature, promising a more comprehensive vessel history management system and more effective monitoring. However, each MoU maintains its own database, and collaboration with other MoUs remains voluntary, underscoring the necessity for more coordinated and cohesive cooperation (Zhang, 2016).

5.1.3 Influence on Other MoUs

This section, which can be considered the pinnacle of the research, underscores the main message the study wishes to convey. It emphasizes the importance of synergy, collaboration, and free information exchange between different MoU regions. The monitoring results depict a concerning situation. These statistics will resonate as a clear call for ports worldwide to strengthen their inspection and enforcement mechanisms.

The claim for stringent investigations is amplified by subsequent data visualizations. Ignoring data from before 2000 due to potential inaccuracies reveals a troubling trend. The stark contrasts shown in Figures 18 and 20 confirm that Banned Ships, even when inspected by PSCOs from various MoUs, consistently receive citations for deficiencies. This revelation indicates the need for PSCOs to allocate more resources, time, and attention to inspect ships that appear to pose higher risks meticulously. The trend in suspension rates in Figures 19 and 20 aligns with these findings. While both comparison groups demonstrate a decline since the initiation of PSC, marking commendable progress globally, discrepancies are still evident. The notable gap signifies that ships banned from the Paris MoU often fall short of top-tier safety standards.

Inspection outcomes from other MoUs frequently mirror these sentiments, underscoring the urgent need for PSC regional bodies to bolster cooperative efforts and take stricter measures against non-compliant vessels. The initial step towards the goal of all MoUs to eradicate substandard ships is awareness and realization of this information (Boljat et al., 2020). To this end, the author plans to share this paper with each MoU's Secretariat. The second step involves every MoU quickly accessing information about ships with poor management conditions, like Banned Ships. While an EQUASIS system exists, not all MoUs participate, and individual database systems don't allow viewing inspection results or ban histories from other MoUs. Establishing a shared database system is the optimal solution to enhance maritime safety on a global scale (Mehrotra, 2000). The third measure is a mandatory reform in MoU procedures (Soares et al., 2017). If a ship has a ban history and has been designated substandard in another MoU, its risk level should be elevated or designated for mandatory inspection. Ultimately, institutional support is essential to follow up on inspections from other MoUs.

5.2 Limitation

Interpreting maritime patterns solely based on a specific agreement can be tough. The maritime world is not stand-alone; it's closely connected to global politics and economic situations. So, any study in this area should be broad and consider these relationships (Ampatzidis, 2021). The Paris MoU is a strong body that backs and implements maritime rules. However, there might be differences when comparing checks in different agreements or within various areas of the same country. Additionally, the ship performance details in this paper are up to July 2023 and may not fully show the overall conditions when the ban was applied. Because the study relies on these details, any mismatch could change the findings. The changing nature of ship risk checks, influenced by ship managers and ROs, brings in potential shifts in the study. The lack of full details on these checks makes this problem bigger. A well-rounded analysis covering all parts of the banned ships might not have been done. Some key areas, like the reasons for bans and the countries giving them, are still being looked into, leaving space for more research.

Although this study tries to give a full view, it's important to see the issues it might have. One big limitation is the limited details of the Paris MoU. Understanding small details, like the real reasons behind a ship's hold or how long it takes to remove rules, is hard. Plus, pinpointing the exact stoppage of ships listed in EQUASIS makes it tricky to connect the rules given and ship breaking. Depending only on Paris MoU data up to July 1, 2023, brings another potential change. Any updates after this date could affect the study's results. It's key to look at results wisely, especially when making conclusions about other agreements outside of Paris.

The Paris MoU's role in accepting global agreements and setting standards in the maritime world is important. But this might mean there are basic differences between checks from the Paris MoU and other agreements. Given that this study doesn't dig deep into the number and importance of issues found, it's hard to make decisions on the real state of certain ships. It's also challenging to see if a ship marked in one agreement showed better or worse conditions when checked in another. Ships not managed well might get checked again, leading to more issues found and holds.

To wrap up, the idea of having one main PSC database system has been around for some time, but it's not easy to put into action. The maritime sector affects the whole world's economy and can directly change people's lives in some countries. The safety of ships and their crews, and the environment, should always come first. However, change is slow because of political and financial reasons (Pomeroy & Earthy, 2017).

Chapter 6 Conclusions

This study researched deeply into the intricate dynamics of maritime operations, emphasizing ship inspections, banning patterns, and their interrelations within various PSC MoUs. By synthesizing the findings from each chapter, the aim was to unearth core insights while also suggesting potential avenues for future maritime research.

In the initial segments, the global significance of maritime activities was spotlighted, laying out the essential role of PSCOs. Their critical function in ensuring vessels meet international safety and operational standards provided a foundational context for the subsequent exploration.

A detailed look at banned ships in Chapter 4 revealed the evolving nature of bans and their broader implications. Through the Paris MoU, it was observed that ships navigate a complex matrix of regulations over time. This trend seems to suggest a movement where banned ships might be gravitating towards regions perceived as more lenient. The progress made by compliance frameworks like the Paris MoU in overseeing and upholding maritime standards is commendable. However, the adaptability and resilience displayed by ship operators consistently challenge these structures.

Chapter 5 brought into focus the nuanced interactions among different MoUs. The differences in safety and operational standards across these MoUs accentuate the urgency for strengthened collaboration. Even though each MoU is molded by its unique geopolitical and economic contexts, there's an undeniable push for a more unified approach. Such a cohesive strategy towards inspections, bans, and enforcement could pave the way for enhanced maritime safety and global compliance.

From this research, key insights naturally surface. Maritime standards, for one, are inherently dynamic. They adjust and mold themselves in response to global shifts in politics, technology, and economics. This fluid nature leads to shifting patterns of ship bans, emphasizing the need for agile and robust monitoring tools. Furthermore, the migration trend of banned ships towards perceived lenient regions indicates that maritime activities in one corner of the world can ripple and impact far-off regions. This web of interconnectedness makes a strong case for comprehensive research that extends beyond specific maritime occurrences or confined MoU boundaries. Beyond the geographical implications, there's also an underlying call for synchronized operations across MoUs, especially in dealing with high-risk vessels. This synergy ensures that vulnerabilities in one MoU aren't exploited in another.

Gazing into the future, several intriguing research pathways come into view. Delving deeper into cross-MoU analyses promises a richer understanding of disparities and offers the potential to extract best practices from each MoU, guiding harmonization efforts. Moreover, as ship-building undergoes transformation and older vessels continue to ply the waters, the promise of technology stands tall. The intricate dance between global politics, economics, and maritime activities is another layer that needs peeling. A closer look at how worldwide events, be they economic downturns or political shifts, affect ship movements and compliance would be enlightening. Lastly, understanding the motivations and decision-making processes of ship operators offers another dimension. Such an exploration can create a foundation for crafting more effective deterrence strategies and policies.

In summary, this research journey has shone a light on the multifaceted world of maritime operations. While significant strides have been taken towards maritime safety and compliance, challenges persist. Navigating these challenges requires not just rigorous enforcement but a holistic understanding of the intricate maritime web. With the horizon of maritime research stretching out ahead, a wealth of opportunities awaits, each promising to elevate global maritime operations to even loftier standards.

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Appendices

Appendix A

Explanation of Term

No.	Term	Explanation
1	IMO Number	A unique identifier consisting of a 7-digit number assigned by the IMO to each ship upon registration. Comparable to a personal identification number or social security number for individuals, the IMO number serves to track a ship's history. Once assigned, this number remains unchanged even after the ship is decommissioned and is used to trace the ship's history across various information systems.
2	Flag State	Refers to the nationality of a ship, determined by its registration. Different countries have varying criteria for granting flag state status. Ship owners typically prefer flag states with lower taxes and less stringent safety standards. The Paris MoU specifies that a ship banned three or more times must change its flag state to a country listed as "White" in the 7) Performance List to lift the ban. The flag state represents the ship's nationality at the time of the ban.
3	Date of Banning	The first day on which an entry ban is enforced within the Paris MoU region. This date serves as a reference point for time-series analysis along with other factors.
4	Banning Authority	It refers to the port state that has issued an order to ban entry to ships in the jurisdiction of the Paris MoU.
5	Reason for Banning	Indicates the reason for a ship's entry ban. There are four possible reasons: 'Failed to call at indicated repair yard', 'Multiple detentions', 'No valid ISM Certification', and 'Jumped detention'.
6	Occurrence	In cases where the 'Reason for Banning' is 'Multiple detention', it refers to the number of times the ship has been banned. It is categorized as 'First', 'Second', or 'Third', with an increase in occurrence corresponding to a longer ban period.
7	Ban Situation	Indicates the current status of the ship's entry ban. If the ban is still valid, it is marked as 'Validated'. If the ban has been lifted, it is marked as 'Lifted'.
8	Flag Performance List	A list categorizing flag states based on the calculated detention rate of registered ships according to the Paris MoU's specified criteria. As of July 1, 2023, there are a total of 66 flag states registered with the Paris MoU, with 39 countries in the 'White' List, 18 in the 'Grey' List, and 9 in the 'Black' List. Countries not officially identified are marked as 'Not Identified'.

9	Flag State (Current)	Includes the ship's current flag state information, enabling the tracking of historical changes. This information is used in conjunction with 7) to assess the ship's improvement efforts following a ban.
10	Gross Tonnage	Represents the total volume of the ship excluding spaces required for safety and hygiene above the upper deck. This tonnage indicates a ship's earning capacity and influences compliance with various international agreements. Additionally, it serves as a basis for taxes such as customs duties, registration fees, income taxes, pilotage fees, and other levies.
11	Ship’s Type	Classifies ships based on the type of cargo they transport.
12	Built Year	The year in which the ship was constructed. Subtracting this year from the year in 3) yields the ship's age at the time of the ban.
13	Status	Indicates whether the ship is currently active or decommissioned.
14	Date of Inspection	Refers to the date on which a PSC inspection was conducted by an inspector within a specific MoU region.
15	Detention	Indicates whether the ship was detained after undergoing a PSC inspection.
16	PSC Region	Specifies the MoU region where the PSC inspection took place.
17	Number of Deficiencies	Represents the count of deficiencies identified during the PSC inspection.
18	Annual Statistics of Each MoUs	Provides insights into each MoU's ship inspection frequency, deficiency rate, number of deficiencies, and detention rate on an annual basis.

Appendix B

Flag Performance List of Paris MoU

ParisMoU Performance List: valid 01-07-2023 / 30-06-2024

Paris MoU on Port State Control

WHITE LIST

RANK	FLAG	INSPECTIONS 2020-2022	DETENTIONS 2020-2022	BLACK TO GREY LIMIT	GREY TO WHITE LIMIT	EXCESS FACTOR
WHITE LIST						
1	Denmark	1,121	9	93	64	-1.87
2	Italy	802	7	69	44	-1.79
3	Greece	617	5	54	32	-1.77
4	Netherlands	2,536	39	199	156	-1.67
5	Norway	1,572	23	127	93	-1.65
6	Singapore	1,601	27	129	95	-1.57
7	Finland	338	4	32	15	-1.43
8	Cyprus	2,023	43	161	122	-1.43
9	Belgium	179	1	19	6	-1.41
10	United Kingdom	659	12	57	35	-1.36
11	Bahamas	1,646	37	133	98	-1.36
12	Turkey	580	11	51	30	-1.29
13	Sweden	287	4	28	12	-1.26
14	Hong Kong (China)	1,583	40	128	94	-1.24
15	Japan	153	1	16	5	-1.24
16	Cayman Islands (UK)	320	5	30	14	-1.23
17	France	227	3	23	9	-1.16
18	Marshall Islands	4,703	145	358	300	-1.16
19	Gibraltar (UK)	409	8	38	20	-1.15
20	Malta	3,710	114	286	234	-1.14
21	Luxembourg	222	3	22	9	-1.13
22	Lithuania	93	0	11	2	-1.09
23	Bermuda (UK)	135	1	15	4	-1.07
24	Ireland	132	1	15	4	-1.04
25	Liberia	4,569	156	349	291	-1.04
26	Portugal	1,473	45	120	87	-1.03
27	United States	128	1	14	4	-0.99
28	China	200	3	20	8	-0.99
29	Russian Federation	832	24	71	46	-0.98
30	Faroe Islands	219	4	22	9	-0.90
31	Antigua and Barbuda	1,712	61	138	102	-0.87
32	Barbados	538	16	48	27	-0.82
33	Isle of Man (UK)	340	9	32	16	-0.78
34	Germany	522	16	47	26	-0.78
35	Estonia	74	0	9	1	-0.77
36	Spain	142	4	15	4	-0.14
37	Latvia	120	3	13	3	-0.12
38	Poland	36	0	6	0	0.08
39	Thailand	33	0	5	0	0.10

Paris MoU on Port State Control

GREY LIST

RANK	FLAG	INSPECTIONS 2020-2022	DETENTIONS 2020-2022	BLACK TO GREY LIMIT	GREY TO WHITE LIMIT	EXCESS FACTOR
GREY LIST						
40	Croatia	64	1	8	1	0.05
41	Saudi Arabia	61	1	8	0	0.07
42	Korea, Republic of	89	3	11	2	0.14
43	Morocco	46	1	7	0	0.17
44	Saint Vincent and the Grenadines	266	14	26	11	0.19
45	India	41	1	6	0	0.21
46	Panama	5,472	366	415	351	0.23
47	Iran, Islamic Republic of	47	2	7	0	0.31
48	Lebanon	40	2	6	0	0.37
49	Switzerland	35	2	5	0	0.42
50	Philippines	126	9	14	4	0.52
51	Belize	195	16	20	7	0.68
52	Egypt	40	4	6	0	0.69
53	Cook Islands	122	11	14	3	0.74
54	Palau	216	19	22	8	0.79
55	Azerbaijan	41	5	6	0	0.83
56	Saint Kitts and Nevis	140	14	15	4	0.88
57	Ukraine	57	7	8	0	0.91

BLACK LIST

RANK	FLAG	INSPECTIONS 2020-2022	DETENTIONS 2020-2022	BLACK TO GREY LIMIT	RISK	EXCESS FACTOR
BLACK LIST						
58	Tanzania, United Republic of	125	14	14	Medium	1.01
59	Comoros	282	28	27		1.07
60	Sierra Leone	186	20	19		1.11
61	Vanuatu	290	30	28		1.21
62	Albania	55	8	7		1.24
63	Togo	325	44	31	Medium to High	2.19
64	Algeria	68	13	9		2.64
65	Moldova, Republic of	229	38	23		2.92
66	Cameroon	93	22	11	Very High Risk	4.25