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Cruise Ship Safety Management in Asian Regions: Trends and Future Outlook

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Abstract: The sinking of the *Titanic* has brought cruise ship safety onto the international agenda. However, different shipwrecks have been occurring in the cruise industry with relatively high frequency for more than one century due to human errors. In order to improve cruise ship safety, the International Maritime Organization and the Cruise Lines International Association introduced a set of safety enhancement policies and measurements. However, the expansion of ships and fairly weak safety regulations continue to pose risks of human life loss during cruise ship accidents, particularly in Asian regions. Asian countries have been constantly implementing various safety measures, but serious cruise ship accidents still occur from time to time, even after significant past experiences. Are the cruise ship accidents predominantly the result of human failures and organizational factors? This paper undertakes a detailed historical review of cruise ship accidents since 1972 through an intensive overview of the documents published by the Safety of Life at Sea (SOLAS) Convention and the Maritime Safety Committee. Furthermore, a set of case studies of representative cruise ship accidents are conducted as a part of this study. The outcomes of this study will help cruise shipping companies to better understand the factors influencing cruise ship accident occurrence and to construct appropriate safety policy measures, aiming to prevent cruise ship accidents in Asian regions.

Keywords: shipwrecks; cruise shipping; Asian regions; maritime safety committee; Safety of Life at Sea-SOLAS Convention

1. Introduction

Passenger transport is designed for the movement of people from one location to another. Basic types of maritime passenger transport include ferry and cruise. A ferry is a ship or a boat that operates on frequent, regular, and return services primarily for passengers across a body of water. On the other hand, a cruise is described as the "transportation of pleasure-seeking travelers on ocean voyages offering one or more glamorous ports of calls" [1] (p. 360). Wild and Dearing [2] (pp. 319–320) defined a cruise as "any fare paying voyage for leisure onboard a ship whose primary purpose is the accommodation of guests and not freight normally to visit a variety of destinations rather than to operate on a set route." Considering recent developments, it can be concluded that the cruise ship experience is generally associated with a recreational experience [3] and a more relaxed atmosphere [4].

The cruise industry has grown rapidly in the past ten years. According to the Cruise Lines International Association (CLIA), cruise passengers have increased remarkably from 17.8 million in

2009 to 28.0 million in 2018, with a growth rate of more than 50% [5] (see Figure 1). In order to maintain a sustainable development of the industry, international cruise shipping companies plan to enlarge their business to emerging markets, notably in Asian regions. In the context of the cruise shipping market, Asian regions have been identified as the most dynamic and the fastest growing cruise market in the world [6]. The industry has recorded 4.052 million passengers, accounting for over 15% of global passengers [5]. Cruise ship safety definitely has an important impact on passenger satisfaction and directly affects the sustainability of the whole cruise industry, which can be considered as an independent industry but is closely associated with the tourism industry.

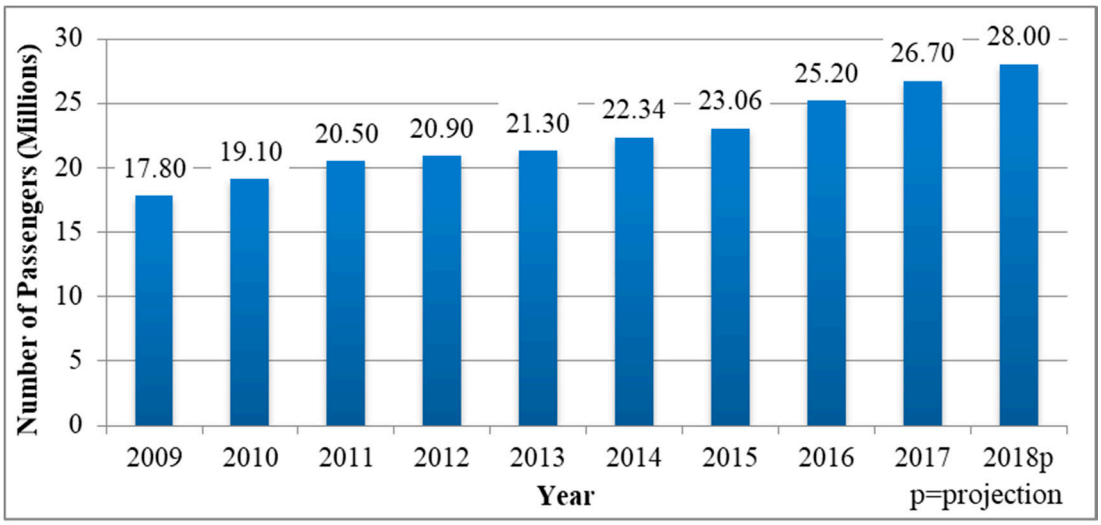

Figure 1. 2009–2018 global ocean cruise passengers.

In the field of passenger transport, a cruise has been identified as a very safe approach to taking a holiday. Approximately 100 years ago, the technological and scientific advances created a major breakthrough in the design, power supply, accommodation, and catering facilities of cruise ships [7]. Because of the sinking of the *Titanic* on 15 April 1912, the subject of cruise ship safety has been attracting researchers, industrial practitioners, and policy makers. Nevertheless, different shipwrecks have been occurring in the cruise industry with relatively high frequency for more than one century because of human errors. From 1989 to 2013, 580 cruise ship incidents have been recorded, including the notable 2012 *Costa Concordia* disaster, when Italian cruise ship *Costa Concordia* struck an underwater rock and experienced overturning. A total of 11 events were related to large cruise lines. In particular, tremendous cruise ship accidents, including the 2012 *Lamma IV*, the 2006 *Star Princess*, and the 1992 *Royal Pacific*, have drawn global attention to the cruise industry and prompted cruise shipping lines to take certain legal actions as well as safety improvement measures [3].

According to the National Transportation Safety Board (NTSB), 37% of passenger ship accidents occurred between 1988 and 2014 [8]. Gossard [9] (p. 157) highlighted that "although most critics acknowledge that cruise industry in general has an excellent safety record, serious losses can and do occur." Fire was found to be the biggest danger for cruise ships. However, collisions and grounding may also pose quite serious consequences for cruise ships [9]. The international shipping community, notably the International Maritime Organization (IMO), the United Sates Senate Committee on Transportation, and other governmental organizations, have implemented various safety enhancement instruments and brought new solutions to the Safety of Life at Sea (SOLAS) Convention. The CLIA has explored the deficiencies and root causes of managerial practices associated with severe cruise ship accidents to develop the required regulations for cruise ships [3]. According to Gossard [9], many cruise ship accidents, along with the associated loss of ships and human lives, could have been prevented if the ship crew had responded professionally.

Cruise ship accidents at sea have given rise to major concerns from the relevant stakeholders [10]. The maritime safety analysis appeared in shipping research in the middle of the 1970s [3]. However, the maritime safety analysis has a general tendency towards a qualitative analysis with a key focus on the implementation of safety regulations, evaluation of the physical conditions of seafarers on the high seas, seafarers' training [3,11], evaluation of ship safety in terms of ship designs and structures [12–14]. Since the 1990s, the maritime safety analysis has concentrated on the methodological aspects instead of on theoretical or conceptual matters [15]. A number of advanced operational research techniques started receiving more and more attention, such as fuzzy logic [16,17], genetic algorithms [18,19], evidential reasoning [20,21], Bayesian networks [22], and Markov chains [23]. In the meantime, some studies still continued addressing the theoretical aspects of cruise ship accidents [24].

Although the issue of cruise ship accidents is a challenging and significant topic in the context of maritime safety, only very few studies have focused on the review and analysis of cruise ship accidents, especially in Asian regions. The IMO has introduced and launched 18 regional projects and programs for Asian countries to reinforce the safety performance and reliability of the maritime activities [25]. Asian countries have continually implemented safety measures and developed appropriate safety research activities. Nevertheless, there is still an increasing risk of losing lives in the event of a cruise ship accident in Asian regions. Almost 25% of ship accidents happened in Asian waters in 2018, and Asia remains a hot spot for ship accidents [26]. In the past decade, the global cruise ships were heavily deployed in Asian regions [4]. As expected, with more ships on the high seas, fears of disasters rise [27] and the need for improvements in safety becomes more apparent [26]. This study focuses on a critical review of 48 cruise ship accidents that occurred in Asian regions from 1972 to 2014 to determine the causes and features of these accidents after the implementation of the International Regulations for Preventing Collisions at Sea by the IMO in 1972. Furthermore, a set of case studies of representative cruise ship accidents that occurred in Asian regions are conducted as a part of this study. The key contributions of this work to the state-of-the-art consist in answering the following research questions:

- What are the reasons for serious cruise ship accidents occurring in Asian regions even after the significant experience of the past accidents?
- Are the cruise ship accidents in Asian regions predominantly the result of human failures and organizational factors?
- What measures can be undertaken by cruise shipping companies and relevant policy makers to improve the safety of cruise ships in Asian regions?

The manuscript has the following structure. The research methodology adopted in this study is presented in Section 2 of the manuscript. Then, we explore cruise ship traffic in Asian regions in Section 3. Section 4 further examines current safety regulations in the cruise industry. Based on the adopted research methodology, a critical review of the factual information from cruise ship accidents is conducted in Section 5 through a comprehensive descriptive statistical analysis and case studies. A supporting discussion of the key findings and conclusions is presented in Sections 6 and 7 of the manuscript, respectively.

2. Methodology

In this paper, we attempt to fill in the research gap and to examine the underlying factors of cruise ship accidents in Asian regions by offering a review of cruise traffic and safety regulations in Asian regions and evaluating 48 cruise ship accidents from 1972 to 2014 through a quantitative and qualitative analysis research. Such efforts have not been undertaken in prior cruise shipping studies. A synthesis of quantitative and qualitative research methods was adopted to effectively achieve the objectives of this study.

A quantitative research method has been widely used over the years for gathering considerable numerical data and published information on cruise ship accidents in Asian regions. However, tracing a historical shipwreck is difficult [28]. According to Hassel et al. [29], some cruise ship accidents can

be unreported due to (1) intentional withholding of information; (2) the shipowner and/or crew are not familiar or do not fully understand the local investigating procedures; and (3) an incident report may adversely affect the company's reputation. A comprehensive data set was built for this study. The casualty data set comprised a total of 9000 records covering the time period from 1900 to 2015 by the Global Integrated Shipping Information System: Marine Casualties and Incidents, which is maintained by the IMO. The Global Integrated Shipping Information System (GISIS) contains full marine safety investigation reports with factual data, identifying overall trends or issues from various sources of marine transportation [30].

Certain data sets may contain duplicate observations of cruise ship accidents [28]. The original data set was filtered for the cruise ship casualty records in Asian regions. A total of 48 unique records of cruise ship accidents in Asian regions were identified for the final cruise ship casualty data set. The cruise ship casualty data set included a large number of descriptive variables, including accident date, location, cause of the cruise ship accident (i.e., groundings, wrecks/stranded, hull/machinery damage, foundered, fires/explosions, contacts, collisions), and type of casualty (i.e., unspecified, less serious, serious, very serious). The available descriptive statistics were mainly used to analyze cruise ship accidents in Asian regions.

A quantitative research was expected to assist with understanding the pattern and root causes of the cruise ship accidents in Asian regions. Furthermore, a qualitative research approach was considered in this study to provide a broader overview of the cruise ship accidents and their tendencies. In particular, in-depth multiple historical case studies were conducted to enable a detailed examination of the cruise ship accidents that previously occurred in Asian regions. Based on the information provided by the IMO, representative historical cruise ship accident case studies were selected to demonstrate the symbolic importance of cruise ship safety. Di Vaio, Varriale, and Alvino [31] (pp. 230–231) stated that "the case study approach is a useful method for examining phenomena still unexplored. Case studies allow the investigation of phenomena separately from their context examining specific variables." Each individual case study has to be rigorously performed. In addition, a collection of different case studies on a similar topic may serve as a starting point of reproducing or verifying the results. A set of case studies on a particular subject were expected to generate a common explanation or synthesis across the cases [32]. Indeed, the case study approach was mainly adopted as a qualitative approach rather than a quantitative approach. In our study, we mainly focused on a thorough case investigation through archives and historical data. The quantitative data approach only evaluated general scenarios or phenomena, which are often insufficient to uncover the rationale behind cruise ship accidents. Therefore, the case study approach was an important addition to the quantitative approach for the evaluation of cruise ship accidents. In this sense, we selected a total of three representative cruise ship accidents to explore the general features and specific characteristics of cruise ship accidents in Asian regions.

3. Review of Cruise Traffic in Asian Regions

Cruising has been regarded as a desirable means of travel for the world's elite community since the 1920s [33]. Up to 1986, the rise in air passenger transport significantly reduced the share of cruise ship services [3]. From 1986 afterwards, Cunard Lines discovered that passengers recognized cruising as a part of leisure [34]. Cruises have become one of the rapidly growing and most dynamic industries in terms of both the expanding sizes of cruise ships (i.e., super-sized cruise ships carrying over 2000 passengers) and rising number of passengers [35]. In general, the world's cruise markets can be classified into three key regions, including Asia, Europe, and North America. The cruise market has spread throughout a vast geographical area between Alaska and Asia [35]. There were more than 100 million worldwide cruise passengers between 2005 and 2012 [3].

From the geographical perspective, Asia is the key maritime region. Asian regions maintain a crucial position in international shipping activities. A total of 20 Asian nations are recognized as maritime countries stemming from their long coastlines [25]. Thus, Asia has experienced an almost

unbroken growth phase for the past three decades as a result of attractive new cruising destinations, unexpected cultures, a variety of itineraries, interesting shore excursions, and exotic experiences for Western travelers [4,35]. CLIA has forecasted that Asia will attract around 3.7 million cruise passengers per year by 2017 and around 7 million before 2020. By the end of the decade, Asian cruise lines will accumulate 20% more cruise passengers [4]. Based on the information reported by Ocean Shipping Consultants (2012) [36], an evolution of Asian cruise travelers is presented in Table 1.

Table 1. Trends and numbers of cruise travelers in Asian regions (millions of cruise travelers).

	Japan	East Asia (China, South Korea and Taiwan)	South East Asia and Others	Sub-Total (Asia)	Total (Global)	The Proportions of Asia Region to Global	Growth Rate of Global	Growth Rate of Asia Regions
2005	0.23	0.44	0.04	1.07	13.6	8%	N.A.	N.A.
2010	0.27	0.72	0.55	1.54	18.0	9%	29.5%	43.9%
2015	0.32	1.00	0.07	2.02	22.6	9%	11.1%	31.2%
2020	0.36	1.20	0.82	2.38	27.0	9%	19.0%	17.8%

The number of cruise ships deployed in Asia has been enlarged by 81% since 2013, tripling the cruise passenger capacity from 1.51 million in 2013 to 4.26 million in 2018 [5]. In order to encourage a rapid growth rate of the cruise market in the 21st century, the majority of cruise lines have enlarged the sizes of their cruise ships. Based on the maximum cruise ship passenger capacity and the purpose of the cruise trip, we can identify different types of cruise ships. Mega cruise ships currently serve over 5000 passengers and are now the largest and most sophisticated vessels on the market. As for the large cruise ships, they can accommodate over 3000 passengers. Regarding the mid-size cruise ships, such a cruise ship has a typical capacity of 850–3000 passengers. Mega, large, and mid-size cruise ships aim to offer familiar destinations. As for small upscale cruise ships, they generally have a capacity of up to a few hundred passengers and pass through waters, archipelagos, and small inlets on culture, ecotourism, history, and sea sport cruises. Furthermore, expedition/niche cruise ships are designed for exclusive experiences in remote waterways or destinations such as Antarctic and Arctic regions. Because of safety and environmental issues, this kind of a cruise only serves a few passengers in one trip [37].

In Asian regions, most of the ships are the large and mega cruise ships. Based on the information reported by Cruise Lines International Association (CLIA), an evolution of cruise ship deployment in Asian regions is presented in Figure 2.

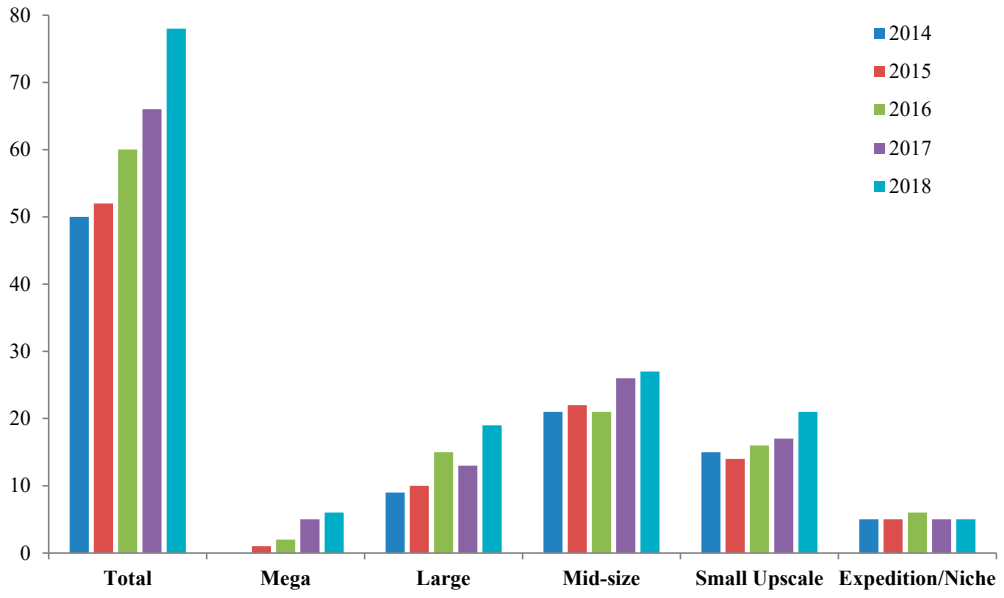

Figure 2. Ships in Asia by size between 2014 and 2018.

A total of 78 cruise ships were scheduled to sail and operate in 2018. Among the deployed cruise ships, mid-size cruise ships had the largest share (i.e., 27 cruise ships), followed by 21 small upscale cruise ships, 19 large cruise ships, six mega cruise ships, and five expedition/niche cruise ships [5].

4. Review of Safety Regulations

In the historical record, cruise ships have been directly involved in different types of accidents, including sinking and collisions in poor visibility; capsizing, foundering in storms, typhoons, and gales; as well as, indirectly, witnessing the event or providing emergency assistance [3]. Maritime safety is generally discussed in the context of "the endangerment of lives at sea from accident, negligent or fortuitous circumstances including safety deficiencies in the overall integrity of the ship as an operational platform and mobile vehicle," Mukherjee [38] (p. 149). The background of maritime safety is traced through the regulatory feedback about various maritime accidents. Samuel Plimsoll has raised our awareness about the intolerable loss of lives at sea in the United Kingdom [39]. In order to explore causes of shipwrecks, the United Kingdom established a forum of maritime investigation [40]. After the *Titanic* collided with an iceberg in the North Atlantic Ocean one century ago, cruise safety has been at the forefront of the international agenda and received much attention from the research community and media [11,39].

The first treaty regarding maritime safety was adopted by the International Conference on Safety at Sea, or SOLAS, Convention in 1914. The IMO was established in 1948 to safeguard the further improvement of maritime safety on the global level. At the beginning, the IMO kept a rather low profile. Towards 1967, the IMO developed a comprehensive profile, focusing more on safety instruments for particular maritime accidents [41]. International Regulations for Preventing Collisions at Sea were implemented in 1972. The International Convention for the Prevention of Pollution from Ships (MARPOL) and SOLAS conventions launched inspection systems and complemented the key conventions of the IMO during the 1970s [42,43]. William O'Neil, the former Secretary General of the IMO, mentioned that the IMO implemented proactive policies and made rigorous efforts aiming to minimize the damage as a result of ship accidents [44]. In order to reduce the endangerment of human life and ensure safety at sea, the IMO Assembly (18th session) introduced Resolution A.741(18) in 1993. This resolution contains the code of International Safety Management (ISM). On 19 May 1994, the ISM code was incorporated in the new SOLAS Convention Chapter IX "Management for the Safe Operation of Ships" by the IMO Assembly [38,45,46].

The basic philosophy of the ISM code was expressed as "the most important of all international treaties concerning the safety of ships" by Bhattacharya [45] (p. 530). The ISM code attempts to give a comprehensive and appropriate method for all the vessels, including cruise vessels, to generate a sound Safety Management System (SMS), provide safety benefits to the public, and minimize mistakes caused by humans [46]. From a cruise line's perspective, an SMS can "provide for safe practices in ship operation and a safe working environment; assess all identified risks . . . and establish appropriate safeguards; and continuously improve safety management skills . . . ," according to the IMO [47] (p. 7). In the 84th session of May 2008, the IMO introduced a new Code of International Standards and Recommended Practices for a Safety Investigation into a Marine Casualty or Marine Incident (Casualty Investigation Code) when the Maritime Safety Committee (MSC) met in London [40,46]. The IMO Casualty Investigation Code requires the appropriate stakeholders to conduct a thorough marine safety investigation after each marine casualty that causes fatalities and/or damage to the environment and/or loss of the entire ship.

The IMO's MSC organized regular meetings at the organization's headquarters in London. The MSC aimed to improve maritime safety through legislation after the occurrence of incidents [29]. The MSC has held a total of 27 maritime safety sessions from 28 May 1997 to 19 January 2015 (i.e., sessions 67 through 94). Cruise ship safety was the key subject of 19 out of 27 MSC sessions. The cruise ship safety agenda appeared in the MSC 68th session (28 May–6 June 1997) for the first time. Under the MSC 69th session (1–20 May 1998), there was a trial application of the Formal Safety Assessment

(FSA) in the cruise ship field. It was proposed to revise the ISM code in order to upgrade the standard safe exercises in ship operations and maintain a riskless working context in the cruise industry during the MSC 70th session (7–11 December 1998). The enhancement of big passenger ship safety was firstly raised by Secretary General William O'Neil at the 72nd meeting of the MSC in May 2000.

In the subsequent sessions (i.e., sessions 73 through 79), the MSC conducted ship safety work plan revisions and highlighted the need to avoid fatalities and injuries due to the accidents that involve larger cruise ships. After that, the MSC discussed the changes needed in a risk-based assessment process, the amendment of SOLAS Protocol and FSA throughout sessions 80, 83, 84, and 86. On the other hand, the MSC sessions 81 and 82 mainly focused on revising the fire regulations on balconies. The elements associated with human factors started attracting more attention from the MSC. The incident of *Costa Concordia* had a remarkable influence on the cruise industry, and the MSC started making efforts towards the development of operational methods to improve the security and safety of big cruise ships during the 90th session from 16 to 25 May 2012. Throughout the 93rd session (14–23 May 2014) held at the headquarters in London, the IMO's MSC focused on revising the long-term action plan on cruise ship safety. In particular, the MSC introduced a set of new requirements, including installation of watertight doors and double hull in the engine room, compulsory adaptation of the Electronic Chart Display and Information Systems (ECDIS), and enhanced damage stability training [48].

A series of safety instruments and policies have been continuously updated and revised to prevent cruise ship accidents from recurring [38,42]. However, none of the MSC sessions specifically focused on cruise ship safety management in Asian regions. Cruise ship accidents continually occur in Asian regions. In the meantime, technological advancement has significantly changed the fundamental nature of the cruise industry over the past 25 years. In Asian regions, cruise shipping companies have witnessed a phenomenal growth of cruise ship capacity by 302% from 2008 to 2013 [49]. Some cruise shipping companies delivered ultra-large cruise ships, carrying 6000+ passengers. Asian regions have a number of islands and long coastlines that attract various cruise ships and bring millions of cruise travelers per year.

Cruise ships may pose quite a high risk of human casualties [3,50]. A fairly high accident rate has been recorded for cruise ships in Asian regions for several reasons. Firstly, Asian countries have implemented different maritime rules and standards. The variance in rules and standards is determined by different normal factors pertaining to population, per capita income, economic progression, and scale of the country [25]. Secondly, the cruise lines typically incline towards profit making and ignore safety issues [10]. In many cases, the cruise lines reduce their running expenditures through re-flagging of the ships to bypass the regulations imposed by flag states and employing low-qualification seafarers [46]. Thirdly, a fairly high cruise ship accident rate can be explained by insufficient training in Asian countries, lack of know-how, scare resources, and low awareness of the ISM code implementation. It seems that the implementation of different safety measurements has not been as successful in Asian regions [51]. Fourthly, human error remains one of the main causes of the cruise ship accidents in Asian regions (and in other parts of the world, as well).

Ek et al. [52] underlined that human factors can substantially influence the safety of cruise ships. A number of cruise shipping studies also confirm that around 80–85% of the total of serious casualties are due to human errors [3,11,39,53,54]. The UK Marine Accident Investigation Branch (MAIB) stated that human error remains the key reason behind maritime casualties [54]. Human errors stem from seafarers being required to perform extremely long working hours, as well as lacking restorative rest. Some seafarers have to operate with illnesses [50,53]. The IMO stated that human error may be caused by a lack of professionalism in cruise seafarers. The level of professionalism directly affects perception and performance [52]. Despite the technological advancements in the cruise industry that have been observed over the last three decades, human error-related cruise ship accidents continue to occur for the same reasons in many cases. For example, the collision of ferries *Lamma IV* and *Sea Smooth* in 2012, which caused the sinking of *Lamma IV* and substantial damage to *Sea Smooth*, along with 39 fatalities and over 90 injuries, was not the first collision due to human error and lack of compliance with the

safety standards. A principle question arises: Why do people continue making the same mistakes that cause cruise ship accidents as they did one century ago?

5. Review of the Factual Information from Cruise Ship Accidents

5.1. Descriptive Statistics

Figures 3 and 4 demonstrate the factual information from the cruise ship accidents in Asian regions. Starting in 1972, a total of 48 cruise ship accidents were recorded in Asian regions. The observed cruise ship accidents were classified into different categories in a comprehensive manner according to the IMO Casualty Investigation Code. In this study, we primarily focused on serious casualty accidents to explore the root cause of these events, as serious marine casualty accidents generally represent the largest number of insurance claims [53]. Figure 3 exhibits the total number of cruise ship accidents in Asian regions by reason from 1972 to 2014. From Figure 3, the most common causes were fire/explosion and collision, causing 27.1% and 25.0% of the cruise ship accidents, respectively. Capsizing/listing, hull/machinery, and stranding/grounding were found to be quite common causes as well, accounting for 18.8%, 10.4%, and 6.3% of the cruise ship accidents, respectively. Foundering, contact, and poor weather were found to be less common causes, each accounting for only 4.2% of the cruise ship accidents.

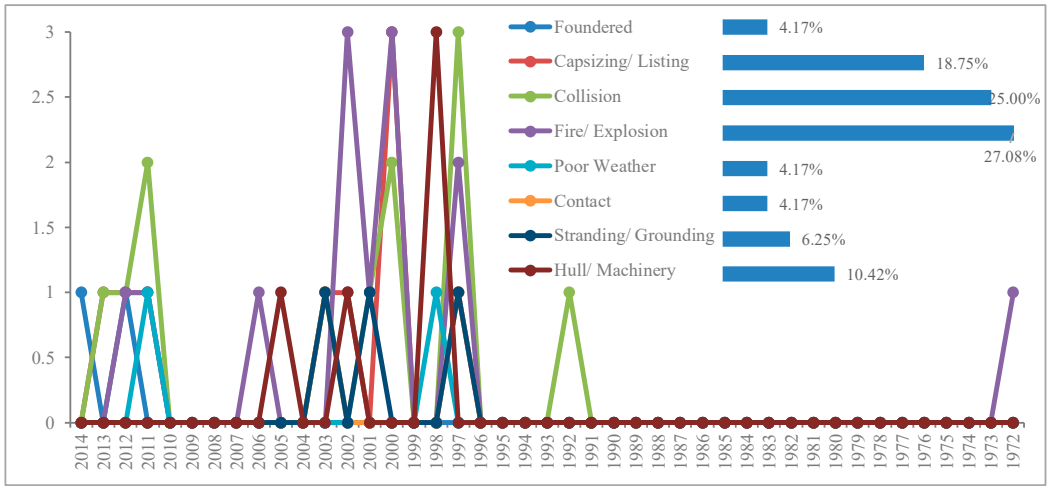

Figure 3. Main kinds of cruise ship accidents in Asia (1972–2014).

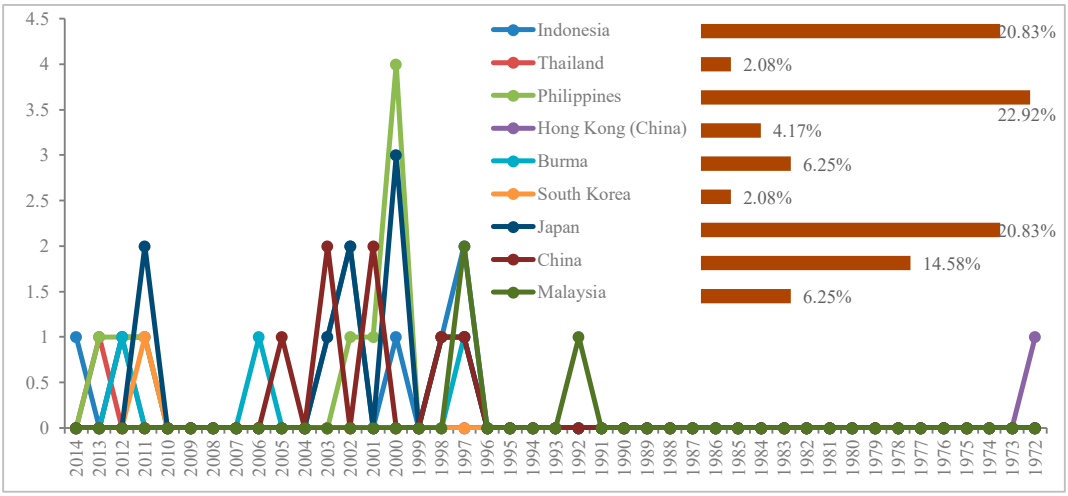

Figure 4. Cruise ship accidents in Asia by country (1972–2014).

In other words, the cruise ship accidents that were caused by human errors accounted for 95.8% in Asian regions. Poor weather caused only 4.2% of the cruise ship accidents. Based on the analysis of the collected data, it can be concluded that the majority of cruise ship accidents occurred between 1997 and 2002. No cruise ship accidents were reported between 1973 and 1991 for Asian regions. Furthermore, Philippines, Indonesia, and Japan accounted for the largest number of cruise ship accidents. In particular, 22.9%, 20.8%, and 20.8% of the cruise ship accidents occurred in Philippines, Indonesia, and Japan, respectively. Quite a significant portion of the cruise ship accidents were observed in China (i.e., approximately 14.6% of the cruise ship accidents). Malaysia, Burma, Hong Kong, South Korea, and Thailand recorded less than 7% of the cruise ship accidents each.

5.2. Case Studies

In this section, we choose and discuss three representative cruise ship accidents, including the following: (a) 2012 *Lamma IV*; (b) 1992 *Royal Pacific*; and (c) 1921 SS *Hong Moh*. Such case studies can be viewed as representative, as they discuss the features that are considered to be common among many other cruise ship accidents that occurred in Asia (i.e., many other cruise ship accidents in Asia were caused by the same reasons as the ones that were selected for the case studies). Although the 1921 SS *Hong Moh* occurred before the accidents that were described in Section 5.1 of the manuscript (i.e., before 1972, when the International Regulations for Preventing Collisions at Sea were implemented by the IMO), it is considered to be one of the earlier major cruise ship accidents in Asia that caused a significant number of fatalities and prompted the community to start paying more attention to cruise ship safety issues. The report for each cruise ship accident was prepared using the data available through the IMO and MSC.

5.2.1. 2012 *Lamma IV*

- A Hong Kong Electric Company-owned ship *Lamma IV* sank after colliding with a Hong Kong & Kowloon ferry named *Sea Smooth*, near Yung Shue Wan, Lamma Island, about 3 km (2 miles) southwest of Hong Kong island, on Monday 1 October 2012, at approximately 20:30 (HKT). As a result of this accident, 39 people died, 90 were rescued, and the number of missing people is unknown.
- *Sea Smooth* collided with *Lamma IV* on the port side at around 20:30 (HKT). The stern of *Lamma IV* was hit by the bow of *Sea Smooth*, breaking the two waterproof sections of the ship and hence, permitting the ship to speed up diffusing the water. The ship quickly capsized, sinking into the sea. During this accident, more than 100 passengers were thrown into the water unprotected, even though plenty of life jackets were available on the ship. The ferry *Sea Smooth* departed from the location and proceeded towards Yung Shue Wan pier after the accident. The bow of *Sea Smooth* was drastically damaged.
- The local Fire Services Department (FSD) deployed seven fire boats (associated with one diving assistant ship), and prepared ambulance, fire personnel and more than 20 emergency vehicles. Onboard barriers and low visibility hindered the salvage work.
- The salvage work had to proceed overnight since the FSD failed to determine whether there were any people remaining on the ship.
- *Sea Smooth* was slightly damaged in the collision and continued towards its destination. However, 99 people (95 passengers and four crew members) aboard suffered minor injuries.

5.2.2. 1992 *Royal Pacific*

- *Royal Pacific* sailed from Singapore on 21 August 1992 on a two-day cruise in international waters with a scheduled return to Singapore. The ship had 355 passengers and 179 crew members aboard.
- *Royal Pacific* was in a collision with the Taiwanese fishing ship *Teh Fu* No. 51 on 23 August 1992, in the Malacca Strait, approximately 12 miles off Port Dickson, Malaysia.

- As a result of the collision there was flooding, initially in the engine room and in the compartments immediately after. There was also pollution of the sea by the ship bunker fuel.
- The ship developed a starboard list and sank stem first in 86 m of water in position 02°27.4″ North, 101°36.3″ East.
- A rescue operation was begun. However, as a result of the accident three people died and six people remained missing.

5.2.3. 1921 SS *Hong Moh*

- SS *Hong Moh* sailed to Swatow from Hong Kong on 2 March 1921. There were 48 crew members and 1135 passengers on board the ship.
- The ship left Swatow on 3 March and set the course for Amoy.
- About two hours later (approximately at 7:20 pm), the weather deteriorated and SS *Hong Moh* struck the northwest point of the White Rocks near Lamock Island in poor visibility and rough seas.
- SS *Hong Moh* was broken into two pieces at 3 am on 4 March, and it was not possible to launch any lifeboats due to poor weather conditions.
- SS *Hong Moh* lost electrical power and was not able to make any signals to passing ships and request their assistance.
- Around 9 am SS *Shansi* approached the location of SS *Hong Moh* and attempted to launch several boats. Although some safety operations were not effective, SS *Shansi* stood by until the afternoon of 5 March, aiming to rescue the crew members and passengers who left SS *Hong Moh* and were trying to swim to safety.
- Some other ships attempted rescuing the crew members and passengers of SS *Hong Moh* (e.g., *Foxglove*, *Carlisle*).
- Despite multiple rescue efforts, this ship accident resulted in the loss of approximately 900 lives.

6. Discussion

Throughout the analysis of cruise ship accidents, it is critical to determine the rationale behind accidents that occurred in the past. Furthermore, identification of the reasons behind past cruise ship accidents will assist with minimizing potential occurrence of future events and implementing risk management procedure [3]. Starting in 1972, cruise ship accidents occurred with a relatively low frequency. However, quite a significant number of cruise ship accidents occurred in Asian regions after 1997. Based on a detailed review of the available data, it was found that 95.8% of the cruise ship accidents were the result of human error. Fire/explosion and collisions were identified to be the main causes of the cruise ship accidents observed in Asian regions. Only 4.2% of cruise ship accidents were caused by poor weather, which can be considered as a non-human-related factor. A combination of human errors caused even more significant impacts on cruise ship safety [55,56]. Therefore, the cruise shipping community and regulators are required to review the safety standards regularly to prevent human errors that may result in serious cruise ship accidents [3].

In our study, we selected three significant cruise ship accidents that occurred in Asian regions. These three accidents along with the supporting statistical information provide critical insights into the typical causes of cruise ship accidents as well as the resulting consequences. The 2012 *Lamma IV* event is considered to be one of the most severe cruise ship accidents in Hong Kong since 1970s. The Hong Kong Marine Department officials reported human error to be the main reason for the accident. Furthermore, the captain of *Lamma IV* and the crew did not receive adequate surveillance radar training. *Lamma IV* also did not meet the need to have a minimum of four crew requirements. As for the ship design, the Hong Kong Marine Department officials found that *Lamma IV* had a missing boat watertight door and inconsistencies between the ship and its design plan. After the accident, the Hong Kong Marine Department was required to make substantial changes in the ship's operational systems, working attitude, and cruise ship safety standards. For instance, marine surveyors and ship

inspectors are now mandated to report in writing any changes in the licensing conditions of a ship as well as inappropriate practices. New actions are also directed at strengthening the monitoring. Each cruise ship should also be equipped with a high-speed operations and training manual [57].

Since 1912, the 1992 *Royal Pacific* accident has been considered as one of the top 10 worst cruise ship accidents in the world. The accident happened when *Royal Pacific* and the Taiwanese fishing ship *Teh Fu* No. 51 had to sail through the Straits of Malacca at the same time. *Teh Fu* No. 51 collided into *Royal Pacific*. The cause of the collision was a joint failure of the bridge watchkeeping personnel on both ships to maintain an efficient lookout and to subsequently follow the International Regulations for Preventing Collisions at Sea. Furthermore, both ships ignored Rules 14 and 15 of the International Regulations for Preventing Collisions at Sea. Rule 14 states that two vessels are required to change course in order to prevent head-on collisions. On the other hand, Rule 15 states that, in case of a crossing situation, the ship that has the approaching vessel on its own starboard side should keep out of the way.

The last case study investigated the accident that involved the cruise ship SS *Hong Moh*, which struck the White Rocks near Lamock Island (Swatow) on 3 March 1921. The ship was broken into two pieces at 3 am on 4 March, and it was not possible to launch any lifeboats due to poor weather conditions. SS *Hong Moh* lost electrical power and was not able to make any signals to passing ships and request their assistance. Several ships attempted rescue missions (e.g., SS *Shansi*, *Foxglove*, *Carlisle*); however, some of the safety operations were not very effective. The ship accident due to the collision of SS *Hong Moh* with the White Rocks resulted in the loss of approximately 900 lives. Although the accident occurred during inclement weather conditions, some safety precautions and more coordinated rescue missions could have been implemented to prevent substantial collision impacts and reduce the number of deaths.

Based on a detailed review of the above three cruise ship accidents and statistical data analysis, it can be concluded that there are common causes. Compared with merchant ships, the cruise ship design is definitely more complicated. Cruise ships are required to operate as floating hotels (including heating facilities, casinos, theatres, sports centers, etc.). The design of cruise ships leads to more sophisticated ship maintenance [3,4]. Generally speaking, a cruise ship carries around 4000+ passengers in one trip. It is quite difficult for a ship's crew to address the demands of all passengers at the same time. Furthermore, cruise ships face operational challenges to provide speedy service under a short period of port turnaround time (i.e., within 24 hrs.). A short port turnaround time not only makes the crew members exhausted physically, but also increases the chances of overlooking necessary repairs and maintenance. As a result of long working periods, certain crew members may become sick during a cruise, which may cause additional human errors [3,50].

Cruise shipping companies have faced keen competition over the years. In order to increase profitability, cruise shipping companies tend to employ less qualified crew members. A number of cruise ship accidents occur due to insufficient manpower in the driving area. Some cruise ship operations are conducted in the absence of key equipment units (e.g., radar, night vision, and light). Many cruise ships still rely on obsolete maritime technologies. Another important factor consists in the fact that the crew members may come from various countries across geographical regions in a cruise. The crew members of different nationalities face problems of language and cultural barriers reflected in miscommunication and deviation from the instructions [3].

Generally, seafarers are able to improve their working attitude and knowledge via a set of comprehensive training programs. However, insufficient training, low safety awareness, scarce resources, and a lack of expertise in the ISM code implementation are found to be common in many Asian countries [46]. Some crew members do not even receive the basic training that is required in order to adequately perform necessary routine functions. From the cruise shipping companies' viewpoint, the implementation of safety plans and additional investments in the appropriate training of the crew members are not profitable economic decisions because of additional costs and the low probability of accidents. Typically, cruise shipping companies have a reactive strategy when it comes

to accident prevention, as they mainly analyze the post-accident events and take certain actions accordingly [3,58].

In the past few decades, the IMO has implemented a variety of safety campaigns and updated the safety standards from time to time. However, there are many differences between Asian countries in the same region that are the consequences of various political systems, legal systems, country scope, and economic development. Therefore, each region tends to adopt its particular maritime safety regulations and standards, irrespective of the IMO stipulation [25]. This study proposes that the Asian regions establish a well-trained and effective safety agency for apprehending and monitoring the incidents to adhere to the law. The majority of Asian countries exhibit deficient safety control systems and establish vague regulations and standards, while other countries take necessary actions in order to effectively meet the IMO requirements. Because of the differences in regulations, some cruise shipping companies tend to re-flag their ships to bypass the regulations enforced by flag states [46]. The regulation compliance issues may further increase accident occurrence in the main hot spot places of the Southeast Asian regions, including the Coral Triangle area [48]. Clearly, the existing ship registration system has a big loophole. As such, the United Nations Convention on the Law of the Sea (UNCLOS) should review the existing regional Port State Control (PSC) Memorandums of Understanding to achieve better control and inspection of vessels. Based on the cruise ship accidents that have occurred in Asian regions, UNCLOS needs to re-establish a "genuine link" concept between the state and each vessel under Article 91 of UNCLOS [59]. Such an approach would allow close monitoring of all the relevant information changes and all the transaction records that are associated with the ship ownership. Port states can also exercise jurisdiction over the ships calling at their ports under the port state mechanism "safety net" to explore substandard vessels [60].

7. Conclusions

This research provides a comprehensive review of cruise shipping safety in Asian regions. The cruise ship accident data were analyzed for the time period between 1972 and 2014. Through a series of quantitative and qualitative research analyses, we explored the general trends of cruise ship accidents in Asian regions for the past 42 years. A total of 48 unique cruise ship accident records were identified for Asian regions between 1972 and 2014. Based on the analysis results, it was found that human error caused 95.8% of the cruise ship accidents. Most of the accidents happened as a result of fire/explosion and collisions. Only 4.2% of the cruise ship accidents were caused by poor weather, which can be considered as a non-human-related factor. Along with a detailed review of statistical data, a set of case studies were conducted to provide more insights into the common causes and outcomes of the cruise ship accidents in Asian regions.

Some additional causes of cruise ship accidents were discussed throughout this study as well, including the following: (1) inability to conduct an adequate cruise ship inspection because of short port turnaround time; (2) certain crew members becoming sick as a result of long working periods; (3) lack of qualified crew members; (4) insufficient manpower; (5) absence of the key equipment and deployment of obsolete maritime technologies; (6) language and cultural barriers among the crew members; (7) insufficient training and low safety awareness of the crew members; (8) ship re-flagging to bypass the regulations enforced by flag states; and (9) regulation compliance issues.

The outcomes of this study are expected to help cruise shipping companies to better understand the factors influencing cruise ship accident occurrence and to construct appropriate safety policy measures, aiming to prevent cruise ship accidents in Asian regions. In this study, we mainly use the qualitative research approach with the adoption of three historical case studies. To some extent, this study cannot generalize certain research findings. In order to address such a limitation, the scope of future research for this study includes the following extensions: (1) conduct a set of interviews with the representative cruise shipping companies to confirm the common causes of cruise ship accidents and the best practices they use to improve cruise ship safety; (2) identify the best practices that are used by the leading cruise shipping companies for appropriate training of the crew members before

they are admitted on cruise ships; (3) develop constructive recommendations for addressing the existing challenges that are associated with the outdated technology deployment on some cruise ships; (4) conduct a set of interviews with the International Maritime Organization representatives to determine how the existing cruise ship safety issues will be addressed in the nearest future; and (5) compare the cruise ship accidents in Asia with the cruise ship accidents that occurred in the other geographical regions. We expect that the identification of causes, the derivation of best practices, and the generalization of study findings will be further improved upon completion of the aforementioned future research activities.

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