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Investigation and analysis of cruise safety in Asia

Linpei Yang

WORLD MARITIME UNIVERSITY

Dalian, China

INVESTIGATION AND ANALYSIS OF CRUISE SAFETY IN AISA

By

YANG LINPEI

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DECLARATION

I certify that all the materials in this dissertation that are not my own work have been identified, and that no materials are 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.

Signature: Yang Linpei

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Supervised by:
Yang Linjia
Professor
Dalian Maritime University

Assessor:
Co-assessor:

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ABSTRACT

Title of research paper: **Investigation and Analysis of Cruise Safety in Asia**

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The cruise, which provides customers with pleasant marine entertainment, has become a popular way for people to enjoy life. With the development of economy, it has driven the rapid expansion of the cruise industry and the intention of expanding the cruise scale, especially the development of Asia, which has become a new goal of cruise development. Although cruise accidents are rare compared with merchant ship, but with the increase of large-scale cruise and passenger capacity, the safety of cruise has attracted the attention of the global media. In addition, some regulators are questioning the safety practices of the cruise industry. In order to improve the safety of cruise ships, the International Maritime Organization (IMO) and the Cruise Lines International Association (CLIA) have issued a set of policies and measures to strengthen the safety of cruise ships. However, the expansion of vessels and relatively weak safety regulations continue to pose a risk of casualties in cruise accidents. Especially in Asia, although the Asian countries have been implementing various safety measures, but serious cruise accidents still occur from time to time. This paper uses two-stage method to evaluate 35 cruise accidents in Asia from 1999 to 2019 and combined with case analysis method to understand the nature of the current Asian cruise industry accidents and find out the causes and potential risks of the them. The application of this method provides a new perspective for the study of disaster assessment, that is, the assessment of reported accidents. Then the accident causes are evaluated and classified by using the accident report data. Finally, it concludes that human factors are still the root cause of Asian cruise accidents. Then, through the questionnaire investigation of M/V COSTA ATLANTICA, this paper summarizes the current practices of Asian cruise companies, in order to reduce the impact of human factors on ship safety, so as to analyze them, and put forward views and suggestions on the future development of Asian cruise.

KEY WORDS: Asia cruise, Safety, Human factor

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LIST OF ABBREVIATIONS

IMO	International Maritime Organization
SOLAS	Convention for the Safety of Life at Sea
CLIA	Cruise Lines International Association
FSA	Formal Safety Assessment
GISIS	Global Integrated Shipping Information System
HFACS	Human Factors Analysis and Classification System
NTSB	National Transport Safety Board
CAGR	Compound Annual Growth Rate
AcciMap	Accident Analyze Mapping
TRACEr	Technique for Retrospective & Predictive Analysis of Cognitive Errors
CREAM	Cognitive Reliability and Error Analysis Method
BN	Bayesian Networks
SMS	Safety Management System
ISM	International Safety Management Code
MSC	Maritime Safety Committee
IUMI	International Union of Marine Insurance
NGO	Non-Governmental Organizations
OI	Operational Accident
PSC	Port State Control
ERP	Emergency Response Plan

1. Introduction

Cruise ship is known as "destination without destination" and "floating resort on the sea", which is an indispensable part of today's world tourism and leisure industry. It was originally a mean of transportation for transporting goods or passengers. Until the beginning of the 20th century, some cruise ships began to provide limited basic facilities for passengers, such as room and restaurant services. Until the beginning of the 20th century, the aviation tourism industry reached a prosperous period, which had a huge impact on the original ocean passenger transport business, then the ocean passenger transport business officially stopped operation in 1986. But at the same time, Cunard Lines has found a niche market that can be exploited, because the passengers prefer ocean cruising as entertainment. That is to say, cruise can be loved by passengers as a new way of entertainment. As many companies join the cruise industry and invest in building cruise ships with more luxurious facilities, richer programs and more displacement, cruise has been proved to be one of the fastest growing vacation projects in the past 20 years (Holt & Wang, 2014). According to the statistics of the CLIA, in 2019, the number of global cruise tourists reached 30 million, a year-on-year increase of 6%, higher than the 28.2 million originally predicted by CLIA, and the growth rate exceeded expectations.

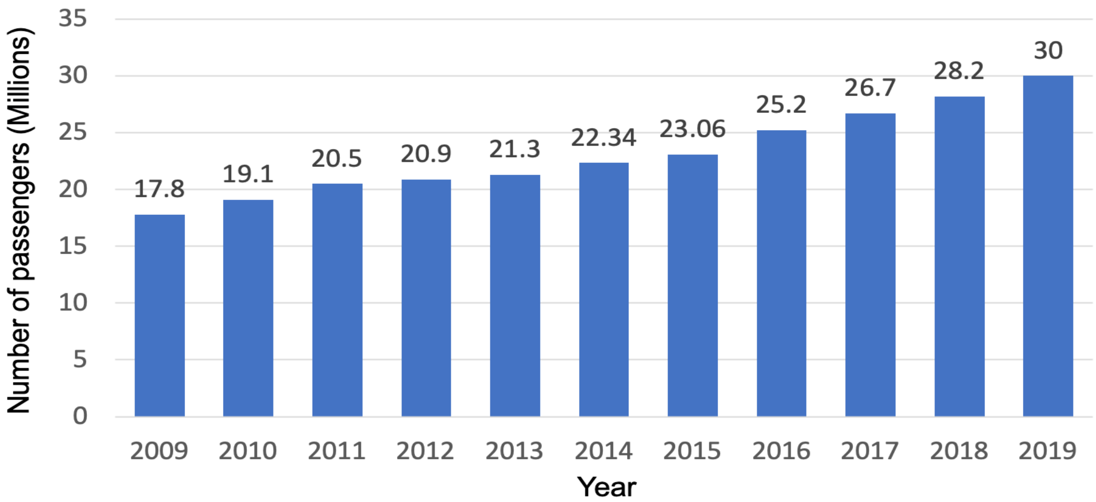

Figure 1- Global Ocean Cruise Passengers (2009-2019)

Source: Cruise Lines International Association (2019), Cruise trend & industry outlook

However, with the development of Asian economy, in order to maintain the sustainable development of the industry, International cruise line companies are expanding their business to emerging markets, especially in the Asia Pacific region, such as Royal Caribbean Cruise Line, Princess Cruise Line and Costa Cruise Line have begun to deploy larger cruise fleets in the Asia, which is considered to be the most dynamic and fastest growing cruise market (Lee & Ramdeen, 2013). In Asia, the industry has recorded 4.24 million passengers in 2018, accounting for more than 15% of the global cruise market, and the growth is higher than average.

In recent years, we have seen several remarkable disasters or cruise accidents. With the 2012 M/V Costa Concordia disaster and the subsequent M/V Carnival Triumphal event, the issue of cruise ship safety began to surface. Although the IMO has clear legal requirements according to the Convention for the Safety of Life at Sea (SOLAS), and Port States even Flag State have strict regulatory systems for the industry, the rapid development of the news media and the high exposure rate of security incidents also make the cruise industry at the top of the storm, since they have to face more security related investigations and other legal actions, the IMO has begun to investigate some of the causes of these incidents and industry practices to address new potential cruise regulations. As early as the mid-1990s, IMO adopted the recommendations of the British Maritime Safety Authority, introduced and applied Formal Safety Assessment (FSA) methods and concepts to the maritime industry, in order to get some recommendations and suggestions on improving maritime safety. In the process of using FSA for research, we must fully consider the factors of human, ship, environment, management and their respective relevant factors. Although there is a large amount of academic literature on maritime disasters, but for an industry with "explosive growth", the academic literature on cruise tourism is "surprisingly small" (Wood, 2000). However, there are few studies on the review and analysis of cruise accidents, especially in Asia. IMO has introduced and launched 18 regional projects and plans for Asian countries to improve the safety performance and reliability of maritime activities (Zhu, 2006). In 2018, nearly 25% of ship accidents occurred in Asia, and it is still a hot spot for ship accidents (Allianz Global Corporate & Specialty, 2019). Based on 35 cruise accidents in Asia which selected from Global Integrated Shipping Information System (GISIS) database from 1999 to 2019, this paper reviews the requirements of the SOLAS for the development of cruise ships, and holds that human factors, including human error and improper organization, which are playing decisive roles in maritime accidents especially for Asian cruise ships. Although the safety is constantly improving with the progress of science and technology, there are still many problems related to the safety factor of Asian cruise ship need to be solved. It not only has common features with other cruise markets in the world, but also has strong characteristics due to the differences in geographical location and cultural. Therefore, cruise companies instead of coping their inherent operation mode mechanically while shifting their development focus to Asia, they should learn from the excellent existing experience and improve the system according to local conditions in combination with the special situation of Asia, so as to reduce the impact of human factors on the navigation safety of Asian cruise ships in essence.

2. Literature review

2.1 Literature review on cruise ship mishaps

Due to the personnel density and property aggregation of cruise ships, even if the risk of danger is very low, the safety problem is perceptual, especially the perceptual reaction to life and property, which makes the cruise events highly concerned by the media and the public. One of the top ten safety issues emphasized by National Transport Safety Board (NTSB) in 2014 is advanced passenger ship safety (Holt & Wang, 2014). Once the accident happens, the consequences are unimaginable, so it is imperative to pay attention to the cruise safety, in order to reduce accidents and save lives. Even so, most of the academic research on the cruise industry tends to focus on the development of the cruise market, the choice of port geographical location, the selection and deployment of voyage and destination, etc., and the attention to cruise failures and accidents is very limited. In particular, the cruise industry in Asia is just in its infancy, and the research on cruise safety in Asia is almost blank.

Yue, J., Dulebenets, M. A. & Lau, Y. (2020) discussed the safety problems of Asian cruise ships before 2014 by using the method of actual case analysis, and pointed out that the special navigation conditions in Asian waters and the different policies of local governments have a certain impact on the safety problems, but human error is still the main reason for the insecurity of cruise ships.

Puisa, R., Lin, L., Bolbot, V. & Vassalos, D. (2018) investigated the severity of injuries in passenger ship accidents and analyzed the role of broader socio-technical background in the causes of accidents. These interactions are classified according to their causes, conditions leading to their dysfunction, and causal categories. Then, the determined interaction is mapped to the functional model of maritime safety control to highlight its weakest link and to put forward the possible explanation behind the maritime accident.

Mileski, J. P., Wang, G. & Beacham IV, L. L. (2014) used a two-stage analysis measurement to analyze the safety problems of cruise ships before 2012, and summed up the proportion of safety problems caused by ship design, human factors and maintenance, as well as the interaction of the two or three. It is found that due to the progress of science and technology, it will be difficult to make a greater breakthrough in ship design. The focus of future development should be to further reduce human errors and constantly improve the maintenance system.

Lu, C.S., & Tseng, P. (2012) did not conduct a direct study on cruise safety, but they assessed the safety of ferry. They used empirical methods to determine the key safety evaluation criteria, and found that the ability of crew is the most important factor to evaluate the safety of passenger ferry, that is, enhancing the quality of crew and standardizing the recruitment screening conditions are the effective barriers to improve safety. The safety equipment, ship structure, navigation, communication, inspection of ship documents and safety instructions stipulated by the law cannot play a decisive role, because it is people who operate the ship in the end.

Talley, W.K., B. D. J., & Kite-Powell, H. (2008) studied the determinants of property damage and injury severity caused by cruise ship accidents. In their study, they assessed the loss costs of various types of accidents, including collisions, equipment failures, fire explosions, leaking, grounding, separation, overturning and sinking. They found that the risk of casualties caused by fire and explosion is the highest in cruise accidents, and the risk of crew injury in ocean cruise accidents is higher than that in inland cruise accidents. In addition, they determined that human factors were more likely to increase fatal and non fatal injuries than environmental factors.

Lois, P., Wang, J., Wall, A. & Ruxton, T. (2004) discussed cruise ships from the perspective of pre disaster. They evaluated nine case studies and proposed safety assessment methods. Finally, it concluded that there are four possible countermeasures to be taken before the cruise safety accident. First, interventions can prevent certain disasters, with equipment, training, detailed procedures and preventive maintenance as appropriate interventions. Second, they listed pre accident interventions, in which enhanced investigations, communication equipment, alarms, remote sensors and routine evolution checklists were necessary. Third, the exercises to deal with common events and the special procedures for high-risk evolution are the intervention measures before the event. Finally, they listed the interventions before the consequences of the incident, such as response planning, emergency drills, life-saving equipment, emergency instructions and crew training.

2.2 Literature review on human factor

Generally speaking, more than 80% of marine accidents are caused by human factors (Antao, & Soares, 2008). Many scholars use different models to analyze from different angles. For example, the Human Factors Analysis and Classification System (HFACS) is used to establish a framework for maritime accident analysis (Chen, Wall, Davies, Yang, Wang & Chou, 2013). Accident Analyse Mapping (AcciMap) is used to evaluate the impact of human factors on ship grounding accidents (Akyuz, 2015). Technique for Retrospective and Predictive Analysis of Cognitive Errors (TRACEr) and Bayesian Networks (BN) are used to calculate the probability of collision accident caused by human error (Sotiralis, Ventikos, Hamann, Golyshev & Teixeira, 2016). The probability of human error in maritime accidents is predicted and estimated by using the modified Cognitive Reliability and Error Analysis Method (CREAM) based on evidential reasoning (Wu, Yan, Wang & Guedes, 2017).

Galieriková, A. (2019) analyzed the investigation report of maritime accidents based on the HFACS, revealed human errors, classified human factors from unsafe behavior, unsafe supervision and organizational factors, and created safety intervention measures through people-oriented technology, organization and work environment design, so as to reduce the risk of maritime accidents.

Lan, Y. (2018) studied the human factors of cruise safety management and put forward that the cruise safety management is an integrated system. The management of human and organizational factors is more important than hardware equipment. The prevention and improvement of safety risk is more effective than the post investigation processing; the rational planning of the overall function and the cultural agglomeration are safer than the traditional shipping mode. Intervention measures and suggestions on human factors affecting cruise safety are put forward from three aspects of ships, companies and competent authorities.

Zhao, W. X., Liu, Y. Q. & Cao, X. (2018) Seamen's professional quality directly affects the probability of human error. By comparing the differences of seafarer training modes between China and the Philippines, it analyzes the differences of seafarer competitiveness between the two countries, finds out the fundamental reasons, and puts forward the direction and methods that China needs to innovate in seafarer education and training mode in the future, so as to improve the overall quality of Chinese seafarers and provide a solid foundation for the development of Asian cruise ships.

Yip, T.L., Jin, D. & Talley, W.K. (2015) used Poisson regression and empirical data of ferry, ocean cruise, and river cruise vessel accidents which obtained from the U.S. Coast Guard to investigate the determinants of passenger ship accident injuries and the relationship between passenger and crew injuries in passenger ship accidents. The empirical results show that there is a positive correlation between the number of passengers injured and the number of crew injured. It is concluded that the safety of the passengers on the passenger ship depends on the safety of the crew on the passenger ship. We can improve the safety of passengers and crew on the cruise ship by effectively training the crew and improving their professional quality, in order to improve the safety factor of the cruise ship and reduce the risk of accidents.

Chauvin, C., Lardjanes, S. & Morel, G. (2013) have studied the HFACS model, applied the improved HFACS model in the research of ship collision accident, and then analyzed the improved HFACS model combined with the classification tree method, and found out the causative factors and key factors at all levels.

Hanninen, M. & Kujala, P. (2010) have made statistics on ship collision accidents in the Gulf of Finland, and combined with Bayesian network, studied the human factors in the accidents, and analyzed the causal relationship between the collision accidents and their results

Cebik, M. & Cebi, S. (2009) have used HFACS model for maritime traffic accidents and uses fuzzy analytic hierarchy process (FAHP) to determine the lowest level of human factors in the model.

Hetherington, C., Flin, R. & Mearns, K. (2006) have sorted out the main research problems of human factors in ship accidents and considered that effective supervision and control of human factors is beneficial to improve the level of ship navigation safety.

3. Research questions and methods

3.1 Two-stage measurement design

In this paper, the two-stage measurement design is used to evaluate the cruise accidents in Asia, and the nature of the causes of cruise safety accidents is analyzed. Combined with the actual operation of today's cruise industry and the past progress and improvement, the research gap is filled (Fischer, Cullen & Turner, 2000). Regardless of any step of analyzing any problem, the most important premise is to determine what happened in the past. Finding the root cause of the problem is the first step to solve the problem. The two-stage measurement method is a new method to study disasters in Sociology of crime reporting. It first determines the causes of disasters, and then determines the causes of disasters. With the analysis parallelism of two-stage measurement, we can analyze "what happened?" and "what caused it?" at the same time, the two problems are analyzed to obtain more convincing results. This method relies on descriptive statistics in the report results, uses the characteristics of qualitative analysis to conduct in-depth case studies, and quantitative analysis focuses on panel data with time series and cross-sectional dimensions. In the implementation of this method, the first step is to define the respondents, so as to limit the scope of search to "Asian cruise disaster". The second step is to determine the time interval of the survey, so as to screen out the respondents in this period. The third step is to collect and review the data of the respondents who meet the requirements, and then integrate and analyze the causes of the accident. Finally, accidents must be classified in a systematic way to determine the pattern of causality. It is worth mentioning that the definition of disaster in this study refers to the cruise events with safety problems. As long as there are reports of accidents that have a negative impact on the operation of the ship, no matter how serious they are, they will be included in the scope of investigation. However, it should be emphasized that this investigation does not involve disease outbreaks, safety and sexual assault, and other emergencies that do not involve the safety of the ship itself. The purpose of this study is to provide a broad overview about the Asian cruise accidents. Compared with other types of ship accidents, the incidence of cruise accidents is lower, but the indirect cost of economic loss and social impact is much higher than other ships. The prevention scheme may be very different from merchant ships. Therefore, it belongs to the use of multiple sources of evidence in multiple cases and multiple time periods. The ability to prevent accidents can be evaluated in a way like crime prevention, that is, to solve the problem of prevention by understanding the types and causes of cruise ship accidents.

3.2 Data collection and resource

The detailed information of the cruise accident can be obtained through the reported event file data set, which can be used to evaluate the situation when the accident occurred and classify the causes of the accident. In addition, data sets are selected to achieve standardized measurements between events and years, thus providing effective comparability. The data set information of this study is based on GISIS ship accident database developed by IMO. the "marine ship accident" module of the database records the data of marine ship accidents from 1900 to 2020, including the actual ship accident data collected through various channels and the more detailed information in the casualty investigation report received by IMO, which is used to analyze the accident data, prevent and reduce similar ship accidents (Mileski, Wang & Beacham IV, 2014). GISIS database divides ship accidents into collision, grounding, collision and collision, structural failure, accidental injury and death such as sudden illness and accidental fall of passengers or crew. This paper holds that it is meaningless to consider the types of accidental injury and death to improve the safety of ships. Therefore, it is not included in ship accidents. At the same time, due to the late construction of GISIS database, the analysis data of many early ship accidents are incomplete, and the Asian cruise started late, with fewer early accidents. (Li, Tang & Zhang, 2018) Recently the whole cruise industry is in a state of abnormal stagnation due to the emergence of COVID-19. Therefore, only the cruise accidents in Asia from 1999 to 2019 are taken as the analysis basis. Thought the website: www.cruisejunkie.com which was produced by Dr. Ross A. Klein of St. John's Memorial University of Newfoundland, we can take the cruise accident reports from 1979 to 2012 as the reference template to summarize and analyze the cruise accidents in Asia from 1999 to 2019. Use the multiple archive sources including Lloyd's List Casualty Report, IHS Fairplay, Cruise Industry News Quarterly, US Security Exchange Commission Filings, various transportation and maritime incident reports from government which include but are limited to Transport UK Marine Accident Investigation Branch, Italian Ministry of Infrastructure, US NTSB, Australian Transport Safety Bureau, Canada NTSB, Republic of Liberia Bureau of Maritime Affairs, USCG and Marine Safety Investigation Unit — Malta Transport Center. Finally, in order to confirm whether the data set is reasonable and comprehensive, we confirm that all cruise ship deaths reported in the Lloyd's register of shipping global casualty report appear in the data set. Therefore, based on the number of events and the years covered, this seems to be quite accurate and the archival data set is considered objective and valuable.

4. Cruise Development in Asia

4.1 Current situation

In 2018, the global ocean passenger volume was 28.5 million, and the total number of cruise passengers in Asia was 4.24 million with increase of 4.6%, which was a record high. It can be clearly seen from Figure 2 that the number of cruise passengers in Asia has changed in recent years the recent five years. Compound Annual Growth Rate (CAGR) of Asian port throughput was 14%, and the growth rate was 88%. Especially the popular destinations such as China, Japan, Philippines, India and Indonesia have shown a higher rate than the average of the rest of Asia (CLIA, 2019). Asia as the third largest cruise market after North America and Europe, accounted for a 14.8% share of the total global ocean passenger volume compared with 15.1% in 2017. The passenger volume of 4.02 million Asian cruise passengers in 2019 is slightly reduced by 5.7% compared with that in 2018, which is not surprising, because after years of rapid expansion, the cruise capacity in 2019 was declined (Pasternak, 2019). From the micro point of view, the reason for the slowdown of Asian ship capacity is that covid-19 first broke out in Asia at the end of the year, which directly affects the development of Asian cruise. From the macro point of view, the global demand for cruise is strong, while the choice of short-term cruise itinerary outside the mainland of China is reduced. But overall, the five-year compound annual growth rate of passenger traffic in Asia since 2014 is 122%. In 2019, 39 cruise brands, including Costa cruise line, Granting Cruise Line, Royal Caribbean Cruise Line and MSC Cruise Line, were sailing in the Asian waters, with a total of 79 cruise ships deployed, the number of ships deployed in Asia has increased by 58% since 2014 (CLIA, 2019). Some Asian destinations are also building new infrastructure to support cruise development. In the future, as the most important source of Asian cruise passengers, China will take the lead in easing the epidemic of COVID-19, rely on the vigorously support from Chinese government, a large number of second-hand cruise ships start to flow into the Asian market, self-built cruise ships will be launched in the near future, which will further expand the development scale of Asian cruise ships.

In fact, senior executives of CLIA described the Asian cruise market as "work in progress" as well, with Asian and Chinese routes accounting for 9.2% of cruise deployment, lagging European (11.1%), Mediterranean (17.3%) and Caribbean (34.4%) markets. Nevertheless, cruise operators hope to deploy more widely in the region, and firmly believe that Asia, as a niche market for cruise ships, is worth maintaining its long-term expansion policy. "The popularity of cruise lines in Asia is expected to further increase in the next few years as cruise companies deploy new large cruise lines designed for Asian consumers," said by Joel Katz, who is the Managing Director of CLIA Australasia and Asia. "A new generation of ships will replace the old ones in Asia, and the new cruise infrastructure in several Asian destinations is expected to arouse strong interest among tourists." Katz added.

Table 1 - Trends and numbers of cruise travelers in Asian regions

	Japan	East Asia (China & Korea)	Sub-Total (Asia)	Total (Global)	Proportions of Asia to Global	Growth Rate (Global)	Growth Rate of (Asia)
2005	0.23	0.44	1.07	13.6	8%	N.A.	N.A.
2010	0.27	0.72	1.54	18.0	9%	29.5%	43.9%
2015	0.32	1.00	2.02	22.6	9%	11.1%	31.2%
2020	0.36	1.20	2.38	27.0	9%	19.0%	17.8%

Source: Yue, J., Dulebenets, M. A. & Lau, Y. (2020). Cruise ship safety management in Asian regions: trends and future outlook.

4.2 Cruise scale in Asia

At present, cruise ships are divided into several different scales according to their service objects, consumption levels and route destinations. For example, the largest and most advanced mega cruise ship in the former market can accommodate more than 5000 passengers. Large and medium cruise ships with capacity of 1000-3000 passengers dominate the market. The above-mentioned large cruise services are designed to provide familiar leisure tourism routes and destinations for the public. There are small luxury cruise ships, which can generally accommodate hundreds of passengers, providing high-end marine tourism experience through water, island and culture, eco-tourism, history and marine sports. In addition, expeditionary / niche cruisers are exclusive experiences designed for remote waterways or destinations such as the Antarctica and the Arctic. But this kind of cruise ship serves only a few passengers at one trip, due to the safety and environmental reason (Wind Rose Network, 2020). In Asia, most ships are large and mega cruise ships. According to CLIA's report, a total of 79 cruise ships set sail in 2019, 13 of them operated throughout the year, and another 22 operated for five months or more. Among the cruise ships deployed, 26 mid-sized cruise ships account for the largest share, followed by 22 small upscale cruise ships. These two types of ships are also favored by the industry and are expected to continue to increase significantly in the future. However, due to the huge gap in passenger capacity, 18 large cruise ships and 7 mega cruise ships still bear the vast share of passenger flow in the Asian market. In addition, there are 6 expeditionary / niche cruise ships, which are basically the same as in previous years (CLIA, 2019). The evolution of cruise deployment in Asia is shown in Figure 2.

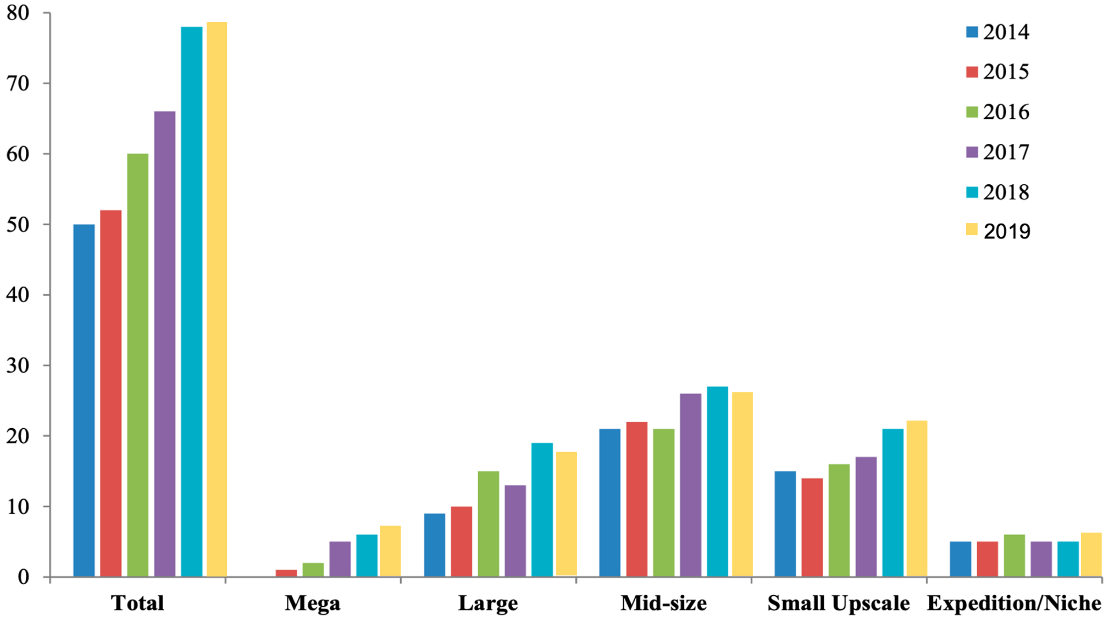

Figure 2 - Cruise ships in Asia by size (2014-2019)

Source: Asia Cruise Industry Ocean Source Market Report. (2019). https://cliaasia.org

5. Review of safety regulations

5.1 Formulation and development of passenger ship regulations

The formulation of international conventions is one of great significance to the safety of ships. Ships can be regulated and restricted to the greatest extent based on the provisions of the conventions. The journey to safer shipping is long, and the progress of international conventions depends on the bloody lessons learned time and time again. On April 14, 1912, the sinking of the Titanic caused the death of more than 1500 passengers and crew, causing the most famous shipping tragedy in history, which aroused the public's doubts about the safety standards of life at sea. Therefore, the British government proposes to convene an international conference to formulate international rules. The meeting was attended by representatives of 13 countries, and the SOLAS formulated at the meeting was adopted on January 20th, 1914, from which the first law on maritime safety was officially born. The Convention imposed new international requirements on safe navigation for all ships. Since then, the shipwrecks have put forward higher requirements to strengthen the personal safety onboard, and the SOLAS has been constantly updated and revised in response to the major passenger ship accidents.

For example, In March 1987, the M/V Herald of Free Enterprise sank just after leaving the port of Zeebrugge in Belgium, resulted in the death 193 passengers and crew members, this accident directly led to the amendment to improve the stability of passenger ships. Based on accident investigation, it is required to review and take a series of thoughts on the integrity of the hull and superstructure. Finally, it is required that the watertight compartment should be equipped with an indicator to show the opening and closing of the watertight door. It is also required that TV monitoring or leakage detection system and other facilities should be installed to show any leakage of the watertight door that may cause serious leakage of the compartment. In 1988, a fire broke out on the M/V Scandinavian Star and 158 people died, which led to the adoption of the SOLAS amendment to the new fire protection standard in April 1992. The amendment improves the fire safety measures of existing passenger ships, including mandatory installation of smoke detection, alarm and sprinkler systems around residential and service spaces, stairs and corridors. In addition, the installation requirements of emergency lighting, general emergency alarm system and communication facilities have also been implemented.

In order to ensure the safety of the sea, IMO summed up and drew lessons from the modern management ideas and methods in many fields of the world, combined with the characteristics of shipping management, adopted Resolution A.741 (18) in 1993, and formally put forward the International Safety Management Code (ISM). Subsequently, the IMO assembly incorporated it into SOLAS as Chapter IX "Management for the safe operation of ships" (Mukherjee, 2007). The basic idea of ISM as the most important of all international treaties on ship safety (Bhattacharya, 2012), it tries to provide a comprehensive and appropriate method for all ships to produce a sound Safety Management System (SMS), so as to reduce human errors as much as possible (Batalden & Sydnes, 2014). From the perspective of cruise companies, SMS can assess all identified risks and formulate corresponding safeguard measures to continuously improve safety management skills, so as to provide safe practice and working environment for ship operation (IMO, 2002). Maritime Safety Committee (MSC) regularly holds meetings at its headquarters in London, as of November 11, 2020, the MSC has held 102 meetings, aiming to improve maritime safety through legislation after the accident (Hassel, Asbjornslett & Hole, 2011). The agenda on cruise ship safety first appeared in the 68th session of the MSC, and then almost every meeting was inseparable from the discussion on cruise ship safety. For example, during the 69th session of MSC, FSA was tried out in the field of cruise ships. During the 70th session of the MSC, it is recommended that the ISM Code should be revised in order to enhance the standard safety exercise of ship operation and maintain the risk-free working environment of the cruise industry. In May 2000, at the 72nd meeting of MSC, former IMO Secretary General William O'Neill proposed for the first time to strengthen the safety of large passenger ships, and MSC revised the ship safety work plan during the 73rd to 79th meetings. In the 81st meeting, the fire protection of cruise balcony was discussed in depth, and the need to avoid casualties caused by the safety of large cruise ships was emphasized.

The attraction of cruise lies in the opportunity to visit remote areas of the world, which greatly increases the difficulty of providing search and rescue assistance from shoreside in case of emergency. Therefore, based on the concept of "the ship itself is the best lifeboat", MSC passed Resolution MSC.216 (82) in August 2006, namely Safe Return to Port (SRtP) requirement was adopted, which means that passenger ships with a length of more than 120m or more than three Main Vertical Zones (MVZ) built after July 1, 2010, need to meet the requirement that they can reach the nearest safe port by their own power in case of fire or flood within the casualty threshold, it greatly improves the requirements of ship survivability. Then, at the 80th, 83rd, 84th and 86th meetings, the changes needed for risk-based assessment process, amendment of SOLAS protocol and FSA revision were discussed respectively.

One hundred years after the sinking of the Titanic, on January 13, 2012, the modern cruise M/V Costa Concordia, carrying 4229 passengers and crew, ran aground on a reef off the Italy Giglio Island, 32 people were killed. As a result of this accident, the safety of large passenger ships has once again attracted great public attention, and the potential safety hazards related to human factors have also triggered more discussions, 27 member states of the European Union, the United States, the CLIA, the International Union of Marine Insurance (IUMI) and the other Non-Governmental Organizations (NGO) have respectively submitted a comment document to the IMO. Therefore, during the 90th, 91st and 92nd sessions of MSC, the mandatory implementation of cruise ship emergency response and muster policy were carried out; recording the nationality of persons on board; Revisioning of " Guidance on Voyage Planning" was incorporated into the long-term plan for passenger ship safety as an unplanned output; non navigational personnel on duty were restricted to enter the bridge to avoid unnecessary disruptions and distractions to the bridge team; the number of spare life jackets should not be less than the number of passenger in each MVZ; at least one lifeboat to be loaded and released with a quantity consistent with its certified maximum passenger capacity every 6 months for training purpose, etc. such items have been conducted in-depth research and discussion. Finally, the revised MSC.1/Circ.1446/ Rev.1, which is a temporary measure to improve the safety of passenger ships, was reviewed and approved. During the 93rd session of MSC held in London headquarters, the long-term action plan focusing on cruise safety was revised. In particular, the MSC has put forward a series of new requirements, including installing watertight doors and double bottom hull in the engine room and instructing the crew to enhance the damage stability and survivability of ship (MSC, 2014). In the 98th session of MSC, the implementation of E-navigation strategy and operational safety is proposed, the MSC.421 (98) was adopted which as well related to SOLAS 2020 stability amendment, it improved the requirements of passenger ship stability in case of damage. The probability damage stability evaluation method is still used, but compared with SOLAS2009, the required subdivision index is further increased, which requires higher requirements for the stability and survivability of passenger ships (IMO, 2017).

5.2 Summary Analysis and Recommendations

Although a series of safety measures and policies are constantly updated and revised to prevent the recurrence of cruise accidents (Knudsen & Hassler, 2011). However, according to the relevant legal provisions of SOLAS, it only distinguishes between passenger ships and cargo ships, and defines a ship carrying more than 12 passengers as a passenger ship. However, considering the huge differences between cruise ships and ordinary passenger ships and Ro / Ro passenger ships, such as the large number of passengers, the high cost of the ship itself, and the frequent port entry and exit, more targeted legislation should be implemented for cruise ships.

Moreover, for Asian cruise ships, the relevant laws and regulations of safety management are not enough, and the implementation of different maritime rules and standards leads to the continuous occurrence of accidents. The differences in rules and standards are determined by different normal factors related to population size, economic development level and national territory size (Zhu, 2006). However, so far, there is no MSC discussion force on the Asia cruise ship safety. At present, the further restriction and regulation of cruise safety requirements mainly depends on the conscious internal procedure and requirement of cruise companies, which leads to the system blind spot in the process of cruise safety supervision and management.

6. Factual information analysis of cruise accidents

6.1 Descriptive statistics

6.1.1 Global cruise incident

According to G. P. Wild (International) Limited report, Significant Operational Accident (Significant OI) is defined as: the delay of the announced journey of the ship for more than 24 hours; the death or serious injury of passengers and crew. Minor Operational Accident (Minor OI) is defined as: the vessel is delayed for 24 hours or less in violation of the published itinerary; passengers and crew are slightly injured. It has analyzed the global cruise accidents from 2009 to 2019, as shown in Figure 5. Although the number of accidents fluctuates every year, the accidents in the cruise industry generally show a downward trend. This has something to do with the progress of science and technology to make more advanced equipment applied to cruise ships, and also benefits from the continuous improvement of rules and regulations to make SMS better implemented onboard.

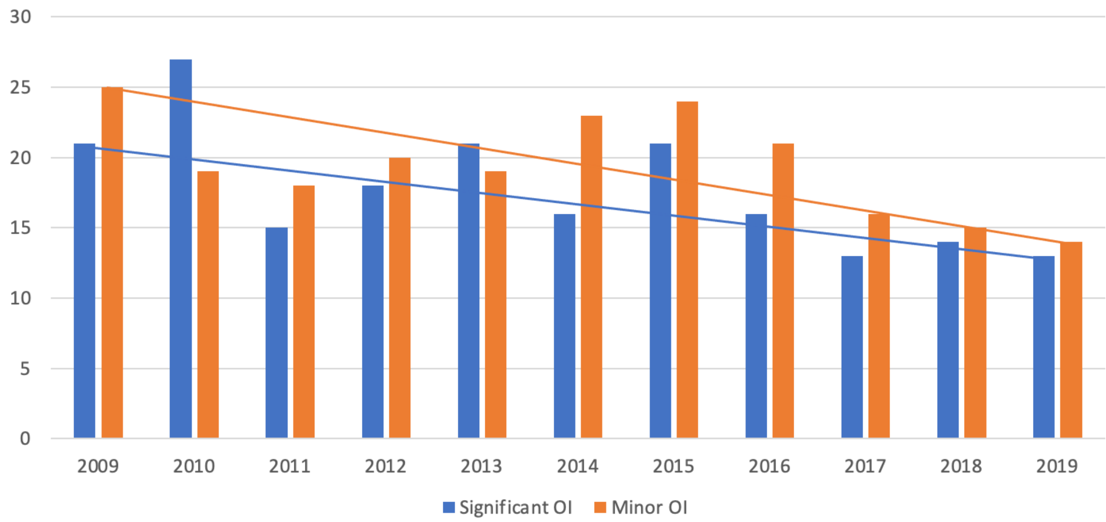

Figure 3 - Underlying trend in Significant OI and Minor OI (2009-2019)

Source: G. P. Wild (International) Limited (2020)

6.1.2 Aisa Cruise Inccident

This paper is based on the statistics of maritime accidents in GISIS database. However, the comprehensive classification of observed cruise accidents in this database is based on IMO accident investigation, so the cruise ship is not listed as a separate category by the ship type selection. Therefore, only 50 meters of passenger ships can be selected as the selection criteria, and then the accident reports are analyzed one by one according to different accident reasons. The final statistical analysis shows that 35 cruise safety accidents in Asia were in line with the scope of study from 1999 to 2019.

It is clear from Table 3 that the Philippines, Indonesia, Japan and China are the countries with the most cruise accidents in Asia. Of all the cruise accidents in Asia, 31.43% occurred in the Philippines, followed by Japan, China and Indonesia, accounting for 20%, 17.14% and 14.28% respectively, while the accident rate in other Asian countries is relatively low, no more than 10%. This is closely related to the geographical environment and traffic conditions of Asian countries. Due to the complex navigation conditions and the development of local fisheries, archipelagic countries have brought great trouble to the navigation of large ships, especially the frequent berthing and departure of ocean-going cruise ships, which is also an important external objective factor of frequent accidents of Asian cruise ships. In addition, it is not difficult to see that although the total number of cruise ships in Asia has been increasing in recent years, the number of accidents in the above countries remains at a relatively low level, so the accident rate shows a downward trend. However, there have been more than one safety accident in Thailand recently, the accident rate has increased relatively. The reason should be related to the policymaking of governments and the effective intervention of Port State Control (PSC).

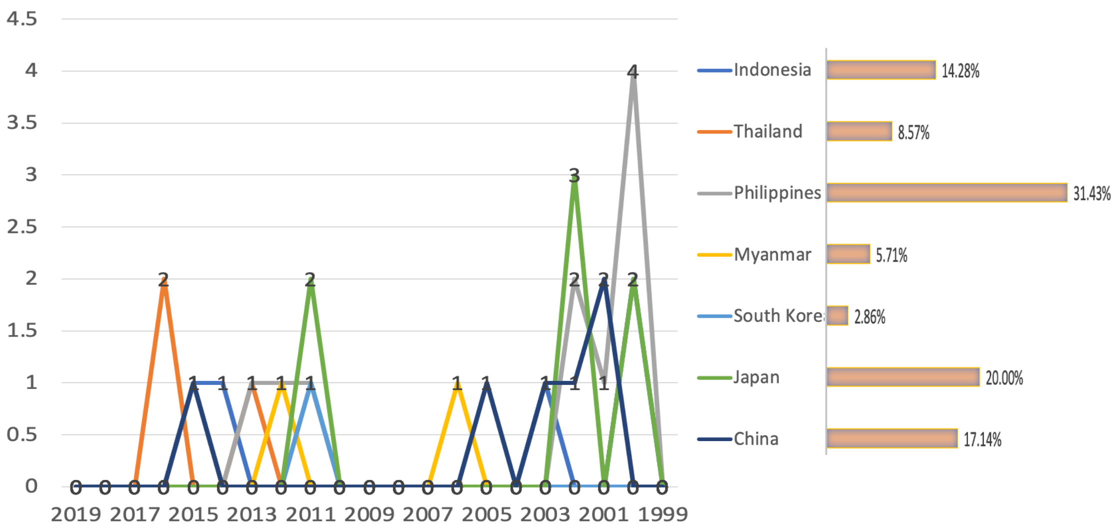

Figure 4 - Cruise Ship Accident in Asian by country (1999-2019)

Source: GISIS: Marine Casualties and Incidents. https://gisis.imo.org/Public/MCI/Default.aspx

Figure 4 shows the total number of cruise accidents caused by various reasons in Asia from 1999 to 2019. As can be seen from it, the most common causes of fire / explosion account for 31.4%, collision and overturning / overturning account for 20%, hull / machinery account for 8.57%, grounding / grounding, sinking, bad weather and contact account for only 5.71% and 2.86% respectively. It is not difficult to see that in addition to the impact of bad weather is an uncontrollable environmental factor, more than 90% of cruise accidents are caused by human factors.

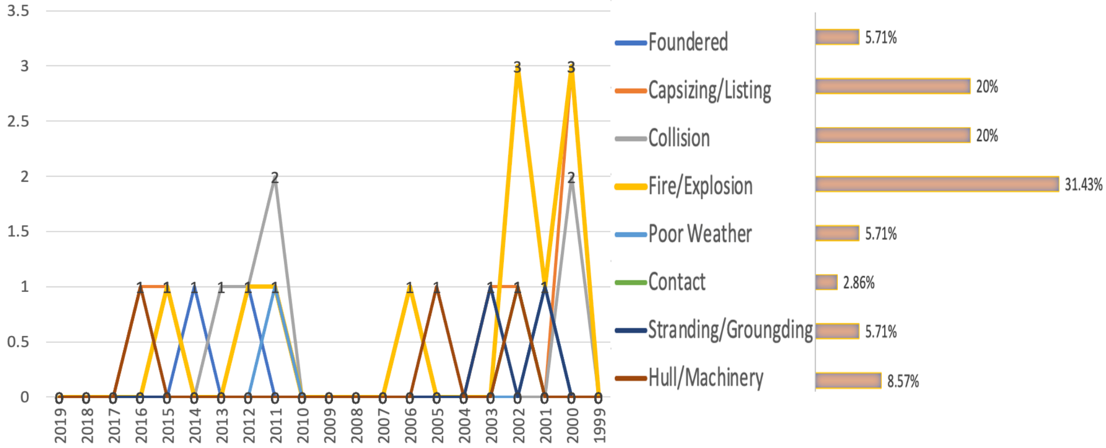

Figure 5 - Main kinds of cruise ship accidents in Asia (1999-2019)

Source: GISIS: Marine Casualties and Incidents. https://gisis.imo.org/Public/MCI/Default.aspx

6.2 Case study

October 1, 2012, about 20:23 HKT, Hong Kong Lamma Island Rongshuwan area collision accident, The M/V Lamma IV which belongs to Hong Kong Electric Group Co., Ltd. was carrying staff and family members to watch fireworks, her stern hit the bow of M/V Sea Smooth which belongs to Hong Kong Kowloon Ferry Holding Co., Ltd., the collision broken the two watertight compartments of the ship and hence, permitting the ship to speed up diffusing the water. Although there are many life jackets available onboard, but there are still more than 100 passengers were thrown into the water unprotected. In the end, 39 people were killed and 92 injured in the most serious maritime disaster in Hong Kong since 1971.

By analyzing the accident report, a few minutes before the collision, the two ships did not slow down or significantly change direction, it can be judged that the two ships are in the state of "high speed collision". Experts believe that the main cause of the accident is that the OOW failed to sail at a safe speed while neglecting to watch, did not give way in time when the risk of collision existed, and did not carry out emergency operation in accordance with the provisions of COLREGs when the close quarter situation was existed. In addition, the captain of M/V Lamma IV which sank after the collision, he did not use the correct and effective emergency measures to evacuate passengers and save their lives as much as possible, also did not pay attention to the radar before sailing from Lamma Island. Otherwise, accidents should be avoided. Therefore, it was finally determined that the accident was caused by various human factors (Lunn & Tang, 2013).

7. Research on human factor

7.1 Definition of human factor

Manmade is relative to nature. In today's world, there are both natural and man-made worlds. Almost all science and technology are inseparable from human invention and manufacturing. However, with the progress of science and technology, technological failures gradually decrease, which in turn reveals the potential impact level of human errors in the causal relationship of accidents (Hetherington, Flin & Mearns, 2006). Human factor refers to the adverse effect of human behavior on the correct function or successful performance of the system when people complete a specific task. Human factors involve psychology, behavioral science, management, system security, ergonomics and other fields. The function and influence of human in man-machine environment system are studied. The individual is far more than a factor of production. There is a relationship between people and things in any organization. But in the final analysis, the relationship between people and things is the relationship between people, and the allocation of any resources is also people oriented. Because people not only have material needs, but also spiritual needs, social and cultural background, historical tradition, social system, people's values, people's material interests, people's mental state, people's quality, people's beliefs will have an impact on people's activities. Due to the above factors, in the process of completing a specific task, whether people have enough comprehensive ability to deal with various situations that may occur in the process has become the key factor to complete the task safely. When people make mistakes in consciousness, judgment and behavior, they do not make the most appropriate judgment on the situation at that time, which eventually leads to the task cannot be completed in the right way. This is the so-called human error. It can also be said that the wrong decisions and behaviors of operators will lead to system failure, efficiency reduction or performance damage (Xi, 2006).

Human factors have been identified as the most important cause of maritime accidents (Kujala, Hänninen, Arola & Ylitalo, 2009). In Part B-VI-1/12 of STCW, the importance of bridge team is emphasized, and it is pointed out that "the crew participating in bridge team work must be composed of sufficient, competent and different ranks of seafarer. They must have clear division of labor, clear task for everyone, clear dialogue and contact between everyone, and concentrate on their work. Only in this way can they timely reflect the changes in the environment and situation and take effective measures at any time." Although the probability of cruise accidents is far less than that of freighters, human error is still the most significant factor in cruise accidents. For the Asian cruise accident, it not only has the common characteristics of the global cruise, but also has its own particularity because of its special geographical location and specific historical stage.

7.2 SHEL Model application

Professor Edwards first proposed SHEL model in 1972, and then Professor Hawkins modified it, and finally formed a model framework widely used in human factors research. The principle of SHEL model is to study and analyze the relationship between other elements and human interaction based on human core elements. The name of the shell model comes from the initial of its feature name. S: Software, H: hardware, E: environment, L: lifeware. It is not difficult to find from Figure 5 that the core of the system is lifeware, and the L-S (Liveware-Sofeware), L-H (Liveware-Hardware), L-E (Liveware-Environment), L-L (Liveware-Liveware) are all related to it. They together constitute the whole system that affects human factors, and the edges of blocks are serrated rather than simple straight line, which means that all elements must be matched around human, and human should also take the initiative to adapt. In order to fully realize the functions and objectives of the system, the relationship between various elements should be strengthened (Zhu,2020).

Figure 6 - SHEL Mode

Source: Internet

7.2.1 Liveware-Hardware

The first element that must match people is hardware. With the continuous development of science and technology, the stability of ship hardware is constantly improving, but this cannot ignore the existence of the relationship between human and hardware, because the normal operation of hardware depends on human operation and maintenance. The design characteristics of hardware should be integrated with human factors, easy to operate, in line with the normal operation habits of people; at the same time, people should also adapt to the hardware, master its performance, improve the operation ability, and strengthen the maintenance of the hardware. The two need to complement each other in order to minimize the adverse impact of human error.

7.2.2 Liveware-Software

The problems in the relationship between human and software are often prominent problems in accidents, which are difficult to find and solve. It is mainly people and management, such as work rules and regulations, safety training and exercises, educational background, navigation information, etc. Ism rules (international safety management rules) point out that about 80% of marine accidents caused by human factors can be controlled by effective management, that is, by strengthening the safety management of ship. At present, although all cruise companies have established a safety management system (SMS), some companies completely copy other companies' management system when establishing their own system, and do not seriously modify it in combination with the actual situation of the company. Some company leaders do not know enough about the establishment of the system, nor do they have effective specific operations. In addition, some crew members did not strictly implement the SMS and violated the navigation control procedures. All these are great potential dangers of human error to safety.

7.2.3 Liveware-Environment

The human environment relationship here mainly refers to the influence of the living and working environment on the ship and the external environment of the ship on people. For example, under the high pressure of the working atmosphere, fatigue caused by heavy workload; long contract period, the crew's life is boring caused by the separation from the society and family; lack of accommodation, diet, sports and entertainment, which affects the physical and mental health; fatigue caused by bad weather such as rainy and foggy season, strong wind and waves, navigation in the sea area, etc. These are factors that affect the increase of human errors

7.2.4 Liveware-Liveware

That is, the interpersonal relationship and cooperation between the bridge team in the work. The factors that determine whether this interface works well are the influence of leadership, interpersonal relationship and team cooperation on individual performance. Ship navigation safety also depends on the mutual help, cooperation and cooperation between everyone. For example, the power gradient of the bridge team, the inability to question wrong decisions caused by collective thinking, communication obstacles or mistakes, lack of adequate Manning or effective supervision and management are all the inducing factors of human errors affecting the safety of ship navigation.

7.3 Feasibility analysis of SHEL model

(1) Operability. Because SHEL model has good classification characteristics for human factors of accidents, it is easy to use it for classifying human factors of accidents. We can start from the meaning of the four elements of SHEL model in ship navigation safety system, combined with HFACS system and the classification

of human factors in aviation field. Therefore, it can realize the classification of human factors in ship accidents, and the words used in classification are easy to grasp for the relevant personnel in the shipping industry.

(2) Integrity. Most of the existing analysis models of human factors in accidents focus on people themselves, while ignoring other factors in the system. A system involves many factors, such as human, software, hardware and environment. We should not only analyze the impact of human's own role on accidents, but also analyze the impact of interaction between human and other factors on accidents. Using SHEL model to analyze the human factors in ship accidents can comprehensively cover all factors of the ship system and understand the causes and evolution process of the accidents from a macro perspective. Combined with the shipping background, the questionnaire defines the meaning of the interaction between human and various elements, then realizes the comprehensive and systematic analysis of human factors in ship accidents. Therefore, the SHEL model is used to classify and define the human factors existing in the navigation safety system, and its integrity is guaranteed.

(3) Compatibility. The SHEL model can be used to analyze the accidents in the shipping industry. It is also applicable to other industries, such as aviation, mining and petrochemical fields. We only need to adjust the model according to the background, and its compatibility can be guaranteed.

(4) Inheritance. Making full use of the existing research results and according to the internationally recommended classification method of human factors, it inherits a lot of previous discussions on the classification model of human factors and the classification analysis of human factors.

7.4 Questionnaire result

The questionnaire is based on SHEL model, using in the Asia cruise fleet, 60 navigators were participated for questionnaire randomly. 58 questionnaires were collected, of which 55 were available, and the effective rate of the questionnaire reached to 91.67%, so it was acceptable and reliable for survey. The data collected are as follows:

Table 2 - Result of the questionnaire

		Unimportant (1 point)	Important (2points)	Very important (3point)
L-H	Complexity of INS	40	10	8
	Reliability of INS	20	23	15
	Lack of Maintenance	5	23	30
	System Failure	16	32	10
	Unreasonable Design	30	20	8
L-S	Clear Procedure	8	10	40
	Education Background	5	22	31
	Training Onboard	20	25	13
	Safety Drill	10	18	30
	Navigation Information	20	20	18
L-E	Noise	18	25	15
	Fatigue	4	14	40
	Living Condition	15	28	15
	Weather Condition	28	22	8
	Traffic Situation	2	18	38
L-L	Collective Thinking	10	10	38
	Rank Hierarchy	6	10	42
	Communication Mistake	18	20	20
	Insufficient Manning	5	22	31
	Lack of supervision	20	30	8

Source: Author

According to the number of votes shown in the questionnaire and the weight of different degrees of importance, the corresponding total score of classification was calculated.

Table 3 - The importance of different factors through scores

		Sub-Score	Total Score
L-H	Complexity of INS	84	540
	Reliability of INS	111	
	Lack of Maintenance	141	
	System Failure	110	
	Unreasonable Design	94	
L-S	Clear Procedure	148	649
	Education Background	142	

	Training Onboard	109	
	Safety Drill	136	
	Navigation Information	114	
L-E	Noise	113	629
	Fatigue	152	
	Living Condition	116	
	Weather Condition	96	
	Traffic Situation	152	
L-L	Collective Thinking	144	660
	Rank Hierarchy	152	
	Communication Mistake	118	
	Insufficient Manning	142	
	Lack of supervision	104	

Source: Author

8. Courses of human factor

Through the analysis of the results of the questionnaire, compared with the other three items, L-H has the least impact, and the other three items have more serious impact on human error. There are several prominent single factors in the survey: lack of maintenance, clear procedure, safety drill, education background, fatigue, traffic situation, collective thinking, rank hierarchy, insufficient manning.

8.1 Lack of maintenance

Ship maintenance is the process of inspection, repairment and maintenance of ship structure, mechanical and electrical equipment and devices. During the long-term operation of ship hull structure, mechanical equipment and parts, due to various internal factors and external conditions, they will be gradually corroded, worn and damaged, resulting in the failure of ship mechanical parts and equipment. Therefore, in order to keep the good condition of the ship, the crew must inspect, maintain and repair the ship, replace the faulty parts in time, and eliminate the equipment failure, which is not only of great significance to the safety of ship navigation, but also to extend the service life of the ship.

First of all, due to the long-term non-stop operation of modern cruise ships and frequent berthing and departing, the flexibility of modern cruise ships depends on the frequent changes of machine operation speed, which itself greatly increases the consumption of ships. Secondly, because most of the cruise ships operating in Asia are European and American cruise ships, the flag state requirements are inevitably different from the policies of Asian port states. Therefore, the maintenance work is often subject to various restrictions of port states, and the application procedures are complex, time-consuming and laborious. Coupled with the limitation of short berthing time of cruise ships, many maintenance tasks cannot be completed on time.

8.2 Neglect of procedure and safety drill

When the emergency happens, external assistance can only be used as a supplementary means, the crew must perform the emergency duty in the ship's emergency response measures based on self-help. The successful emergency performance depends on well-trained crew, perfect emergency facilities and equipment, feasible emergency plan, correct wisdom and good team cooperation. This requires the crew to carry out routine maintenance and inspection for emergency equipment, in order to keep it always in a complete and good standby state, so that it can be used at any time in case of emergency. At the same time, cruise companies are required to formulate detailed ERP according to the actual situation and external environment of different ships, and specify the frequency and participants of regular drills, so as to ensure that they are familiar with the emergency procedure according to their own emergency duty or even more, in case they can cover the emergency duty for others when necessary. This requires the effective implementation of the usual safety drill, acting as a real emergency to simulate the operation, in order to play the role of training, and find out the defects and problems to correct in time. But most of the time, due to the short alongside time in port and the heavy task of shore-based maintenance, the crews are easy to slack off in frequent safety drill. In particular, if the captain and other senior officers do not pay enough attention to the idea and play a good exemplary role in action, it will lead to a mere formality of the drill, resulting in poor emergency response ability of the crew, being at a loss in the actual emergency situation, and causing potential dangers of ship safety caused by human errors.

8.3 Education background

According to the research of Japanese experts, the direct cause of man-made accidents is lack of skills, accounting for 50.6% of the accidents, safety attitude accounting for 19.2% of the accidents, and 81% of drivers have wrong perception. Due to the different education, maritime qualifications, self-control ability, judgment ability and personality of the crew, they will eventually adopt their own ways of behavior for the same incident and produce different results. The main factors affecting the safety behavior of the crew are the knowledge, skills, experience, psychological and physical health of the crew. It can reflect that the crew's competency and professional quality need to be further improved. It also shows that the overall level of crew's quality has a direct impact on the probability of safety problems caused by human error. The crew market has continued to shift from traditional maritime countries, such as Western Europe, Japan and North America, to the Far East, the South Asian subcontinent and Eastern Europe. One of the reasons for these changes is the low cost. As we all know, the salary level of European and American seafarers is much higher than that of Asian seafarers. Therefore, in order to save costs, most shipping enterprises choose to use Asian seafarers to replace European and American seafarers as operation level officers, and retain European and American seafarers as management level combination. This creates language and cultural barriers, which may lead to wrong communication. On the other hand, due to the fact that the mastery of English among Asian people is still in a relatively low level, in many cases, even though European and American pilots can communicate well with internal personnel, they cannot communicate effectively with other Asian ships that meet at sea. Especially, China and Japan, as the main source and visiting place of Asian cruise ships, although English should be used as an international language, due to long-term historical reasons, the popularity of English in these two countries is still poor. Judging from the development of Asia, these problems are still difficult to be effectively solved in a short time.

8.4 Fatigue

Fatigue is always fatal when it comes to human factors in maritime safety. According to a report issued by the Adelaide Sleep Research Center, the risk of a seafarer who does not fall asleep at least 7 hours is equivalent to the risk of a person with a blood alcohol concentration of up to 0.05%. This makes us wonder whether fatigue reflected in overtime work is equivalent to drunk driving, and real evidence shows that fatigue truly result in disastrous consequences. In addition, the Institute of Medicine Committee Sleep Medicine and Research has also adopted more and more evidence that insufficient sleep has a great negative impact on behavioral cognition and quickly thinking decisions. It should be considered that the crew members work uninterruptedly every day during a contract period, their fatigue becomes more and more serious as time goes by. Safety culture of cruise ship that psychosocial work environment has a significant impact on crew's safety commitment (EK & Roland, 2005). Therefore, the results of this study show that seafarers working on passenger ships show the highest level of exertion, highlights the importance of working systematically and proactively with improving the physical, organizational and social work environment board. The fact that experience working environment is different from other types of ships shows that all functions of passenger ships constitute a more intense working environment than other types of ships. This may be due to the pressure of high responsibility, frequent port calls, passenger contact and regular intensive and tense situations. In a study of seafarers' sleep and fatigue, they found that seafarers working on cruise ships were significantly more tired than those working on any other kinds of ship at sea, since the frequent port calls and extra pressure of passengers on board. The main causes of fatigue for seafarers are lack of sleep, heavy workload, physical environment and stress. (Hystad & Eid, 2016)

8.6 Collective thinking

Collective thinking means when a team is paying too much attention to integrity, so the team members will feel the pressure of reaching consensus on group norms, which increases the pressure on conformity, and makes difficulty to get an objective evaluation of unusual, minority or unpopular views. It is to say, when a team expresses its opinions on a certain issue or matter, sometimes it is in a state of collective silence for a long time, and no one expresses their opinions, and then people will unanimously pass it. Usually, the ideas of the main members of the team who are authoritative, confident and like to express their opinions are more easily accepted, but in fact, most people do not agree with this proposal. The reason for this is that the team members feel the pressure of group norms demanding consensus and are unwilling to express different opinions. At this time, the individual's critical thinking and moral judgment will be affected and decline. In this case, group decision-making is often unreasonable and failed. This happens when a team focus on integrity too much and cannot evaluate its decisions and assumptions with a critical attitude. The higher the cohesion of a collective, the more likely it is to lead to group thinking errors. Therefore, collective thinking is "the deterioration of psychological benefits, which comes from the pressure within the group" (Janis, 1972). As we all know, in work, people naturally tend to maintain a harmonious working environment and are not willing to take the initiative to put forward different opinions on a certain judgment or decision of their colleagues. The tendency of collective thinking or maintaining harmonious organization is also one of the hidden dangers of safe operation of ships (Lan, 2018).

8.7 Rank hierarchy

Power hierarchy is usually used to describe, even when people with low power level can clearly judge that people with high power level's decision is incorrect or have obvious doubts about it, but it is difficult to question it because of fear and worry. Shipping industry, especially ship operation, has always followed the strict semi militarized hierarchy system, which has laid an important hidden danger for poor communication caused by power of rank. Taking the sank of M/V COSTA CONCORDIA as an example, we learned from the accident report that before the accident. Firstly, without effective communication with the bridge team, the captain temporarily decided to change the original planned ship route. Then, during the voyage, the captain violated the company's procedure of forbidding the use of telephone on the bridge to make calls which unrelated to the navigation, which led to the loss of real-time tracking and understanding of the ship's navigation status, and did not realize that the ship had entered the dangerous waters in time. After the accident happened, the captain's emergency response was slow, and the passengers were not evacuated effectively according to the Emergency Response Plan (ERP). However, no bridge member was found to remind or question the captain about this series of wrong behaviors.

8.8 Insufficient manning

With the increasingly fierce competition in the shipping industry, in order to ensure profitability and competitiveness, some companies are operating the ship only with minimum manning. It may be can meet the requirements of open sea navigation, but it is not enough to cope with conjunction waters, and even less to meet the requirements of maintenance, port operation and emergency response. Especially for the current situation that most Asian cruise ships are old ships, they are facing not only the disadvantages from old equipment and heavy maintenance workload, but also have uncontrollable factors such as bad sea conditions and heavy traffic in Asia, which lead to many maintenance tasks can only be carried out after berthing. At the same time, they must face all kinds of pressure from port state, flag state and company inspection. Even if the minimum manning is in line with the regulation, but it will greatly increase the working load of the crew then effect the safety of ship.

9. Current countermeasures of cruise company

Safety management, including supervision and training, is generally considered as the key means to solve accidents caused by human factors (Trucco, Cagno, Ruggeri & Grande, 2008). Similarly, the cultivation of safety culture on board, the rational allocation of human resources and the formulation of reasonable and clear procedures are also considered to play a certain role in preventing accidents caused by human factors (Kovats, 2006). Starting from these basic aspects, modern cruise companies have made corresponding prevention and solutions to deal with the impact of human factors on ship safety**.**

9.1 Modern maintenance theory

Modern ship maintenance theory mainly adopts three different ways for the maintenance of ship machinery and equipment: Scheduled Maintenance (SM), Breakdown Maintenance (BM) and Preventive Diagnostic Maintenance (PDM).
BM is carried out after the failure of ship equipment. Due to the fact that the faults of some complex equipment of the ship cannot be predicted when some of its parts

and components maintain good basic functions, or the lack of applicable detection means and critical parameters for some complex equipment, some equipment does not have the conditions for detection, so it can only be repaired after the fault occurs.

SM is to demolish and repair the marine machinery and equipment according to the specified time limit to prevent the occurrence of faults. It is mainly aimed at the mechanical equipment with obvious fault loss period and equipment failure free working period.

PDM refers to the continuous monitoring of mechanical equipment, recording the specific operation status of the equipment, and quantitative analysis of its status information, according to the actual situation to determine the repair time, so as to avoid the occurrence of failure. Because the workload and cost are relatively small, this method is the core of modern preventive maintenance (Wu, 2001).

Based on modern ship maintenance theory, cruise companies mainly use ship PMS to carry out detailed regular maintenance plan for ship equipment. Its working principle is: firstly, the ship owner collects and sorts out the equipment records, spare parts inventory records and personnel records of the whole ship, divides the ship equipment system according to the level and indicates the maintenance requirements, and then puts them into the work order card of PMS system. The ship manager (usually the master or the chief engineer) arranges specific maintenance work for the crew. The system transmits instructions, orders and information between the manager and the executor, forms a complete work record in the system, and feeds back to the company management for inquiry and reading, so as to timely and accurately monitor the actual situation of ship maintenance, and plan and arrange the next maintenance progress in advance. Through the system to develop and implement the ship equipment maintenance plan, it is conducive to the implementation of the maintenance plan, strengthen the supervision of the maintenance work, and improve the ship management level. It is of great significance to extend the service life of ships and reduce the operating costs of enterprises.

9.2 Establishment of ERP

Through the development of detailed ERP, according to the impact degree of the accident occurrence and development, the emergency deployment is divided into the following stages shown in the Figure 7. Different stages have different response personnel and corresponding actions shown in the Table 4. The master decides whether to activate only the initial key personnel or all crew to evacuate the passengers or even release the lifeboat to abandon the ship according to the development of situation.

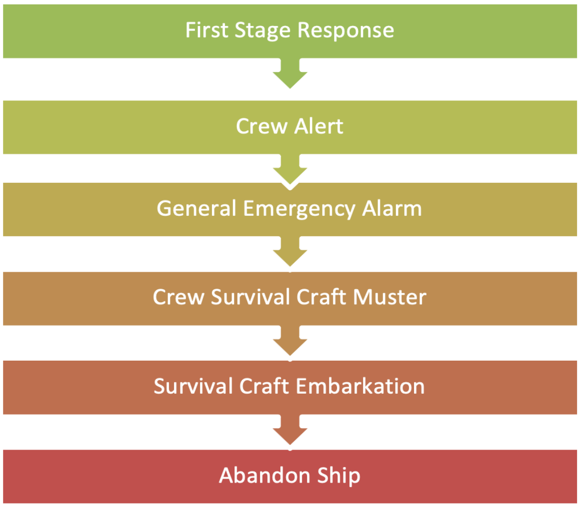

Figure 7 - Emergency Response Stages

Source: M/V COSTA ATLANTICA Emergency Response Plan

Table 4 - Emergency Response Stages Description

First Stage Response	Depending on the type of incident, the Master, OOW or senior officers must activate the appropriate assessment team as designated in the ships muster list, to quickly assess the severity of the incident then recommend to the Command & Control whether to sound the Crew Alert or General Emergency Alarm.
Crew Alert	The crew alert signal signifies that all crew must proceed to their assigned emergency duty stations. At this stage, a complete muster will be conducted. Passengers, other than those required

	to collect their children, are not involved, but they should be kept informed thorough frequent broadcasts.
General Emergency Alarm	Any determination by the Master that an emergency can compromise the safety of people on board will result in giving the General Emergency Alarm. This signal is used for summoning guests and crew to the Muster Stations and to initiate the actions included in the Muster List.
Crew Survival Craft Muster	This order is given verbally through the chain of command for all crew to proceed to their assigned survival craft muster stations. Containment Team, lifeboat preparation team, life raft preparation teams and passenger muster teams, shall continue their emergency duties.
Survival Craft Embarkation	This order is given verbally through the chain of command to move passengers and crew from their muster stations to embark the survival crafts. When passenger embarkation process is complete, passengers muster stations teams will be dismissed, and each member must proceed to the assigned Crew Muster Station.
Abandon Ship	This order is given verbally from the bridge directly by the Master (or by the Second in Command if the Master is incapacitated) to commence launching of the survival crafts. The evacuation and abandonment procedures can be referenced for further guidance.

Source: M/V COSTA ATLANTICA Emergency Response Plan

Before being assigned to shipboard duties, all persons employed or engaged on a seagoing ship other than passenger, shall participate on familiarization training including a personal survival technique or receive enough information. The mandatory minimum requirements for vessel familiarization training and instruction for all seafarers are defined in Section A-VI/I of STCW Code 95. The key positions which shown in the Figure 8 will cover virous roles and combine essential teams to response according to the ERP in case of emergency.

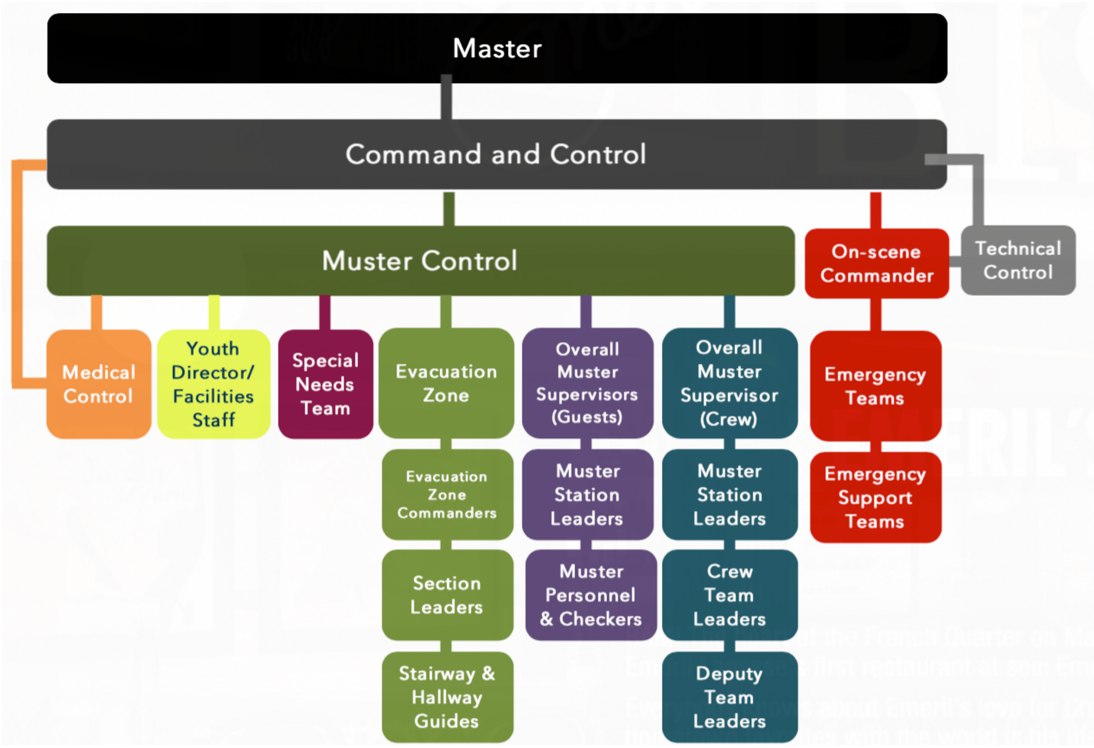

Figure 8 - Key Departments in case of Emergency

Source: M/V COSTA ATLANTICA Emergency Response Plan

- The Master's role in an emergency is to maintain a strategic overview of the situation, so he must not be excessively involved in the actual operation of emergency operations. His main responsibilities are: lead and organize ship emergency response, to ensure that all necessary emergency functions are in place, and to ensure that passengers often know the latest situation through PA system. To ensure the safety of the ship, the overall well-being of passengers and crew members, according to the nature and severity of the accident, judge whether to upgrade the response level or even abandon ship. And timely and appropriate liaison with Fleet Operation Center (FOC) and Marine Emergency Response Service (MERS) Provider, authorities, other support services, and ships in the area. If the master is incapacitated, the staff captain must assume all the responsibilities of the captain.
- Command & Control, whose responsibilities include: Strategically manage the emergency as per ship's ERP. Where responsibility for Command &

Control or other emergency response activities need to be delegated, ensure that they are assigned to a competent person. Keep the Master up to date with all pertinent information on the management of the incident and response. Monitor the general mustering situation of passengers and crew meanwhile advise the Master accordingly. Monitor the stability situation, advise the Master accordingly, and liaise with shore-based MERS providers and shore support. Ensure internal communication and information flow is maintained with the various emergency teams and maintain records of key information.

- The Bridge Team is responsible for the safe navigation of the ship and it shall not be directly involved in managing other aspects of the emergency. Inform Command & Control of any developing navigational situation that may negatively affect the handling of the entire emergency. For example, the course alterations with subsequent change of relative wind direction and speed, influencing the smoke management, etc.
- The On-Scene Command (OSC) oversees tactical measures to deal locally with any emergency on the ship. The OSC is to ensure that Command & Control is fully informed of the ongoing emergency response operations. Responsible for the management of local resources needed to deal with the incident and control the safety of the incident scene, including security of the area and staging location. In case of the machinery space, the OSC will work closely with the Technical Control as required to manage the support organization and response team assigned to OSC to control the accident scene.
- Technical Control must ensure Command & Control is fully informed and kept up to date on any technical situation that might influence the emergency response levels. Responsible for providing tactical input during a machinery space emergency response. Maintaining availability of relevant safety systems including propulsion, steering, sources of power and the operation of the emergency switchboard in case of emergency. Assisting Command & Control in isolating affected areas and operating emergency systems like releasing CO2 systems under captain’s instruction.

- Muster Control is responsible for all aspects of the mustering and evacuation of all passengers and crew. Ensuring children and parents are reunited as soon as possible when youth facilities are in operation. Accounting of persons located in the medical facility, aiding passengers identified as requiring assistance and always keep Command & Control fully informed of the situation regarding passengers and crew mustering and evacuation.
- Medical Control is responsible for the safety of patients in the shipboard Medical Center, and for the reception and treatment of anyone sustaining injury as a result of the emergency. In addition, Medical Control must liaise with Muster Control to ensure that all patients under treatment in the ship's medical facility or in their cabins are relocated as needed.

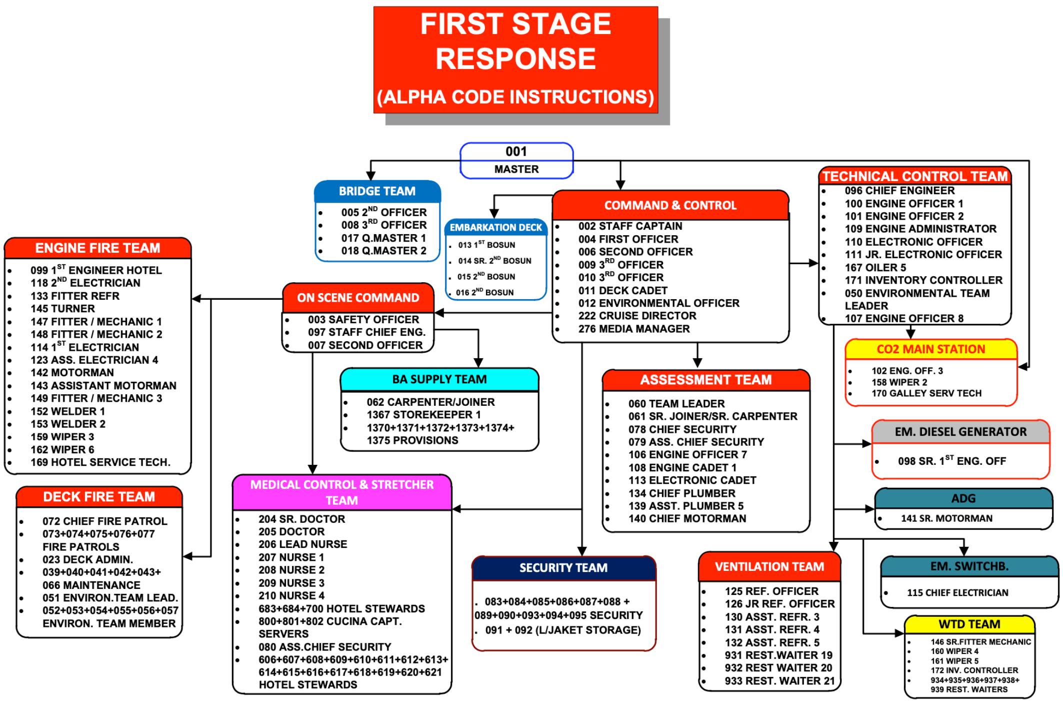

Figure 9 - Reporting System in case of Fire Onboard

Source: M/V COSTA ATLANTICA Emergency Response Plan

The muster station is a safe place where all persons on board (passenger & crew) must proceed when the General Emergency Signal is given, wearing the lifejacket and waiting for orders. For example, as you can see the Figure 10 has shown the muster station arrangement for M/V CARNIVAL BREZZE, it has totally 9 passenger muster stations and 3 crew muster stations, which can carry 3690 passengers with 1386 crew members as per SOLAS requirements. In case of some stations could not be available because of disaster, alternative muster stations are also set up on the both sides of embarkation deck for use.

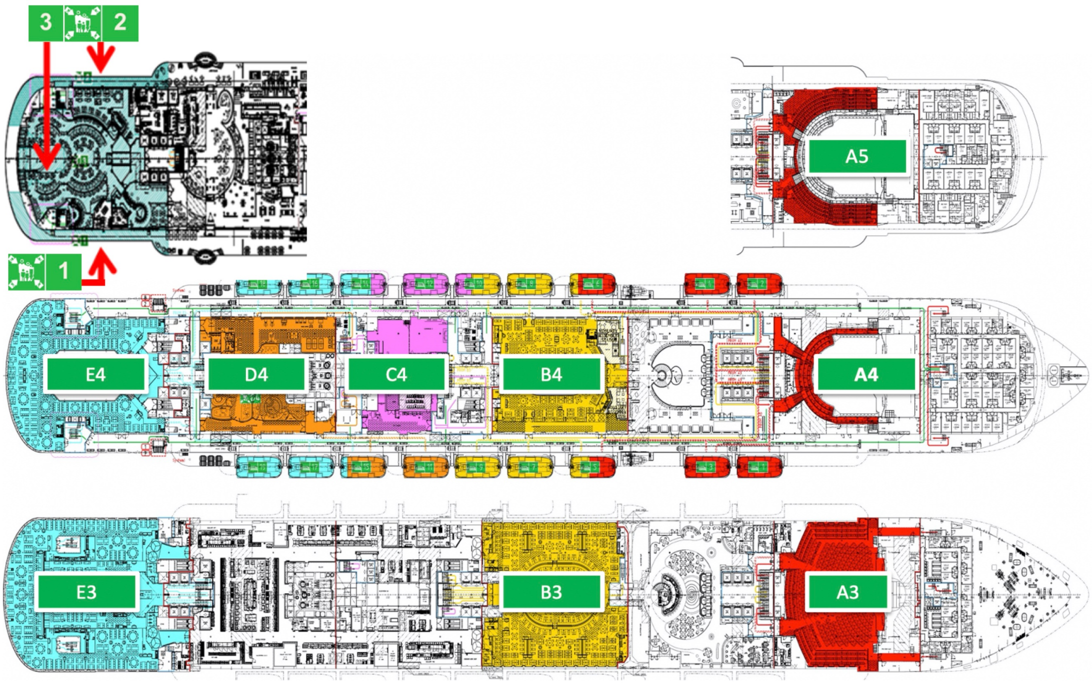

Figure 10 - Muster Stations Arrangement

Source: M/V CARNIVAL BREEZE Emergency Response Plan

9.3 Improving crew quality

In order to improve and solve the language communication barriers of Asian cruise crew, many fleets operating in Asia now choose to use Chinese officers, so that they can use Chinese as a backup means when they are unable to communicate effectively with other ships in English. However, due to many conflicts between China's maritime education, examination and certification rules and the current system of cruise companies, and the lack of cruise driving experience in China, there are few officers suitable for the development of cruise in Asia. In the long run, if we want to fundamentally change the situation of undesirable quality of seafarers in Asia, especially in China, we should start from the fundamental issue of maritime education and training mode.

Among the 1.2 million seafarers in the world, the Philippine seafarers account for more than 25%. Although the Philippines is a developing country, it is the most important source country of seafarers in the world, which provides a good reference for the cultivation of Chinese cruise officers. First, there are three main modes of modern world navigation education, namely, consistent mode, sandwich mode and comprehensive mode. The consistent training mode is a traditional continuous training mode, in which students are arranged to practice on the ship after a period of continuous study at school, and then obtain the practice certificate through the examination; the sandwich training mode divides students' study into three stages: study at school, practice at sea and then study again. The Philippines mainly adopts the same comprehensive training mode as most European countries, that is, undergraduate students need to complete one year of maritime practice based on completing three years of theoretical study. In China, the consistent training mode is adopted. Undergraduates study in school for three and a half years, and then arrange a total time of no less than 22 weeks of marine practice. After passing the exam, they can graduate. Thus, the maritime practice courses of students in Philippine maritime colleges and universities are more than twice as many as those in Chinese maritime colleges and universities, and the training mode is more focused on the training of students' maritime practice skills.

Moreover, as far as the content of education and training is concerned, professional courses and self-reliance training in the Philippines are mostly written in English, and teaching is also taught in English. Besides professional English, most textbooks in China are Chinese textbooks, and few teachers teach in English. Moreover, the training is mainly exam oriented, ignoring the English teaching and cultivation of students' ability of using English makes it impossible for them to apply what they have learned to work effectively. Although there are some historical and humanistic reasons, English, as an international working language, should be given enough attention in maritime education.

The last point is school enterprise cooperation, which is also the fundamental reason for the success of Philippine seafarer training. Because the Philippines pursues market-oriented maritime education, the demand of enterprises is the direction of schools. In recent years, China has been advocating the mode of school enterprise cooperation, but up to now, the scale of school enterprise cooperation is still relatively limited, and many ways of cooperation just stay in the mode of order cultivation.

9.4 Fatigue relief

According to STCW, seafarers must rest for 10 hours in any 24 hours and 77 hours in any 7 days. The rest time can be divided into two periods, one for at least 6 consecutive hours, and the interval between the rest periods should not exceed 14 hours. Captain C.W. Filor believes that 39% of accidents reported at sea are related to fatigue. IMO experts believe that the most effective way to deal with fatigue is to ensure an effective sleep, which must have enough time and good continuity at the same time. Everyone needs different sleep time, and it is generally considered that an average of 7-8 hours is appropriate; and a sleep lasting for 7 hours is far better than seven naps lasting for 1 hour. A survey on sleep problems shows that the average sleep time at sea is 6.6 hours, and the continuity of sleep is poor, while the sleep time of the crew on duty is less than 5 hours. There is no doubt that for the crew, especially the personnel on duty, effective sleep is the premise to ensure the safety of navigation.

Compared with cargo ships, cruise companies pay more attention to the fatigue of crew. For example, the "6 + 2" duty system is adopted to replace the existing 4H or 6h duty system, and the duty time is recombined: the duty time of the first watch is 0600 ~ 0800 hours (2H) + 1200 ~ 1800 hours (6h), the duty time of the second watch is 0000 ~ 0600 hours (6h) + 0800 ~ 1000 hours (2H), and the duty time of the third watch is 1000 ~ 1200 hours (2H) + 1800 ~ 2400 hours (6h). In this way, the rest time can be divided into a longer period and a shorter period on the premise of ensuring that the officers on duty work 8 hours a day, which not only meets the requirements of the Convention, but also makes the arrangement of rest time more flexible, thus increasing the chance of getting enough sleep. With the advanced work record system, the crew must clock in according to the work schedule before starting work and clock out after work or rest. The department head and the director of human resources on board will check whether the records comply with the regulations and company procedures. Moreover, due to the more comfortable living

condition of the cruise ship, frequent berthing can give the crew a short time to travel, which greatly alleviates the mental fatigue of the crew.
The second is the manning problem. Unlike the minimum manning standard adopted to reduce costs, most cruise companies adopt the dual watch system, that is, two officers and two sailors are on duty together. At the same time, they are also equipped with chief of staff, safety officer, chief mate, patrol fireman, security guard and other posts to ensure that there are enough crew to deal with various emergencies. This not only meets the requirements of BRM to reduce the single person decision-making error rate, effectively alleviates the decision-making error caused by excessive mental stress, but also greatly reduces the workload of navigators in the process of on duty, so that they can focus on navigation tasks rather than other tasks. The above system is basically used by all cruise companies. However, in view of the actual situation in Asia, the traffic intensity is much higher than that in other regions, which means that the workload and tension of drivers are higher than that of other people. Therefore, shortening the cooperation period appropriately can be used as an effective measure to relieve the pressure of crew members, and the company can develop a more humane management, it will give seafarers the right to apply for extension and shortening of the contract within a certain range, so that they can reasonably choose the length of contract service according to their own mental state

9.5 Implementation of BRM

BRM was inspired by CRM which widely used in aviation. It is the use and co-ordination of all available resources including people, equipment and procedures to promote safety and enhance the efficiency of shipboard operations. In recent years, with the continuous development of cruise technology, management concept and the deepening of theoretical research on bridge resource management, more and more cruise companies have adopted the bridge structure design based on functional objectives, which adjusts and deploys the equipment according to the division of personnel, and adjusts the personnel allocation flexibly according to the function (Xuan, 2007). If the ship is in the critical period of entering and leaving the port, the captain usually controls the ship, and other personnel report relevant information to him. So, he needs to process multiple information at the same time, which will greatly increase the workload. Meanwhile, due to the influence of the power hierarchy and collective thinking, it is difficult for other members of the bridge team to put forward reasonable challenges to the captain's behavior or decision, which leads to the safety risk grows up as well.

In recent years, based on the continuous in-depth research on bridge resource management theory, more and more cruise companies have adopted functional target-based bridge structure design which has shown in the Figure 11 and Table 5, adjusted resources according to the division of labor. Deployment and staffing can be flexibly adjusted according to functions, this has a very good mitigation effect on the human factors caused by the power hierarchy and collective thinking.

		Bridge Functions					
		Navigator	Co-Navigator	Administrator	Operations Director	Lookout	Helmsman
Bridge Manning Level	Green	Yes	Yes		No	Yes	As required
	Yellow	Yes	Yes		Yes	Yes	Yes
	Red	Yes	Yes	Yes	Yes	Yes	Yes

Figure 11 - Assignment Functions According to Manning Level

Source: Carnival Corporation & PLC (2012) Bridge Resource Management Manual

Table 5 - Manning Level Description

Green Manning	Minimum bridge manning required underway. There is one officer assigned two functions (Co-Navigator and Administrator).
Yellow Manning	Used in situations were indicated by the Risk Analysis and Bridge Manning Level Table. Compared to Green Manning, the bridge team is strengthened by the Operations Director and another able body ready to assume function of helmsman at any time if required.
Red Manning	Always used for arrivals, departures and other situations according to the risk analysis. In Red Manning the bridge must

	be in closed condition, the captain shall present with the charge and assume one of the bridge team functions.

Source: Carnival Corporation & PLC (2012) Bridge Resource Management Manual

- The Navigator is responsible for conning, navigating the ship following the approved passage plan and collision avoidance. He must use “Thinking Aloud” to share his intentions and planned actions to all bridge team including the pilot, and ensure they are aware of the situation. And always foster a climate that encourages other members of the bridge team to challenge the him if warranted. In case the pilot has the conn, he should ensure the pilot’s intentions and planned actions are well understood in advance by all bridge team members and agreed upon by the Navigator.
- The Co-Navigator should support, challenge, and recommend actions to the Navigator. He is responsible for monitoring traffic and cross-checks the actions of the Navigator, using real time navigation methods to check if the ship's position against the passage plans. Notifies the Master or Second in Command whenever he has reason to believe that the Navigator has taken or plans to take any action that violates the captain’s orders or is inconsistent with the safe navigation of the vessel. Unless directed otherwise by the officer with the charge, he will take the responsibility for external VHF and internal communications as directed liaison with the ECR. And in charge of alarm management and actions. Alarms to be identified as either urgent or non-urgent alarm. Responsible for logbook entries, checklist management and status board as well.
- The Operations Director usually will be assigned by senior officer, who will manage UHF/ VHF Internal communications and responsible for monitoring the safe embarkation or disembarkation of the Pilot. He should directly monitor of both the Navigator and Co-Navigator, ensure that safe passage is maintained and that no internal or external influences are permitted to distract them from their primary tasks. Overview of the entire bridge operation, workload and transfers tasks between functions as circumstances dictate ensuring that it is carried out in accordance with procedures. Provides guidance and suggestions to other members of the bridge team as

necessary or appropriate. If the Operations Director has the charge, he can assume any of the other functions at any time, but once the he takes the conn, then the position of Operations Director must be re-established as soon as possible.

- The Administrator is the person who is responsible for alarm management which should to be identified as either urgent or non-urgent alarm. internal communications as directed and logbook entries, checklist management and status board. Ancillary tasks as assigned as well.
- The Helmsman directly steers the vessel by acknowledging and executing steering orders which given by the person with the conn and advise him about any steering concerns.
- The Lookout must keep all time giving full attention to maintain all around lookout by sight and hearing, reporting all sightings and sound signals to the Navigator. Maintaining awareness of planned intentions and reports any necessary clearances before an alteration of course, no other duties shall be undertaken or assigned which could interfere with the task. The duties of the Lookout and the Helmsman are separated, which means the helmsman shall not be considered as lookout while steering, but he should be available to interchange duties with the Helmsman if necessary.

In the bridge structure with functional objectives, the captain decides the bridge team according to the ship's sailing status. For example, when the ship is navigating in open water, the number of persons on duty can be appropriately reduced, and the bridge can be kept full manning when entering and leaving the port. The Figure 12 shows the requirement of Carnival Cooperation BRM for manning in different traffic and visibility situations.

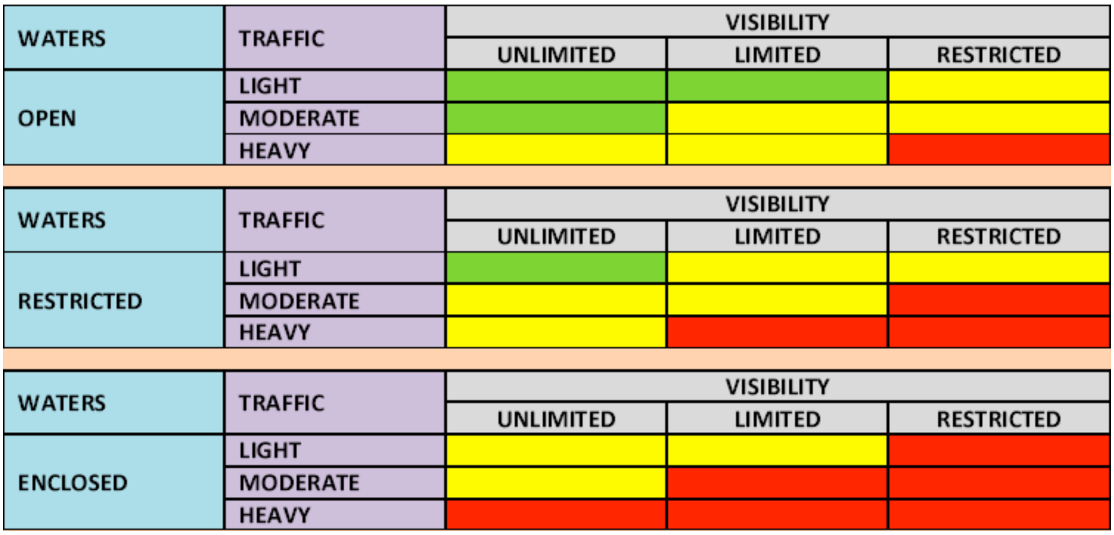

Figure 12 - Bridge Manning Level According to Risk Analysis

Source: Carnival Corporation & PLC (2012) Bridge Resource Management Manual

BRM not only allocates the corresponding human resources according to different situations, but also creates a harmonious and orderly operation environment of the bridge through reasonable resource allocation. For example, PRO (Plan Reason Outcome) technique requires navigator should share his action plan, action reason and desired effect with the whole bridge team before carrying out any action. At the same time, every member of the team is encouraged to think aloud, which intends develop a shared mental model of the current situation and future intentions in order to prevent the development of a possible human error. On the other hand, any officer, including the captain, may make mistakes or make wrong decisions. Therefore, all bridge members have the responsibility to supervise the safe navigation of the ship and have the obligation and right to challenge any suspicious operation. The master shall encourage the bridge members to express any doubts when they are uncertain or worried about the condition of the ship, without fear of criticism, disciplinary action, ridicule or ridicule for questioning the decision-making. It can effectively reduce the probability of collective thinking phenomenon by acting on the questions raised by the query or telling the person who questions the decision why he does not take any actions. Another example is to encourage the captain to change from direct control of the ship to the role of a mentor or supervisor for overall supervision. The reasonable division of bridge tasks is not only conducive to promoting the learning of members and gaining practical experience through operation, but also the direct participation of each member can enhance their collective integration awareness and promote their identification with the company culture, so as to effectively reduce the impact of hierarchical power and improve the overall safety management level and efficiency.

10. Discussion

First of all, in terms of the overall environment, although the international community is increasingly concerned about cruise safety. However, compared with the European and American markets, the Asian market is still in the stage of development and lack of enough experience. If we copy the European and American market operation mode mechanically, it is difficult to meet the special situation of Asia. At the same time, there is a lack of targeted thinking from the perspective of legislation. In the future MSC, it is necessary to conduct regional research and discussion on cruise safety, in order to establish a more effective legal supervision system in combination with the reality of each region and the relevant requirements of the port state government.

From the perspective of the ship itself, human factors are still an important hidden danger leading to safety accidents. For example, although the problem of fatigue has been widely discussed, and various companies have also formulated a series of measures to prevent fatigue, it is difficult to have the same superior environment as working on land due to the long-term industry characteristics of navigation. Only by further improving the living environment and enriching the spare time life on board can be beneficial to the mental health of the crew and alleviate the safety problems caused by fatigue.

The company's procedures have been detailed and improved enough through continuous updating, but the key to improving the safety factor depends on the implementation of the procedures by the crew, especially considering the fact that the English ability of the crew in the Asian cruise market is generally poor, which makes the usual safety training and exercise particularly important. Although there are detailed plans and arrangements, whether the quality can be guaranteed, it will be a key factor difficult to control to improve the safety awareness of the crew. Supervision and inspection are important, but considering that if it is too frequent, it will increase unnecessary workload, which requires the company's management and crew to find a good balance. How to establish an efficient training exercise supervision and management system will be the focus and difficulty of future research, which can not only enable the crew to understand the emergency measures, but also make it a natural response in an emergency At the same time, it can also effectively supervise and inspect from the company level, truly improve the ship safety level, and ultimately achieve a win-win situation.

In terms of cruise ship maintenance, due to the design of cruise ships makes ship maintenance more complex than that of merchant ships, but the port stay time is usually less than one day, and the higher demand than merchant ships for timely service (Rodrigues & Nottebohm, 2008). In addition to the application of the existing PMS system, it is also necessary to comprehensively consider and evaluate the effectiveness of the existing best maintenance methods, formulate maintenance plans in advance, and reserve relevant personnel and equipment, so that the cruise ship can start work in time and go through customs clearance procedures after berthing. In addition, Therefore, in order to improve the maintenance efficiency, in addition to having well-trained and flexible crew resources, it may also be necessary to introduce new technologies in ship design, such as separation of ship parts, so as to dismantle and replace them at the port, so as to strengthen the maintenance plan, improve the maintenance efficiency and save time.

In addition, it has been proposed that since human factors are unavoidable, the development trend of unmanned intelligent ships seems to be able to effectively reduce the safety risks caused by human factors. But in fact, unmanned ships bring more human factors. Even if the ship will not be interfered by the operator's fault, the operator is still a part of the intelligent system. When the system cannot solve some problems, people still need to take over. Although quality and safety are the focus of many literatures, the human factors that should be considered are still insufficient (Ramos, Utne & Vinnem, 2018). At the present stage, unmanned intelligent technology has not been fully applied in cargo ships. For cruise ships with high-risk coefficient, whether unmanned technology can be adopted will be a topic worth pondering.

11. Conclusion

Based on GISIS database, this paper analyzed the accident records of Asian cruise ships and found out that human error is still the main factor affecting their navigation safety. In the form of questionnaire survey, made a statistical analysis of the specific factors causing human errors. Combined with practical work experience, summarized the main policies and countermeasures adopted by cruise companies. After the analysis, it is not difficult to find that although a lot of efforts have been made to ensure the safety of ships, there are still many aspects worthy of thinking and research in order to improve for Asian cruise safety in the future.

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Questionnaire

Sample survey of Asian cruise fleet navigator

In order to further study the causes of human errors leading to Asian cruise safety issues, promote the practical application of theoretical research results, and find out the way to minimize the safety risk caused by human factors, a sample survey for the captains and officers of Asian cruise fleet has been conducted. The main purpose of this questionnaire is to estimate the factors that may affect human error. Please participate in the survey as a representative of Asian cruise fleet. The investigation is anonymous and strictly confidential.

1、Rank (Single choice questions)

○ Captain (Staff Captain)

○ Chief Officer (Safety Officer, Training Officer)

○ Officer on Watch (2^{nd} Officer, 3^{nd} Officer)

○ Cadet

2、Age (Single choice questions)

○ Under 25

○ 25-35 years old

○ 36-45 years old

○ Over 45 years old

3、Sailing Age (Single choice questions)

○ Less than 3 years

○ 3-5 years

○ 6-12 years

○ More than 12 years

4、Nationality

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5、The following table lists the factors that may cause human error. Please choose the degree of influence according to your own experience.

		Unimportant (1 point)	Important (2points)	Very important (3point)
L-H	Complexity of INS	○	○	○
	Reliability of INS	○	○	○
	Lack of Maintenance	○	○	○
	System Failure	○	○	○
	Unreasonable Design	○	○	○
L-S	Clear Procedure	○	○	○
	Education Background	○	○	○
	Training Onboard	○	○	○
	Safety Drill	○	○	○
	Navigation Information	○	○	○
L-E	Noise	○	○	○
	Fatigue	○	○	○
	Living Condition	○	○	○
	Weather Condition	○	○	○
	Traffic Situation	○	○	○
L-L	Collective Thinking	○	○	○
	Rank Hierarchy	○	○	○
	Communication Mistake	○	○	○
	Insufficient Manning	○	○	○
	Lack of supervision	○	○	○

Suggestions for supplement and modification

6、What other factors do you think affect human error

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7、What do you think of the influencing factors listed in the questionnaire

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