Journal of Marine Science and Technology

Volume 29 | Issue 3 Article 3

Enhancing marine administrative management based on human factor through safety criteria

Wen-Cheng Lin
Department of Business Administration, National Taipei University of Business, wencheng@ntub.edu.tw

Hsin-Hung Cheng
Institute of Transportation, Ministry of Transportation and Communication, hhcheng@iot.gov.tw

Recommended Citation

Lin, Wen-Cheng and Cheng, Hsin-Hung (2021) "Enhancing marine administrative management based on human factor through safety criteria," *Journal of Marine Science and Technology*: Vol. 29: Iss. 3, Article 3.
DOI: 10.51400/2709-6998.1432
Available at: https://jmstt.ntou.edu.tw/journal/vol29/iss3/3

RESEARCH ARTICLE

Enhancing Marine Administrative Management Based on Human Factor Through Safety Criteria

Wen-Cheng Lin, Hsin-Hung Cheng*

Department of Business Administration, National Taipei University of Business, Taiwan, ROC
Institute of Transportation, Ministry of Transportation and Communication, Taiwan, ROC

Abstract

This study aims to improve maritime safety by enhancing administrative management based on human factors. This study used Fuzzy analytic hierarchy process to analyze the risks and threats regarding safety maritime criteria. Establishing administrative reform is given the highest priority. First, the current model for crew training system is explored. Second, the marine surveyor is examined to determine if it is professional enough for inspection work. Third, the investigation system used by maritime safety investigators should be inspected. The suggestions mentioned expect to establish a maritime administrative reform that could pave the way for the application of maritime safety around the world.

Keywords: Marine management, Taiwan water, Fuzzy analytic hierarchy process

1. Introduction

The effective management and maintenance of safety of coastal shipping around a harbor is a challenge for island nationals, especially in major maritime transport of world shipping routes. The total coastline of Taiwan stretches up to 1140 km and lies off the Pacific Ocean with Eurasia. Thus, Taiwan has superior traffic location in Asia. Taiwan experiences scarcity in natural resources because it is a small nation. At present, over 90% of Taiwan's resources are transported by sea. Taiwan is ranks 14th among the top 20 container ports in the world. The rapid economic growth of China helped increase the economy, trade, and number of ships operated between Taiwan and China; an increase in the number of maritime ships in Taiwan and other countries was also observed. This information shows that Taiwan plays a key maritime role in Asia and the world. However, this development also means that any marine accident that occurs around Taiwan waters will leave a negative impact on maritime transport across Taiwan and China and even across Asia and the world. Therefore, maritime authorities should propose effective policies for improving maritime safety to avoid the occurrence of maritime accidents.

The United Nations enacted the International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (INTERVENTION) in 1969 and the United Nations Convention on the Law of the Sea (UNCLOS) in 1982 to avoid the occurrence of marine accidents, which clearly defined the meaning of maritime casualties and marine accidents. The Code of International Standards and Recommended Practices for a Safety Investigation into a Marine Casualty or Marine Incident (Casualty Investigation Code) Resolution MSC.255 (84) also clearly define the type of marine accidents [1]. Vessel technologies are

Received 8 April 2020; revised 22 May 2020; accepted 7 August 2020.
Available online 25 June 2021.

* Corresponding author. No.240, Dunhua N. Rd., Songshan Dist., Taipei City 105004, Taiwan, ROC. Fax: +886 2 2545 0429.
E-mail address: hhcheng@iot.gov.tw (H.-H. Cheng).

https://doi.org/10.514/2709-6998.1432

developed every year, but marine accidents continue to occur [2]. Thus, an increasing number of studies were published to avoid marine accidents from happening. These studies include discussions on different types of ship collision [3] and hull/machinery damage [4] and improvement of management methods [5,6]. The Formal Safety Assessment (FSA) for International Maritime Organization (IMO) and Maritime Safety Committee (MSC) were adopted in the assessment and management of maritime accidents based on human factors [7]. An increasing number of studies also explored maritime management to help reduce the risk of marine accidents [8–11]. These studies reached a unanimous consensus that a safe maritime environment can be maintained through administrative reform. Taiwan's maritime authorities consider the domestic condition of Taiwan and international situations to propose effective maritime safety strategies.

In the 1970s, Saaty is a well-established multicriteria method in which factors are organized in hierarchical structures and developed the analytic hierarchy process (AHP) [12]. It assists by ranking alternatives and choosing the most efficient alternative among multiple criteria. Although typical AHP has been widely recognized as an effective decision making tool, through the last two decades, its fuzzy extension have gained popularity among researchers and practitioners. In MCDM, fuzziness arises because of DMs' limited capacity to deal with complexity. The goal of this study is based on the human factor to propose maritime administrative reform through Fuzzy AHP. Specifically, it is to enhance the administration management to increase maritime safety and reduce accidents rate. From the past years of marine accidents statistics, it is hoped that the insights offered by this paper will contribute positivity towards the policy recommendations. Among them, what is worth discussing is the concrete measures to realize the interrelationships issues within crews, ships and maritime safety so that we can understand the importance of human influence between them.

This paper is structured as follows. Next section introduces Taiwan's marine management system, including the current situation of maritime administration, maritime personnel development and employment. Section 3 uses Fuzzy AHP technique to analyze maritime accident criteria and factors. In Section 4, the authors derive policies from crews, ships, and maritime safety to establish a framework for maritime safety. Section 5 is for conclusions and suggestions.

2. Literature review

2.1. Marine management system of Taiwan

Taiwan has a long history of development of maritime affairs. Based on its growth pattern, the development of Taiwan's maritime affairs underwent two stages. Four separate maritime authorities operated in four ports in Taiwan prior to 2012. They exercised public authority and business-model management in implementing their maritime policies. This set-up was often questioned given that maritime authorities cornered the market of maritime affairs. Taiwan's maritime affairs underwent another stage of development after 2012. The Maritime and Port Bureau (MPB) was established, which is mainly responsible for handling maritime affairs. MPB was divided into four maritime affairs centers that handle local maritime affairs. The Taiwan International Ports Corporation Ltd. (TIPC) was established to handle business-model management affairs. TIPC operates for Taiwan's commercial ports. This administrative reform was geared toward implementation of maritime policies, increased safety, and reduction of accident rate. Unfortunately, some policies apparently lack effective consideration and integration in addressing maritime cases, which lead to the lack of systematic and organized prevention of marine accidents. Given the pattern of maritime cases, the first priority should be administrative management, which originated from human factors. Therefore, the professional abilities of maritime employers should be the top priority of Taiwan's administrative authority to ensure administrative reform in maritime management.

2.2. Analysis of marine accidents

Statistics on marine accidents are important ways for measuring the safety of Taiwan waters. According to Lloyd's List Intelligence Casualty [13], Taiwan is located in a high-risk region for maritime accidents. This study analyses statistical data from MPB, but the types of ships were not distinguished because all ships presumably follow administrative and consistent approaches for implementing the policies to maintain the safety of Taiwan waters.

A total of 547 maritime accidents were recorded in Taiwan from 2013 to 2016 [14]. Fig. 1 shows the principal causes of maritime accidents. In terms of numbers, collision/contact, grounding/stranding, and others accounted for 71.3% of the total accidents. The remaining marine accidents accounted for less than 3%, which pertained to leaking and

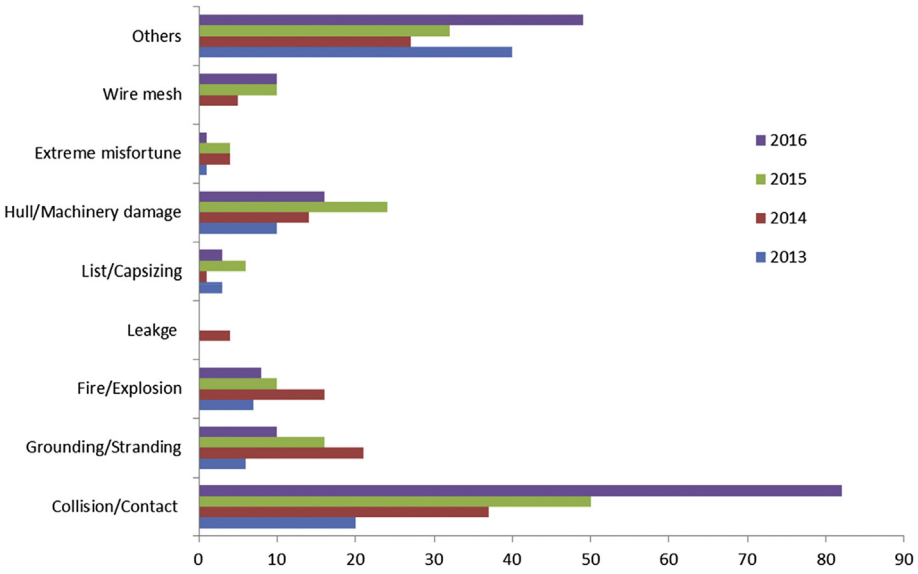

Fig. 1. The principal causes of maritime accidents (Source: Maritime and Port Bureau, MOTC).

extreme misfortune. These statistics reflect that hull/machinery damage, grounding/stranding, and fire/explosion did not change significantly in recent years, but collision/contact and others seemed to increase. Moreover, the location of marine accidents can serve as basis for marine treatment. To analyze marine accidents in Taiwan waters, the Taipei Air Defense Identification Zone (TADIZ) was designated as research range and the median line in Taiwan Strait was used as separation range.

According to the organization law of Taiwan, maritime jurisdiction was divided into four regions as shown in Fig. 2. Marine accidents that occurred in the north (Taipei port and Keelung port)comprised 223 cases (40.77%) and 209 cases (38.21%) in the south (Kaohsiung), 92 cases (16.82%) in the center, and 23cases (4.2%) in the east. These statistics show that marine accidents occurred frequently more near the ports. This result is expected. Cockcroft proposed the relation between collision probability and ship density [15]. Further comparison of collision probability and ship density was provided in Marine Traffic [16], which showed that high ship density results in increased occurrence of accidents.

Fig. 3 aims to determine the reasons marine accidents happen in these maritime affairs centers. First, the collision/contact and other situations are the primary reasons for accidents in the maritime affairs center in the north, which respectively accounted for 26.4% and 28.7%. Collision/contact comprised 31.52% of accidents in central maritime affairs center. Collision/contact comprised 44.5% of accidents in the maritime affairs centers in the south. Only a few marine accidents occurred in the maritime affairs centers in the east, of which 44% are attributed to other factors, 35% for collision/contact, and 13% for grounding/stranding. Overall, collision/contact and others are the major causes of accidents followed by grounding/stranding and hull/machinery damage.

According to the above analyzed Collision/Contact results from small activities water, high density for ships around Taiwan water. For Grounding/Stranding, the main reason is that the crews are strange in environment. As for others, the most of marine accidents might be caused by human. On the other side, due to high shipping density of ships in west of Taiwan water especially in north and south maritime affairs centers, we consider that is the main reason to causes accidents of Collision/Contact and Grounding/Stranding, even worse in south maritime affairs center. For central maritime affairs center, except Collision/Contact and Grounding/Stranding are much, the wire mesh is caused that not only the central of Taiwan water is north-south transportation through the fairway, but also for frequent activities of fishing. As for east maritime affairs center, because of the ship's activity is not that frequently so that the probability of occurrence is small, but others factors might be particularly large. Obviously, all of the maritime affairs centers have different situations of marine accidents.

2.3. Administrative reform

Several studies examined the relation between the causes and effects of marine accidents [17, 18).

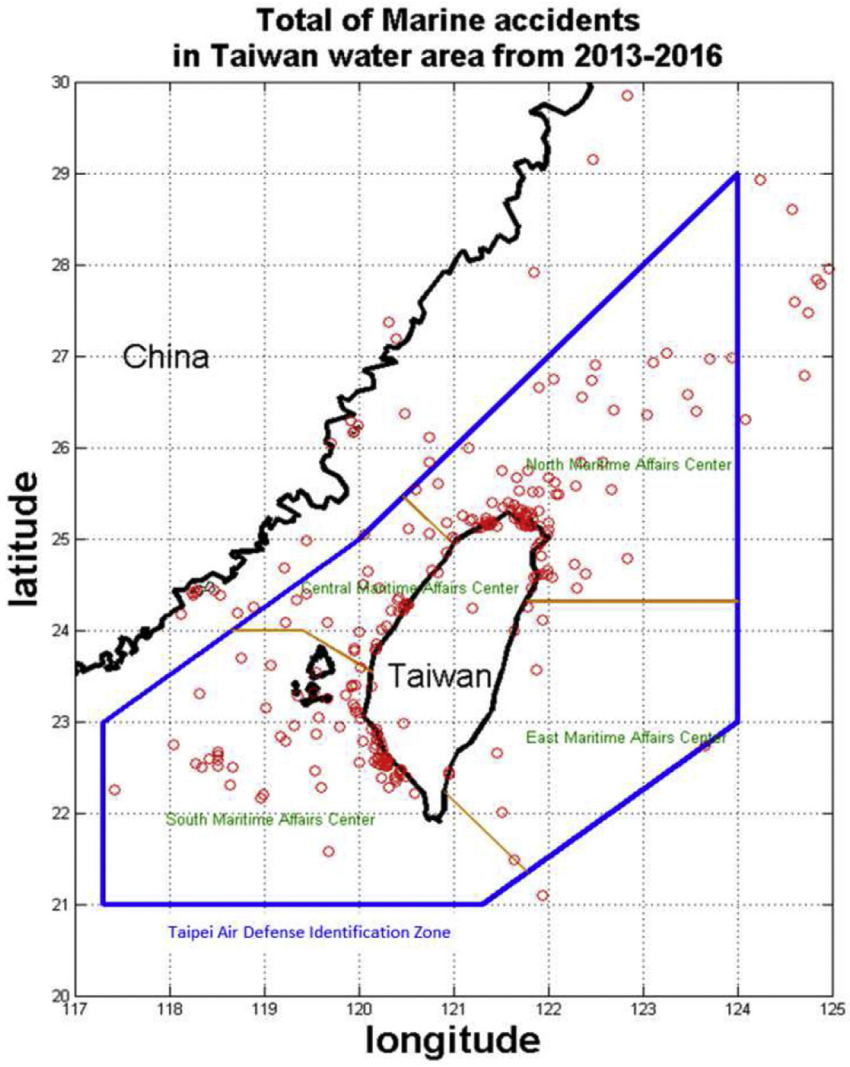

Fig. 2. Distribution of marine accidents around Taiwan water area from 2013 to 2016 and each red circles represents the location of marine accidents.

Results confirmed that most accidents are caused by human factors [19]. Figure 4 shows the analysis of the causes and effects of reconstruction of administration in humans. Initially, marine crews are formed to provide maritime professional background through systematic education in schools or institutes. Crewmembers then seek employment in the marine industry and undertake shipbuilding, engineering, and other relates tasks. In terms of ship inspection, the major work task involves inspection work after a ship docks at the port to ensure safety of ship systems. During shipping, crewmembers ensure the safety of the ship by undergoing cargo training and education. Lack of education and training increases the risk of marine or shipwreck incidents. Therefore, when marine accidents happen, a well-trained maritime investigator should conduct comprehensive investigation of the incident to determine the cause. The investigating authorities should then submit a safety report or a maritime investigative report. This process is repeated until all human are avoided. We summarized the factors related to crew, ship, and maritime safety.

In terms of crew-related factors, studies showed that the majority of marine accidents are attributed to human factors. A comparison of marine accidents in Taiwan with statistics from other countries showed that marine accidents in Taiwan are caused by human factors. Thus, effective management, exploration, and solution of crew-related factors can reduce marine accidents in Taiwan.

In terms of ship-related factors, studies showed that ship damage can be attributed to threat, injury, and accident [20]. Therefore, the details of this

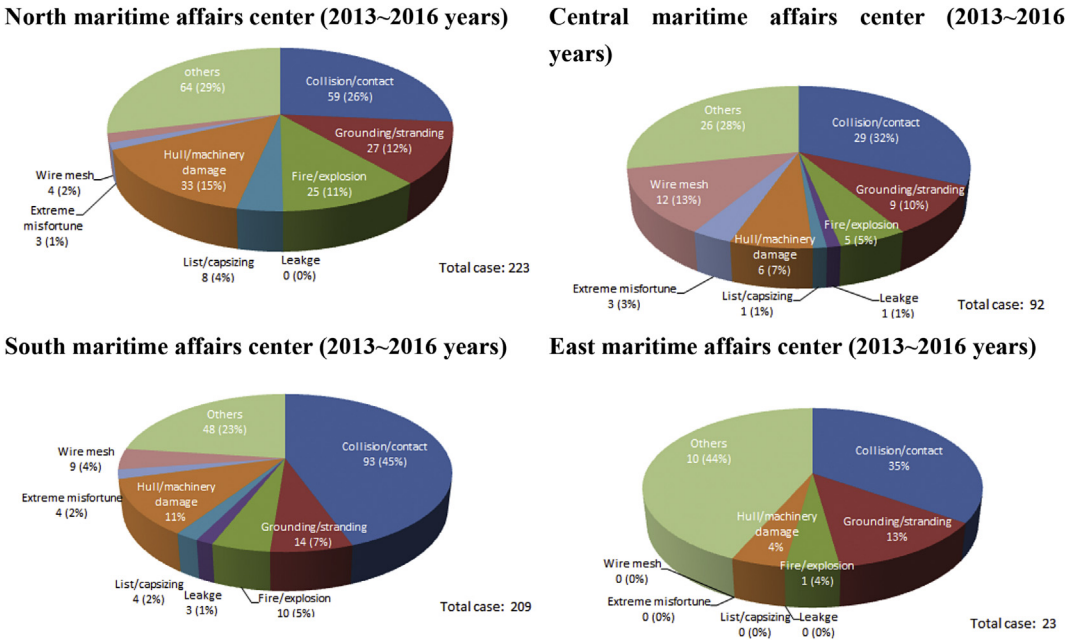

Fig. 3. Distribution of Taiwan's marine accidents in the four maritime affairs centers. (Source: Maritime and Port Bureau, MOTC).

process should be examined if we want to avoid the occurrence of marine accidents. Ship management should also be considered in addition to technical and maintenance issues. The management and inspection of ships should be improved.

Mistakes should not be repeated to avoid similar accidents from happening. Preventive work is the first step of avoiding these incidents [21]. Reconstruction of administration, reestablishment of the institution, and development of personnel are the main considerations of preventive work. Human factors in safety maritime affairs should be enhanced to achieve preventive work and avoid dealing with the aftermath of marine accidents. Thus, this study proposes three aspects of administrative reform based on the cause of marine accidents.

3. The concept of fuzzy AHP

AHP addresses subjective issues by using ''fuzzy set'' theory based on the idea that decisions are usually not

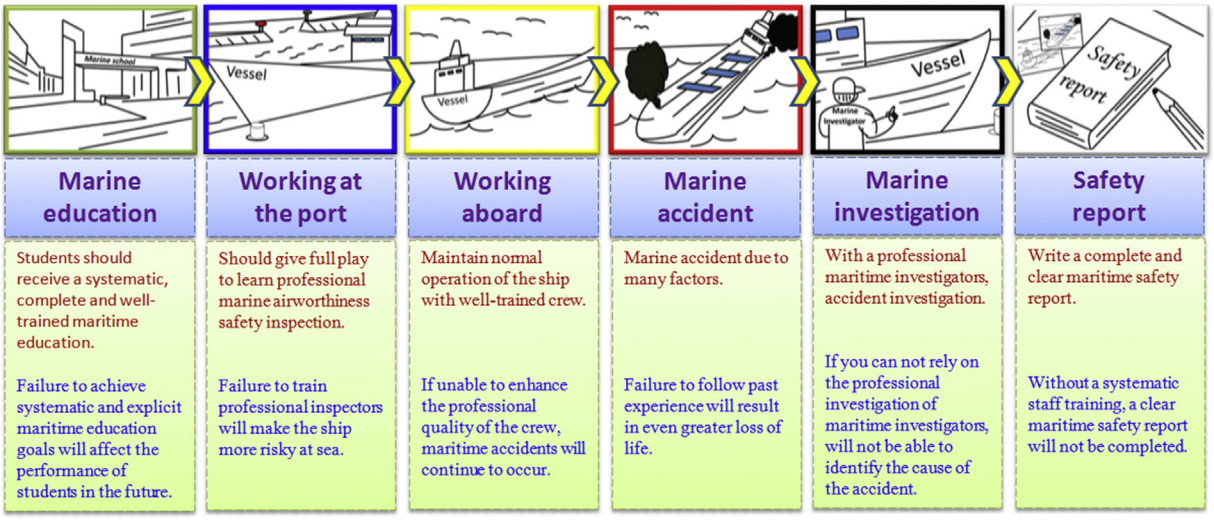

Fig. 4. Safety assessment categories: the analysis of the causes and effects of reconstruction of administration in humans.

absolute but are often made up of concepts that are defined only in ''fuzzy'' or relative terms [12]. Developed by Saaty, it has been used as a method for evaluating complex multi-criteria decision-making problems. The method allows users to analyze both qualitative and quantitative criteria for purposes of generating weights of importance of the decision criteria and measuring the relative performance of alternatives in terms of each individual decision criterion. AHP simplifies the decision-making process by breaking the problem into three basic steps: (1) problem decomposition, (2) comparative judgments, and (3) synthesizing the result [22].

3.1. Criteria definition

The main objective was to select the most suitable tool for improving maritime safety. A tool is most suitable if it satisfies the following criteria:

3.1.1. Crew management

This is a very common criterion for evaluating a maritime safety. In this study, we measured the crew management according to the: Establishing a uni-education system; To integrate maritime educational resources; and Enhance students understanding on marine accident.

3.1.2. Vessel management

This is a very common criterion for evaluating a maritime safety. In this study, we measured the vessel management according to the: Establishment of inspectors appointment mechanism.; Enhance inspectors professional qualifications experience.; and Develop a variety of maritime inspection capabilities.

3.1.3. Maritime safety management

This is a very common criterion for evaluating a maritime safety. In this study, we measured the maritime safety management according to the: Establish an independent and objective investigation organization; Develop professional maritime investigators; and Provide safety inspection report as a teaching materials.

3.2. Definition of the hierarchy

The hierarchy of the case example consists of three criteria (Crew, Vessel, and Maritime Safety) further analyzed into nine sub-criteria as shown in Fig. 5. After determining the sources of maritime accident that can be included in this study, we made a classification of these sub-criteria into three categories of reforms (Crew, Vessel, and Maritime Safety), and we constructed a hierarchy, customized to the problem under study.

This paper first built the problem structure through the criteria next must be prioritized. After building the structure, the next step was to calculate pairwise comparisons. These calculations are based on a scale that ranges from 1 to 9, as shown in Table 1. To do this, we needed to assign an importance value to each criterion. We then calculated the pairwise importance. As shown in Table 2, we had the highest importance compared to the other criteria.

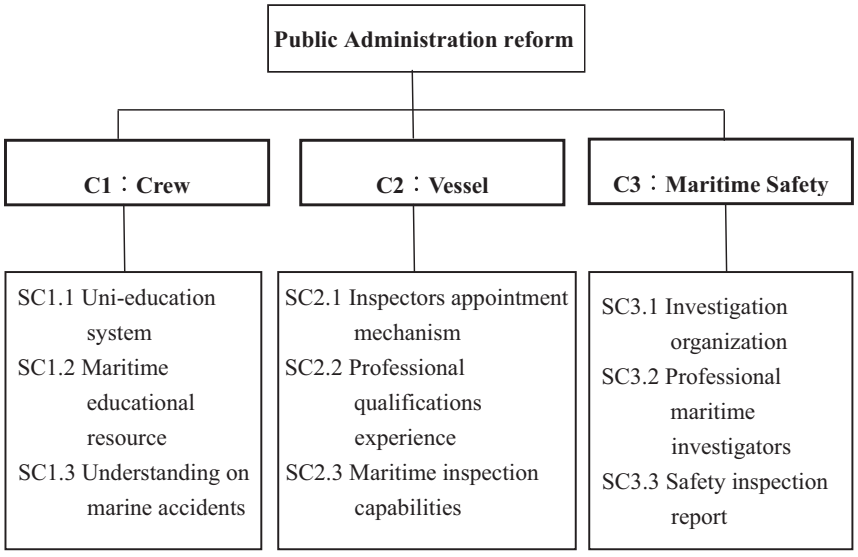

Fig. 5. The Hierarchy of the public administration reform.

4. Results

4.1. Fuzzy AHP

After checking consistency, we employ the Fuzzy AHP process on the same judgements of the decision maker. The scale used in this study has been proposed by Ref. [23]. The Fuzzy AHP priorities numerical results are summarized in Table 3. The Table 3 shows the importance of the criteria along with their weights as percentages.

Through calculating the priorities results by Fuzzy AHP, we found that all three perspectives have average weights. The top three are in order: SC3.2 Professional maritime investigators; SC1.1 Uni-education system and SC2.3 Maritime inspection capabilities. We will further explore their relationship with each other.

4.2. Develop crew training and assessment

Reducing maritime cases caused by human factors is a necessary measure. Several studies aimed to improve the abilities and quality of the crew [24,25] to avoid marine accidents and ensure safety. Taiwan is not a member of the IMO, but crew training in maritime education follows the International Convention on Standards of Training, Certification and Watch keeping for Seafarers (STCW). Moreover, certificates issued by Taiwan's maritime authorities are recognized in other countries. All processes should be complete regardless of maritime education or crew.

Taiwan's crew education and training evolved into two major administrative systems, namely, education and transportation. Differences in opinion might occur between the two systems. Crew education in Taiwan falls under the education department, whereas training falls under the transportation management department. The Taiwan government often fails to establish connection between education and training, which then results in wastage and overlap of resources. For example, students are required to acquire maritime education before they can obtain crew qualification. However, they are still required to pass the training examination administered by the transportation management department. In this situation, the development goal differs from the requirements for education and training, which then results in the difficulty of improving the abilities of the crew. Therefore, students do not only encounter difficulty in obtaining crew qualification, but they also face increased cost and additional administrative processed in the government given the lack of a unisystem for the crew development model. This situation leads to inefficient administrative enforcement of crew management and education.

Moreover, incompatibility between the education and transportation departments results in ineffective maritime education and failure of students to obtain proper training. Students who need to obtain opportunities for on-board learning should seek opportunities from shipping companies. Moreover,

Table 1. Table of labels associated with Saaty's model.

Weight	Description
1	Equally important
3	Equally to moderately important
5	Strongly more important
7	Very strongly important
9	Extremely more important
2, 4, 6 and 8	Represent compromises among the tabulated scale

Table 2. Matrix illustrations.

Criteria 1	Alternative A	Alternative B	Alternative C
Alternative A	1	7	5
Alternative B	1/7	1	3
Alternative C	1/5	1/3	1

Table 3. The Fuzzy AHP priorities results.

	Fuzzy priorities for criteria			Fuzzy local priorities for subcriteria			Defuziyfied	Normalized
	l	m	u	l	m	u		
C1	0.3175	0.3851	0.4293					
SC1.1				0.3715	0.4327	0.6843	0.4425	43.40%
SC1.2				0.0825	0.2586	0.3177	0.2687	26.35%
SC1.3				0.1528	0.3158	0.4253	0.3319	32.55%
C2	0.3074	0.3453	0.3769					
SC2.1				0.2159	0.3215	0.3494	0.3342	32.77%
SC2.2				0.2647	0.3348	0.3458	0.3421	33.55%
SC2.3				0.2478	0.3459	0.3547	0.3569	35.00%
C3	0.3125	0.3567	0.3791					
SC3.1				0.1523	0.2113	0.2567	0.2256	22.12%
SC3.2				0.4185	0.4587	0.4629	0.4682	45.92%
SC3.2				0.2743	0.3158	0.3267	0.3259	31.96%

schools offer limited opportunities for training and education despite substantial efforts of maritime schools. To promote administrative reform, this study conducts statistical of the importance of the education system. First, students should closely study marine accidents including vessels, species, and location before they can fully understand the situation in relation to its causes and effects. The education department should obtain data from the transportation department and analyze them to obtain results. Moreover, education and training systems should be combined to improve crew abilities and avoid brain drain [26]. Therefore, government authorities should form an effective management plan or policy to educate, train, and manage crew and make full use of educational resources [27,28]. Past studies indicated that enhanced maritime education and training could avoid marine accidents [29,30]; another important approach is the integration of education, training, and assessment to obtain qualification from the transportation department. This approach may facilitate the effectiveness of the goal of education and training. Education, training, and assessment with a clear purpose will improve crew quality and reduce marine accidents.

4.3. Enhance the ability of inspectors for the seaworthiness of ships

Improving maritime seaworthiness is indispensable and important in maintaining the safety of ships, promoting maritime security, avoiding pollution of ships, and enhancing crew ability. IMO-related resolutions were adopted by other countries to establish organizational structures that meet maritime conditions and implement maritime air seaworthiness policies. This framework mainly requires countries to be responsible for policy development, development of the domestic legal system, and the technical specifications of the convention. These countries should organize competent personnel to conduct inspections.

To enhance the effectiveness of inspection of Taiwan's maritime seaworthiness, the training and certification of inspectors should be considered to ensure their competence. However, this task is also performed by executives with public power in fact due to the scarcity of inspection professionals. If authorities cannot effectively implement inspection, the effectiveness of administrative work will decrease. Therefore, the continuity of operation of Port State Control (PSC), Flag State Control (FSC), or Planned Maintenance Scheme (PMS) depends on positive management by the government and development of personnel training, which are primary tasks of the government.

The Taiwan government has well-established specification for maritime rules and regulations, but marine accidents continue to occur. Related studies attributed these accidents to human factors in safety management systems [31]. However, improper operation, non-compliance with safety programs, and lack of awareness of the management system are other factors that cause these accidents [32]. Lack of awareness can be classified into two. The first instance pertains to the situation when the inspector is not understood well in the maritime education profession. Thus, a complicated shipping system is difficult to assess if the inspector does not have proper education and training. The second aspect is the lack of inspection experience. If an inspector does not have professional knowledge and relevant inspection experience, he or she cannot deliver competent inspection work. Inspectors should be able to understand that collision/contact is the most common cause of marine accident. For other accident-prone areas, inspectors can strengthen inspection items. For example, the southern area is more prone to collision; the eastern area is affected by more factors; and the central area is highly prone to wire mesh. The northern area is prone to fire/explosion, but not collision and others factors. Inspectors should observe different approaches for different inspection areas because of differences in these four areas. These capabilities are all necessary for inspectors. The solution is to introduce maritime professionals every year, which could increase the standards of inspectors through active training and annual related assessment [33]. The frequency of shipping accidents increased in recent years. The technical safety of ships also improved, but accidents did not decrease. Therefore, enhanced inspections can reduce the risk of marine accidents [34]. Maritime safety is not a problem of a single country, but a comprehensive and international issue [35]. Administrative reform in ship inspection should prioritized, especially inspectors' professionalism, to effectively maintain the seaworthiness of ships. When a professional inspector carries out inspection work, it should be done in a timely manner to diagnose the health and safety conditions of vessel navigation. This is the main solution for reducing vessel failure.

4.4. Cultivate maritime investigation professionals to improve maritime safety

An effective and feasible maritime policy is important in ensuring the safety of crews, vessels,

and cargoes. Taiwan's maritime authorities drafted related policies to ensure safe navigation. The management and implementation of policies are critical to crew management. The main objective of maintaining maritime safety is prevention [36]. This study obtained the percentage of marine accidents in Taiwan waters, but these are only numbers. The most important work is reducing these data and figuring out solutions.

The purpose of the United Nations is to establish a casualty investigation code based on marine accidents to investigate overall incidents and figure out their causes. Taiwan's maritime investigation system does not include a law on the management of Taiwan's maritime traffic that could formulate the organization and content of maritime investigations. Thus, a complete mechanism of training for investigators should be established. Chapter 16 of the United Nation's casualty investigation code [37] states that maritime safety investigation authorities should do justice to the investigation work and ensure circulation of information. Investigation work should avoid involvement of relevant interests. The qualifications of investigators should also be appointed based on Item 2, Chapter 15 of Administrative Responsibility [38]. IMO Resolution A.996 (25) states that any investigator should possess maritime safety investigator skills and professional knowledge. Maritime investigators include captains, chief engineers, and persons with relevant engineering and scientific backgrounds of at least three years. However, qualified investigators in Taiwan's maritime authorities are few. To address this problem, maritime investigators may early make preparations for the investigation of maritime cases. They should be able to figure out the reason for frequent marine accidents. Furthermore, investigators should have a general understanding of port topography, climate, walrus, and hydrology [39]. For example, results of investigation of a Taiwanese research vessel that sank in 2015 [40] showed that the accident was caused by human factors; however, if investigators are capable of conducting maritime investigation and education of professionals, they could figure out more deeply the causes of human factors and mechanical failures. Moreover, the causes of accidents should be explored in-depth [17]. The development of these fields cannot be cultivated overnight.

Therefore, this paper suggests that in maritime education, except to cultivate professionals of navigational and marine engineer, it is also necessary to train maritime investigators at the same time to help maritime investigators can understand causal relationships so that offer suggestion based on the evidence for future investigations [18]. For investigators are short-handed, maritime authorities can hire the current Captain, Chief Engineer to accept the relevant survey education courses temporarily, so that to have the ability to carry out the investigation works right now. The establishment of a professional maritime investigator and maritime accident investigation organization [4] of professional, independent and objective can to figure out the causes of marine accidents and reduce the incidence of most marine accidents. Therefore, it is important and necessary to train marine engineers and investigation professionals. Because this paper convinced that face the maritime safety, prevention is better than aftermath. And then the precaution depends on maritime investigators finding the real cause of the marine accidents.

With this in mind, Fig. 6 shows the study suggested that the Standard Operating Procedure (SOP) of safety assessment administration reconstruction. First of all, for crew factors, the government should be establishing the uni-systems of training policy immediately and to integrate educational resources. Furthermore, the government also should according to the future marine accidents situations to enhance the students understanding on marine accidents in Taiwan waters. Second, part of the ship factors should be established the employment mechanism for inspectors to enhance the professional qualities and experience of inspectors, and finally for different maritime cases, to strengthen the inspection abilities for ship seaworthiness. Thirdly, for maritime safety factors, establish an independent and objective investigation organization is necessary. Then, develop the maritime investigators with specialty background of maritime education and investigation. The most important is that implement the investigation reports to offer study for students in schools. On the other side, the maritime authorities should be formulated a marine accidents policy in the future direction of governance. However, we want to emphasize that as a mention above, the all of the crew, ship and maritime safety factors have looked more closely relations at the causes and effects each other. We also do expect to use these relationships to reduce the marine casualties and accidents on around Taiwan waters. Furthermore, the purpose of this paper is also expected be a reference offer island or littoral national. After all, keep maritime safety has become a global accepted trend.

5. Conclusion and suggestion

The FAHP is a powerful multi-criterion selection tool. It can assist decision makers when selecting the

Fig. 6. The Standard Operating Procedure (SOP) of safety assessment administration reconstruction.

most suitable criteria from among existing factors. Enhancing the administrative reform is an effective method to improve maritime safety and reduce the occurrence of marine accidents. This study proposed human beings as the factor of administrative reform. Furthermore, it focuses on three main frameworks: First, developing the crew's education, training and assessment to enhance the ability of inspectors for ship's seaworthiness and cultivate the ability of professional maritime investigation and safety. Second, establishing the uni-training system for crews is an effective way to enhance the quality and ability. Third, improving the professional skills of ship inspectors is one way to enhance ship safety. It is true that building up the prevention work of marine accidents is an effective way to avoid the occurrence of other similar accidents.

This study considers that human factor is the main influence on maritime safety. If lack of professional training or a well-established system, not only is it more difficult to find out the real cause of accidents, but also hard to avoid similar cases from occurring. Therefore, enhancing prevention work is necessary and it is expected that administrative reform can reduce marine accidents in the future. Eventually, the research results of this paper can assist relevant maritime nations to establish a uni-policy and maritime management so that reducing the number of marine accidents and paving the way for maritime safety to be applied throughout the world is the main goal.

References

[1] IIMO. International Maritime Organization. Appendix 5, table 4, the code of the international standards and recommended Practices for a safety investigation into a marine casualty or marine incident(casualty investigation code)255. London: Resolution MSC; 2008 (84).
[2] Eleftheria E, Apostolos P, Markos V. Statistical analysis of ship accidents and review of safety level. Saf Sci 2016;85: 282−92.
[3] Pedersen PT. Review and application of ship collision and grounding analysis procedures. Mar Struct 2010;23(No. 3): 241−62.
[4] Schröder-Hinrichs JU, Baldauf M, Ghirxi KT. Accident investigation reporting deficiencies related to organizational factors in machinery space fires and explosions. Accid Anal Prev 2011;43(No. 3):1187−96.
[5] Hee DD, Pickrell BD, Bea RG, et al. Safety management assessment system (SMAS): a process for identifying and evaluating human and organization factors in marine system operations with field test results. Reliab Eng Syst Saf 1999; 65(No. 2):125−40.
[6] Arslan O, Turan O. "Analytical investigation of marine casualties at the Strait of Istanbul with SWOT−AHP method. Marit Pol Manag 2009;36(No. 2):131−45.
[7] Kontovas CA, Psaraftis HN. Formal safety assessment: a critical review. Mar Technol 2009;46(No. 1):45−59.
[8] Wang J, Foinikis P. Formal safety assessment of containerships. Mar Pol 2001;25(No. 2):143−57.
[9] Kaneko F. Methods for probabilistic safety assessments of ships. J Mar Sci Technol 2002;7(No. 1):1−16.
[10] Lois P, Wang J, Wall A, et al. Formal safety assessment of cruise ships. Tourism Manag 2004;25(No. 1):93−109.
[11] Hu S, Fang Q, Xia H, et al. Formal safety assessment based on relative risks model in ship navigation. Reliab Eng Syst Saf 2007;92(No. 3):369−77.
[12] Saaty TL. The analytic hierarchy process. NY): McGraw-Hill; 1980.
[13] Lloyd's List Intelligence Casualty Statistics. Data analysis & graphic. Allianz Global Corporate & Specialty; 2017.

[14] Maritime, Port Bureau. MPB other statistics. 2017. https://www.motcmpb.gov.tw/informationlist_406.html. [Accessed 20 July 2017].
[15] Cockcroft A. Statistics of ship collisions. J Navig 1978;31(No. 2):213–8.
[16] Marine traffic: global ship tracking intelligence. 2018. https://www.marinetraffic.com. [Accessed 16 March 2018].
[17] Er Z, Celik M. Definitions of human factor analysis for the maritime safety management process. IAMU AGA-6, Malmö; 2005.
[18] Tirunagari S, Hanninen M, Stanhlberg K, et al. Mining causal relations and concepts in maritime accidents investigation reports. Int J Innovat Res Dev 2012;1(No. 10):548–66.
[19] Millar IC. The need for a structured policy towards reducing human-factor errors in marine accidents. Marit Pol Manag 1980;7(No. 1):9–15.
[20] Nordström J, Goerlandt F, Sarsama J, et al. Vessel TRIAGE: a method for assessing and communicating the safety status of vessels in maritime distress situations. Saf Sci 2016;85:117–29.
[21] Weng J, Yang D. Investigation of shipping accident injury severity and mortality. Accid Anal Prev 2015;76:92–101.
[22] Ahmad N. The design, development and analysis of a multi criteria decision support system model: performance benchmarking of small to medium-sized manufacturing enterprise (SME). Doctorate. Rensselaer Polytechnic Institute; 2005.
[23] Lamata MT. Ranking of alternatives with ordered weighted averaging operators. Int J Intell Syst 2004;19(No. 5):473–82.
[24] Gold E. International maritime law in transition: new challenges for education and training. Mar Pol 1989;13(No. 3):178–92.
[25] Helmreich RL, Wilhelm JA, Klinect JR, et al. "Culture, error and crew resource management," *Improving teamwork in organizations: Applications of resource management training*. 2001. p. 305331.
[26] Gekara V. Understanding attrition in UK maritime education and training. Glob Soc Educ 2009;7(No. 2):217–32.
[27] Pallis AA, Ng AK. "Pursuing maritime education: an empirical study of students' profiles, motivations and expectations. Marit Pol Manag 2011;38(No. 4):369–93.
[28] Chiou CH. A study of knowledge-based resource and controlled modes in Taiwan governmental organizations. Lex Localis- J Local Self-Govern 2015;13(No. 4):1067–93.
[29] Gudelj A, Krcum M, Krcum P. The role of information technology in maritime education for hazard avoidance. Int J Emerg Manag 2008;5(No. 3–4):219–34.
[30] Paine-Clemes B. What is quality in a maritime education. IAMU J 2006;4(No. 2):23–30.
[31] Chauvin C, Lardjane S, Morel G, et al. Human and organisational factors in maritime accidents: analysis of collisions at sea using the HFACS. Accid Anal Prev 2013;59:26–37.
[32] Batalden BM, Sydnes AK. Maritime safety and the ISM code: a study of investigated casualties and incidents. WMU J Marit Aff 2014;13(No. 1):3–25.
[33] Hetherington C, Flin R, Mearns K. Safety in shipping: the human element. J Saf Res 2006;37(No. 4):401–11.
[34] Eleftheria E, "Apostolos P, Markos V. Statistical analysis of ship accidents and review of safety level. Saf Sci 2016;85:282–92.
[35] Bueger C. What is maritime security? Mar Pol 2015;53:159–64.
[36] Fukuoka K, Furusho M. Relationship between latent conditions and the characteristics of holes in marine accidents based on the Swiss cheese model. WMU J Marit Aff 2016;15(No. 2):267–92.
[37] IMO., International Maritime Organization. Chapter 16, principles of investigation. The code of the international standards and recommended Practices for a safety investigation into a marine casualty or marine incident (Casualty Investigation Code)255. London: Resolution MSC; 2008 (84).
[38] IMO., International Maritime Organization. Chapter 15, administrative of investigation. The code of the international standards and recommended Practices for a safety investigation into a marine casualty or marine incident (Casualty Investigation Code)255. London: Resolution MSC; 2008 (84).
[39] Erol S, Demir M, Çetişli B, et al. Analysis of ship accidents in the istanbul strait using neuro-fuzzy and genetically optimised fuzzy classifiers. J Navig 2018;71(No. 2):419–36.
[40] Normile D. Human error led to sinking of Taiwanese research vessel. Science 2015;3/27.