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A Hybrid Framework for Assessing Near Miss Reporting Culture in Greek Ship Management

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ABSTRACT

This study develops a hybrid risk analysis method combined with the FAHP-TOPSIS ranking method for ship management companies to evaluate their performance in occupational risk prevention. Emphasis is given to ships' near-miss reports weighted with their occupational risks. The proposed ranking system avoids biases favouring specific vessel types or large companies. The proposed methodology ranking system avoids biases favouring larger fleets or specific vessel types. The data was collected from 14 Greek ship management companies managing 167 ships. Initially, the risk analysis revealed that larger companies collect extensive data. However, fleet size and type do not significantly influence reporting trends. Findings highlight that near-miss reporting involves occupational risks related to personal protective equipment, safe movement (including embarkation), health, and work. However, significant underreporting persists in security, pollutant handling, navigation and engine room operations. Following risk analysis, the FAHP-TOPSIS was used to evaluate each company based on the types of near-miss and more frequent reporting that contribute to occupational risk prevention due to weight. The findings show that companies' preventive culture, as shown in near-miss reporting, is not dependent on the number or characteristics of their fleets. Future research should examine cultural variations in reporting practices beyond the Greek maritime industry to enhance global maritime safety.

1. Introduction.

The seafaring profession is recognised to have higher fatal occupational accidents than other industries (Mallam et al. 2019; Wang and Yang 2018). The literature describes several examples of Occupational Health and Safety hazards (OHS) onboard ships, including slips, trips, and exposure to magnetic fields from navigation equipment (Liu et al. 2022; Roşu et al. 2016). Furthermore, relevant research reveals that the cause of some loss of lives is attributed to diseases due to a lack of medical facilities and evacuation plans (Çakır 2019; Battineni et al. 2022). Similarly, during a sea voyage, when mental health issues or suicide risks arise, their treatment may be very challenging (Puisa et al. 2018).

Proper communication of these risks within a company could be an essential proactive control in eliminating them (Hassan et al. 2019). For this purpose, some industrial management systems and guidelines have been published (Boiral et al. 2017). These systems are effective when communications within a company are well-established and safeguarded (Lee 2022). The International Maritime Organization (IMO) has produced some guidelines and regulations for reporting near misses within a company (Hasanspahić et al. 2022).

However, sometimes, the safety culture established by a company prioritises commercial obligations over occupation hazards (Tang 2017). For instance, seafarers' competency on-board a ship is determined by how much they contribute to work (Bailey and Winchester 2018). Therefore, their communication of incidents and safety actions within management companies is challenging. This study investigates how near miss reporting can improve preventive safety reporting and reduce occupational risks aboard ships. The sample consists of Greek-managed

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ships of different types and sizes. A hybrid FAHP-TOPSIS methodology is used to rate the performance of these companies based on the quality of near miss reports aiming at occupational hazard elimination. For a rational presentation, this study is organised into five sections. The rationalism and benefits of this research are prese

2. Literature Review.

The Maritime Labour Convention 2006 (MLC 2006), which was eventually enforced worldwide by states in August 2014, offers comprehensive regulations regarding seafarers' working and living conditions. MLC 2006 is a worldwide accepted set of regulations regarding seafarers' occupational safety and health standards (Fraitag et al. 2022). MLC describes ergonomic conditions on-board as the ship may vary to include physical and mental, such as stress or anxiety (Almeida et al. 2023). Regulations 4.3.5, 4.3.6 and 4.3.8 of MLC 2006 contain standards regarding statistical presentation and analysis of shipboard occupational safety and health incidents by ship operating companies (ILO 2017). Revisions to MLC 2006 now include provisions regarding bullying and harassment (Österman and Boström 2022). However, statistical analysis by ship management companies is challenging due to the reduced number of incidents (Kulkarni et al. 2020).

The enforcement of MLC 2006 depends on exchanging information within a ship management company. The International Management Code for the Safe Operation of Ships and Pollution Prevention (ISM Code) is the only compulsory documented management system for ship operators that demands continuous information collection and monitoring (Pantouvakis and Karakasnaki 2016). As per IMO guidelines, near miss reporting is part of hazardous occurrence prevention and the ISM Code (Hasanspahić et al. 2023; Hasanspahić et al. 2022). Its complete definition, as per IMO, is *"A near miss is a potential hazard or incident in which no property was damaged and no personal injury was sustained, but where, given a slight shift in time or position, damage or injury easily could have occurred. Near misses also may be referred to as close calls, near accidents, or injury-free events"*. As per IMO guidelines, the near miss reporting requirement has a broad scope and includes business damages such as reports, contract violations and loss of reputation. Recent studies highlighted seafarers' willingness to report near misses, indicating their safety perception (Arslanoglu et al. 2022). The contribution of near miss reporting in safety prevention is supported by recent findings (Bicen and Celik 2022).

However, it is argued that ship operators and seafarers have different understandings of the scope and requirements of the ISM Code, resulting in conformity challenges due to low mutual trust (Størkersen 2020). Consequently, self-reported accidents are a minor fraction of actual cases and are subject to bias. For example, PSC officers commonly detect a silent enforced imbalance of work and rest hours (Uğurlu et al. 2018). There are also concerns about the lack of commitment by ship managers since there are cases where injured seafarers have been abandoned in foreign ports (Nwokedi 2023). One solution is stricter enforcement of convention guidelines for the social responsibility of seafarers and ship managers unions (Yu et al. 2022). Authorities may enforce penalties, such as ship detention, and third-party claims against a ship operator may be raised. Such actions target ship management companies and substandard ships (Graziano et al. 2017).

One solution could be enforcing international standards for managing occupation risks, such as ISO 45001 (Heras - Saizarbitoria et al. 2020). Studies emphasise that occupational hazards hinder companies from achieving their commercial goals (Górny 2019). Implementing ISO 45001 minimises employers' liabilities concerning employee safety and health (Álvarez-Santos et al. 2018). A critical focus of ISO 45001 is identifying, reporting, and analysing near misses to prevent future accidents. Effective leadership is essential in fostering a safety culture that encourages near miss reporting (Kark et al. 2018b; Sheehan et al. 2016; Neag et al. 2020). However, challenges such as maintaining document control, training, and supervision persist (Fernández-Muñiz et al. 2017; Lee 2022).

In the maritime industry, there is no requirement to conform to ISO 45001. However, its structural similarities with the ISM Code can be incorporated into existing ship management systems (Banda and Goerlandt 2018; Cahyono and Yudoko 2022). Effective near miss management benefits ship management in commercial, knowledge, economic, and organisational areas (Mohammadfam et al. 2017; Morgado et al. 2019) and positively impact workers, subcontractors, customers, and regulatory authorities (Solano-Martos et al. 2019; Animah and Shafiee 2022). Despite these benefits, integrated management systems may yield variable results at the site level and increase operational costs (Podgórski 2015; Truant et al. 2017).

Ship management companies do not have a commonly accepted tool to measure the efficiency of reporting near misses. Therefore, a research gap exists in how an evaluation system may be implemented in the maritime industry that will satisfy MLC 2006 and ISM Code requirements without generating additional burdens, such as ISO 45001, to maritime companies and their ships. Such a system would be designed to identify safety trends, record near misses, and inform risk management policies efficiently, reducing the administrative load while still enhancing safety. Studies in other disciplines show that reporting errors show a robust information flow system, which is more beneficial for a company than analysing real cases (Hofmann et al. 2017; Kark et al. 2018a; Robertson and Barling 2017). Sharing experiences and mistakes is part of a company's knowledge management principles (Georgoulis and Nikitakos 2019).

3. Material and methods.

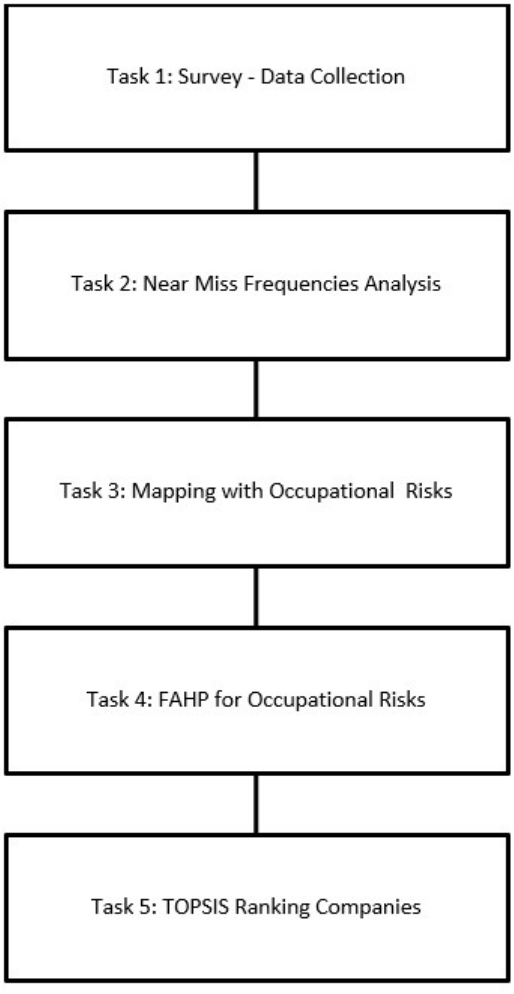
The study aims to compare near miss reporting with occupational risks on Greek-managed ships. As occupational accidents are expected to be infrequent, the methodology needs five tasks, as shown in Figure 1. Initially, a survey is required to collect data from ship management companies about near miss types recorded for a calendar year. In the second Task, risk

analysis for near misses is carried out to identify the frequency of different types of records. Some key factors considered are type, size of ships and size of fleet operated by a company. As per the third Task, Occupational risks are mapped for near miss types. In the fourth Task, the Fuzzy Analytic Hierarchy Process (FAHP) is used to determine the weight of occupational risks. Then, TOPSIS is carried out to identify the performance of each company based on its variation and severity of near miss reporting, focusing on occupation risks. The methodology is useful for organisations to develop more comprehensive safety management strategies by addressing these areas simultaneously.

The methodology's main point is to investigate the following hypotheses:

1. Ships' frequency of reporting near miss depends on their type, size, or company fleet size
2. The type of near miss records is representative of shipboard occupational risks
3. The severity of occupational risks is reflected in the near miss reporting

Figure 1: Research Methodology.



Source: Author.

3.1. Survey Design.

The survey targeted ship management companies based in Greece. It was designed to reach various companies irrespective of their fleet size, type, or flag. The questionnaires were distributed as an online survey. The questionnaires were distributed online, initiated by email invitations to ship management companies from a carefully selected list, requesting their valuable participation. Using an online survey platform allowed us to reach a wider audience and engage with a larger sample of ship management firms. The confidentiality of participants was preserved, and access to their replies was available.

The survey is thoughtfully structured into four distinct sections, each with its unique purpose. The introduction sets the stage by clearly and concisely outlining the study's objectives, giving readers an overview of their contribution. The second section looks into the demographics of the respondents and their companies, allowing the author to verify the participants' essential qualifications and experience. The third section focuses on near miss reporting, including questions about quantity, type, and department distribution.

3.2. Near Miss Reports Analysis & Mapping.

As defined by the IMO, near misses may include several categories, from cargo handling to moving on-board to health issues. The frequency of reporting some of them on some companies may show higher efforts to reduce occupation risks. Another explanation may be that seafarers may be less tolerated or alerted to some types of bad workplace practices or omissions. Part of this study is a risk analysis to identify if some reports are more frequent to some ships or companies. A risk analysis is carried out by creating event trees. This approach helps visualise information to identify relationships and improve decision-making (Pirbalouti et al. 2023). It is very popular in safe science and engineering screening initial data (Kabir and Papadopoulos 2018).

3.3. Weights of the Occupational Risks with FAHP.

The occupational risks on a ship are not frequent events. However, when they happen, the consequences are severe for the companies. Therefore, weighing the occupational risks for each near miss type at this stage is necessary. The survey asks the participants to weigh the consequences of occupational risks. The consequences, as validated by responders, were injury cases, sickness cases (W_1), third-party workplace claims (W_2), medication/hospitalisation days (W_3), delays /deviations hours (W_4), and light injuries (W_5). The FAHP is used to determine the weight of the consequences. The benefits of FAHP in decision-making have been found in several maritime applications (Başhan et al. 2022; Kashav et al. 2022a; Mollaoglu et al. 2022). Calculations are simple and do not need advanced software other than a spreadsheet (Kashav et al. 2022b; Kyriakidis et al. 2018). FAHP assist in generating weights and ranking orders of a dataset (Nazim et al. 2022a). The process of FAHP is described below:

Step 1. A decision-making matrix D with alternatives and criteria.

$$D = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \dots & & & \\ x_{m1} & x_{m2} & & x_{m1} \end{bmatrix}$$

$$W = [w_1, \dots, w_i, \dots, w_n]$$

In matrix D the criteria weights are denoted as w_j, $j = 1; 2; \dots$ The number of operations is indicated as x_{ji} , $i = 1; 2; \dots$; (n), j = 1, 2, . . . , number of criteria.

Step 2. Weights of criteria are calculated with AHP.

$$w_i = \frac{1}{n} \sum_{j=1}^{n} \frac{a_{ij}}{\sum_{k=1}^{n} a_{kj}} \tag{1}$$

Step 3. Weights of criteria are calculated with FAHP

$$CI = \frac{\lambda_{max} - n}{n - 1} \tag{2}$$

FAHP is sensitive to experts' judgment; therefore, specific steps were followed in this study to address this issue. Linguistic terms are used to reduce uncertainty, as shown in Table 1 (Bozbura et al. 2007). Also, the consistency ratio (*CR*) was considered. The *CR* of a FAHP matrix is the ratio of the Consistency Index (*CI),* as calculated by Equation 2, by the expected Random index (*RI*) pre-set values (Li et al. 2022). If experts are consensus in judgment, then the overall *CR* should be less than 0.1. Otherwise, the expert's participants panel should be reconsidered (Qu et al. 2022).

Table 1: Linguistic Scale.

Linguistic Scale	Triangular Fuzzy Scale	Triangular Fuzzy Reciprocal Scale
No Importance	(1,1,1)	(1,1,1)
Slightly Important	(1,3/2,2)	(1/2,2/3,1)
Important	(3/2,2,5/2)	(2/5,1/2,2/3)
Fairly Import	(2,5/2,3)	(1/3,2/5,1/2)
Very Important	(5/2,3,7/2)	(2/7,1/3,2/5)

Source: Author.

Step 4. Change FAHP to Crisp Numbers.

$$M_{crisp} = \frac{(a + b + c)}{3} \tag{3}$$

After determining the weight of occupational risks, the near miss types weights W_{NM} need to be calculated using the process described by Chakhrit et al. (Chakhrit et al. 2023). Each near miss type (e.g., PPE Use) is assigned a H_i binary value (0 or 1) based on whether it is associated with a specific *i* hazard. Then, the near miss weight was determined by summing the binary value of the products of hazards with the corresponding FAHP weight w_i.

Step 5. Calculate Near miss type weight with Parent Occupational Weights.

$$W_{NM} = \sum_{i=1}^{n} H_i \times w_i \tag{4}$$

3.4. Ranking of Companies with TOPSIS.

TOPSIS is used as a valuable process for determining the ranking of each company. The combination with FAHP can be found in several applications (Ak and Gul 2019; Albooyeh and Yaghmaie 2019; Venkatesh et al. 2019; Zhang and Lam 2019). The application of TOPSIS can be carried out with the process described below without also requiring advanced software tools (Asadi et al. 2016; Ding et al. 2016; Karahalios 2021; Nazim et al. 2022b). The outcome of TOPSIS is the best and worst alternative, which in this case are the companies. The fuzzy sets are then changed to crisp numbers using equation 11 (Rahmani et al. 2016; Voskoglou 2015). The next step of TOPSIS after FAHP are shown below:

Step 6. Calculation of the element r_{ij}.

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{n} x_{ij}^2}} \tag{5}$$

Step 7: Calculation of the v_{ij}.

$$v_{ij} = w_j r_{ij} \tag{6}$$

where *j*= 1, 2, . . . ,*n*; *i* = 1, 2, . . . , *m.*

Step 8: Calculation of (A_i^+) and (A_i^-) :

$$A^+ = \{v_1^+, \dots v_2^+, \dots v_i^+, \dots v_n^+\} \tag{7}$$

where

$$v_j^+ = \left\{ \left(\begin{matrix} max \\ iv \end{matrix} \left\{ v_{ij} \right\} \middle| \, i \in J \right) i = 1, \dots m \right\} \tag{8}$$

$$A^- = \{v_1^-, \dots v_2^-, \dots v_i^-, \dots v_n^-\} \tag{9}$$

where

$$v_j^- = \left\{ \left(\begin{matrix} min \\ i \end{matrix} \left\{ v_{ij} \right\} \middle| \, i \in J \right) \, i = 1, \dots m \right\} \tag{10}$$

Step 9: Determine the ideal solution from PIS and NIS:

$$S_i^+ = \sqrt{\sum_{j=1}^{m} \left(v_{ij} - \, v_i^+ \right)^2} \tag{11}$$

j= 1, 2, . . . , *m and i=1,2,. . . .n*

$$S_i^- = \sqrt{\sum_{j=1}^{m} \left(v_{ij} - \, v_i^- \right)^2} \tag{12}$$

Step 10: Evaluation of T_i^+.

$$T_i^+ = \frac{S_j^-}{S_j^+ + S_j^-} \tag{13}$$

4. Data Collection and analysis.

4.1. Data Collection.

As per Task 1, a survey was distributed to ship management companies based in Greece, and data was collected in April and May 2022. The criteria for selecting companies included managing at least three ships of more than 10,000 dwt. As per the Skolarikos database, the target group comprises 472 companies (Skolarikos Maritime Bureau 2022). Data were collected from 14 companies managing 167 ships, comprising 100 bulk carriers, 59 oil tankers, and 8 cargo ships.

4.2. Analysis of Near Miss Records.

In Task 2, the analysis focused on the frequency of near miss reports received by ships. Most ships report 1-5 near miss reports every month. The research also examined the distribution of near miss reports by ship department. Responses to the survey question, "Which Ship Department Reports More Monthly Near Misses?" indicated that most reports originated from the deck department (13 reports), followed by the galley (1 report). As shown in Table 2, the majority of most near misses are within the 1-5 range. Categories with higher numbers in the 6-11 range include Work Aloft, Other, Use of Machinery, Use of Equipment (including boat launching), and Cargo Handling. Categories with incidents reported in the 11-15 range include Safe Movement, Other, Work Aloft, and PPE Use. Safe Movement, Health and PPE Use are the only categories with incidents reported in the More than 15 range. Most categories have no near-miss reporting, indicating areas with no incidents reported in those cases.

Table 2: Frequency of Near Miss Types Reported by Ships.

Near Miss Types	1-5	6-11	11-15	More than 15	Nil
Mooring	13	1	2	0	2
Navigation, Mooring	12	2	1	0	3
Safe movement (including embarkation)	11	0	3	2	2
Health	11	2	1	1	3
Bunkering	10	3	1	0	4
Work Aloft	10	5	2	0	1
Other	10	5	3	2	0
Security	9	3	1	0	5
Use of Machinery	8	5	2	0	3
Handling of pollutant material (environmental)	8	3	0	1	6
Use of equipment (including boat launching)	7	7	1	0	3
Cargo Handling	7	6	1	0	4
PPE Use	6	4	3	4	1

Source: Author.

Table 3 summarises near miss reporting frequency compared per company, fleet size and type of ships. Companies with fewer managed ships tend to report more near misses per ship, potentially due to more focused reporting and monitoring. Nil values are pretty low across categories, with a maximum of 7 at companies operating small fleets of 8 and 2 ships. Concerning the type of ships across various sizes, bulk carriers are mainly in the 1-5 and 6-10 range for most categories. For oil tankers, the range is more varied, with some instances of high PPE use and health incidents. For companies, operation mixed bulk carriers and oil tankers are also in the 1-5 range.

Concerning the size of ships, the Nil near miss values are highest in the "Between 36,000 and 80,000 DWT" category with 13 counts. This detailed breakdown shows that most counts fall within the 1-5 range, especially for vessels between 36,000 and 80,000 DWT. Larger ships (more than 80,000 DWT) often report higher near misses in the range of 6-10, possibly due to more complex operations. The 11-15 range is relatively low across all categories, with the highest in "Between 36,000 and 80,000 DWT" at four companies.

Table 3: Summary of Near Miss Reporting.

Type	Fleet	Size	Nil	1-5	6-10	11-15	More than 15
Bulk Carriers	3	Less than 36,000 DWT; Between 36,000 and 80,000 DWT	1	11	0	1	0
Bulk Carriers	2	Between 36,000 and 80,000 DWT	2	3	4	3	1
dry cargo ship	8	Less than 36,000 DWT	7	6	0	0	0
Bulk Carriers, Oil Tankers	6	Less than 36,000 DWT	3	6	1	1	2
Bulk Carriers	2	Between 36,000 and 80,000 DWT	7	5	1	0	0
Bulk Carriers	4	Between 36,000 and 80,000 DWT	6	7	0	0	0
Oil Tankers	30	More than 80,000 DWT	5	7	0	0	1
Bulk Carriers	5	Between 36,000 and 80,000 DWT	0	6	6	1	0
Oil Tankers	15	More than 80,000 DWT	2	4	5	2	0
Bulk Carriers	4	More than 80,000 DWT	2	8	3	0	0
Bulk Carriers, Oil Tankers	36	Between 36,000 and 80,000 DWT; More than 80,000 DWT	0	11	2	0	0
Oil Tankers	14	Between 36,000 and 80,000 DWT	1	6	2	4	0
Bulk Carriers	14	Between 36,000 and 80,000 DWT	0	3	5	3	2
Bulk Carriers, Oil Tankers	24	More than 80,000 DWT	2	6	3	0	0

Source: Author.

Task 3 is about mapping near miss reporting with occupational risks, which was carried out and presented in Table 4. The comparison shows that most cases with more than two types of occupation risks are also more frequently reported in near miss by seafarers. For instance, PPE usage has the highest average of near miss reporting (10.39). Activities like safe movement during embarkation (average of 6.29) and health-related tasks (average of 5.04) also show a high number of near miss reports. On the other hand, the near miss reports of less than three categories of near miss averages were navigation, handling pollutants, and bunkering. These are the categories with fewer occupation risks. An exception is cargo handling, which has a 4.10 average of near miss reports. Reading the previous tables comparing frequencies with mapping of occupant risk, seafarers report more near misses related to at least two occupational risks. Therefore, there is some positive indication that reporting aims at the most severe actions onboard a ship.

4.3. FAHP with Experts.

In Task 4, the responders' replies were used to calculate the weight of occupational risks. The responders had academic and professional qualifications and several years of managerial experience, as shown in Table 5. Another finding is that most persons with higher managerial experience, above ten years, were working in smaller companies and managing less than six ships. The responders had a high level of expertise, and their judgements were used in creating an FAHP Matrix. Using Equation 3, the fuzzy sets were changed to crisp numbers, which are shown in Table 6 below. The rate matches the linguist terms

Table 4: Mapping Occupational Risks with Near Miss Types.

Near Miss Types	Average Near Miss Reporting	Sickness Cases	Third-Party Workplace Claims	Delay Hours Due to Injury/Sickness	Deviations Hours Due to Injury/Sickness	Light Injuries
PPE use	10.39	NO	NO	YES	YES	YES
Safe movement (including embarkation	6.28	YES	NO	YES	YES	YES
Health	5.03	YES	NO	YES	YES	NO
Use of machinery	4.64	NO	NO	YES	YES	YES
Use of equipment (including boat launching)	4.64	NO	NO	YES	YES	YES
Cargo handling	4.10	NO	NO	YES	YES	NO
Work Aloft	4.07	NO	NO	YES	YES	YES
Mooring	3.50	NO	NO	YES	YES	YES
Navigation, Mooring	3.10	NO	NO	YES	YES	NO
Handling of pollutant material (environmental)	2.39	NO	NO	YES	YES	NO
Bunkering	2.00	NO	NO	YES	YES	NO
Security	1.64	NO	YES	NO	NO	NO

Source: Author.

used in Table 1 and follows the FAHP equations described in Steps 1-3 in 3.3 Section. Consensus among experts was high as *CR* was evaluated at less than 0.1. The weights were determined as follows

1. $W_1 = 0.215$.
2. $W_2 = 0.188$.
3. $W_3 = 0.210$.
4. $W_4 = 0.181$.
5. $W_5 = 0.207$.

After determining the weight of occupational risks, weights of near miss types were determined as described in Step 5 of the FAHP process and are illustrated here with an example of Table 7 for PPE use. PPE misuse may cause occupational risks such as medication/hospitalisation day deviations hours due to injury/sickness light injuries. The associated occupational weights are included when applicable to find the total weight. Then, the PPE near miss weight was calculated with Equation 4, and the value was equal to 0.598. With a similar approach, all weights are shown in Table 8.

Table 5: Responders' Qualifications.

Responder	Academic Qualifications	Area of Expertise	Managerial Experience	Professional Qualifications
1	PhD	Safety Management	More than 11	Ship Surveyor
2	MSc	Safety Management	More than 11	Auditor
3	BSc	Operation Management	Between 6 and 10	Auditor
4	BSc	Safety Inspection/Audit/Accident Investigation	Less than 5	Auditor
5	BSc	Safety Management	Less than 5	Captain
6	MSc	Safety Management	More than 11	Captain
7	Other	Safety Inspection/Audit/Accident Investigation	More than 11	Captain
8	MSc	Safety Management	More than 11	Auditor
9	BSc	Safety Management	No Managerial Experience	Auditor
10	MSc	Safety Inspection/Audit/Accident Investigation	More than 11	Auditor
11	MSc	Safety Management	Less than 5	Auditor
12	MSc	Safety Inspection/Audit/Accident Investigation	Between 6 and 10	Auditor
13	MSc	Safety Management	Between 6 and 10	Auditor
14	MSc	Safety Management	Less than 5	Auditor

Source: Author.

Table 6: Pairwise Comparison Matrix.

	Health Cases	Third-Party Workplace Claims	Delays /Deviations Hours	Medication/Hospitalisation Days	Injuries Cases
Health Cases	1.000	1.145	1.186	1.023	1.039
Third-Party Workplace Claims	0.873	1.000	1.035	0.893	0.907
Delays /Deviations Hours	0.843	0.966	1.000	0.863	0.876
Medication/Hospitalisation Days	0.978	1.120	1.159	1.000	1.016
Injuries Cases	0.963	1.103	1.142	0.985	1.000

Source: Author.

Table 7: Calculation of $W_{PPE\ use}$.

Near Miss type	Sickness Cases	Third-Party Workplace Claims	Medication / Hospitalisation Day	Deviations Hours Due to Injury / Sickness	Light Injuries
PPE Use	0	0	1	1	1
Weight	0.215	0.188	0.210	0.181	0.207

Source: Author.

Table 8: Weights of Near Miss Types.

Near-Miss Types	Weight
PPE use	0.598
Safe movement (including embarkation)	0.813
Navigation, Mooring	0.598
Use of machinery	0.598
Use of equipment (including boat launching)	0.391
Cargo handling	0.188
Security	0.606
Health	0.391
Handling of pollutant material (environmental)	0.391
Bunkering	0.391
Mooring	0.598
Work Aloft	0.598

Source: Author.

4.4. FAHP-TOPSIS.

As described in Task 5, the annual frequency of near miss type recorded by each company is used for the TOPSIS matrix, as shown in Table 9. Then, TOPSIS is carried out using the weight of near misses listed in Table 7. Proceeding with TOPSIS Steps 6-10 and equations described in the 3.3 Section, the ranking of companies is shown in Table 10. In the TOPSIS analysis, option "o" achieved the highest ranking as the best choice, with a score of 0.652, indicating the best reporting

performance. Companies like ”n” (0.458), ”b” and ”b” (both 0.446), and ”h” (0.427) also scored well. The lowest scores are for companies’ ”f” (0.133), ”e” (0.114), and ”c” (0.105).

Table 9: Weights of Near Miss Types.

Company	PPE use	Safe movement (including embarkation)	Navigation, Mooring	Use of machinery	Use of equipment (including boat launching)	Cargo handling	Security	Health	Handling of pollutant material (environmental)	Bunkering	Mooring	Work Aloft
a	2.5	2.5	13	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
b	16	2.5	0	2.5	8	8	2.5	13	8	8	0	13
c	2.5	0	2.5	2.5	2.5	2.5	0	2.5	0	0	0	0
d	16	13	2.5	8	2.5	2.5	0	16	0	0	2.5	2.5
e	8	2.5	0	2.5	0	0	0	2.5	0	0	0	2.5
f	2.5	2.5	0	0	2.5	0	0	0	0	2.5	2.5	2.5
g	16	2.5	2.5	2.5	2.5	2.5	0	0	2.5	0	2.5	0
h	13	2.5	8	2.5	8	8	2.5	2.5	2.5	2.5	8	8
k	13	13	2.5	2.5	2.5	8	0	8	8	2.5	8	0
l	8	0	2.5	8	8	2.5	0	2.5	2.5	2.5	2.5	2.5
m	8	8	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
n	8	13	2.5	13	13	2.5	2.5	2.5	0	2.5	2.5	8
o	16	13	2.5	8	8	8	8	8	2.5	2.5	13	13
p	16	13	2.5	8	2.5	8	2.5	8	2.5	0	2.5	0

Source: Author.

Table 10: Weights of Near Miss Types.

o	0.652
n	0.458
b	0.446
h	0.427
k	0.398
p	0.392
a	0.380
d	0.371
m	0.295
l	0.257
g	0.196
f	0.133
e	0.114
c	0.105
o	0.652

Source: Author.

4.5. Overall Performance of Companies.

The ranking shows which companies achieve a more conclusive preventive culture in reporting near miss in their fleets. For detailed comparisons, Table 11 is completed, where each company is listed with its fleet size, ship size, and type of ships. Top FAHP-TOPSIS Performers Companies ”o” and ”n” have the highest ranking with medium-sized ships and medium fleet sizes, focusing on bulk carriers ”o” and oil tankers ”n”. However, reading the table carefully, there is no concluding evidence that some types of ships produce more reports. Similar findings applied to large fleet operating companies and large ships.

Table 11: Comparison Companies Performance.

Company	FAHP-TOPSIS	Fleet	Ships Size	Type of ships
o	0.652	14	Between 36,000 and 80,000 DWT	Bulk Carriers
n	0.458	14	Between 36,000 and 80,000 DWT	Oil Tankers
b	0.446	2	Between 36,000 and 80,000 DWT	Bulk Carriers
h	0.427	5	Between 36,000 and 80,000 DWT	Bulk Carriers
k	0.398	15	More than 80,000 DWT	Oil Tankers
p	0.392	24	More than 80,000 DWT	Bulk Carriers, Oil Tankers
a	0.380	3	Less than 36,000 DWT, Between 36,000 and 80,000 DWT	Bulk Carriers
d	0.371	6	Less than 36,000 DWT	Bulk Carriers, Oil Tankers
m	0.295	36	Between 36,000 and 80,000 DWT, More than 80,000 DWT	Bulk Carriers, Oil Tankers
l	0.257	4	More than 80,000 DWT	Bulk Carriers
g	0.196	30	More than 80,000 DWT	Oil Tankers
f	0.133	4	Between 36,000 and 80,000 DWT	Bulk Carriers
e	0.114	2	Between 36,000 and 80,000 DWT	Bulk Carriers
c	0.105	8	Less than 36,000 DWT	Dry Cargo

Source: Author.

Discussion & Conclusions.

This paper contributes to maritime safety by developing a hybrid methodological framework for assessing ship management near miss operating efficiency. The survey results provide valuable insights insight into companies near miss reporting. It is also interesting that from the fleet sample, the top five near misses are those with at least three occupational risks combined. These are PPE use, safe movement (including embarkation), health, use of machinery, and use of equipment (including boat launching), with average annual reporting of 10.39, 6.28, 5.03, 4.64, and 4.64, respectively. This indicates that near miss reporting is highly associated with those errors that have combined occupational risks by seafarers.

A key finding is that some companies did not receive near misses from all categories. For instance, 44 ships that did not receive near misses in more than five types were asked in the questionnaire. These areas were security, handling of pollutant material, bunkering, and navigation. Many areas, particularly the engine department, are consistently underreported, suggesting that the process is viewed more as a bureaucratic task than an effective data collection tool. This observation is interesting, as engineers working primarily in machinery spaces report fewer near misses than deck department personnel. Larger companies have an advantage with their capacity to collect extensive reports. Interestingly, the number of near misses reported is not significantly dependent on fleet size or type. Furthermore, larger ships tend to report slightly more near misses. This could be due to the infrequent port calls and the potential for lower bureaucracy. On the other hand, smaller companies,

despite their lower reporting capacity, tend to collect several near misses per ship.

Using FAHP-TOPSIS and expert assessments, a raking method was designed for the companies regarding their near-miss preventive culture reporting. A company's performance is accounted for by those near miss types, which have higher weight with respect to the five main consequences of occupation risks. The model is biased, free from the perception that companies managing several ships, oil tankers, or larger ships perform better in occupational risk prevention.

The findings from this study could be used to improve ship management companies' reporting and risk mitigation practices. One option is adopting targeted training for departments such as the engine room, where near miss reporting rates are lower. Additionally, regulatory bodies and authorities should place greater emphasis on this issue. Their guidelines may be based on reducing perceptions of bureaucracy. As the sample is only 14 Greek companies, future research could explore other cultural differences in near miss reporting practices.

References.

Ak, M.F. and Gul, M. (2019). AHP–TOPSIS integration extended with Pythagorean fuzzy sets for information security risk analysis. Complex & Intelligent Systems, 5(2), pp.113–126.

Albooyeh, S. and Yaghmaie, F. (2019). Evaluation of knowledge management model in construction companies using the fuzzy AHP and fuzzy TOPSIS. International Journal of Business Excellence, 18(1), pp.64–97.

Almeida, J.A.G., Guedes, R.M., Guanga, D.A.C., Ganzo, M. and Martín, F.P. (2023). Traineeship students and risk prevention on board merchant ships: risk factors and effects on their health. Journal of Maritime Research, 20(1), pp.131–144.

Álvarez-Santos, J., Miguel-Dávila, J.Á., Herrera, L. and Nieto, M. (2018). Safety management system in TQM environments. Safety science, 101, pp.135–143.

Animah, I. and Shafiee, M. (2022). Status of ISO 45001:2018 implementation in seaports: A case study. In: Proceedings of the 32nd European Safety and Reliability Conference (ESREL 2022). Research Publishing, Singapore.

Arslanoglu, B., Elidolu, G. and Uyanık, T. (2022). Application Of Machine Learning Methods For Prediction Of Seafarer Safety Perception. International Journal of Maritime Engineering, 164(A3), pp.269–282.

Asadi, H.H., Sansoleimani, A., Fatehi, M. and Carranza, E.J.M. (2016). An AHP–TOPSIS predictive model for district-scale mapping of porphyry Cu–Au potential: a case study from Salafchegan area (central Iran. Natural Resources Research, 25, pp.417–429.

Bailey, N. and Winchester, N. (2018). Framing Social Justice: The Ties That Bind a Multinational Occupational Community. Sociol, 52(4), pp.796–812.

Banda, O.A.V. and Goerlandt, F. (2018). A STAMP-based approach for designing maritime safety management systems. Safety Science, 109, pp.109–129.

Başhan, V., Yucesan, M., Demirel, H. and Gul, M. (2022). Health, safety, and environmental failure evaluation by hybridising fuzzy multi-attribute decision-making methods for maritime scrubber systems. Environmental Monitoring and Assessment, 194, p.641.

Battineni, G., Chintalapudi, N. and Amenta, F. (2022). Maritime Telemedicine: Design and Development of an Advanced Healthcare System Called Marine Doctor. Journal of Personalized Medicine, 12(5), p.832.

Bicen, S. and Celik, M. (2022). A hybrid approach to near-miss report investigation towards next-generation safety solutions on-board ships. Ocean Engineering, 266, p.112768.

Boiral, O., Guillaumie, L., Heras-Saizarbitoria, I. and Tayo Tene, C.V. (2017). Adoption and outcomes of ISO 14001: a systematic review. Int. J. of Manage. Rev, 20(2), pp.411–432.

Bozbura, F., Beskese, A. and Kahraman, C. (2007). Prioritisation of human capital measurement indicators using fuzzy AHP. Expert Systems with Applications [online], 32(4), pp.1100-1112. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0957417406000868 [accessed 25 October 2024].

Cahyono, B.N. and Yudoko, G. (2022). Toward Health, Safety, Security, & Environment (HSSE) Integration into Business Sustainability of Marine, Shipping, & Logistics Companies in Indonesia. Inclusive Society and Sustainability Studies [online], 2(2), pp.17–31. Available from: https://journals.researchsynergypress.com/index.php/issues/article/view/1118 [27 - June 2023].

Çakır, E. (2019). Fatal and serious injuries on board merchant cargo ships. International Maritime Health, 70(2), pp.113–118.

Chakhrit, A., Guetarni, I.H.M. and Chennoufi, M. (2023). A hybrid multi-criteria decision-making approach for the risk assessment in the automotive parts industry. 28 December 2023. Available from: https://www.researchsquare.com/article/rs-3347625/v1 [accessed 12 November 2024].

Ding, L., Shao, Z., Zhang, H., Xu, C. and Wu, D. (2016). A comprehensive evaluation of urban sustainable development in China based on the TOPSIS-entropy method. Sustainability, 8, p.746.

Fernández-Muñiz, B., Montes-Peón, J.M. and Vázquez - Ordás, C.J. (2017). The role of safety leadership and working conditions in safety performance in process industries. Journal of Loss Prevention in the Process Industries, 50, pp.403–415.

Fraitag, D.N., Popescu-Stelea, M., Moraru, R.I. and Băbuţ, G.B. (2022). Prevention activities in ship loading and unloading operations. In: MATEC Web of Conferences. EDP Sciences, p.00003.

Georgoulis, G. and Nikitakos, N. (2019). The importance of reporting all the occurred near misses on board: the seafarers' perception. TransNav: International Journal on Marine Navigation and Safety of Sea Transportation, 13(3).

Górny, A. (2019). Assessment and management of risk in improving the OHS management system. System Safety: Human-Technical Facility-Environment.

Graziano, A., Schröder-Hinrichs, J.U. and Ölcer, A.I. (2017). After 40 years of regional and coordinated ship safety inspections: Destination reached or new point of departure?. Ocean

Eng, 143, pp.217–226.

Hasanspahić, N., Vujičić, S., Kristić, M. and Mandušić, M. (2022). Improving Safety Management through Analysis of Near-Miss Reports—A Tanker Ship Case Study. Sustainability, 14(3), p.1094.

Hasanspahić, N., Vujičić, S. and Mandušić, M. (2023). Ship Safety Officers' Perceptions and Attitudes Toward Near-Miss Management Systems. Transactions on Maritime Science, 12(1).

Hassan, N.A., Zailani, S.H.M. and Hasan, H.A. (2019). Integrated internal audit in management system. The TQM Journal, 2019.

Heras-Saizarbitoria, I., Boiral, O. and Ibarloza, A. (2020). ISO 45001 and controversial transnational private regulation for occupational health and safety. International Labour Review, 159(3), pp.397–421.

Hofmann, D.A., Burke, M.J. and Zohar, D. (2017). 100 years of occupational safety research: From basic protections and work analysis to a multilevel view of workplace safety and risk. Journal of applied psychology, 102(3), p.375.

ILO. (2017). Guidelines for implementing the occupational safety and health provisions of the Maritime Labour Convention, 2006. 2017. Available from: http://www.ilo.org/wcmsp5-/groups/public/@ed_dialogue/@sector/documents/normativeinstrument/wcms_325319.pdf.

Kabir, S. and Papadopoulos, Y. (2018). A review of applications of fuzzy sets to safety and reliability engineering. International Journal of Approximate Reasoning [online], 100, pp.29–55. Available from: https://linkinghub.elsevier.com/retrieve/pii-/S0888613X18301671 [accessed 25 October 2024].

Karahalios, H. (2021). Application of AHP-TOPSIS for knowledge evaluation of ship operators. International Journal of Business Excellence, 24(4), pp.437–459.

Kark, R., Dijk, D. and Vashdi, D.R. (2018a). Motivated or demotivated to be creative: the role of self-regulatory focus in transformational and transactional leadership processes. Applied Psychology, 67(1), pp.186–224.

Kark, R., Dijk, D. and Vashdi, D.R. (2018b). Motivated or demotivated to be creative: the role of self-regulatory focus in transformational and transactional leadership processes. Applied Psychology, 67(1), pp.186–224.

Kashav, V., Garg, C.P., Kumar, R. and Sharma, A. (2022a). Management and analysis of barriers in the maritime supply chains (MSCs) of containerised freight under fuzzy environment. Research in Transportation Business & Management, 43, p.100793.

Kashav, V., Garg, C.P., Kumar, R. and Sharma, A. (2022b). Management and analysis of barriers in the maritime supply chains (MSCs) of containerised freight under fuzzy environment. Research in Transportation Business & Management, 43, p.100793.

Kulkarni, K., Goerlandt, F., Li, J., Banda, O.V. and Kujala, P. (2020). Preventing shipping accidents: Past, present, and future of waterway risk management with Baltic Sea focus. Safety Science, 129, p.104798.

Kyriakidis, M., Majumdar, A. and Ochieng, W.Y. (2018). The human performance railway operational index-a novel approach to assess human performance for railway operations. Reliab. Engin. Syst. Saf, 170, pp.226–243.

Lee, Y. (2022). How dialogic internal communication fosters employees' safety behavior during the COVID-19 pandemic. Public relations review, 48(1), p.102156.

Li, Z., Hu, S., Zhu, X., Gao, G., Yao, C. and Han, B. (2022). Using DBN and evidence-based reasoning to develop a risk performance model to interfere ship navigation process safety in Arctic waters. Process Safety and Environmental Protection [online], 162, pp.357–372. Available from: https://linkinghub.-elsevier.com/retrieve/pii/S0957582022003044 [29 June 2023].

Liu, W., Liu, X., Hu, Y., Shi, J., Chen, X., Zhao, J., Wang, S. and Hu, Q. (2022). Fall Detection for Shipboard Seafarers Based on Optimised BlazePose and LSTM. Sensors [online], 22(14), p.5449. Available from: https://www.mdpi.com/1424-8220/22/14/5449 [accessed 27 June 2023].

Mallam, S.C., Ernstsen, J. and Nazir, S. (2019). Safety in shipping: investigating safety climate in Norwegian maritime workers. Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 63(1), pp.1844–1848.

Mohammadfam, I., Kamalinia, M., Momeni, M., Golmohammadi, R., Hamidi, Y. and Soltanian, A. (2017). Evaluation of the quality of occupational health and safety management systems based on key performance indicators in certified organisations. Safety and health at work, 8(2), pp.156–161.

Mollaoglu, M., Demirel, H. and Balin, A. (2022). Evaluation Of The Effects Of Industry 4.0 On The Maritime Sector With Fuzzy Ahp–Vikor Hybrid Method. International Journal of Maritime Engineering, 164, pp.135–146.

Morgado, L., Silva, F.J.G. and Fonseca, L.M. (2019). Mapping Occupational Health and Safety Management Systems in Portugal: outlook for ISO 45001: 2018 adoption. Procedia Manufacturing, 38, pp.755–764.

Nazim, M., Mohammad, C.W. and Sadiq, M. (2022a). A comparison between fuzzy AHP and fuzzy TOPSIS. 2022.

Nazim, M., Mohammad, C.W. and Sadiq, M. (2022b). A comparison between fuzzy AHP and fuzzy TOPSIS methods to software requirements selection. Alexandria Engineering Journal, 61(12), pp.10851–10870.

Neag, P.N., Ivascu, L. and Draghici, A. (2020). A debate on issues regarding the new ISO 45001: 2018 standard adoption. In: MATEC Web of Conferences. EDP Sciences, p.00002.

Nwokedi, T.C. (2023). Sustainable Compensation Strategies for Ship Owners Liability for Occupational Injury and Death Costs Affecting Seafarers in Nigeria. Journal of ETA Maritime Science, 11(1).

Österman, C. and Boström, M. (2022). Workplace bullying and harassment at sea: A structured literature review. Marine Policy, 136, p.104910.

Pantouvakis, A. and Karakasnaki, M. (2016). An empirical assessment of ISM Code effectiveness on performance: the role of ISO certification. Marit. Policy Manage, 43(7), pp.874–886.

Pirbalouti, R.G., Dehkordi, M.K., Mohammadpour, J., Zarei, E. and Yazdi, M. (2023). An advanced framework for leakage risk assessment of hydrogen refueling stations using interval-valued spherical fuzzy sets (IV-SFS). International Journal of Hydrogen Energy [online], 48(54), pp.20827–20842. Available

from: https://linkinghub.elsevier.com/retrieve/pii/S036031992-301042X [accessed 30 October 2024].

Podgórski, D. (2015). Measuring operational performance of OSH management system–A demonstration of AHP-based selection of leading key performance indicators. Saf. Sci, 73, pp.146–166.

Qu, J., Feng, Y., Xu, G., Zhang, M., Zhu, Y. and Zhou, S. (2022). Design and thermodynamics analysis of marine dual fuel low speed engine with methane reforming integrated high pressure exhaust gas recirculation system. Fuel, 319, p.123747.

Rahmani, A., Hosseinzadeh Lotfi, F., Rostamy-Malkhalifeh, M. and Allahviranloo, T. (2016). A New Method for Defuzzification and Ranking of Fuzzy Numbers Based on the Statistical Beta Distribution. Advances in Fuzzy Systems [online], 2016, pp.1–8. Available from: https://www.hindawi.com/journals/afs-/2016/6945184/ [accessed 28 October 2024].

Robertson, J.L. and Barling, J. (2017). Toward a new measure of organisational environmental citizenship behavior. Journal of Business Research, 75, pp.57–66.

Roşu, G., Samoilescu, G., Rau, M.C. and Baltag, O. (2016). Aspects regarding the occupational and non-occupational exposure to low frequency and radiofrequency electromagnetic fields. In: Applied and Theoretical Electricity (ICATE); Int. Conf. on. IEEE, pp.1–6.

Sheehan, C., Donohue, R., Shea, T., Cooper, B. and Cieri, H. (2016). Leading and lagging indicators of occupational health and safety: The moderating role of safety leadership. Accid. Anal. Prev, 92, pp.130–138.

Skolarikos Maritime Bureau. (2022). Skolarikos Communication Catalogue.Solano-Martos, J.F., Cano-Iglesias, M.J. and Cañero, J.M. (2019). The new challenges of the Manufacturing Industry applying the norm ISO 45001. , 2019.

Størkersen, K.V. (2020). Safety management in remotely controlled vessel operations. Marine Policy, 104349.Tang, C.X.L. (2017). David Walters Who is dominant? Occupational Health and Safety management in Chinese shipping. J. of Ind. Relat, 59(1), pp.65–84.

Truant, E., Corazza, L. and Scagnelli, S.D. (2017). Sustainability and Risk Disclosure: An Exploratory Study on Sustainability Reports. Sustainability, 9(4), p.636.

Uğurlu, Ö., Yıldız, S., Loughney, S. and Wang, J. (2018). Modified human factor analysis and classification system for passenger vessel accidents (HFACS-PV. Ocean. Eng, 161, pp.47–61.

Venkatesh, V.G., Zhang, A., Deakins, E., Luthra, S. and Mangla, S. (2019). A fuzzy AHP-TOPSIS approach to supply partner selection in continuous aid humanitarian supply chains. Annals of Operations Research, 283, pp.1517–1550.

Voskoglou, M.G. (2015). Defuzzification of Fuzzy Numbers for Student Assessment. American Journal of Applied Mathematics and Statistics, 3(3), pp.206–210.

Wang, L. and Yang, Z. (2018). Bayesian network modelling and analysis of accident severity in waterborne transportation: A case study in China. Reliability Engineering & System Safety, 180, pp.277–289.

Yu, Y., Lorenc, M. and Shao, Y. (2022). Legal Challenges in Protecting the Rights of Cruise Ship Crew at the Post COVID-19 Pandemic Era. Sustainability, 14(16), p.9875.

Zhang, X. and Lam, J.S.L. (2019). A fuzzy Delphi-AHP-TOPSIS framework to identify barriers in big data analytics adoption: case of maritime organisations. Marit Pol & Manag, 46(7), pp.781–801.