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Project OPTIMISM: Novel Means of Finding Root Causes of Accidents and Incidence at Sea and Port, as Well as Identifying Key Factors for Improved Safety from Ship Audit and Inspection

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ABSTRACT: This paper presents a set of methodologies for analysing accident investigation reports to enhance learning from past incidents. While these reports are primarily designed to prevent accident recurrence, they often overlook key contributing factors such as personal, organisational, and cultural influences—particularly leadership practices and potential mental health issues that may have played a role. Moreover, accident investigation reports vary in quality and do not always adhere to standardised frameworks, limiting their effectiveness. This paper proposes a novel approach to accident analysis, offering a structured method to distinguish whether an accident is crew-related or company-related - an essential differentiation, as these factors require distinct management and preventive measures. The study draws on findings from multiple recent projects, analysing over 1000 accident reports to develop a new taxonomy. This taxonomy aims to facilitate a more systematic approach to accident analysis while identifying management deficiencies and crew-related challenges, ultimately improving safety and operational practices.

1 INTRODUCTION

This paper presents the findings of the EU-funded Erasmus+ project OPTIMISM, which builds upon the outcomes of several earlier initiatives, including Mai'der, SURPASS, SeaTALK, MarTEL, ACTs, ACTS Plus, PROMETHEAS, and others [1]. Collectively, these projects analysed over 1,000 maritime accidents with the overarching goal of reducing incidents at sea. The OPTIMISM project focuses on developing a comprehensive training programme aimed at supporting the effective implementation of the International Safety Management (ISM) Code—a framework introduced by the International Maritime Organization (IMO) to enhance maritime safety. The ISM Code consists of 12 core elements and provides guidance on verification and certification processes. A key feature of the OPTIMISM project is the systematic analysis of past maritime accidents in order to extract lessons learned and promote safer practices onboard vessels.

The main objective of this paper is to explore further insights that can be gained from accident investigation reports and to determine whether ISM Code audits and port inspection reports can contribute to a reduction in the number of maritime accidents at sea and in ports. For this purpose, a sample of approximately 130 accidents was selected from over 1,000 investigation reports—many from 2010 onwards, with most occurring in recent years. These incidents span various ship types and accident categories, including collisions, groundings, capsizing, falls from height, onboard fires, and toxic fume inhalation in enclosed spaces. Each accident was systematically recorded across several parameters: accident number (1), vessel name (2), type of vessel (3), type of accident (4) such as collision or fire, description of the incident (5), cause of the accident (6), casualty information (7), actions taken or recommendations made (8), and whether the accident is likely to recur (9). Additionally, in nearly all cases, the ISM Code element or sub-element contributing to or causing the accident was identified (10). The results provide valuable insights into how adherence to the ISM Code and targeted training can help prevent future maritime incidents and enhance safety across the sector.

Figures 1, 2 give details the year of the accidents selected followed by type of accidents and the ship type.

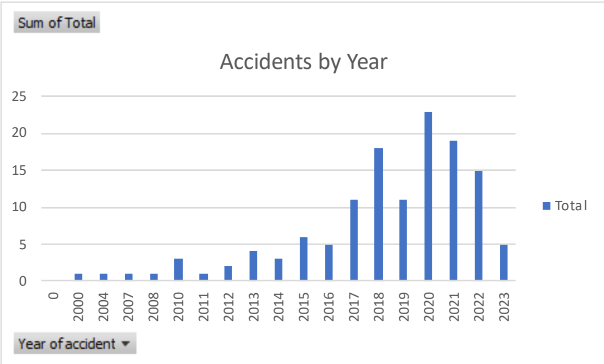

Figure 1. Accidents each year vs. Year of accidents

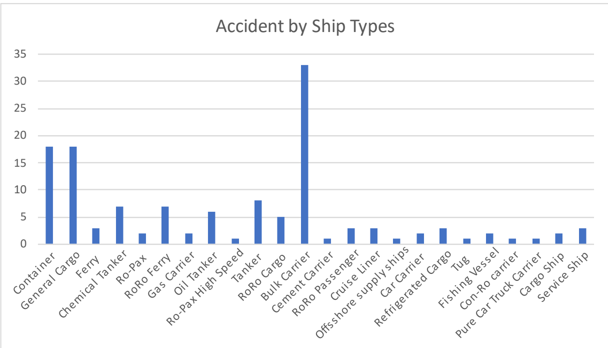

Figure 2. Number of accidents vs. Ship Type

2 MARINE SAFETY INVESTIGATION REPORTS

The marine safety investigation reports selected for analysis in this study were chosen to represent a range of recent accidents involving various ship types and incident categories. During the review of these reports, it became evident that many were less than satisfactory in terms of providing comprehensive evidence and actionable insights to reduce the likelihood of similar accidents occurring in the future [1, 2, 3]. A significant number of reports featured inadequate or poorly substantiated conclusions, with recommendations that were either vague or lacked practical relevance. In several cases, critical details were inconsistent or missing—for instance, the nature of casualties was not clearly stated, and there was often no mention of the key organisations involved in the incident.

This lack of clarity suggests that some investigators may not have had a thorough understanding of the requirements associated with the Safety Management Certificate (SMC) or the Document of Compliance (DOC). Frequently, there was no clear indication of the administration responsible for the vessel, nor were there references to ownership, crew, or even essential documentation such as crew timesheets. Human factor analysis was generally superficial, often reduced to vague statements about inadequate training, with little distinction between potential deficiencies under the STCW Convention or specific ISM Code sub-elements, such as non-conformities related to sub-element 6.5. Furthermore, the quality and relevance of many recommendations and corrective actions were found to be insufficient for the purpose of accident prevention. In most cases, key contributing factors were barely addressed.

The primary sources for the accident data used in this study were reports listed in the Global Integrated Shipping Information System (GISIS) and those maintained by the European Maritime Safety Agency (EMSA). The study placed a strong emphasis on evaluating the actions and recommendations provided in these reports, comparing and validating them against other significant works, including a report submitted to the IMO titled "Lessons Learned and Safety Issues Identified from the Analysis of Marine Safety Investigation Reports" [2]. As part of this effort, a new framework for reviewing accident reports was developed (Ziarati, R. et al., 2024; De Melo Rodriguez et al., 2024) [3, 4].

These analyses focused primarily on identifying whether the root cause of each accident was attributable to a quality assurance (QA) failure (Error) or a human or systemic deficiency (Mistake), based on the available data. Findings consistently highlighted communication failures, human vulnerability, and poor decision-making as the most common issues, with other contributing factors such as crew members' lack of knowledge and inadequate risk assessments by companies also playing significant roles. The review process also included an assessment of management accountability, including whether issues related to manning contributed to the incident.

Furthermore, the review of selected accidents, including those reported in a recent paper submitted by Sweden to the IMO (Zachau, J., 2023), highlighted specific areas where the implementation of the ISM Code could be strengthened [2].The methodology used in accident report reviews is shown in Figure 3.

Figure 3. Flowchart Analysis of Investigation Results – Error vs Mistake - Based Bains Simmons' Behaviours Flowchart [5] – See also Karakasnaki, M., et al., (2018) [6].

Figure 3 presents the Centre for Factories of the Future's (C4FF) methodology for accident reviews, a diagnostic tool developed to systematically classify the outcomes of maritime incident investigations. The framework is grounded in rule-based behavioural assessment and organisational analysis, helping investigators determine not only what went wrong, and hopefully why, with emphasis on the role of intention, decision-making, and contextual constraints focusing as to whether primarily this is a crew or company/management fault.

This taxonomy begins first by distinguishing whether rules were intentionally broken, forming the primary bifurcation that determines the investigative direction. If intentionality is confirmed, the analysis evaluates whether the consequence was as intended. When both conditions are satisfied, the act is deemed sabotage, signalling deliberate and harmful misconduct.

If the intended consequence did not materialise, the model queries whether the task could have been completed within the boundaries of existing rules. This distinction captures instances where rule-breaking may have been perceived as necessary. Where compliance was feasible, yet substantial and unjustifiable disregard for risk is evident, the action is categorized as recklessness. If the risk was not egregious, the model examines motivational intent, differentiating between organisational gain (e.g. efficiency, performance pressures) and personal gain, to arrive at more nuanced classifications of non-compliance.

In scenarios where the rules could not realistically be followed, the model explores whether the event occurred outside standard practice. If so, it is labelled as situational rule breaking, acknowledging external pressures or novel circumstances. If not, the case is considered exception rule breaking, typically involving procedural blind spots or gaps in rule coverage.

In contrast, if rules were not intentionally broken, the framework evaluates whether the correct plan of action was selected. A "no" leads to a crew-related classification, highlighting individual or team-level errors. A "yes" redirects the focus to company-related deficiencies, such as flawed procedures, inadequate training, or systemic weaknesses in safety management.

This figure operationalises investigative analysis by aligning behavioural intent with procedural structure and organisational accountability. It integrates human factors, system limitations, and environmental context, making it especially valuable for accident analysis, compliance auditing, and continuous improvement in safety-critical domains such as maritime operations. The taxonomy also supports fair and consistent attribution of responsibility, avoiding premature blame while promoting evidence-based learning.

Once it is established whether root cause or contributing factor to the accidents is company-related then it has to be decided if it is a QA related matter or not. The same is true if the accident is classified as crew-related, the question is then is it negligence the cause of or factor in the accident happening or a lack of knowledge/competence.

With regard to root causes of or contributing factors to the accidents, the current accident investigation practice and reporting methodology do not provide a uniform means of identifying the cause(s) of an accident or incident. Therefore, it is difficult to learn more about key ISM Code deficiencies/non-conformities from the accident investigation reports. The GISIS has made an attempt to establish a standard for learning from accidents more systematically.

An in-depth analysis of some 130 accident reports selected from 1000 accidents, taken place since 2010 by C4FF, clearly show that the reports produced by accident investigation agencies are primarily produced to ensure these accidents do not occur again and often do not specifically mention the ISM non-conformities. Thus, they do not contain all the necessary information to deduce effectively all the contributing root causes of accidents or apply a standard means of reporting them.

When analysing accident investigation reports the primary intention was to consider if the wrongdoing was also as a result of recklessness or violation of the rules (IMO's or company's policies, procedures and plans) and to what extent the accident happened due to inadequacy of the QA components (Error) or non-QA factors (Mistake). If the latter it could highlight the need for more training or lack of knowledge by a crew member or that the failure was a system/machinery failure; a good account of these is given in Horck (2007) [7]. Also, the caveat that the company could be deficient in providing the support to the crew members to gain knowledge and skills or competence needed to operate its systems and machineries. There is also a list all other possible areas which could have had an impact on the accident happening or making it worse. Some 25 possible causes were found based on past studies which corroborated well with the findings from recent studies such as Stroeve et al (2023) [8].

Figure 4 offers a conceptual framework that synthesizes the taxonomy discussed earlier in this paper. It visually maps the hierarchical structure of root causes of accidents and contributing factors into four broad categories:

1. Quality Assurance (QA) Errors – These are typically rooted in organisational oversight and reflect compliance gaps that can lead to recurring non-conformities.

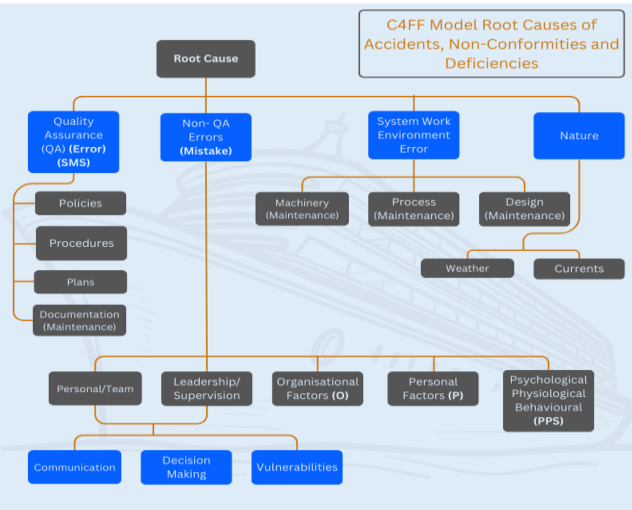

Figure 4. Root Causes of Accidents

2. Non-QA Errors (Mistakes) – These encompass human errors that fall outside formal QA processes, including lapses in communication, decision-making, and personal/team vulnerabilities. Here, leadership and supervision emerge as critical influencing factors. This category closely aligns with what Baines and other scholars identify as operational and managerial contributors to incidents.
3. System Work Environment Errors – These errors stem from physical and procedural conditions aboard the vessel, such as machinery, process, and design-related maintenance deficiencies. Failures in these areas often have cascading effects, leading to system-level breakdowns that compromise safety.
4. Natural Factors – External conditions like weather and sea currents, while uncontrollable, often act as amplifiers of latent system weaknesses. Though not always preventable, these factors must still be accounted for in risk assessments, voyage planning, and emergency preparedness protocols

By mapping out these interdependencies, the C4FF model offers a practical, easy-to-interpret guide that aids in categorizing root causes during incident analysis. It reinforces the argument that maritime safety cannot rely solely on procedural compliance; instead, it requires a multidimensional approach that integrates technical, organizational, and human factors.

Figure 4, further identifies four key areas for consideration when deciding on root causes or contribution factors for a non-conformity or an accident/incident as presented below:
– O - Organizational Factors
– P - Personal Factors
– PPS - Psychological, Physiological and Behavioural Factors

O = Organizational Factors

– Health and safety policies that are missing or inadequate – Leading to stress and other health and safety issues on board as opportunities are not in place to identify and manage them appropriately
– Poor communication – Resulting in confusion not knowing what to do and feeling that the crew is not supported
– Poor management practices - Failing to explain roles and responsibilities, unclear reporting lines, failure to provide sufficient resources and failure to manage crew effectively
– Inflexible working hours and long stints which do not support seafarers in managing work/life balance
– Giving seafarers tasks which are unsuitable for their competencies or insufficient training or knowledge and type of support provided with tasks which may lead to non-achievement of objectives
– High or unrelenting workloads which mean seafarers do not have time to complete tasks
– Unfair distribution of group work where one or more persons are not doing their job properly and others have to compensate for them
– Lack of procedures to deal with bullying or psychological harassment

P= Personal Factors

– Vulnerability such as low self-esteem and insecurity, or inadequate coping mechanisms that seafarers may experience
– Lifestyle choices, for example alcohol and drug use which can put seafarers at risk of developing mental health problems
– Family history of mental ill health which may be hereditary
– Problems at home such as domestic violence, neglect, divorce or family breakdown
– Feeling cut off from family and friends or from the local community which can lead to feelings of isolation or rejection
– Negative or traumatic life experiences such as threat of unemployment, homelessness, bereavement, sudden illness, or being assaulted or abused
– Big life changes even where these are positive such as getting married, having children or moving home which can be stressful
– Financial worries arising from threat of unemployment, redundancy or business failure, as well as mounting debt or worries about the managing the cost of living
– Community or local environmental problems such as prejudice and discrimination, violence and crime or poor living conditions.

PPS = Psychological, Physiological and Behavioural Factors

The Psychological, Physiological and Behavioural Factors often putting pressure on seafarers' mental well-being are summarized in Table 1.

The model further connects these as cross-cutting influences that underpin various types of Mistakes. These categories mirror the human-centric aspects outlined earlier in the paper, showing how internal stressors and external conditions interact to impact crew performance and safety .

Table 1. Factors Affecting Mental Health at Sea (Source: Ziarati R., et al. 2020) [8].

Factors Putting Pressure On Mental Health

Physical	Psychological	Behavioural
Fatigue	Anxiety or distress	Increased smoking and drinking
Indigestion/upset stomach	Tearfulness	Using recreational drugs
Headaches	Feeling low	Withdrawal
Appetite and weight changes	Indecision	Resigned attitude
Joint and back pain	Loss of motivation	Irritability, anger or aggression
Changes to sleep patterns	Loss of humour	Over excitement or euphoria
Visible tension or trembling	Increased sensitivity	Restlessness
Nervous trembling speech	Distraction or confusion	Apparent over reaction to problems working for long hours
Chest or throat pain	Difficulty relaxing	Intense or obsessive activity
Sweating	Lapse in memory	Repetitive speech or activity
Constantly being cold	Illogical or irrational through processing	Impaired inconstant performance
	Suicidal ideation	Uncharacteristic problems with colleagues
	Responding to experience, sensations or people not observable to others	Risk-taking
		Disruptive or anti-social behaviour
		Lateness, leaving early extended lunches' meals

3 ACCIDENT INVESTIGATION REPORT ANALYSIS

A methodology was developed to extract notable information from these accident investigation reports, including the description of each accident, actions recommended by investigators, the main root causes, and any contributing factors such as inadequate risk assessment, insufficient knowledge, inappropriate decision-making, poor supervision, and similar shortcomings. One column was dedicated to assessing the likelihood of the accident recurring, with a particular focus on how effectively investigators addressed the core investigative task.

The information used to compile the accident summary table was derived from C4FF's structured list of diagnostic questions and categorizations of causes and contributing factors. This approach aimed to accurately identify the primary root causes of each accident while also distinguishing between types of human error, such as Mistakes, Errors, Recklessness, Lapses, Slips, Violations, or Sabotage. Two examples of these accident investigation review summaries are presented in Appendix 1, Tables 1.1 and 1.2.

In the final stage of summarising each accident, the designated sub-focus group determined the primary root cause and also assessed whether Human Vulnerability, Decision Making, or Communication played a role in initiating or exacerbating the accident.

In Appendix 2, Tables 2.1 and 2.2, it is noteworthy that the majority of safety issues identified were related to Quality Assurance (QA), although non-QA factors also played a significant role—either as the primary cause or a contributing factor. In nearly all cases, there were identifiable deficiencies linked to Human Vulnerability, Decision Making, and Communication. Furthermore, in almost half of the reviewed accidents, issues relating to inadequate knowledge, skills or competence were evident. This finding strongly suggests that quality assurance systems within many shipping companies require urgent improvement.

Throughout the review of reports from various accident investigation agencies, particular attention was paid to identifying whether factors such as Human Vulnerability, Communication (including technical and language-related deficiencies), and Decision Making contributed to the incidents under investigation.

4 LEARNING FROM NON-CONFORMITIES (AUDITS) AND DEFICIENCIES (PORT INPECTIONS)

Ziarati et al (2024) in their paper viz., Pareto Analysis of ISM Code Deficiencies, demonstrated that a great deal can be learned from non-conformities reported in ISM Code Audit reports. Table 2 shows that there is a correlation between ISM Audit non-conformities and causes of accidents, viz., issues with non-compliance with rules and regulations, maintenance and shipboard operations. This clearly showed a lack of rigid and robust ISM Code verification by flag States, and while understandable, it is in need of serious review.

Table 2. Pareto Analysis of ISM Non-conformities as against those observed in LR Audits

Pareto Analysis - ISM Code Audit Non-conformities vs Root Causes of/Contributing Factors ot Accidents

Non Conformities Observed/Noted	ISM Code Pareto Ranking	Accident Analyses/ Reviews Pareto Ranking	Notes
1.2.2.1 - Safe Working Practices			The Pareto analysis of findings from accidents showed that the highest frequency occurences are the ISM Code Elements 1, 7 and 10. this was true for the IACS/LR's data. In Element 1 'Compliance with rules and regulations', 'Taking into account of codes, guidelines and statndards', 'Safguard against identified risks' and 'Safe working practices' were the main problem areas. Element 7 'Shipboad Operatrions' was the second most occuring problem area. In Element 10 'Establishing procedures to maintain the ship' was the next top occuring problem area. If these problem areas are targeted and resolved they are expected to make the most impact on effectiveness and the effective implementation of the ISM Code. Review of accidents also showed that 'Ineffective communication/language issues'. 'inadequate suppervions', Crew familiarization on board', 'Human Vulnerabilities' ands 'lack of knowledge' to be main root causes of, or a contgributing factor in many accidents. The limited review of accidents tallied well with the outcome of the ISM audits by IACS/LR, on like for like basis.
1.2.2.2 - Safeguards against identified risks			
1.2.3.1 - Compliance with rules & regulations			
1.2.3.2 - Taking into account of codes, guidelines & standards	1	1	
10.1 - Establish procedures to maintain the ship plus 10.3 - Identification & Measures for critical equipment plus 10.4 - Inspection routines & follow up incorporated in the maintenance routines	3	3	
10.2.1 - Inspections held at the proper interval Plus 12.1 - Internal audits at 12 month intervals Plus 12.3 - Management review Plus 12.4 - Audits and corrective actions in accordance with procedures Plus 12.7 - Timely corrective action on findings noted Plus 5.1.5 - Master periodically reviewing the SMS			
10.2.2 - Deficiencies reported			
10.2.3 - Appropriate action on deficiencies taken			
10.2.4 - records of activities maintained			
11.1 - Establishing document & data control			
11.2.1 - Valid documents available on relevant locations			
6.2.1 - Ship manned with qualified and medically fit persons Plus 6.2.2 - Ship appropriately manned to safely cover all operations			
6.5 - Identification of training needs			
6.4 - Adequate knowledge of rules and regulations			
6.3 - Crews familiarisation on board			
7 - Shipboard Operations			
8.2 - Drills & exercise planning for emergencies			
8.3 - Companys ability to respond to emergencies	2	2	
9.1 - Reporting, investigating, analysing accidents, NCs, etc.			
9.2 - Implementation of corrective actions			

In the same paper references were made to deficiencies observed during port inspections and concluded that again risk of accidents could be reduced if deficiencies could be reviewed and eliminated.

Table 3. Learning from Port Inspections

Deficiencies Recorded by PSC MoUs 2018-2022

PSC MoU	US Coast Guard MoU	Mediterranean MoU	Black Sea MoU	Tokyo MoU	Riyadh MoU	Indian Ocean MoU Secretariat
PSC Inspections with ISM deficiencies	929	944	1743	5630	891	1666
ISM and ISM-related deficiencies	1152	5657	11756	6187	994	1751
Detainable ISM and ISM related deficiencies	313	1213	1799	1230	42	332

The categories of the ISM Code deficiencies, identified by the Black Sea Memorandum of Understanding (MoU), as follows, has provided the identified categories of the ISM Code deficiencies . These encompass various aspects of maritime safety management, starting with the core safety and environment policy, company responsibility and authority, and the specific roles of designated person(s) and the master. Deficiencies also relate to operational readiness, including the provision of adequate resources and personnel, the conduct of shipboard operations, and emergency preparedness. Furthermore, the framework addresses procedural integrity through the handling of reports of non-conformities, accidents & hazardous occurrences, the maintenance of the ship and equipment, proper documentation, and the essential process of company verification, review and evaluation to ensure ongoing compliance and system effectiveness. It is worth mentioning that other MOUs such as Paris MoU consider several other deficiencies which are not directly ISM Code related.

5 CONCLUSIONS

A comprehensive review of maritime accident investigation reports was conducted with the objective of identifying recurring safety issues and enhancing the effectiveness of accident analysis. The findings revealed that a common problem across many cases was the lack of adequate risk assessments. In a smaller proportion of the cases, the International Safety Management (ISM) Code had not been properly implemented.

As illustrated in the sample case studies (Tables 1.1 and 1.2), several ambiguities remain, particularly in determining whether safety failures resulted from insufficient crew knowledge or from the absence of appropriate company-provided training and guidance (as referenced in ISM Code, section 6.5).

Furthermore, the analysis of data in Tables 2.1 and 2.2 (Appendix 2) identified three recurring contributory factors in maritime accidents: ineffective communication, poor decision-making, and the failure to properly consider human limitations.

This research led to the development of a taxonomy categorising the causes and contributing factors of maritime accidents. In parallel, methodologies were introduced to distinguish between incidents attributable to crew actions and those caused by organisational failures. It also enabled differentiation between non-conformities identified during ISM audits and deficiencies detected during port state inspections. These methods helped to determine whether issues stemmed from management failures, manning inadequacies, or other structural weaknesses.

In many instances, ISM deficiencies recorded during port inspections should have been identified earlier through ISM audits. A critical issue uncovered is that even when non-conformities are flagged by Administrations, Recognized Organizations (ROs), the International Association of Classification Societies (IACS), or Port State Control Officers (PSCOs), a significant number of companies fail to implement corrective measures.

A recent survey conducted by C4FF found that more than half of the Administrations/ROs had evidence of recurring deficiencies from previous ISM Code audits. This points to a systemic shortcoming among certain companies in addressing safety issues identified during audits or port inspections.

As part of the OPTIMISM project, a follow-up study has been launched to assess whether accident investigation reports can reliably identify ISM Code elements or sub-elements as either root causes or contributing factors in maritime accidents. Where ISM-related causes are evident, further analysis will seek to determine the specific ISM Code components involved. This continued work could have significant implications for future reporting, analysis, and classification of maritime accidents.

The OPTIMISM training programme is supported by data from IACS and Lloyd's Register, both of which reveal thousands of non-conformities that, if addressed, could help mitigate the risk of accidents at sea. Likewise, thousands of deficiencies are recorded annually during port inspections. Notably, within Paris MoU regions, ISM Code deficiencies consistently rank among the top ten most frequent inspection findings.

APPENDIX 1 - INVESTIGATION REVIEW SUMMARIES

Table 1.1.Micro Presentation of a Review of an Accident

Reference	RZ/GDMR1
Description	While chief officer (C/O) was checking the cleanliness of the empty tanks prior to loading cargo at the next destination port, he discovered dampness and residue remaining inside one of the tanks and decided to remove them with support from the bosun and two ordinary seamen (OS), A and B without having conducted gas freeing or checking oxygen and gas levels beforehand and without carrying a portable detector or wearing personal protective equipment (PPE). The OS A felt drowsy and dizzy and noticed OS B lying on the floor at the bottom of the tank. Bosun was informed and the incident was reported to C/O. Later, OS B recovered but the C/O did not.
Key root causes or contributing factors	Company-related (Error) - Inappropriate policy manual - Inappropriate procedures, Inadequate risk assessment. Crew-related (Mistake) – Failure to have conducted gas freeing or checking oxygen and gas levels beforehand and without carrying a portable detector or wearing personal protective equipment (PPE) - Inadequate supervision - Problems with safety culture - Inadequate decision-making/leadership of operational tasks, including a lack of correction of unsafe practices - Inadequate team composition - Inadequate Knowledge - Inadequate competence/skills - Incorrect perception.
Casualties	1 Fatality
Action taken	Shipping companies must constantly provide training programs for crewmembers so that they do not let their experience, practices, and work efficiency concerns override the need to be safe in confined spaces. The shipping companies, too, need to maintain strict guidance and supervision through internal audits.
Would it happen again?	No, if SMS was enforced and the crew were trained and had access to a detector and wore the correct PPE.

Table 1.2. Micro Presentation of a Review of an Accident

Reference	RZ/GDMR2
Description	Grounding and capsizing due to unsafe passing distance to shore at high speed. The collision caused severe income of water which led to the immediate loss of propulsion and general services.
Key Root Causes	Crew-related (Mistake) - Poor leadership and Team operation - Captain's inattention/distraction due to the presence of persons extraneous to Bridge watch and a phone call not related to the navigation operations. Company-related (Error) - ISM non-conformity due to inadequate risk assessment - The General Emergency Alarm was not activated immediately after the impact. This fact led to a delay in the management of the subsequent phases of the emergency. The analysis of crew certification, of the Muster List (ML) and of the familiarization and training highlighted some inconsistencies in the assignment of duties to some Crewmembers.
Casualties	32 fatalities: 16 passengers, 4 crew and 4 still missing.

Action-Recommendation	The human element was the root cause in the Costa Concordia casualty, both for the first phase of it, which meant the unconventional action which caused the contact with the rocks, and for the general emergency management. A complete review of safety culture recommended. About the different scope of the Minimum Safe Manning (MSM) document and the Muster List (ML), the SOLAS regulation V/14.1 requires that the ship shall be sufficiently and efficiently manned - Marine Casualties Investigative Body – C/S Costa Concordia Page. 7. This regulation makes reference, but not in a mandatory way, to the Principles of Safe Manning adopted by the Organization by Resolution A.890(21) as amended by resolution A.955(23).
Would it happen again?	No, if the Master not distracted/inattentive and did not sail too close to the coastline and pass at an unsafe distance at nighttime and at high speed (15.5 kts).

APPENDIX 2 - QA RELATED ACCIDENTS VS. NON-QA ACCIDENTS AND COMMON CAUSES OF, CONTRIBUTING FACTOR TO, ACCIDENTS

Tables 2.1 and 2.2 show the outcomes of micro analysis of 50 accidents divided equally for review by two different focus group respectively. What is significant here is that both focus groups are the view that company-related mistakes (Errors) are more dominant than crew-related mistakes and human vulnerability, poor decision-making and ineffective person to-person communications are key causes of, or contributing factors to, accidents.

Table 2.1. The First Set of Micro Analysis of Accident Reviews

Type	Accident	Mistake	Error	Human vulnerability	Decision making	Communication
Ro-Ro Ferry	Grounding	x		x	x	x
Ro-Ro Ferry	Fire in the ER		x	x	x	x
Bulk Carrier	Collision		x	x	x	x
Offshore Supply ship	Sinking		x	x	x	x
Container	Containers overboard		x	x	x	x
Car Carrier	Collision	x	x	x	x	x
Bulk Carrier	Lifeboat falling		x	x	x	x
Life Boat safety latch	Lifeboat falling		x			x
Ro-Ro Passenger	Lifeboat falling		x	x	x	x
Oil Tanker	Engine room fire	x		x	x	x
General Cargo	Drowning of 3/O	x	x	x	x	x
Container/Cargo ship	Collision	x	x	x	x	x
General Cargo	Fall and death		x	x	x	x
Bulk Carrier	Fall and death		x	x	x	x
Reefer	Fall and death		x	x	x	x
Bulk Carrier	Mooring rope death		x	x	x	x
Bulk Carrier	Drowning of bosun		x	x	x	x
Bulk Carrier	Oiler died		x	x	x	x
Cruiser	OS drowned			x	x	x
Ro-Ro Passenger	Passenger died	x	x	x	x	x

Table 2.2. The Second Set of Micro Analysis of Accident Reviews

Type	Accident	Mistake	Error	Human vulnerability	Decision making	Communication
Container	Collision	x		x	x	x
Gas Carrier	Collision	x		x	x	x
Ro-Ro Ferry	Grounding	x		x		x
Cement Carrier	Capsize/Sinking		x	x	x	
Bulk Carrier	Grounding	x	x		x	
RoRo Passenger	Fire	x				
Ro-Ro Ferry	Grounding		x		x	x
Chemical tanker	Explosion		x		x	
ULCC	Grounding		x		x	x
Ro-Ro Ferry	Collision	x		x		x
Cruise Ship	Grounding	x		x		x
Oil Tanker	Fatal accident		x	x		
Bulk Carrier	Fatal accident	x	x		x	x
Bulk Carrier	Fatal accident		x	x		x
Gas Carrier	Fatal accident		x	x		
Bulk Carrier	Fatal accident	x	x		x	x
General Cargo	Collision	x	x		x	x
General Cargo	Collision	x	x		x	X
Chemical Tanker	Grounding		x	x		
General Cargo	Fatal accident		x	x		
Bulk Carrier	Fatal accident		x		x	

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