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Pareto Analysis of ISM Code Deficiencies

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Management (ISM) Code

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- The International Safety Management (ISM) Code concerns safety at sea and marine environment protection; primarily regarding SOLAS class vessels.
- The main purpose of this paper is to highlight the importance of reviewing the outcome of ISM external audits and port inspections as well as analyzing accident reports with a view to improve safety at sea and marine environment protection. The paper focuses on the outcomes of some **50000** Administration and Recognized Organizations (RO) noted non-conformities and over **100000** deficiencies observed by Port State Control Officers (PSCO) during their inspections.
- Included is a sample selected from some **300** accident reports to establish the root causes of non-conformities, deficiencies and accidents at sea.
- In reviewing the root causes and contributing factors to the accidents, audit non-conformities and inspection deficiencies, the paper makes an attempt to find those with highest frequency of occurrence by applying Pareto analysis.
- This paper concludes with a taxonomy model identifying the key factors contributing to accidents, non-conformities noted by Administration or ROs, as well as deficiencies observed by PSCOs when inspecting ships.



- To prevent accidents and incidents at sea and in ports, it is crucial to establish a safety system that focuses on prevention of contributing factors. This approach aims to ensure that safety measures are implemented correctly the first time (Right First Time) and focuses on eliminating the underlying causes through practices like Poka Yoke². Establishing key performance indicators at international, national, and company levels can help reduce the risk of accidents by highlighting the main causes and enabling stakeholders to learn from past incidents.



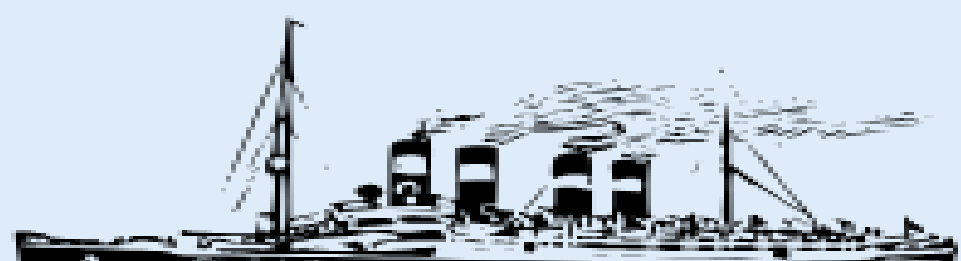
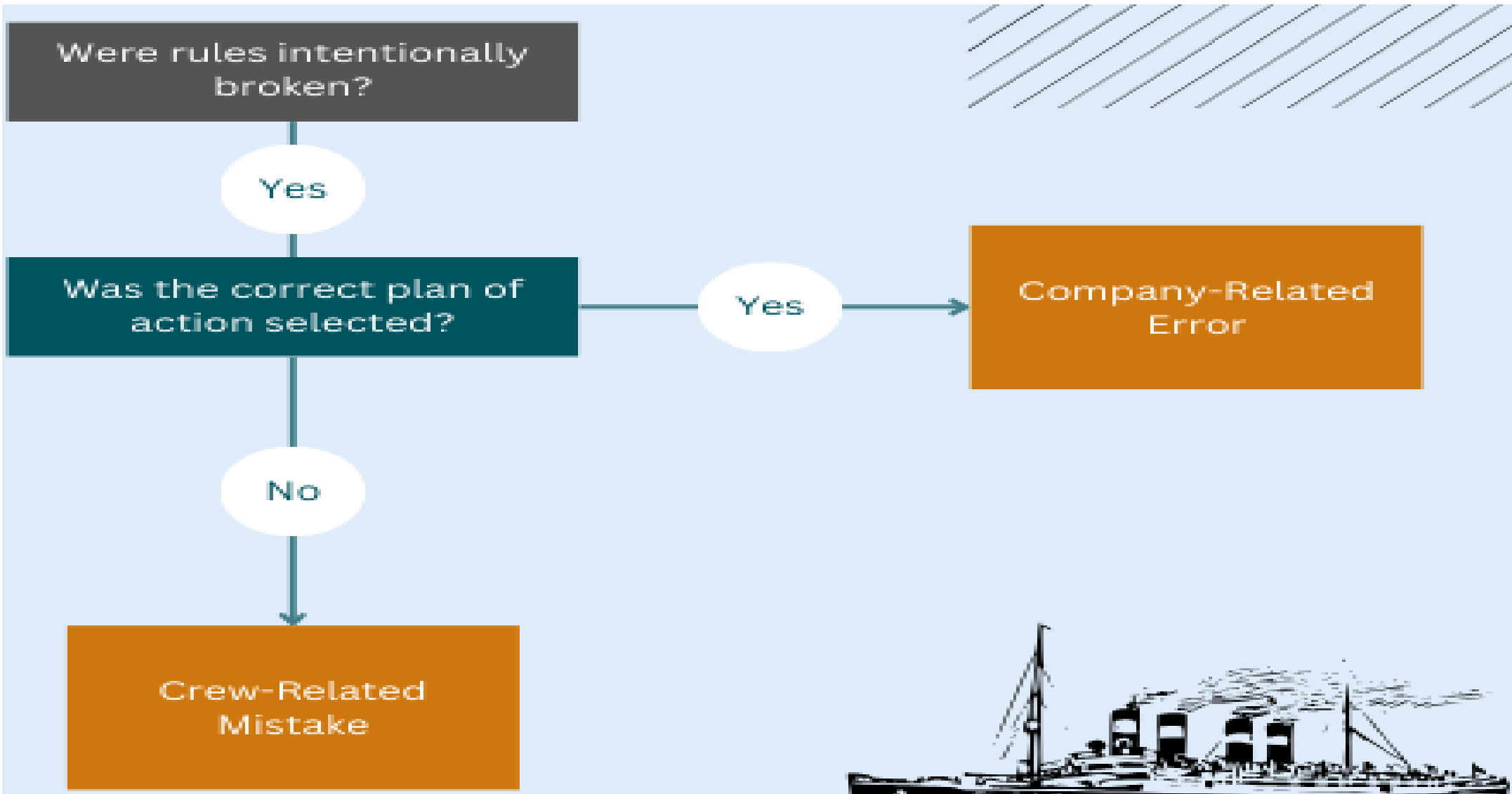
- It should be recognized that the companies, due to pressures from the clients, have introduced a host of ISO systems in addition to ISO 9000 such as ISO 14000, ISO 45000 and several have also opted for ISO 50000 and ISO 25000. Each of these systems demand top management commitment, involvement of all personnel in implementation of the ISM Code; and continuous development of quality assurance and control which includes development of the crew, ship and means to protect the marine environment. ISO systems are often the core of Total Quality Management.



- As companies are allowed to develop their safety management system, therefore, there are as many grades of quality as they are shipping companies. Quality means fitness-for-purpose and compliance with specification. The crews' and ships' fitness/seaworthiness are a measure of ISM effectiveness. Compliance with rules and regulations as well as the companies' own policies, procedures, processes/operations and plans are measures of effective implementation. Fitness/seaworthiness and compliance are the sides of the same quality coin.
- It is recognised that a system is as strong as its weakest link. A review of corrective actions taken after audits or inspection as well as after accidents and incidents clearly suggests serious issues with ISM and its implementation.



- Over 100,000 deficiencies including 5,000 ISM non-conformities were reported by PSC Paris MoU during 2019-20213 and during 2018-2022 over 45,000 ISM non-conformities were reported by Recognised Organizations (IACS/LR) clearly suggesting that the shipping industry has to see the wood from the trees and address the ISM Code weaknesses
- A review of deficiencies by PSC Paris MoU shows that the ISM non-conformities have shown, by far, to be the highest category, responsible for some 25% of the deficiencies in the top 10 categories.





Non Conformities Observed/Noted								
Row Labels	1 Jan - 31 Dec 2018	2 Jan - 31 Dec 2019	3 Jan - 31 Dec 2020	4 Jan - 31 Dec 2021	5 Jan - 31 Dec 2022	Grand Total	Average	
1. General	1401	1203	1207	1824	1765	7400	1480	1.2.2.1 - Safe Working Practices, 1.2.2.2 - Safeguards against identified risks, 1.2.2.3 - Safety Management skills & preparing for emergencies, 1.2.3.1 - Compliance with rules & regulations; 1.2.3.2 - Taking into account of codes, guidelines & standards; 1.4 - Functional Requirements
2. SAFETY AND ENVIROMENTAL PROTECTION POLICY	112	72	90	112	135	521	104.2	2.1 - Establishing a safety & environmental policy; 2.2 - Implementing the SMS Policy
3. COMPANY RESPONSIBILITY AND AUTHORITY	230	184	183	205	186	988	197.6	3.1 - Ship owner assigning ISM responsibility; 3.2 - Defining & documenting responsibilities and 3.3 - Adequate resources for the DPA
4. DESIGNATED PERSON(S)	95	76	83	79	107	440	88	4 - Role of the DPA
5. MASTER'S RESPONSIBILITY AND AUTHORITY	322	328	286	309	380	1625	325	5.1.1 - Master implementing the SMS Policy; 5.1.2 - Master motivating the crew; 5.1.4 - Master verifying SMS related activities; 5.1.5 - Master periodically reviewing the SMS and 5.2 - Use and knowledge of the overriding authority
6. RESOURCES AND PERSONNEL	1642	1625	1425	1732	1877	8301	1660.2	6.1.1 - Master properly qualified for command; 6.1.2 - Master fully conversant with SMS; 6.1.3 - Master given necessary support; 6.2.1 - Ship manned with qualified and medically fit personnel; 6.2.2 - Ship appropriately manned to safely cover all operations; 6.3 - Crews familiarisation on board; 6.4 - Adequate knowledge of rules and regulations; 6.5 - Identification of training needs; 6.6 - Working language used and 6.7 - Effective communication used.

Table 1a. ISM Non-Conformities Observed 2017-23 – Part 1 (Source: IACS, the final column is from LR)



7. SHIPBOARD OPERATIONS	2038	1897	1848	2027	2424	10234	2046.8	7 - Shipboard Operations
8. EMERGENCY PREPAREDNESS	1201	1195	1033	1202	1470	6101	1220.2	8.1 - Identification of contingency plans; 8.2 - Drills & exercise planning for emergencies and 8.3 - Companies ability to respond to emergencies.
9. REPORTS AND ANALYSIS OF NON-CONFORMITIES, ACCIDENTS AND HAZARDOUS OCCURRENCES	1127	1088	1028	967	1107	5317	1063.4	9.1 - Reporting, investigating, analysing accidents, NCs, etc. and 9.2 - Implementation of corrective actions.
10. MAINTENANCE OF THE SHIP AND EQUIPMENT	3968	3689	3296	3778	4419	19150	3830	10.1 - Establish procedures to maintain the ship; 10.2.1 - Inspections held at the proper interval; 10.2.2 - Deficiencies reported; 10.2.3 - Appropriate action on deficiencies taken; 10.2.4 - records of activities maintained; 10.3 - Identification & Measures for critical equipment and 10.4 - Inspection routines & follow up incorporated in the maintenance routines.
11. DOCUMENTATION	1152	965	912	968	1086	5083	1016.6	11.1 - Establishing document & data control; 11.2.1 - Valid documents available on relevant locations; 11.2.2 - Review & approval of (changes to) documentation; 11.2.3 - Obsolete documents promptly removed and 11.3 - Suitable & effective SMS maintained.
12. COMPANY VERIFICATION, REVIEW AND EVALUATION	692	713	679	719	728	3531	706.2	12.1 - Internal audits at 12 month intervals 12.2 - Personnel undertaking tasks in conformity with Companies responsibilities; 12.3 - Management review; 12.4 - Audits and corrective actions in accordance with procedures; 12.5 - Independence of internal auditors; 12.6 - Reporting results of internal audits and reviews and 12.7 - Timely corrective action on findings noted.
Grand Total	13980	13035	12070	13922	15684			

Table 1b. ISM Non-Conformities Observed 2017-23 – Part 2 (Source: IACS – the final column is from LR)



- The reason why the LR data is significant is that whilst IACS data is able to for instance identify Ship Maintenance as the top most frequent non-conformity, the LR data shows that the top most frequent non-conformity to be Non-Compliance with rules & regulations (Sub-element 1.2.3.1). The following shows the top ten most frequent non-conformities from LR data:
 - 1.2.3.1 Non-Compliance with rules & regulations.
 - 10.2.1 - Inspections not held at the proper interval; 10.1 - Establish procedures not in place to maintain the ship; 10.3 - Identification & Measures not in place for critical equipment; 10.4 - Inspection routines & follow up not incorporated in the maintenance routines.
 - 12.1 - Internal audits not held at 12-month intervals; 12.3 - Management review not conducted 12.4 - Audits and corrective actions not in accordance with procedures; 12.7 - Timely corrective action not taken on findings noted.
 - 5.1.5 - Master not periodically reviewing the SMS.
 - 7. Shipboard operations
 - 1.2.2.2 Inadequate safeguards against identified risk
 - 9.1 – Lack or inadequate reporting, investigating, analyzing accidents, NCs, etc.
 - 8.2 – Inadequate drills & exercise planning for emergencies
 - 11.2.1 - Valid documents not available on relevant locations
 - 9.2 – Non-implementation of corrective actions



Table 2. PSC MoU Observed deficiencies

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

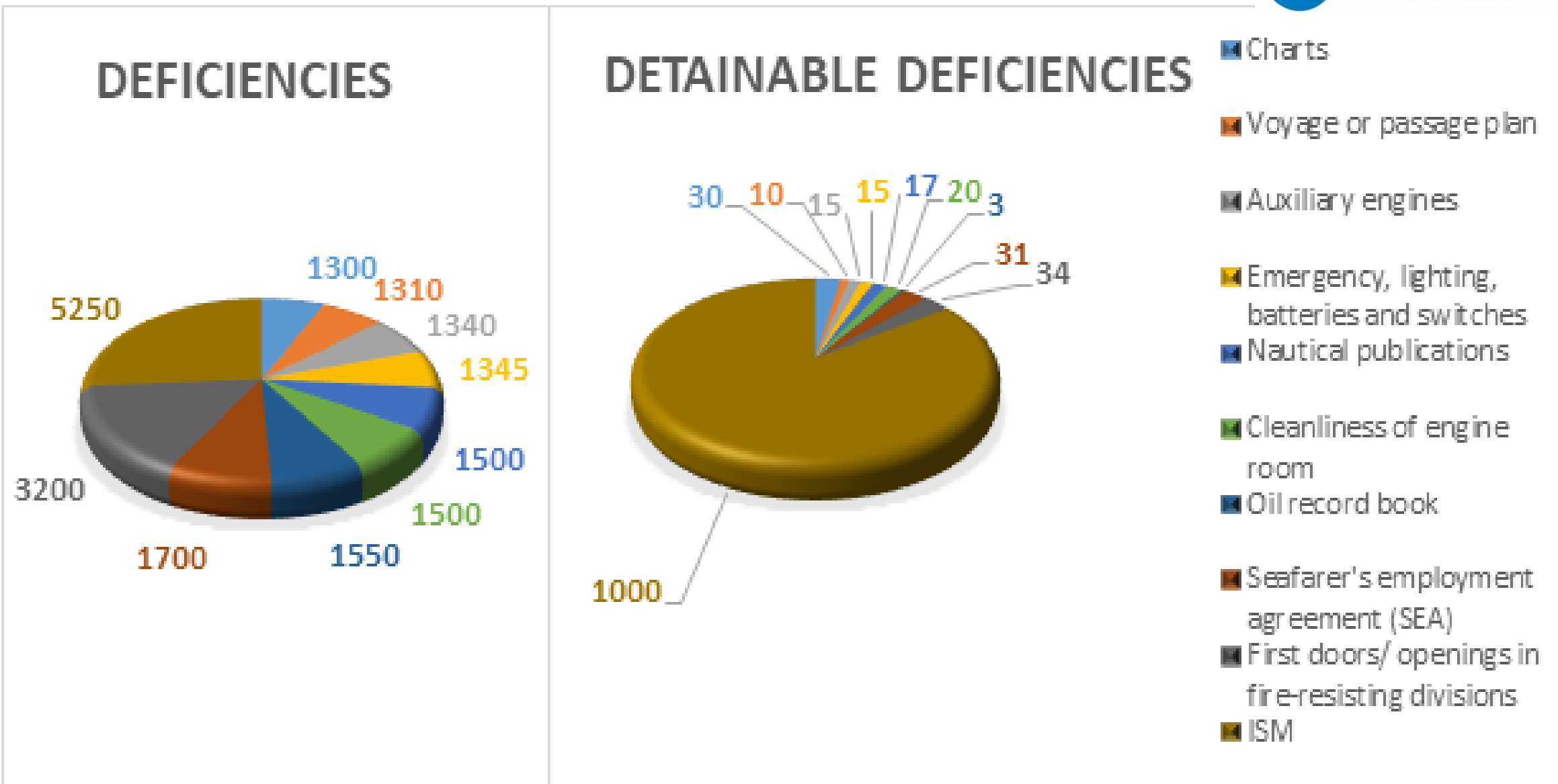


Figure 2. The ten most frequent deficiencies detected on ships during by Paris MoU 2019-2021 (Source: Paris MoU Annual Report 2022)



Pareto Analysis of ISM Code Deficiencies



A- Work Environment	1	Lack of visibility, excessive noise or vibration, hot/cold working environment, bad weather, sudden movements.
	2	Inappropriate work environment/ergonomics, poor human-machine interface, automation issues, maintenance and equipment misfunctions.
	3	Inadequate system design
	4	Issues with procurement/purchasing

B- Personal	5	Inadequate personal fitness
	6	Inadequate mental fitness
	7	Inadequate Knowledge
	8	Inadequate competence/skills
	9	lack of motivation or complacency
	10	Ineffective communication, language differences, non-standard (Non SMCP) or complex communication and the impact of differences in rank.
	11	Poor team operation, working towards different goals, no cross-checking, no means of reporting or speaking up, no quality circles.
	12	Incorrect perception, motion illusion, visual pretention/illusion and the misperception of changing environments or instruments.
13	Lack of focus/incorrect awareness leading to misinterpretation of the operation by a crew member – lack of attention, confusion, distraction, discoordination, stress/poor mental perception.	
	14	Forgetfulness, inaccurate recall or using outdated information.

Table 5b. The top 25 categories of the root cause of non-conformities, deficiencies and contributing factors to accidents and incidents at sea – Source: M’aider 2010, ACTs 2015 and ACTS Plus 2017 and OPTIMISM 2024,



C- Leadership	15	Inadequate leadership and personnel management, including no personnel measures against regular risky behavior, a lack of feedback on safety reporting, no role model and personality conflicts.
	16	Inadequate risk assessment, inadequate team composition, inappropriate pressure to perform a task and a directed task with inadequate qualification, experience or equipment.
	17	Inadequate leadership of operational tasks, including a lack of correction of unsafe practices, no enforcement of existing rules, allowing unwritten policies to become standards and directed deviations from procedures
	18	Inadequate manning (intentional or unintentional disregard for the guidelines).

D - Organizational	19	Inappropriate policy manual
	20	Inappropriate/inadquate procedure
	21	Inadquate supervision
	22	Problems with safety culture, lack of culture of reporting, learning or just culture, social and status barriers causing misunderstandings.
	23	Unsuitable documented policy or procedures, limitations of proactive risk management, reactive safety assurance, lack of safety promotion and training
24	Insufficient resources for safe operations, including personnel, budgets, equipment, training programs, operational information and lack of operational manual of ship installations.	
25	Commercial Pressures, business and competition affecting safety, including relations with contractors, trade pressure to keep the plans and costs.	

Table 5b. The top 25 categories of the root cause of non-conformities, deficiencies and contributing factors to accidents and incidents at sea – Source: M’aider 2010, ACTs 2015 and ACTS Plus 2017 and OPTIMISM 20249



- CONCLUSIONS:
- The Pareto Analysis of ISM Non-conformities, PSC Inspections and accidents clearly suggests that focusing on ship maintenance, shipboard operations and non-compliance with rules and regulations to be the top most frequent key factors in audit non-conformities, inspection deficiencies and accidents.
- The Pareto analysis of findings from accidents showed that the highest frequency occurrences are the ISM Code Elements 1, 7 and 10.
- This was also true for the IACS/LR data and PSC inspection. In Element 1 'Compliance with rules and regulations', 'Taking into account codes, guidelines and standards', 'Safeguard against identified risks' and 'Safe working practices' were the main problem areas. Element 7 'Shipboard Operations' was the second most occurring problem area. In Element 10 'Establishing procedures to maintain the ship' was the next top occurring problem area.
- Review of accidents also showed that 'Ineffective communication/language issues', 'Inadequate supervisions', Crew familiarization on board', 'Human Vulnerabilities' and 'lack of knowledge' to be main root causes of, or a contributing factor in many accidents. The review of accidents tallied well with the outcome of the ISM audits by IACS/LR, on like for like basis.



- It is equally important to identify other specific aspects of rules and regulations that have led to accident at sea such as COLREGs. In appendix 2, it is shown that Pareto analysis identified one of the key issues regarding accidents at sea to be collisions primarily due to complexities of the Rules, particularly Rule 19.
- The results presented here clearly shows that the focus of improving the effectiveness and effective implementation of ISM Code should be on ISM Audit non-conformities, PSC Inspections and accidents and a further analysis is required to ascertain what are the key issues with specific rules for instance with COLREGs or ship maintenance or shipboard operations. Safety improvements are only possible if ISM and STCW are reviewed together since ISM and STCW are sides of the same coin.
- Furthermore, the studies that have led to this paper clearly suggest human vulnerability, decision-making and person-to-person communications to be key factors for consideration. Safety is not an absolute phenomenon and a system such as ISM is as strong as its weakest point. Risk assessment plays a major role in ISM. To this end, whilst this paper promotes the idea of Pareto analysis to focus on areas that bear maximum impact, it should be noted that each non-conformity or deficiency or root cause of a near miss is an accident waiting to happen.



- THANK YOU FOR YOUR ATENTION
- ANY QUESTIONS?

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