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DEPARTMENT OF MARITIME STUDIES

M.Sc. in Shipping Management

“HUMAN FACTOR AND ACCIDENTS. THE CASE OF THE SHIPPING INDUSTRY”

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Dissertation

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Preface

This topic was chosen because of the wholeheartedly belief that the human factor in the shipping industry is of the utmost importance. The human factor is unique and cannot be replaced by any kind of machinery. The crew on board is always alerted to ensure the smooth passage of every vessel, always in accordance with the on-shore personnel and by following the international regulations. In every decision that takes place, the human effect is there and as a result, even the slightest mistake can lead to tragedies. As it will be pointed out in this research, the majority of maritime accidents are caused from human errors.

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ABSTRACT

This paper focuses on the important role that human plays on the maritime sector. Marine accidents have been occurring ever since men started to sail. It goes without question though, that human factor has a huge impact on the majority maritime accidents and that despite the constant evolution of technology, people are still vital for the proper operation and safe passage of every vessel. The first part of this paper emphasizes on the safety as a term in shipping, presenting the relative legislation, the meaning of risk and the culture prevailing nowadays about safety in vessels. The second part, presents the crucial role of human factor on-board, as well as some memorable accidents that occurred due to mistakes that were made from the crew.

Keywords: Human factor, Maritime accidents, Safety, Human Error

ΠΕΡΙΛΗΨΗ

Η διατριβή αυτή εστιάζει στον καθοριστικό ρόλο που παίζει ο ανθρώπινος παράγοντας στη ναυτιλία. Ναυτικά ατυχήματα υπήρχαν από την πρώτη στιγμή που ο άνθρωπος ταξίδεψε. Είναι αδιαμφισβήτητη η επίδραση των ανθρώπων στην πλειοψηφία των ναυτικών ατυχημάτων, όμως παρά τη συνεχή εξέλιξη της τεχνολογίας, οι άνθρωποι είναι ζωτικής σημασίας για τη σωστή λειτουργία και ασφαλή πλεύση του πλοίου. Το πρώτο μέρος αυτής της διατριβής, εστιάζει στην ανάλυση του όρου της ασφάλειας στη ναυτιλία, παρουσιάζοντας τη σχετική νομοθεσία, την έννοια του ρίσκου και την κουλτούρα που επικρατεί στις μέρες μας αναφορικά με την ασφάλεια των πλοίων. Το δεύτερο μέρος, παρουσιάζει τον σημαντικό ρόλο των ανθρώπων πάνω στα καράβια, καθώς και ορισμένα αξιομνημόνευτα ατυχήματα που συνέβησαν εξαιτίας ανθρώπινου λάθους.

Λέξεις – κλειδιά: Ανθρώπινος παράγοντας, Ναυτικά ατυχήματα, Ασφάλεια, Ανθρώπινο λάθος

CONTENTS

INTRODUCTION

Human error is the result of human actions that occurred either consciously or unconsciously. Despite whether these errors are considered minor or major, they can always lead to accidents, with sometimes disastrous outcomes. The purpose of this research is to understand the impact of humans in the shipping industry and how important the term safety is. Regardless of the positions and either aboard or in an office or in other maritime role, the nature of this job is highly demanding and requires a great load of effort from every side involved.

Throughout this research, the risks involved in the shipping industry will be mentioned, alongside with all the legislation that exists. Undoubtably, there has been remarkable progress of the safety culture in shipping over the past years but there is still quite a lot of room for improvement. Terms like Safety management and Total Quality Management will be thoroughly explained, to understand their importance. Visions of the future of safety for the shipping industry exist and will be presented, to prove that even better days will come.

The subject of this research came from the liking of the possibilities of humans and from the strong belief that humans cannot and will not be replaced by machines or technology. There was a strong will to explore the role of human factor in shipping, to understand the needs of seafarers and the challenges that they face almost every day onboard. One of the most intriguing parts of this journey was the description of remarkable maritime accidents that took place due to human error.

In order to fulfill the aim of this research, the synthesis of relevant literature was chosen as the preferred research methodology. Academic articles and book extracts were the main sources, coming from professionals, accessed via Google Scholar and Scopus. This Dissertation is consisted of 4 chapters, apart from the introduction and the conclusion. The first chapter provides a general overview over the safety in the maritime sector, along with the risks involved, whereas the second chapter presents in detail the methodology used throughout this research. The third chapter analyzes the impact of human factor and the final chapter presents various accidents that occurred due to human error.

CHAPTER 1: SAFETY IN THE MARITIME SECTOR

1.1 LEGISLATION

1.1.1 INTERNATIONAL SAFETY MANAGEMENT CODE

The International Safety Management (ISM) Code is considered to be an international standard for the safe operation and management of the vessels and for precaution against pollution. The goal of the ISM Code is to ensure the safety onboard, prevent the human injury or loss of life and avoid any damages to the environment or the vessel.

The ISM Code is a part of Safety of Life at Sea (SOLAS) Convention, chapter IX, since 1994. The regulations involved in this chapter give a better understanding of the aims of the ISM Code and the points where it focuses. The first couple of regulations contain the definitions and applications clauses, defining the term of ISM Code and the types of vessels where the Code should be applicable. Although the term “company” may be considered as a vague one, inside the chapter it has a specific meaning as not only a simple body corporate but as a shipowner in many forms, including any person or organization who takes operational responsibility of the vessel. The third regulation is the most important as it presents the fundamental statement of law that both the company and the vessel must follow. This regulation also specifies that a vessel should be operated by a company which holds a Document of Compliance (DOC). According to the fourth regulation, DOC is usually issued by the classification society when a company is in compliance with the ISM Code. Afterwards, a Safety Management Certificate (SMC) is issued for every vessel that follows the Code’s regulations but only if at the same time it is ensured that the company operates according to the Safety Management System (SMS) procedures. The fifth regulation provides that the Safety Management System should be maintained according to the standards set from the Code and the sixth regulation incites for the verification from time to time, of the proper working procedures of the Safety Management System (ISM Code, 2018).

Until the year 2002, almost the whole maritime cluster had complied with the requirements of the Code. Also, every maritime company had an organized Safety Management System which included the company’s policy regarding the safety and protection of the environment, the steps and procedures required to ensure the safe operation of the vessel, the levels of responsibility between the onshore and offshore personnel and the links that they have, the procedures of reporting accidents, the procedures concerning the preparation and response in cases of emergency and the auditing process enforced by the management. The ISM Code is consisted of two parts, the part A is about the implementation of the Code which is considered to be the companies' duty and the part B which is about the certification and verification of the companies which is needed in order to fulfill the obligations set as per part A (Mukherjee, 2007).

The implementation part of the ISM Code, begins with various definitions, the objectives and the application of the code and the functional requirements of a Safety Management System. The safety and environmental protection policy are then described along with the responsibilities and the authority of the company. Moving on, the role, responsibility and authority of the Designated Person Ashore (DPA), who is the link between the company and the personnel onboard, and the Master of the vessel are analyzed, along with the resources, personnel and shipboard operations required. As approaching towards the end of part A, the emergency preparedness of the company and the reports of non-conformities, accidents and hazardous occurrences are described thoroughly, in order to prove their importance. The first part of the ISM Code closes with the maintenance of the vessel, the maintenance of the equipment used and the necessity of proper documentation for everything that takes place and the need of reviewing and evaluating the company via internal safety audits both on board and ashore.

The part B of the ISM Code which features the certification and verification need, begins with the certification and periodical verification, presenting the lifespan of Document of Compliance (DOC) and Safety Management Certificate (SMC), meaning how long each one is considered to be valid and when it needs a renewal. The next chapter is about the Interim certification of the DOC and the SMC presenting when and why it is used this kind of certification and for how long its validity stands. This part of the Code closes with a brief mention to all the verifications required by the Code and have to be carried out and the forms of the certificates required.

The target of the ISM Code is not to alter the procedures that take place on board of the vessel but to facilitate and ensure the compliance with the rules and the proper supervision. However, the ISM Code has been criticized in the past that instead of helping to achieve faster and better results at problems that may arise, it creates extra trouble due to the vast amount of bureaucracy that it comes with (Vlachos G.P, 2011). There has been made significant progress in the past 20 years as far as safety is concerned due to the implementation of the code. A major benefit of the Code is that it encourages lessons to be learned from past incidents which may not be significant but could pose a danger to human life and the environment, in other circumstances. The global implementation of the ISM Code can offer the maritime industry the much-needed opportunity to move away from a culture which is based on blaming each other, to one of common sense of responsibility for safety throughout the organization, in every aspect that this industry covers.

1.1.2 CLASSIFICATION SOCIETY

The main role of a Classification Society is to provide classification and statutory services and assist the shipping industry in matters of safety and to prevent pollution. Throughout the process of the vessel classification, the structural strength and the integrity of essential parts and services is tested in order for the vessel to be deemed as sea worthy. The majority of vessels are surveyed after the completion of their building, for compliance with the standards set by the Classification Societies. These standards are issued as published rules and they are constantly developing via research and practical experience. A vessel that successfully follows all the rules set, is eligible to apply for a certificate of classification from that Society. A certification however, is not always considered to be a warranty for the vessel's safety and seaworthiness but just a proof that it is complying with the rules. The role of Classification Societies has been recognized in the International Convention for the Safety of Life at Sea (SOLAS).

According to the International Association of Classification Societies (IACS), the classification procedure has some certain steps. First of all, a technical review of the design plans and relative documentation for a new vessel to verify compliance with the rules is required. Shortly after, an attendance at the shipyard where the vessel is constructed takes place, where it is assured that the process of building is following the rules and the initial plans. Another attendance is made at the relevant production facilities that provide key components for the building procedure. The final attendance occurs at the time of vessel's sea trials, to verify the total conformance with the applicable rules. Upon satisfactory completion of the previous steps, the shipowner has to request the issuance of class certificate by the relevant Classification Society. After all procedures have ended, the shipowner has to keep in mind that a specified routine of periodical class surveys has to take place, in order to ensure that the ship is still following the rules set from the Class. It needs to be mentioned that when the conditions for the proper maintenance of class are not met, class may be suspended, withdrawn or revised to a different notation, as deemed appropriate by the Society by the time it becomes aware of the situation.

The ultimate goal is to establish clear, demonstrable and verifiable targets, so as a properly built, operated and maintained vessel should provide minimal risk to its cargo, its crew and the environment, during its operational lifespan.

Name	Abbreviation	Date	Head office	IACS member
Lloyd's Register	LR	1760	London	Yes
Bureau Veritas	BV	1828	Paris	Yes
Registro Italiano Navale	RINA	1861	Genoa	Yes
American Bureau of Shipping	ABS	1862	Houston	Yes
DNV (Det Norske Veritas)	DNV	1864	Oslo	Yes
Nippon Kaiji Kyokai (ClassNK)	NK	1899	Tokyo	Yes
China Classification Society	CCS	1956	Beijing	Yes
Korean Register of Shipping	KR	1960	Busan	Yes
Indian Register of Shipping	IRCLASS(IRS)	1975	Mumbai	Yes
Russian Maritime Register of Shipping	RS	1913	Saint Petersburg	Yes
Polish Register of Shipping	PRS	1936	Varna	Yes
Croatian Register of Shipping	CRS	1949	Split	Yes
Hellenic Register of Shipping	HR	1919	Piraeus	No
Korean Classification Society	KCS	1947	Pyongyang	No
CR Classification Society	CR	1951	Taipei	No
Vietnam Register	VR	1964	Hanoi	No
International Register of Shipping	IRS	1993	Miami	No
Dromon Bureau of Shipping	DBS	2003	Piraeus	No
Overseas Marine Certification Services	OMCS	2004	Panama	No
Maritime Bureau of Africa	MBA	2014	Cape Town	No
International Maritime Classification	IMC	2015	Dubai	No
Dutch Lloyd	DL	2018	Eindhoven	No
Asia Classification Society	ACS	1980	Tehran	No
Bulgarian Register of Shipping	BRS	1950	Varna	No
Shipping Register of Ukraine	RU	1998	Kiev	No

Table 1.1: List of Classification Societies (Source: maritimekr.com)

1.2 RISK ANALYSIS AND RISK ASSESSMENT

Risk can be defined as the chance of an adverse event, the likelihood of a hazard being realized and the combination of the probability, or frequency of occurrence of a defined hazard and the magnitude of the consequences of the occurrence (Royal Society, 1992). It is therefore considered as a measure of the likelihood of a specific undesired event and its unwanted consequences or losses. The main categories of risks involve collisions, groundings, explosions, foundering and fires.

A distinction should be made between risk analysis and risk assessment. Risk assessment usually comes after obtaining the results of a risk analysis process, in order to improve the safety of a system, by reducing or eliminating any threats and risks that may arise.

1.2.1 TYPES OF HAZARDS

Technical hazards and safety and health hazards

These are the "classic" dangers in maritime sector. Shipping companies through Designated Person Ashore (DPA) / Company Security Officer (CSO) Managers have already been organized against these risks and in the context of this article there is no need to expand further (Aven, 2011).

Regulatory and regulatory risks

In recent years, maritime has been hit by crossfire of Regulations and Regulations. Environmental Control Areas Regulations, SOx, NOx, CO2 Emissions, Balance Water Treatment, Monitoring - Reporting - Verifying Regulations, severely torture shipowners, who have entered a process of sometimes defense and sometimes attack. The fact is that these regulations, some of which come by 2020 and others are already in force, require a comprehensive plan for those who have not already done so (Aven, 2011).

Financial / insurance risks

Financial and insurance risks can also be described as "classic" risks for Shipping. Nevertheless, the constant change of the relevant environment increases the types of relevant risks and exacerbates the potential effects. In addition, the pressure of regulators in the financial sector creates discontinuity in their ability to provide smooth credit support to companies, increasing the risks (Goerland and Montewka, 2015).

Cyber-security hazards

New technologies are logical and next that they have affected Shipping and its activities. The combination of the use of cheaper crews with the increasing complexity of equipment and the rise in the use of remote two-way information and operation through sensors and intelligent computer systems, which are vulnerable to e-safety in maritime, lead to increased cyber risks. cyber security, for which little has been done so far globally (Goerland and Montewka, 2015).

Legal risks & GDPR

From 25 May 2018 onwards, all companies operating in the European Union will be required to follow the European Regulation 2016/679 -General Data Protection Regulation- (GDPR), otherwise the fines imposed will be up to 4% of the global turnover of the company. This is a combination of legal and IT risk, for which shipping companies should be activated immediately and before it is too late, as no extension is provided (provided it is a European Regulation and not a Directive). Also, the fact of the multiple geographical activities of the shipping companies makes them more vulnerable to legal risks (Papanikolaou, 2009).

Business / organizational risks - ISO 9001: 2015

Operational risk in the context of maritime safety concerns injuries to property, property damage or natural contamination environment. It should be noted that in general the risk does not should be limited to safety, but linked to avoidance of an adverse effect. In addition, the risks - or rather the risk factors - and the opportunities can sometimes be dealt with separately, but are rarely independent (like the two sides of a coin, which can be considered one at a time, but are not independent when the coin is dropped). Based on this revised definition, the risk can be divided into two main categories: the "down-side risk", i.e., the risk it poses significant threat or side effects, and the "desired risk" (up-side risk), which refers to the emergence of significant opportunities or desired result (Papanikolaou, 2009).

In the field of safety in particular, it is generally recognized that consequences are only negative and therefore risk management safety focuses on the prevention and mitigation of catastrophic consequences. In addition, the IMO (International Maritime Organization) recognizes that absolute safety is not possible. The adopted levels of safety each time is always a product of compromise, which is based on available technology, cost / benefit ratio, reliability, in the marine environment and in the socio-economic expectations regarding the safety of stakeholder's societies. Although safety standards are a compromise product, but they do not cease to represent the highest, instead of the lowest standards, as long as this is practical. In this way, according to IMO, it is ensured that these standards will be universally accepted in reasonably short time (Goerland and Montewka, 2015).

So, the IMO following this policy has promoted numerous conventions and protocols amounting to over 700 Codes and Recommendations, while its member states today are over 158. It is recognized by all that in this way great strides have been made towards improvement of the design, construction and equipment of ships with consequently being advocated by some that it is not possible to expect great achievements in terms of security with similar ways in these areas. The latter are the ones who claim that it is time to focus on the human factor, which is the only area that has not been sufficiently explored in relation to others (Aven and Zio, 2011).

In the new Quality System ISO 9001: 2015, risk management has a prominent place. The Quality Systems mainly concern the organization of the company, while at the same time the specialized ones (ISO 14001 for the environment, OHSAS 18001 for safety and hygiene, HACCP for food and their management, ISO 27001 for information security, etc.) They are constantly gaining ground as they become necessary to participate in competitions, where they are now more and more required. The lack of quality systems, but especially the absence of the functions that they systematize and delimit, carries risks (Goerland and Montewka, 2015).

Other risks

The "Other risks" in this case are of particular importance. Depending on the case, the shipping or para-shipping company and its place of business (either geographically or in terms of cargo), the additional risks may be different and of other gravity. They should, however, be identified before proceeding to the next stage of treatment (Papanikolaou, 2009).

1.2.2 RISK MANAGEMENT

The basic steps

After the collapse of Lehman Brothers, the precautionary approach is superior to the repressive one, in other words, the logic now is that the risks must be prevented (proactive approach) and not face them when they come to the surface (reactive approach).

This approach begins with the creation of the Risk Breakdown Structure. In this structure, the main "branches" are the risk categories mentioned above. After identifying the potential risks (which are not the same for all shipping and para-shipping, since it depends on their object, their geographical activity, etc.) follows the Impact Analysis. Therefore, by categorizing the risks according to their estimated impact on the operation of the company, their probability of occurrence, etc., and identify those for whom it is considered that is necessary to create a response plan before they occur, known as Contingency Plan. This can range from a simple list of emergency telephone numbers to the overall corporate operations plan (Goerland and Montewka, 2015).

Those involved

The Risk Sharing Structure can be started by the DPA / CSO Manager, but in no case can he complete it himself. For Risk Analysis, all managers / owners of the company's operations must be involved, contributing their perception of the risks they face and the impact in case of occurrence of any risk. The Emergency Plan can be assigned to an official, but requires the participation of representatives from all sectors and of course, the Management should be actively involved and give directions (Goerland and Montewka, 2015).

Follow-up

Risk management does not end with the completion of the above steps, it could be said that it probably starts from there. At regular intervals the company must re-check the completeness of the "Risk Registry" and re-evaluate the effects, choosing the appropriate actions to reduce them. There is no specific norm, but it is a good practice to do the review on an annual basis. The basic suggestions and advice are not to be complacent, in the sense that in an ever-changing environment everyone must always be ready to recognize and manage new or changing risks (Papanikolaou, 2009).

1.2.3 RISK ANALYSIS PROCESS AND TECHNIQUES

Risk analysis is the process of calculating the risk for the identified hazard. It involves analyzing a system in terms of its risks and the concept of risk is always related to the safety of the vessel. Nowadays, risk analysis is considered to be an element of major importance when it comes to reviewing system performance and identifying areas that have room for improvement for the safety of the vessel. Safety is a perceived concept which determines to what extent the management, engineering and operation of a system are free from danger to life, property and the environment (Kuo, 1998).

The initial step in the process of risk analysis is to make a problem definition and system description (define the vessel's characteristics, define the vessel's activities that can cause risks). The second step is to perform a hazard identification exercise, where possible events that may result in unwanted situations, are examined. After the identification of the hazard(s), risk analysis is performed which is the process of estimating the risks either qualitatively or quantitatively. At first, a frequency analysis takes place, to estimate how likely is that the various hazards can occur. Assuming that the hazards will occur at any time, the consequence modelling evaluates the results of these hazards to the vessel, crew, cargo and environment. After the completion of both the frequency and consequence analysis, they are combined to form a measure of overall risk which is then presented (Kristiansen, 2005).

In order to support, facilitate and improve the process of risk analysis, a variety of techniques have been established as it can be seen below:

Preliminary Hazard Analysis (PHA)

The objective of Preliminary Hazard Analysis (PHA) is to identify hazards that may develop into accidents through a systemized way of methodology, given the importance of the need to identify the hazards as soon as possible in order to implicate corrective measures. In order to generate the hazardous situations, deviations from the usual operation of the vessel have to take place. It is generally considered a general and vague technique of analysis but it can be of high value in early stages of risk analysis.

Hazard and Operability Studies (HAZOP)

A Hazard and Operability Study (HAZOP) is considered as a more in-depth and comprehensive method to identify hazards than the PHA which was previously mentioned. The concept of HAZOP is to constantly search for deviations from the normal operation of the systems that can cause harmful consequences, by looking into every part of the system separately. In order to perform a HAZOP analysis, the existence of a detailed system description and its parts is a must.

Failure Mode, Effect and Criticality Analysis (FMECA)

The Failure Mode, Effect and Criticality Analysis (FMECA) is a systemized inductive method of determining equipment functions, functional failure modes, assessing the causes of such failures and their consequences, as well as their effect on production availability, reliability, safety, cost, quality on a component level (Kristiansen, 2005). It is categorized as both a qualitative and quantitative technique. It is the basis for many reliability studies with the objective of establishing better maintenance strategies. FMECA should always answer questions about how can each part fail, what mechanisms might produce these modes of failures, what could be the effects of the failure and is the failure detected (Institution of Electrical Engineers, 1987).

Fault Tree Analysis (FTA)

Fault Tree Analysis (FTA) is one of the most common used risk analysis techniques. Such a technique of analysis can be used to identify the subsystems that are most crucial for the proper operation of a system or to point out how undesirable events occur. FTA can be described as visualization of the relationship between the failures of the analyzed system and also can be analyzed both quantitatively and qualitatively. The FTA technique gives the opportunity to analyze how an unwanted event took place and its causes (Lambert, 1973).

Event Tree Analysis (ETA)

An Event Tree Analysis (ETA) is a diagram which is used to analyze the effects of an accident, a failure or an unwanted event. It is shown the probability of the accident, in parallel to the actions required to be taken in order to prevent the escalation of the event or minimize its consequences. The chances of success or failure of these actions are explored in-depth, on the basis that each successful or failing path can lead to a variety of consequences, each with its own severity.

1.2.4 RISK ASSESSMENT

The purpose of risk assessment is to estimate the importance of the various hazards identified, in order to place them on a scale. At the moment, the best practice is the one which recognizes three levels of risk, the Intolerable, where the risk will not be justified except in rare circumstances, the Negligible, where the level of the existing risk is too low that no precaution is mandatory and the As Low As Reasonably Practicable (ALARP), which is a position between intolerable and negligible (Kuo, 1998).

In order to perform a proper risk assessment, there are some steps to follow. First of all, there is the need to identify the hazards that exist in the vessel. An important fact is that there should be a distinction between hazard and risk. For example, a bad maintained ladder in a vessel is a hazard and it creates the risk of falling. Also, grease on the deck is a hazard which creates the risk of slipping. According to the Western Sydney University, hazard can be defined as a substance, situation or practice that has the potential to cause harm, whereas risk can be defined as the probability of the harm occurring. Hazard identification as a first step should be a team work as it is generally considered difficult to declare completeness of a hazard identification process and it is a routine that ought to be reviewed in short time spans. The second step is about estimating the risk and its accepting limits. According to the IMO, risk is the combination of the frequency and the severity of the consequence. In other words, in order to calculate the risk effectively, the likelihood of occurrence (frequency) and the effects that would cause (severity of consequences) must be explored. After the estimation of risks, comes the control of them as a next step. Options to control the risks are presented and evaluated. Ultimate goal is to either remove the risk or set it to as low levels as possible or in other words as low as reasonably practicable (ALARP), as previously mentioned. According to a study conducted by Pomeroy, there are four possible options to handle the identified risk. The first one is to accept the risk, do not do any further planning or actions and proceed and it goes without saying that it is not one of the best solutions. Secondly, there is the possibility to transfer the risk to another party which is not a commonly used technique but can happen through a contract by hiring for example a third party to do a work. Another option is to avoid the risk identified, which is also not one of the best techniques but it can be mandatory at emergency times to ensure safety. For example, if there is the need to abandon the ship, it cannot be postponed although the weather may be bad and it could be a risky decision. Last but not least, there is the option of reducing the potential impact of the identified risk, just by taking extra precautionary measures and doing preventative actions. The final step of risk assessment involves the implementation of the actions required and the constant monitoring of the risks, via feedback, to further improve the procedures (FSA - IMO, 2002).

There are different types of procedures for the conduction of a risk assessment. The initial distinction is between a formal and an informal risk assessment. A formal risk assessment is conducted as a team, by identifying hazards, completing all the steps of the process that were mentioned and keeping logs of every single thing that happens. An informal risk assessment complements the formal process but it is not considered as a substitute for the formal risk assessment, as it is usually used for the everyday workload from individuals. Another distinction is made among qualitative, quantitative and semi-quantitative forms of risk assessment. Qualitative risk assessment techniques are the simplest ways to calculate risk, as it does not need much effort. Quantitative risk assessment uses special software to calculate precisely the risk and it is considered as a more difficult technique. Semi-quantitative risk assessment is a medium between the previously mentioned techniques and it provides numerical values to estimate the risk but without using special software. On vessels, qualitative techniques of risk assessment are most commonly used (DNV, 2001 and MSA, 1995).

1.3 SAFETY CULTURE

The main axis of a shipping company - regarding safety - is to perform the same data / procedures for both the inanimate part and for the soul, since they are interconnected, in the office and on its ships. Its safety is based on some key pillars that achieve it, which are the (Dionne, 2013):

- organization
- human factors
- safety measures
- environment
- technology

The organization primarily concerns the way the company will be structured, i.e., with its parts and its primary purpose for what it wants to achieve as organization, setting clear goals. In addition, it concerns the existence of and corresponding placement of executives for the respective issues without reaction and problem-solving time is lost, such as SQE Department. Finally, with communication and information transmission channels, to be evaluated by those in charge, as well as by recording and archiving them. In this way deficiencies are identified and corrected and / or mistakes, while at the same time creating safety valves and the corporate culture (Saunders, 2015).

Human factors are related to what role everyone has, who is responsible and for what issue, vital elements for ships in particular in emergencies. It is especially important to control the potential risks, be monitored, evaluated and addressed beforehand lead to uncontrollable situations. In this context, the issue enters training and assessment - mainly crews - so that with proper training and education to know how to try to cope in any needs-situations. Of course, the benefits of education are manifold after contributing to the development of common goals and collectivity, in identifying weaknesses and improve them, in motivating and rewarding the participants (Ericksen and Dyer, 2007). The exercises / experiential seminars / simulations include many possible emergency scenarios thus improving the speed and quality of reaction, when and if it occurs really. This approach is part of the company's Safety Culture. In short, it could be said that with the above approach it becomes clear how the company wants to operate and what role each stakeholder takes on.

Also, the safety measures refer to organizational and technical level. In organizational level means constant monitoring and control of activities and procedures, so that it is immediately corrected that it has negative results or that it deviates from the expected. The consecutive and cross-checks reduce the chance of overtaking something without perceived and lead to incidents or accidents. In addition, it is necessary the training of staff to control and monitor activities, that is, to have knowledge of what and how they should do (Saunders et al., 2015).

As far as the technical level is concerned, the safety measures refer to the existence (Hystada and Bye, 2013):

- systems that will ensure the operation on board the ship and its office: firefighting, backup, backup.
- required personal and technological equipment: helmets / uniforms / shoes, leak detectors of hazardous materials, stability, correct cargo distribution, proper ship loading.
- identification and marking of dangerous areas: engine room, barns.
- existence of a suitable stock for emergencies.

In addition, maintenance - emergency and regular - is very important for the reliability of machinery and non-technological equipment. This means that they will continue to work or will be able to work in required conditions, such as the fire-fighting system, and that they will provide the needed safety in humans, such as helmets. Their strict policy maintenance saves resources and trouble-free periods / problems, which are costly for the business. Especially important is the preventive maintenance because it prevents errors while saving at the same time and money (Dionne, 2013). Necessary element for effective maintenance is the education of people according to their responsibilities since this way they will know when to take the necessary actions, ensuring the uninterrupted operation of ships.

Going forward, technology is a key factor in the organization of the shipping company always focusing on safety. So, the use of advanced office and fleet communication systems, as well as direct transfer of information -in the competent departments- through multiple channels to ensure that errors are reduced after the system and the corresponding decisions / measures are taken. The same goes for use of easy-to-use and efficient management software thus facilitating the most efficient planning with the actions to be performed, while assisting in the proper allocation of resources (Veltri et al., 2013).

The reliability of such a design therefore yields significant financial costs benefits the shipping business. The reasons are that they are avoided wrong decisions, while correcting at the same time any gaps / errors that will led to negative effects on humans and their environment (natural and artificial). Simultaneously with the use of modern and durable machines, is increased productivity and optimal levels of operation. According to this way - with the know-how and the technological tools - the appropriate ones are given supplies to the company to have a competitive advantage over the rest. Another pillar of safety is the environment, in which the shipping company is called to operate and in particular its fleet. More specifically, shipping is a dynamic environment with multiculturalism character something that makes communication difficult. The goal is through participation and common trainings - mainly for the crews - to create a common code of communication and a common naval language. In addition, this is achieved with clarity of procedures, roles and stakeholder responsibility (Rusconi, 2013).

This will make it possible to transfer information inside and external environment of the shipping company, filtering the inputs / information of the latter. Essentially the external environment is characterized by increased risk, for which it is important the assistance of the administration with the implementation of the above pillars for proper evaluation of the information entered (Storgard et al., 2012).

The skeleton of safety for every shipping business is summarized in three questions, which define the safety levels it will apply (Storgard et al., 2012):

- how it can be achieved
- how much risk is acceptable
- how much risk can be financially supported

Safety is defined as the freedom / release from unacceptable risk, i.e., the anticipation of adverse events and protection against adverse events results (Dong- Wook and Panayides, 2012). The approaches of safety are two: traditional (Insurance I) based on quantitative risk assessment and theoretical (Safety II) in the sense of resilience and qualitative inquiries on how safety can be described as result of the successful course.

More specifically, Safety I is based on policies, training, safety meetings, in the respective slogans, awards, committees and councils, as well as regulations. And Safety II ensures that things are going according to plan rather than going wrong (Schröder-Hinrichs et al., 2015). The sure thing is that safety fails when treated only as an obligation and / or priority but not as value. This means that the stakeholders – staff office and ship- do not understand why what should be followed are etched through company policies and procedures, they just have to do it.

Behavior is what is now to focus on companies to avoid incidents and accidents. Based on this, the Behavior Safety approach / methodology has been created (B.B.S.), which is voluntary, i.e., the working environment must desire it and be disciplined accordingly. The basic principles of B.B.S. is to investigate external factors that influence behavior, direct activation and motivation to address the consequences, focus of positive effects of a motivational behavior, anthropocentric planning interventions, as well as focus on interventions related to remarks behaviors (De Pasquale and Gelle, 1999).

Essentially this process includes measurements, feedback, problems-solutions. More illustratively, the B.B.S. is a complex approach, which deals with the following fields (De Pasquale and Gelle, 1999):

- the systematic process of identification, measurement and change conduct of employees.
- the approach that examines the motivation for different behaviors.
- the behavior of workers at risk and in relation to safety.
- the emphasis on the type of behavior that contributes / contributes to accidents.
- finding the deeper / root causes of accidents and relevant behaviors
- the continuous and dynamic approach to safety through operations and countermeasures.

In short, the B.B.S. argues that through the approach i) safe activities and (ii) reduction of dangerous behaviors, accidents minimized. In this context it should accordingly exist (Pasman, 2015):

- employee training
- data collection and analysis in permanent databases
- confidence in that corporate environment
- interruption of work by those involved if it is unsafe

- positive perception of any remarks

The benefits of adopting the above procedure are manifold. Primarily, it leads to safe improvement and increases its recognition in each case risk. In addition, the employees of the institution / company and increases their attention while enhancing references. Finally, it leads to positive change of the company culture, laying the foundations for a safety culture (Pasman, 2015).

In terms of human behavior, it is understood that it is observable, measurable, and composed of actions and abilities, while accompanied by consequences. This means it can be the administrator someone. For this reason, it is important to have a mechanism for measuring behaviors to identify and predict behaviors. The tools that could be used for this purpose are questionnaires, interviews and safety committees. In addition, the existence and recording of staff skills is crucial because it designates the competent persons in the respective positions effectively. The skills are not just about knowing about a (specific) issue and / or a machine (mechanical) but also include the visual, mental and psychomotor therefore should all be measured accordingly and compose the overall picture for each employee (Hystada and Bye, 2013).

Moreover, behaviors that create risk are:

- conscious (burning garbage in a cabin)
- custom (lighting a cigarette on the gas deck)
- unintentional (press button down).

The result in any case is material and human losses, since there is exposure to risk. The solution to the risk is either to smear it either to isolate it (special smoking areas) or to be removed or given the appropriate equipment to deal with (fire safety system) staff should be assisted in order to not adopt behaviors that underlie the existence of risk (Mauritzon, 2011).

Aid can be both negative and positive. The aid that is negative is characterized by the fact that employees want to avoid to do something, with the consequence of reducing performance, not creating motivation for improvement, while the only motivation it provides is that of fear. On the other side are the positive aids, in which the employees voluntarily want to act on work issues which leads to happy / satisfied employees, in increasing efficiency, while at the same time it dynamically promotes positive behavior (Mauritzon, 2011).

In conclusion, one realizes that it is in human nature factor to make mistakes, so it does not make sense to return employees without no mistakes. The question, however, is how much will quickly return to its original state - after the incident - the ship with the crew, i.e., how long it will take and what actions it will have to take, that is, resilience. However, preventive risk management is difficult, especially in a system such as shipping, which seeks to meet the daily pressures. For this it is needed an organizational structure and culture that will be able to manage Safety Culture in general, using the tools available. Essentially, the concepts that result are Resilience Safety Culture and Safety Culture and are no different, the difference is in how it is used in practice. Regarding, as Resilience Safety culture means the organizational culture it cultivates safe practices, in order to improve Safety, through efficient management of safety with emphasis on resilience, organizational learning and continuous improvement (Akselsson and Koornneef, 2009). That's why shipping companies now adopt the triptych Safety, Resilience and Safety Culture, as integral parts of each other, according to the interviews conducted.

Therefore, the leaders / mentors of B.B.S. they have to commit, to strengthen, give feedback (from bottom to top), set a goal and observe their groups. Also, they need to realize and be alleviate the stress of the people who manage. Pressure in humans it can be either acute or chronic. The two cases are just as serious as it creates distraction, mistaken judgment for the download while prolonged stress has a psychosomatic effect (Lappalainen, 2008).

Finally, the long working hours - especially on ships - bring fatigue to humans with implications for teamwork, communication, implementation knowledge. The word “fatigue” is used for this situation. Especially in shipping “fatigue” is an additional factor / cause for a number of events. So, it is the job of the leaders / leaders to reverse the “fatigue”, using the Based Behavior Safety process as a tool (Lappalainen, 2008).

The limitation of the negative situations captured above can be achieved directly by selecting the box it chooses to operate a business and specifically the corporate culture it develops. As culture is those attitudes, values, perceptions and beliefs that it adopts and applies to the organization in all its activities and procedures. In conclusion, that is, human behavior can manage this as well through its measurement (Pasman, 2015).

Essentially, the Safety Culture, and in particular the maritime environment, supports and improves daily the above, while the Supreme Management is the one that through the decisions it will take will demonstrate it as value for business (Anderson, 2013). Also, its integration safety of processes and the contribution of each individual to improve, is an element of Safety Culture. In addition, continuing education internally by the company, for the knowledge of either the legal framework or the use of machinery and equipment, presents its Safety Culture, while achieves in less time the improvements it has made but also the desired one's levels (Hetherington et a., 2006).

In short, it is defined as a Safety Culture, the ways in which manages workplace safety and often reflects attitudes, beliefs, perceptions and values that employees share in relation to safety. In addition, high Performance Safety Culture is considered (Hetherington et a., 2006):

- Safety Leadership
- Performance Management
- Safety Coaching
- Behavioral Safety

The key elements of a Safety Culture are that it develops a clean purpose and safety objectives, communicates with its vision and objectives allows each region to achieve its own objectives for safety as part of the whole. It also strengthens positively, encourages and builds in individual participation, while establishing mutual respect and support (Chauvin, 2011).

The shipping sector is a heavy industry with great potential environment and with many unbalanced factors. For this reason, the necessity is not found in the mere existence of a Safety Culture, but a Maritime Safety Culture, like something corresponding was formulated for the aviation sector which has its Culture Aviation Culture. The companies adopt a No Blame policy workforce and acceptance of its human momentum in error in order to urge staff to communicate directly, without fear of being reported Deficiencies and / or problems and / or incidents will be considered inappropriate. But, practically and to avoid misinterpretations, the most correct term is that of Just Culture, since each position of the staff is characterized by duties and responsibilities. Just Culture means the grid where it is created atmosphere of trust, employees are encouraged to provide important information related to Safety while at the same time achieves a clear distinction between acceptable and non-acceptable behaviors. In short, it is a safety policy that reinforces change mentality and not just changing safety systems (Chauvin, 2011).

As a result of the above, the requirements for Safety Culture. Primarily it is the commitment of the Management as a function of and of Leadership, something that is reflected through the policies of the company. Also, the emphasis on safe and unsafe behaviors, social and personal non-techniques skills, the positive intervention in unsafe behavior, its importance the role of the employee. Still, the organization should be 'open' to learning daily, has binding resources, good working environment, job satisfaction. Finally, the company should focus on education and to have feedback on all its processes (Mackay, 2000).

In summary, Behavior and Safety Culture are interrelated and interdependent. In particular, culture is the master determinant of employee behavior, while Safety Culture is a prerequisite for implementing B.B.S. approach. Also, the wider environment but also the work environment shapes the behavior of employees (Mackay, 2000).

Therefore, all of these are adopted by a shipping company as a solution to reduce incidents, namely accidents, which have multiple and long-term catastrophic extensions. Finally, they are adopted in the context of customer / charterer satisfaction and in general stakeholders, as well as the image to the outside (Chauvin, 2011).

1.3.1 TOTAL QUALITY MANAGEMENT (TQM) – SAFETY MANAGEMENT

The shipowner or the manager of a vessel always operates within the framework of safety regulations to ensure the proper passage of the ship and the well-being of the crew on board. Safety management is indisputably an integral part of the overall management system of a shipping company. Quality affects every aspect of business. A popular and emerging management philosophy that bases itself on this all-embracing notion of quality is the Total Quality Management (Costin, 1998). The crisis that there is in quality, the traditional ways of dealing with quality crises being more and more inadequate, the need for continuous learning and improvement at all organizational levels and the requirement of a universal way of thinking since quality management affects all functions and levels of the organization have been stated as motivations for a TQM approach (Juran, 1998).

There are three major points of the TQM that focus on quality planning, quality control and quality improvement. These are considered to be the basis of the TQM philosophy (Juran, 1998). Quality planning has to do with identifying both external and internal customers, finding out their needs, developing products that are adequate to their needs and prove that the process can meet the quality goals under operating conditions. The quality control focuses on choosing what to control, how to measure it, establishes standards of performance, measures the actual performance and take corrective actions towards the difference between actual and standard performance. Quality improvement identifies specific areas that have room to improve, organizes the guidelines of the procedures and provides solutions.

Safety is a quality of an organization and the organization safety level can be managed through the use of a set of a basic safety management activity. Safety management within an organization should be an iterative process, which is in accordance with the important TQM principle of continuous improvement (Aitken, 1996). There are five elements in the safety management system which are influenced by the total quality management. The first one is policy, meaning the set of guidelines of organizations so as to achieve their goals. The second one is organization, meaning the responsibilities divided to each individual via the management system, which improves the communication and cooperation between each other. The third one is implementation, which helps in ensuring that the policies and objectives are set. The fourth element is measurement, which is closely linked with the previous element, as throughout the process, it is measured whether the implementation went as expected or not. The last element is review, a very useful and necessary mechanism to evaluate the performance of a system and to try to constantly improve it.

1.3.2 EMERGENCY PREPAREDNESS AND PROCEDURES

Emergency preparedness includes all the necessary actions required to be taken when an undesirable event occurs such as an accident. Emergency preparedness is also known as contingency planning and includes the constant readiness of the crew of the vessel to take mitigating actions in case that an accident tends to escalate and to threaten people and the environment. However, the safety of personnel should be the highest priority. It is generally accepted that many accidents would have been prevented or would have minor consequences if the appropriate actions were taken at the right time. In 1997 the IMO adopted the Emergency Response Procedures for Ships Carrying Dangerous Goods Guide which contains guidance on emergency situations including the Emergency Schedules (EMS) to be followed in case of incidents. The purpose of this guide is to provide guidance for dealing with fires and leakages on board ships involving the dangerous goods listed in the International Maritime Dangerous Goods Code (IMDG Code). Below, apart from a fire and spillage incident, it will also be examined the incidents of abandoning ship, collision and man overboard. In each incident that occurs, every member of the vessel is notified through the general alarm, which consists of seven short blasts followed by one prolonged blast.

Emergency Procedures in case of Fire

Ship fire accidents are both instantaneous and developing events and small errors can cause significant accidents (Su and Wang 2013). Preventing a fire from occurring is the most important part but when a fire starts, a well-trained crew is the best chance to control the fire. By the time the procedures begin, all the crew involved must wear appropriate protective clothing such as a firefighter's outfit along with self-contained breathing apparatus. After the alarm sounds, fire's exact area should be detected. Doors ought to be closed so as to stop ventilation and dangerous cargo must be identified. Then, an analysis of the method that will be used to extinguish the fire and the possible development of the fire is made. If it deemed necessary to evacuate the vessel, procedures to save all the documents are made. If not and the fire can be put down, a message before and after the extinguishment is sent to the company and any third parties needed and everything that occurred is kept in logbook (IMO, 2018).

Emergency Procedures in case of Spillage

Incidents involving dangerous goods may result in spillages from such goods, and the magnitude of the effects of an incident depends upon the type and amount of product released, together with the type of any other product involved and whether the spillage is on deck or in enclosed spaces (IMO, 2018). As in any case of an emergency, the alarm will sound. Any contact with dangerous substances should be avoided and distances are to be kept from possible gases. As mentioned above with the fire incident, full protective clothing is required, specifically resistant to chemical attack along with self-contained breathing apparatus. The position of the leaking cargo should be identified and a consideration of which measures of the EMS Spillage Schedule are applicable is required. Medical First Aid Guide (MFAG) must be prepared at any time required and there is the need for an immediate contact with the DPA to obtain additional advice.

Emergency Procedures in case of Abandoning Ship

By the time the emergency alarm sounds, each member of the crew should have joined his emergency station to prepare the lifeboats always with their lifejackets worn. In the radio room, vessel's position, satellite terminal and distress transmitters (e.g., GMDSS) should be updated and a distress message will be sent in order to alert other vessels that might be in close range. A thorough check to ensure the presence of all crewmembers will take place and in case of someone missing a quick and immediate search will begin. The Emergency Position Indicating Radio Beacon (EPIRB) will be activated, engine will be stopped and if there is enough time, vessel's documents (prioritizing the log book) will be prepared.

Emergency Procedures in case of Collision

In the unfortunate event of a collision of a vessel, instantly the alarm will sound. As per the Collision Regulations, sound and/or light signals will be given and if required, a maneuver of the vessel will take place in order to mitigate the effects of collision. Deck lighting will be switched on and watertight doors will be closed, as precautionary measures. The VHF will be kept on channel 16, which is the international distress frequency of vessels (Lees, 2015). There should be a continuous communication with the company to analyze and evaluate the situation and pictures of the accident should be taken. Also, a contact with the other vessel involved should be established, to exchange all necessary information. In case that this collision poses no threat to the environment (e.g., pollution) and no human lives are harmed, the log book is updated and further directions from the company are provided.

Emergency Procedures in case of Man Overboard.

In this emergency case, all actions ought to be taken quickly to have better chances of saving the man at sea. Apart from the sound of the alarm, the first crew member that will notice this incident must yell "Man Overboard", multiple times. Master and Bridge are to be immediately informed about the side of the ship that this person is. A lifebuoy will be released and a rescue boat will be prepared, along with treatment on board. The company and the Automated Mutual Assistance Vessel Rescue System (AMVER) will be informed. By the time the rescue is completed, all parties involved will be informed and the log book will be updated.

1.4 POSSIBLE FUTURE SAFETY TECHNOLOGIES

When considering the future in the maritime sector, the year 2050 is a hallmark. The average year of the world's merchant fleet is 21 years (UNCTAD, 2020), which means that the vessels of 2050 will be built in 2030. It is highly possible that they will have a mix of ships with different levels of autonomy, but not necessarily unmanned. The role of seafarers will greatly change, while remaining of critical importance for the vessel at the same time. Just like today there are unmanned machinery spaces (UMS), it is highly possible that in 2050 they could exist unmanned bridges, with a duty officer on-call in case of alarms. However, in dangerous areas or in areas of heavy traffic, bridge could remain manned just like it is nowadays.

Assuming that by 2050 connectivity is improved, remote monitoring, remote control ships and remote pilotage will become more widely used. Seafaring could transform to typical nine to five job. Automation will undoubtedly change many aspects of sea life, probably for the better, since seafaring has always been considered as a hazardous profession. Tasks like watchkeeping and inspecting tanks will be assigned to automated systems, thus letting seafarers focus on safer tasks (Gardner, 2021).

The pace at which technology has dominated in the maritime sector has been beyond any possible expectations that were made some years ago. Technology has a variety of use causes, from ship design to protecting the environment. Research that was conducted in 2020 and carried out by Lloyd's Register Foundation found that the total global safety technology market is expected to be worth $863 billion in the next three years and for safety critical industries around $257 billion. Therefore, by the end of 2023 a growth of approximately $6.6 billion is expected.

The peril of the sea is known to every person who is into the shipping industry and it has been a subject of analysis over the years. Unfortunately, seafarer lives are lost every year, despite the fact that the industry always tries to improve and promote safety. Bad weather conditions and human errors are things that are difficult to predict and mitigate. Although the use of drones and sensors has been safer for the crew on board, the human factor is still irreplaceable and dynamic. However, it goes without saying that the lives of seafarers are extremely demanding, with only a few hours to rest, not to mention the fact that they spend months away from their homes. Often, the accumulation of the fatigue that they have, leads to disastrous accidents that can even cost their lives. In order to ensure the safety of seafarers, there is a technology being developed by Lloyd's Register Safety Accelerator startup, which scans with cameras the retina of the eye of a crew member, to determine if he is fit for duty. This technology would prevent a seafarer to work when he is fatigued and this type of solution could drastically reduce safety incidents caused by human error.

Another future project which aims to reduce the possibility of human error, which is the main reason of ship accidents, is the CyClaDes project. The research project CyClaDes, or Crew-centred Design and Operations of Ships and Ship Systems, started in October 2012 and was finalized in September 2015. It aims to improve the current lack of implementation of user-centred design (UCD) principles in workspace and equipment design. It is expected that better access to information regarding UCD will improve the design of workspaces on board and thereby reduce the likelihood for human error (Kaehler, 2012).

The use of data and technology in the shipping insurance industry has made great strides in the last decade. In an industry that is often portrayed as being more comfortable with delivery rather than downtime, there is an awareness that the sheer amount of information available there is of tremendous value - if used properly. According to Alvin Forster, Loss Prevention Executive, North P&I Club, there are two key areas where the Northern Loss Prevention Division has truly embraced the use of technology and is collaborating with innovative and future companies (Loyd's Register, 2021).

The first is how insurers can better assess the risk of the ships they cover and any potential new business. Traditionally, they have used simple, yet effective, measurements such as performance of historical claims and performance of compliance with regulations (such as deficiencies and port state inspection reservations) to help assess the risk posed by a vessel, a fleet or an air carrier (Loyd's Register, 2021).

These are still excellent indicators and continue to be based on them. But leveraging the huge amount of real-time shipping available can tell us more. For example, AIS data, which monitors ships around the world when combined with accident and claim data, can detect higher risk transactions and transactions. As a result, North P&I Clum has partnered with Concirrus to develop an analytics tool that not only collects this data, but also understands it.

Thus, instead of relying on risk assessment on only a small number of performance indicators, the North P&I Club analysis tool now has the ability to examine over a hundred measurements and give them the appropriate weighting. And perhaps the most impressive aspect of this tool is that it learns. Using artificial intelligence (AI), it periodically undergoes a learning process to enhance its accuracy in predicting future risk profiles (Loyd's Register, 2021).

The second area helps in the way of providing information and information to the members of the Club. Creating and providing information to prevent losses is a key aspect of their role and, for decades, they have amassed a vast knowledge base. Club members take advantage of this so that they can take appropriate precautions before setting new loads, trading in new areas or when facing new issues and challenges (Loyd's Register, 2021).

In the past, they have provided this information by posting articles on their website and answering questions from members' subscriptions. However, there is now collaboration with Geollect geospatial experts to provide members with an interactive map-based information portal called MyGlobeview. This allows easy access to key information specific to a port, country or region that can help the shipowner, operator or charterer assess the risks of a voyage - whether related to sanctions, maritime safety, port operations or risks related to the load (Loyd's Register, 2021).

Recent additions that improve this tool include the Route Risk Tip feature, where the user plans the ship's planned voyage on a map and generates a report containing the required hazard information. The report can then be sent to the ship's operations team and the master to allow them to take the necessary precautions. Warned means prepared.

A simple example: a shipowner is considering setting a freight to transport bulk cargo from the United States Gulf to China. A quick check on MyGlobeview will show the dangers of piracy and robbery (locating access points) in the Straits of Malacca and the risk of claiming cargo damage. This is complemented by loss prevention tips and links to useful resources that will help mitigate these risks in case the shipowner decides to rectify (Markopoulos et al., 2019).

Another new addition concerns the quality of fuel. Since the introduction of the IMO 0.50% sulfur fuel on January 1, 2020, the proliferation in the use of VLSFO (low sulfur fuel oil) products has brought quality and operational issues. To help shipowners and charterers make more informed decisions about fuel market arrangements, the Club is partnering with VPS fuel quality experts to provide warehouse data from around the world. VPS has a wealth of historical data based on the thousands of sample warehouses receiving and sharing this information, so those who buy fuel - and just as importantly those who use fuel - have a better idea of what to expect.

MyGlobeView has already proven to be a valuable resource for Club members, but last year's events have really shown its value. The COVID-19 (coronavirus) pandemic has affected almost every nation in the world. Every country has taken action to combat the epidemic and this inevitably affects shipping - which of course has continued to do so. Shipowners, charterers and ship crews need to be aware of the latest port-specific measures, and MyGlobeview has proven to be a useful way to provide this information. Simply navigating the map and clicking on a country, information such as entry and port reporting requirements, quarantine settings and any restrictions on crew movement and crew changes are in the hands of shipping players (Loyd's Register, 2021).

The increasing use of advanced Information & Communication Technology (ICT) and Operational Technology (OT) on ships has taken - as expected - an exponentially growing course. This increases the efficiency and effectiveness of operations both on board and on land. However, a ship that was traditionally considered a relatively "closed" - hence "isolated" & "protected" system, has now opened its gates to cyberspace. This has resulted in vulnerabilities to a significant number of cyber security threats.

The main stakeholders of the shipping Industry are well aware that an ineffective cyber security protection can lead to major security, environmental and trade issues! This creates a new "sector" of challenges in shipping: The challenge of cyber security.

In response to the challenge of cybersecurity, the International Maritime Organization (IMO), the global authority for setting standards for the safety and environmental performance of international shipping, adopted on 16 June 2017 the resolution MSC.428 (98) - Management Cyber Risk in Maritime Cyber Risk Management in Safety Management Systems as part of the mandatory regulatory framework for the shipping industry. IMO Resolution MSC.428 (98) is complemented by IMO Guidelines for Cyber Risk Management IMO Guidelines on Maritime Cyber Risk Management MSC-FAL.1 / Circ.3 and entered into full force on 1 January 2021 as part of the mandatory International Safety Management Code (Resolution A.741 (18)).

In addition, the following are recognized (but not limited to) best practices for implementing cyber risk management:

Guidelines on Cyber Security Onboard Ships: The Cyber-Safety Guidelines for Ships written and endorsed by the international shipping organizations BIMCO, CLIA, ICS, INTERCARGO, INTERTANKO, OCIMF and IUMI.

ISO / IEC 27001: The ISO / IEC 27001 Standard on Informatics - Security Techniques - Information Security Management Systems - Requirements. Published jointly by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC).

NIST Framework: A framework for the United States National Institute of Standards and Technology for Improving Cybersecurity Infrastructure.

As the title of the BIMCO publication suggests, the Guidelines on Cyber Security Onboard Ships (GCSOS) provide a set of cybersecurity guidelines for use by ships to respond to and protect against cyber threats. In particular, the main body of the guidelines provides guidance on the application of cyber security controls. Annex 1 of the Guidelines identifies and lists a summary of the onboard systems, equipment, technologies and data that could potentially be vulnerable to cyber threats. Annex 2 of the guidelines provides the minimum measures that all companies should consider implementing in order to address cyber-risk management within the approved Security Management System (ISM Code) and Annex 3 provides guidance for on-board networks of ships.

EU regulations such as the GDPR and the NIS Directive have a significant impact on the shipping industry. The first is because the shipping industry uses the Personal Data and Privacy Information of passengers, crew and visitors. The second is because maritime transport is an area covered by the NIS Directive and, as a result, some shipping companies may have been identified as Basic Service Operators (OES). At the same time, some states through the Port State Control Authorities have already begun to carry out strict controls and impose strict control measures to ensure that cyber risk management is properly addressed and implemented within the framework of the security management system. All State Port Control Authorities are expected to follow very soon the intensification of controls at the same level (Markopoulos et al., 2019).

CHAPTER 2: METHODOLOGY

2.1 INTRODUCTION

This chapter explains the methodologies that were used in gathering data and analysis which are relevant to the research. The methodologies will include areas such as the research design, the research approach that was used, the type and the sources of data gathered to be included in this research.

2.2 RESEARCH DESIGN

The purpose of this study is to further analyze and gain insights about the human factor in the shipping industry and its effect on maritime accidents. During this process, certain examples of accidents are stated, in all of which the human factor had a crucial impact on the outcome. Based on that negative outcome, the reasons behind human errors are explored.

2.3 RESEARCH APPROACH / STRATEGY

There are two types of research approach according to Kombo (2006). The first one is the quantitative approach, in which technique are used numerical data or data that are quantified and the other one is the qualitative approach, that uses non-numerical data or data that have not been quantified. In this research, qualitative approach was chosen, and more specifically, a synthesis of relevant literature, in order to meet the goal of research. The research for the collection of published articles was conducted on trust-worthy databases, such as Scopus and Google Scholar, always alongside with useful material from books of academics of the shipping industry.

Relevant keywords were used to find journal articles and material from books, such as “maritime safety”, “human factor”, “human error” and “maritime accidents”. Although the abovementioned databases provided a big variety of articles, a thorough examination of each one of them was conducted, so as to choose and mention the most relevant and the most important ones towards the research objective. For this examination, criteria such as the date of publication and the quality of the research were used, to ensure a satisfactory and accurate result. As far as the date of publication is concerned, the academic articles that were finally chosen, have been published in well-known scientific journals during the past 20 years. Regarding the quality of the chosen material, only the most reputable sources were chosen, sources which are considered to be trustworthy.

2.4 DATA SAMPLE OF THE RESEARCH

Since the first time that the concept of maritime safety was conceived and since the impact of human factor was recognized, many researches have been conducted. There was an increase in the research interest of this field, simultaneously with the increase of the maritime transportation over the years.

For conducting this synthesis of relevant literature, over 15 academic articles which have been published in high quality journals were used. Segments from 5 academic books were utilized, to strengthen the facts presented. Additionally, at least 20 papers were identified which examined the safety on the maritime sector and the impact of human factor on maritime accidents.

For the last part of this thesis, the official accident reports were used, for each one of the six cases included. Everything that is known about these accidents is in these reports, and after careful examination of them, the most important parts were selected, to reveal the bigger picture, which is the importance of the human factor in the majority of accidents.

CHAPTER 3: HUMAN FACTOR

Over the past century, the shipping industry has made some major improvements in the structure and reliability of vessels, in order to minimize casualties and maximize efficiency and productivity. There have been some significant breakthroughs in hull design, propulsion systems and navigational equipment along with the constant evolution of technology. However, despite of all these improvements, the casualty rate in the shipping industry is still considered to be high. The reason is that the maritime system is a people system and human errors are the main cause of accidents. Studies have shown that about 75-96% of casualties are caused, either partly or entirely, by some form of human error. Thus, the human factor plays a crucial role in almost every activity of a vessel and it is the key to reducing the number of accidents. In this chapter, the legislation regarding the human factor will be analyzed along with its role and accidents that took place because of human error will be presented.

3.1 LEGISLATION

3.1.1 SAFETY OF LIFE AT SEA (SOLAS)

The International Convention for the Safety of Life at Sea (SOLAS) is the most important international maritime treaties regarding the safety of merchant ships. It was first established in 1914, following the disastrous events of the Titanic and later it was revised in 1929, 1948, 1960, leading to the final version of 1974 which is being constantly updated ever since. It includes a variety of regulations which deal with safety precautions and procedures in every possible aspect, including both the construction of the ship and emergency situations. It is consisted of 14 chapters which specify the minimum standards for the operation of the vessel.

According to the IMO, the first chapter provides the general provisions, which include regulations concerning the survey of the ships. The second chapter is divided into two parts, the construction part and the provisions in case of fire part. Chapter three is about life-saving appliances and arrangements and chapters four and five emphasize on radiocommunications and safety of navigation, respectively. The sixth chapter describes the carriage of goods for all types of cargo and the seventh chapter focuses on the carriage of dangerous goods. The eighth chapter presents the basic requirements for nuclear-powered ships and the possible radiation hazards. Chapter nine focuses on the management for the safe operation of ships along with safety management system that needs to be established by each shipping company. The tenth chapter of SOLAS Convention, makes mandatory the International Code of Safety for High-Speed Craft (HSC Code). Chapters twelve and thirteen include the additional safety measures for bulk carriers and the verification of compliance, respectively. The final chapter of the convention made mandatory from 2017, the International Code for Ships Operating in Polar Waters.

3.1.2 STANDARDS OF TRAINING, CERTIFICATION AND WATCHKEEPING FOR SEAFARERS (STCW)

The International Convention on Standards of Training, Certification and Watchkeeping (STCW) for Seafarers was adopted in 1978 at the International Maritime Organization (IMO) in London and entered into force in 1984. Generally, it applies to seafarers, ship-owners and training establishments and aims at creating a series of standards for the safe keeping of the environment and the oceans. The STCW 1978 sets strict qualification standards for the on-board crew of every merchant vessel. This convention has been amended two times, at 1995 and at 2010.

On 7 July 1995, the International Maritime Organization adopted a comprehensive revision of STCW, which also included a proposal to create a new STCW Code which would include the technical details associated with provisions of the Convention. The new amendments entered into force on 1 February 1997 and by the end of February of 2002, full implementation was required (Christodouloulou, et al, 2007). Seafarers who already had the certification, could just renew their certificates so as to be in accordance with the new changes, while those who entered training programs after the 1st of August 1998 were required to meet the standards of the new amendments. The most memorable amendments of the 1995 revision concerned the enhancement of port state control, the communication of information to IMO, the quality of standards systems, the oversight of training and the certification procedures.

The IMO Convention on Standards of Training Certification and Watchkeeping of Seafarers adopted a new set of amendments in Manila in 2010 called "The Manila Amendments". These amendments were necessary to keep training standards in line with new technological and operational requirements that require new shipboard competencies. By the end of 2017, all seafarers should have been certified and trained according to the new standards. According to the International Maritime Organization, the most significant amendments concerned the new rest hours for seafarers, the new and updated training, the obligatory training in modern technology systems, the mandatory safety training, the additional medical standards and the set of specific alcohol limits in blood or breath.

The STCW Convention consists of three sections. The first section is the articles, which outline the legal responsibilities that every party is obliged to meet. The second section is the annex, which gives some technical details about how the legal responsibilities that are mentioned in the articles should be met by each party. The last section is the STCW Code which analyzes in-depth the technical details that were previously mentioned and are contained in the annex. The Code is separated into two parts, the part A which has the mandatory standards of training, certification and watchkeeping and the part B which has the recommended guidelines for the proper training, certification and watchkeeping. A copy of the STCW Code is always kept on-board of all sea-going merchant vessels.

3.1.3 MARITIME LABOUR CONVENTION (MLC)

The Maritime Labour Convention (MLC) was adopted on 23 February 2006 at the 94th session of International Labour Convention (ILC) of the International Labour Organization (ILO). It clearly sets the minimum requirements for nearly every aspect of working and living conditions for over 1.2 million seafarers, including recruitment practices, conditions of employment, working hours, resting hours, annual days of leave, accommodation, health protection, payment of wages and others. MLC is deemed to be essential in order to maintain the high reputation of the maritime industry. On the basis of the Maritime Labour Convention, the Seafarer's Employment Contract is implemented. According to the International Labour Organization, the Maritime Labour Convention became obligatory for 30 countries in 2013 and by the end of December 2020, 97 countries had ratified the MLC, which has resulted in more than 91% of the world's shipping fleet being regulated. The COVID-19 pandemic, forced the Maritime Labour Convention to make some amendments so as to keep up with the latest developments. MLC is similar to the other statutory certifications abovementioned, like ISM and ISPS and its certificate has 5 years of validity with initial, interim and intermediate surveys. Moreover, according to the Convention, the ship owners are required to submit a Declaration of Maritime Labour Compliance (DMLC) to their respective flag states which consist a party to the convention and the flag states issue the MLC Certificate to the fleet, which is posted at a noticeable place onboard of every vessel.

The Convention is consisted of 16 articles containing general provisions as well as the Code. The Code is made of 5 Titles in which specific provisions are grouped by standard. The first title is about the minimum requirements for seafarers to work on a ship and the second analyzes the conditions of employment. The third Title focuses on accommodation, recreation facilities, food and catering, while the fourth is about health protection, medical care, welfare and social security protection. The fifth and last Title describes the general compliance and enforcement. Each Title is bound to regulations, which are mentioned throughout the Maritime Labour Convention as Standards or as Guidelines and both should be fully implemented. However, there has been established a perception where only Standards are mandatory and Guidelines are usually not followed.

Some seafarers criticize the Maritime Labour Convention, saying that it lacks teeth, does not address real issues. The more important parts of the convention have been placed in the non-mandatory section "B"; other issues, such as air conditioning or interpretations of what could be termed as good nutritious food, are not addressed by the convention. Some seafarers have complained that the convention does not carry any stipulations to make the crew cabins on cargo ships any bigger than they currently are and does not increase the number of cupboards or shelves, which are typically minimal on cargo ships. The convention also does not address the issues of rest hours during work or rest when joining ship; these issues are determined by crew and companies alone (Lavelle, 2014).

3.1.4 CREW COMPETENCE

Competence can be described as a mix of skills, qualifications and knowledge that gives a person the ability to work as a part of a team or, when it comes to the maritime sector, a crew. According to a study that was conducted by the Seafarer's International Research Centre (SIRC) at the late 90’s, a lack of crew competence is a problem which is getting worse and worse. Proficiency in English is definitely one clear example. This was highly noticed from the frequency of pilots using sign language when communicating with the crew. The use of sign language in the pilot-crew communication was high in both single national crews where English was not spoken and in multi-national crews where English skills were not very good (Lane 1999).

The Seafarer's International Research Centre defines crew competence as “uniform standard of the provision of high-quality training and education opportunities and to be as least as important as professional training”. It focuses on the importance of the so called “silent” knowledge comprising unwritten roles and attitudes of the seafaring culture. Moreover, competence is a combination of technical and social skill and a place where terminology and vocabulary are taken for granted (Lane 1999). By summing up all the above mentioned, it could be said that competence is equal to education plus experience. According to Ding & Liang (2005), competence includes knowledge, skills and understanding in terms of communication, with emphasis on issues such as fluency in English. Competence can also mean physical and psychological attitudes, including attitudes concerning the seagoing safety and the health protocols. Competence and cost are considered to be the two most important factors when it is time to recruit seafarers. It is a common thing that the shipowners want labor that it will come as cheap as possible, with the risk that they are not sufficiently educated and trained (Ding & Liang 2005).

3.2 ROLE OF HUMAN FACTOR

As far as maritime safety is concerned, the term human element or human factor plays a crucial role. There is no established international definition of the term, but according to IMO (2004a), it is defined as a “complex issue affecting marine safety and security”. It involves activities done by the ships’ crews, port operators and authorities among others. This also makes the human element an important factor in ship design and operation. For example, a poorly designed ship or a system where the crew is tired or unaware of cultural differences contributes to the safety of the operation of the ship (IMO 2010).

3.2.1 CULTURAL FACTORS AS A MATTER OF SAFETY

Culture can be described as a combination of ideas, customs and social behavior of a group of people or a society. The shipping culture consists of habits, traditions and terminology that are widely used until nowadays. Cultural issues are not to be undermined when, for example, implementing new safety concepts, since many habits and traditions are adopted by younger seafarers from old seamen. Very often new restrictions and codes do not have common grounds with old habits and as a result, they are hard to implement on board. Culture is also a subject of change, for example the old habits of alcohol abuse at sea has today almost totally vanished (Ala-Pöllänen 2012).

National culture has significant importance in explaining the occurrence of human errors on ships (Lu et al, 2012). They underline that the dimensions of national culture are closely linked to human failures that occur in ship operations. Lu et al (2012) studied the impact of national culture on work safety on board tankers by comparing the beliefs of seafarers from different national cultures in a questionnaire to seafarers. They used the theory of cultural dimensions which suggests that there are five elements that have the ability to affect the intercultural cooperation and therefore the maritime safety, which is extremely important. These are Power Distance, Collectivism, Uncertainty Avoidance, Masculinity and Confucian Dynamism, also known as long term orientation.

Power distance is the way that the members of an organization or institution will accept the distribution of power. For instance, people who come from countries with low power distance relations are more consultative and democratic in contrast to people from high power distance cultures, who are more respectful of authority and less effective without orders coming from their supervisors. Collectivism is the way that people are treated in a group. In cultures with high sense of collectivism, all people feel strongly committed to the group and put the group above of everything else. Uncertainty Avoidance is the ability of the society to tolerate changes that occur. People from countries which have high levels of uncertainty avoidance, put an effort to avoid the unknown by trying to predict changes as early as possible and by implementing rules and restrictions to cope with them. On the other hand, people from societies with low uncertainty avoidance are comfortable in changing situations and they try to have as few rules as possible, while simultaneously are more tolerant of change. Long term orientation is defined as society's attitudes towards time. People who have a low level of orientation, tend to show higher appreciation towards the future and they are considered to be careful, hardworking and ambiguous, while those with a higher level of long-term orientation are grateful of tradition.

There is evidence that lower levels of masculinity can lead to a safer working environment. Lu et al (2012) assume that the higher the masculinity level in a culture, the higher the probability of human failures. Factors such as avoiding humiliation and respect for social status are considered to have a negative impact to work safety. The seafarers who are motivated to look to the future are thought to be safer as operators compared to those who are afraid of losing their face. Lower power distance and Collectivism as experienced by seafarers, aids in reducing human failures in shipping operations.

Grøn & Knudsen (2011) present the concept of social cultural structure on board of a ship and use the theory of cultural dimensions to their support. When it comes to compare Norwegians and Filipinos crews, the problem of cultural differences arises. Norwegians see work as a value and highlight individualism, in contrast to Filipinos, who come from a highly collectivistic culture and see work as a means to support their family and their community, which leads to fewer risks from them, in comparison to other nationalities. Grøn & Knudsen 2011 state that Filipino seafarers encounter fewer accidents than Danes.

Hansen et al (2008) focused on the on-board occurrence of accidents and illnesses of various nationalities by comparing Filipinos with Danes. It was discovered that Filipinos can face way more less occupational accidents than Danish seafarers. Moreover, notable differences in the physical abilities of the two groups were noted. The Danes, for instance, are usually overweight, which can lead to many back problems. It was concluded that a seafarer from the Philippines is facing a greater risk of losing his job because of an accident on board and for that reason he might be willing to avoid potential risk situations to a greater extent than his Danish colleague.

Theotokas & Progoulaki (2007) studied the extent of how well Greek seafarers interact with crews who originate from different nationalities. They discovered that as far as the Greeks are concerned, it is way more difficult to cooperate with people who come from cultures which have a power distance lower than their own, Russians for example, purely because they think that they could question their position and behavior. It is also clear that when all crew members participate in the decision making and a flexible leadership management exists, the crew members can work more adequately and be more effective. The Greeks also faced problems with communication, language and religion. The study that was conducted, indicated that mixed crews can be a potential threat.

Filipinos have the tendency to not want to work with fully Filipino crews because of nepotism and favoritism that exist towards relatives, which on board ships means favoring seafarers from the same region. Additionally, it is proven that working with persons from various cultures can increase safety, as it has the ability to create a social distance, tolerance and respect among people from different nationalities and makes it extremely viable to form professional relationships on board. Some crew members also noted that a multinational crew increased cultural understanding and racial tolerance (Sampson & Zhao 2003).

The main problem that arises with a multicultural crew is according to Horck (2010, 2006) the diverse background of the seafarers and the fact that the crews usually do not know each other in advance and are therefore not able to work as a team very fast. A good and easy solution to increase maritime safety would be to introduce more social activities on board as well as make longer contracts with the crews, according to Horck (2010). In situations like the previous ones, the leader should act differently than in a crew where everybody comes from same or close cultural backgrounds. In order to achieve a proper and effecive multicultural environment on board, the maritime industry has to adopt even stronger leadership and a more developed culture of teamwork (Horck 2010).

3.2.2 HUMAN FACTOR

The human element is the most unpredictable factor; given that everyone has different behavior and understanding, people's capability to deal safely and effectively with the complexity, pressures, workload or difficulty of the daily tasks, not only in emergency situations but also during daily routine, can differ. Human factor is about people and their interaction with their environment, especially during their working hours. Human factors are affected by the person, the job, the organization and the management. Those four elements combined, determine the behavior of people. Applying human factors into the design and operation of a vessel or its systems means taking into consideration human capabilities, skills, limitations and needs.

The term "human factors" is also used to describe the characteristics of a person, which are the physical, the physiological and the behavioral ones. The physical characteristics refer to attributes of the human body like height and weight. The physiological characteristics are about the muscle strength, the endurance, the visual acuity and others. Lastly, behavioral characteristics include the capabilities of memorizing and mental reaction time to a variety of stimuli.

Undoubtedly, maritime activity is a risky activity and history has proved that the majority of maritime disasters that took place through the years, are due to the complex environment of the ship. Caridis (1999) stated that despite the significant advances that have been achieved in recent years in the field of marine technology, the number of maritime accidents that occur on a worldwide basis has not reduced significantly. As it has been proved in several studies, the majority of maritime accidents are related to human factors. Moreton (1997) talked about the wrong tendency to think that these new and improved technologies and rules can counteract the human limits increasing safety at sea. There is an agreement that the key means of lessen the human element contribution to accidents will be via safety management which will include inspection and training (Thematic Network for Safety Assessment of Waterborne Transport, 2003).

3.2.3 WELFARE OF SEAFARERS

Over the years, the number of crew on each cargo ship has been remarkably reduced and a global labor market of seafarers has been established (Chaumette, 2016). Stricter rules and regulations to ensure the safety onboard and the safety of environment have been applied and this has resulted to increased work for the crew of the vessel. Among a variety of issues within the human element, fatigue is one of the most critical. The International Maritime Organization is heavily concerned about this, as shown in the 2019 Guidelines on Fatigue, adopted by its Maritime Safety Committee. These guidelines refer to the minimum hours of rest and the maximum hours of work for every seafarer. The role of crews on the bridge has changed in terms of advances in technology and in the way of manning ships due to the employment of multinational crews (The Nautical Institute, 2015). This makes the impact of seafarers in the maritime safety system evident.

In times when fatigue is increasing, the safety of the vessel is maximized and accidents are more likely to occur (Hetherington et al, 2006). Accidents like the Herald of Free Enterprise in 1987 and Exxon Valdez in 1989 revealed that the fatigue is considered as one of the most critical contributors to maritime disasters and a main concern for maritime safety. IMO's response to the fatigue of seafarers was the inclusion of "fitness for duty" provisions in the 1995 amendments to the 1978 International Convention on Standards of Training, Certification and Watchkeeping for Seafarers. From that point onwards, it was required that watchkeepers should have at least 10 hours per day to rest. McCallum (1996) stated that fatigue was a contributor to 16% of the critical vessel casualties and 33% of the personnel injury casualties. The International Labor Organization contributed to the rest of the seafarers, with the adoption of the 1996 Convention on Seafarers' Hours of Work and the Manning of Ships. They were established specific daily and weekly limitations on hours of work and daily minimum rest periods in order to prevent fatigue caused from excessive work.

Pauksztat (2017) conducted research, asking seafarers the causes of their fatigue. They responded that long working hours, inadequate manning levels and poor sleep quality combined with commercial pressure were the main reasons of fatigue. Moreover, they underlined the significant working time differences at sea and in the port area. At sea, they estimated working between 8 and 11 hours per day, while at port between 12 and 15 hours per day. Many seafarers expressed complaints about receiving limited support from companies. Fear of reprisal or criticism prevents seafarers from communicating with the on-shore personnel about their rest hours and the violations that they suffer. Seafarers, communicate their concerns via email, phone or directly to company representatives during ship visits or audits. However, seafarers have reported that the feedback they received was not what they expected and that no actual improvements were made, on the company's side.

The Covid-19 pandemic led to a crew crisis and put a firm spotlight on seafarer mental health, since many seafarers were unable to return to shore for way more months than originally expected, thus resulting in serious mental problems, depression and anxiety coming to the fore. Unfortunately, the Covid-19 pandemic clearly showed that the Maritime Labor Convention is not always applicable. Throughout this period, many companies have ignored multiple times the obligations set by the MLC, while at the same time seafarers have been requested to remain strictly professional and oblige to the rules. Although it remains unknown at the time, when this pandemic will end, it goes without saying that it will take a lot more time for things to go back to normal.

3.2.4 CHALLENGES FACING THE MARITIME INDUSTRY

It is widely considered that shipping is the primary and major force driving global trade growth, a fact that was firmly confirmed by the Covid-19 pandemic. About 70% to 90% of the traded materials around the globe, are transported via merchant vessels, proving their importance. However, there are certain threats and dangers that pose to the smooth function of the maritime industry, affecting all parties concerned, from workers within the industry to global markets.

First of all, safety at sea is always a factor that poses a constant threat to the maritime industry, due to its dynamic nature. 2020 was one of the most tough periods of all time for seafarers due to the Covid-19 pandemic, since a huge proportion of them were forced to remain at sea for way longer time than expected. However, going into 2021 with the development of the vaccine and its mass production and use, things were a bit stabilized but still there is a long way to go back to normality.

Moreover, the shipping industry has always been targeted by cybercriminals and latest cyberattacks on organizations like Google, should make the maritime sector more vigilant towards cyber-attacks. Considering the damaging effect that such an attack could have on crew safety and operations, International Maritime Organization will implement new safety rules and will make compulsory to add cyber risks into the Safety Management Systems on every vessel.

CHAPTER 4: HUMAN ERROR ON MARITIME ACCIDENTS

4.1 DEFINITION OF HUMAN ERROR

Over the years, the shipping industry has put a great effort on improving vessels, making them more reliable and secure, in order to reduce accidents and increase their efficiency. However, the rate of maritime accidents is still considered to be high. The main reason is that ship structure is a relatively small part of the safety equation, since the maritime cluster is all about its people and as a result human error will be on top of the list of the causes of accidents. It has been estimated that about 75-96% of maritime accidents are caused, either entirely or partly, by human error. Studies concerning the subject of human error in the maritime industry have shown that it contributes to 84-88% of tanker accidents (Transportation Safety Board of Canada, 1994), 79% of towing vessel groundings (Cormier, 1994), 89-96% of collisions, (UK P&I Club, 1992) 75% of allisions (Bryant, 1991) and 75% of fires and explosions (Bryant, 1991).

Human error is defined as a result or effect of human actions, the causal factor of an accident, deliberate violation, and the actual action taken by a human being as mentioned by Hansen (2007). In general, researchers rarely agree on either a specific definition or how to prevent human error. According to Hansen (2007), any action done by a person unintentionally refers to human error. In addition, Toffoli et al. (2005) state that once this error has occurred, it started from bad to worse and led to a major accident. Therefore, it is crucial to eliminate the human error which could assist to reduce the number of marine accidents.

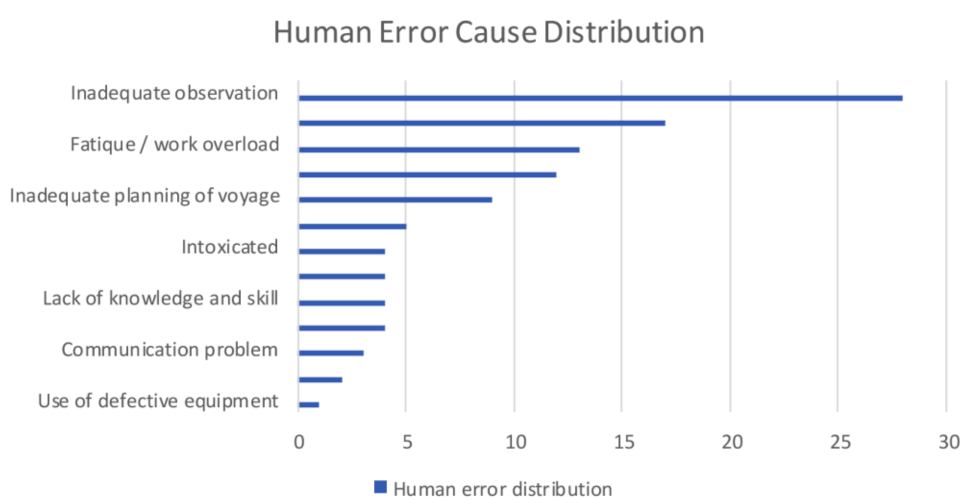

Table 4.1: Human error cause distribution (source: STCW, 2011)

A way to identify the types of human errors that occur in the maritime cluster is to study each accident separately and track down how each one of them happened. Accidents usually happen after a chain of mistakes and errors and not after a single mishandling. So, in order to examine the proper causes of an accident, the first mistake in the chain previously mentioned, must be found. Wagenaar and Groeneweg in 1987 studied a total of 100 maritime accidents and found that human error contributed to 96 of them and in every one of the 96, the number of human errors varied from 7 to 58. In the majority of these 100 cases, everything was starting from minor, inconspicuous mistakes but at the point that all these mistakes were merged, then disastrous events were caused. In 93 of the accidents, two or more people made mistakes, each one separately from the other. The intriguing point of this study is the fact that every human error that took place was a necessary condition for the accident. In other words, if just a single error had not happened, the chain of events would have been altered in a way that the accident would have never occurred. Therefore, the conclusion of this study was that if it is managed to track down these small human errors, it is possible to increase the probability of a safer maritime industry.

Assuming that the safe operating procedures are well established and understood to the whole crew of a vessel, any deviation would bring the violator face to face with increased danger and risk. Each violation leads onto the next one, increasing the subsequent errors and resulting into higher chances of injury, death or damage. Factors that have led to non-complying attitudes are the nature of the workplace, the quality of tools and equipment, the “blind eye” approach of the supervisors to get the job done and the absence of the organizations’ safety culture. The unsafe acts committed by operators, usually are separated into two types, errors and violations. The basic error forms are the decision errors, which represent the actions of individuals who made the wrong choice, maybe because of lack of knowledge, the skill-based errors which are made due to lack of attention or not a thorough thought and lastly the perceptual errors, which are errors that can happen when someone on the crew is extremely tired and can have visual illusions or spatial disorientation. Violations can be defined as the willful departure from authority and are separated into routine violations, meaning that they are a part of a person’s behavior and exceptional violations, which appear like isolated departures from authority, without being necessarily a behavior pattern of an individual (Hanzu et al, 2008).

It would be wrong to completely think that errors are solely an individual's work. In many cases, the work is done in teams, meaning multiple persons. Team error can be categorized as a form of human error. The main difference is that team error considers how a group of people made human errors when they work in a team or a group. Team errors can be categorized into three types, mistakes, lapses and slips. Mistakes and lapses occur in the planning and thinking process, contrary to the slips which emerge out of the execution process. Slips can be defined as errors in the action process of a single individual and are usually separated from the activities of the team.

There are three factors that are the main reasons of human errors, fatigue, communication, and lack of technical knowledge. According to Sharma et al. (2013), fatigue is considered to be the most common factor for seafarers in various surveys and studies. In a study conducted, concerning critical vessel casualties and personal injuries, it was concluded that fatigue contributed to 16% of vessel casualties and 33% of injuries. Fatigue can be presented due to poor health and underperformance. In addition, Hanzu-Pazara et al. (2008) stated that fatigue is considered to be the root cause of the human error. Moreover, Oluseye and Ogunseye (2016) agree that fatigue can contribute to maritime accidents as human error and leads to the high frequency of maritime accidents.

Hanzu-Pazara et al. (2008) underline that poor communication can exist due to language barriers, unfamiliar terminology, background noise, or failure to speak distinctly. All these can ultimately lead to misunderstanding, mistakes and maritime accidents. Good communication is indisputably vital among all members of a vessel. By improving procedures and training better communication and coordination can be achieved both on board and on shore. In addition, Sharma et al. (2013) state that inadequate communication is enough to cause accidents during duty on the ship. Moreover, Oluseye and Ogunseye (2016) underline that poor communication at every work area is one of the human errors which cannot be avoided and will be the cause of marine accidents sooner or later. Apostol-Mates and Barbu (2016) found out that the causes of the accidents are based on the type of breakdowns and are categorized in four types such as: (1) problems related to multicultural crews, such as Bunga Teratai Satu accident, the Sally Maersk death, and the Scandinavian Star accident; (2) problems related to communication failure due to different cultural background between the crews and the pilot, such as the Bright Field accident; (3) problems related to miscommunication among crew members and passengers on passenger's vessels such as the

Skagerak accident, and the Scandinavian Star accident; and (4) problems related to the usage of different languages with respect to external communication, and VHF communication with other vessels, such as the Royal Majesty accident.

Hanzu-Pazara et al. (2008), stated that inadequate general technical knowledge is to be blamed for 35% of casualties. The main reason behind this is the inadequate training and insufficient development. In many occasions, seafarers cannot understand how the automation works or under what set of operating conditions it is designed to work effectively, such as radars. The outcome of this unpleasant situation is that seafarers sometimes make errors while using the equipment or depend on a specific piece of equipment instead of getting necessary information from the other sources.

4.2 SIMULATION AS A WAY TO COUNTERACT HUMAN ERRORS

The maritime sector as a whole is put into difficult times each time an accident occurs and one of the problems arising in these situations is the costs associated to this unfortunate event. It is an undisputed fact that human error is the reason behind many accidents and many costs that come with them. In order to help the maritime sector be sustainable in the long run, the impact of human error should be mitigated and crisis management capability should be improved. Simulation processes are a great tool to ensure that all the above-mentioned things will be taken care of and finally reduce the accident rate.

The use of simulation in providing solutions to the problems of risk and crisis management and the optimal use of crew resources has a long-established pedigree in maritime training (Barnett et al 2002). The first simulators were consisted of real radars with simulated signals. There was the opportunity to learn what is needed for radars, either as an individual or as a team, under the guidance of an experienced instructor who would work at a separate master console. Bridge simulators with a nocturnal visual scene also appeared and facilitated teams into conducting simulated passages in an extremely realistic environment but with only a few lights available as indicators for other vessels and shore lights. Simulator-based training courses were introduced primarily to train the skills of passage planning and the importance of the relationship between Master and Pilot (Hensen H., 1999). This type of training was developed into the Bridge Team Management courses, that take place today on many simulators around the globe, and are the basis for training in other industries, such as aviation. Many types of simulators such as bridge, engine and cargo control room are released for Personal Computers and combined with the evolution of technology, they present an extremely realistic environment to train.

Simulation is proposed to replace sea trials, a known method of investigating human performance issues, which is considered not to be one of the best methods though, for a variety of reasons. First of all, crisis events cannot be replicated in real time securely. Secondly, there is a certain limit to the number of the people that can take place in a sea trial, thus making it difficult to extract correct results from the trials. Last but not least, it is difficult to control variables in sea trials, an issue that causes a very difficult process of identifying cause-and-effect relationship for the investigators.

The detection and correction of error, along with the management of crisis are the last issues in the human error chain. At the present time, the simulators available are used to train crews on how to detect and correct possible errors, in time. As far as crisis management is concerned, simulators have still a long way to go until they are considered to be one hundred percent effective and adequate. Moreover, the scope and amount of simulator-based training in crisis management needs to be increased and accidents like a spillage of oil or a simple distress incident, are needed to be incorporated into simulation training programs (Hanzu et al, 2008).

Other sectors such as military and aviation provide useful lessons to maritime simulation and the biggest one is that simulation has a much wider application than training in the reduction of human error. It is generally accepted that maritime sector has not yet adopted the simulation process to the same extent as other sectors. A simple example of the utility of simulation process would be through a mission rehearsal. This process could aid the evaluation of the impact of a new technology on human performance, thus resulting in improved design, better contingency plans and better chances on reducing human error.

4.3 ACCIDENTS IN THE MARITIME SECTOR

A common feature of all serious maritime accidents is their large extent of the consequences they have. It would be good to define what exactly the term nautical accident means. According to the New Zealand Maritime Transport Act 1994 (Lehr, 2018), a maritime accident is defined as an event involving a ship in which:

A ship suffers severe damage or structural failure when (Suraj Bhan et al., 2013):

- Significantly affects its performance or even its buoyancy.
- requires large-scale repairs or even replacements of parts.
- the safety of occupants is threatened.
- causes partial or total collapse of the mechanical equipment that affects its airworthiness.
- there is a loss or destruction or partial displacement or change of physical form of the cargo of the ship which may pose a threat to the safety of the ship or other adjacent ships.
- there is destruction of assets (not related to cargo) that either concern the ship itself or its occupants and crew.

Causes loss or leakage of any chemical (gaseous, liquid or solid), which can cause:

- personal injury,
- damage to the ship in question or to other adjacent ships
- damage to any asset (whether inside the ship or besides).
- abandonment of the ship, extensive fire within its premises or even its overthrow.

As can be seen from the above analysis, a shipping accident has many different forms and the damage caused can harm both the human lives and the environment. This is a matter of concern for both shipping and insurance companies, which have to face the unpleasant situation to pay for losses, sometimes more often that could be expected. That is why in recent decades more research has taken place with the aim of finding and analyzing factors causing maritime accidents, as well as finding solutions to address them (Zheng et al., 2016).

According to the existing literature, the largest percentage of maritime accidents are caused by various forms of human error, which often lead to disastrous results. Based to the information provided, it is estimated that the rate of maritime accidents due to human error can reach up to 80%. This is evidenced by the fact that although in the last forty years shipping companies have minimized the chances of causing an accident due to mechanical damage by improving the shipbuilding structures (better design, airworthiness systems) but also improve the reliability of their mechanical parts, accidents remain frequent and with a large number of losses (Lehr, 2018). This is mainly due to the fact that the involvement of the human factor in the process of operating ships is significant, resulting in the likelihood of an accident increasing rapidly.

Shipping companies should focus on finding mechanisms that can minimize the human errors. But it is also a fact that the human factor is involved in almost all the functions of a ship, making it difficult to limit them.

4.4 MARITIME ACCIDENTS DUE TO HUMAN ERROR

4.4.1 M/V SANTA CRUZ II AND USCGC CUYAHOGA

During the night of the 20th October 1978, the U.S. Coast Guard Cutter CUYAHOGA and the Argentinian general cargo vessel SANTA CRUZ II collided in Chesapeake Bay near the Potomac River. The CUYAHOGA was struck on the starboard side and was pushed by the SANTA CRUZ II for almost a minute. As a result, she flooded rapidly and sank in approximately two minutes, resulting in the loss of eleven persons. Eighteen crew members of the CUYAHOGA were rescued by the crew of SANTA CRUZ II. The proximate cause of the accident was that the commanding officer of the USCGC CUYAHOGA failed to properly identify the navigation lights of the M/V SANTA CRUZ II. As a result, he did not comprehend that the vessels were in a collision course and altered the CUYAHOGA's course to port taking his vessel into the path of the SANTA CRUZ II.

In this accident there were two primary errors that were made. The first one was on the CUYAHOGA's captain who failed to understand the lights of the SANTA CRUZ II and misperceived its size and heading. The second error was on the part of the crew. They all realized what was going on but failed to inform or question the captain. They thought that they were on the same page with the captain and that he had a good reason for ordering the turn of the vessel, so they did not interfere at any point. It also needs to be stated that the vessel was undermanned, thus resulting in fatigue and excessive workload, a fact that could have impacted the decisions of both the captain and his crew.

4.4.2 EXXON VALDEZ

On March 24, 1989, the Exxon Valdez tanker ran aground on the Blight Reef at Prince William Strait in Alaska. It took just a few minutes to drill a large hole in the tanker's single hull and pour about 40,000 tons (11 million gallons) of crude oil into the virgin waters. The inconceivable accident was the worst ever in American history. It destroyed more than 1,300 miles of coastline, disrupting the living conditions of local people and killing hundreds of thousands of birds and marine animals.

Exxon Valdez came face to face with icebergs and the captain Hazelwood ordered to drive the Exxon Valdez out of it predetermined navigation line to avoid icebergs and go around them. He then handed over control of the steering wheel to the third assistant Gregory Cousins with precise instructions, to put the tanker back on track of when the tanker reaches a certain point. For reasons that remain vaguely, the crew failed to get the boat back on track lines and eventually it collided with the sharp dry reefs of Bly on 12:04 a.m., March 24, 1989. The National Transportation Safety Board investigated the accident and rated five possible causes of grounding:

- The 3rd mate could not maneuver the ship, probably due to fatigue and excessive workload.
- The captain probably failed to properly supervise the navigation affected by alcohol consumption.
- The shipping company EXXON failed to control the captain and to man the ship with a capable and relaxed crew.
- The U.S. Coast Guard failed to provide an effective ship traffic management system in the area.

The auxiliary services but also the ability of the pilots was not the best possible. It all happened when the ship's captain, Joseph J. Hazelwood, left the bridge at a critical moment. Hazelwood had drunk five double vodkas on the night of the disaster, according to witnesses, and abandoned the rudder, leaving it in the hands of a third officer, Gregory Cousins, who, however, had neither the experience nor the required diploma. The leak managed to be stopped after a few days, but it was already too late.

4.4.3 PRESTIGE

On 13 November 2002, the 77,000dwt Prestige tanker, 26-year-old Bahamas flag suffered a large rupture on its right side, off the coast of Spain. The captain fought with the waves for six days and in collaboration with rescue crews tried to save the ship. On the other hand, the Spanish authorities never allowed the Prestige to sail to a safe haven. The Spanish authorities removed its crew in addition to the master and two other crew members, who remained on the ship waiting for the help of rescue workers. Meanwhile the master of the ship asked to sail to a nearby port of refuge to avoid not only the sinking of the ship but also the great ecological disaster that could happen. After the refusal of the Spanish authorities to grant a port of refuge, the ship, with assistance tugs moved off the coast about 130 miles. There the ship after six days, on November 19, and under adverse weather conditions broke in two and sank causing one of the greatest ecological disasters of the century (Montero, 2003).

Thousands of tons of oil and especially fuel oil were spilled into the sea infecting the Spanish, Portuguese and French coasts creating a particularly big oil spill. It is estimated that about 20,000 tons of cargo sank along with the ship, while the rest of the cargo polluted the sea ecosystem (Montero, 2003).

The ship belonged to the ship-owning company Mare Shipping Inc based in Liberia, while the management company was Universe Maritime Ltd. Based in Greece. The ship was registered as ABS (American Bureau of Shipping), while the last general inspection took place in April 2001. The last annual inspection took place in Dubai in May 2002, a few months before the tragedy accident (Lennon et al., 2003).

The ship was detained by port authorities for port state control at six ports over a period of one year, namely the ports of Port Hawksbury, Long Island (US) -2 times, New York, Baltimore, Rotterdam, but without deficiencies and reasons for booking the ship (Lennon et al., 2003). The Greek captain of the ship was sentenced to 12 years in prison in 2002 but remained in prison for three months and was released on bail.

4.4.4 SEA DIAMOND

At noon on Holy Thursday, April 5, 2007, the cruise ship "Sea Diamond" of the company Louis Hellenic-Cruises departed from the port of Heraklion, Crete to Santorini. The massive ship with a capacity of 22,412 tons carried 1,163 passengers and 390 crew members (Giakoumatos and Kalogirou, 2020).

It was just an hour after his departure when one of the ship's four engines malfunctioned and he was soon shut down. The journey continued for another three hours with only the three engines running, until an attempt was made to restart the now repaired engine (Giakoumatos and Kalogirou, 2020).

It should be noted that throughout the intervening period, the ship's management did not provide any information about the damage to any competent body, which according to the law should be aware of the fact and carry out an inspection of the ship before it is found safe to continue its course. When the fourth engine was put back into operation, the ship was already in the Caldera of Santorini, but began to deviate uncontrollably from its intended course, until it was found colliding with its right side on the cliffs and water began to enter through the vessel. Thousands of eyewitnesses, residents and visitors of the island, were surprised to see for the first time a huge cruise ship reach so close to the reef (O' Brien, 2010).

The master ordered the closure of the 19 watertight doors of the ship, which had remained open during the voyage, in violation of the safety protocol, but this was no longer possible. Short-circuit explosions began to occur in the electrical control systems of the engine and soon a fire broke out (Gidarakos, 2011). Additional problems with other safety systems prevented the pumps from operating and water continued to fill the ship. After being driven quickly to the bay of Fira, the engines stopped permanently and the huge cruise ship was left unmanned, now counting down to its sinking (Gidarakos, 2011).

For half an hour the port of Thera was trying to contact the captain via VHF without getting a response and was informed about the collision about 20 minutes late. The massive ship had taken a steep incline and was ordered to evacuate, when private boats and fishermen of the island rushed to the spot first to help the trapped passengers (Giakoumatos and Kalogirou, 2020).

The vessel finally sank around 7 am the next day, April 6, 2007. It is reported that the tugs did not have the required cooperation that they were looking for from the master and crew of Sea Diamond and various questions are raised about the rescue conditions of the ship and from the side of the ship-owning company (O' Brien, 2010).

The ship-owning company, Louis Hellenic Cruises, had to send in time from the time of the collision the appropriate tugs in force to prevent the sinking of the ship, while at the same time it had to conclude a timely contract with a specialized lifeguard company. But none of this happened and, as many believe, perhaps deliberately.

Two rescue companies from nearby areas started on their own initiative to send lifeboats to the spot, but were repulsed by the ship-owning company and returned. The company finally formally asked for help late at night, about 12 hours later, but it seems it was already late (Gidarakos, 2011).

Why from the beginning did the ship's management deal so irresponsibly with the issue of engine failure and later the fatal accident? Why was the operation to tow and rescue the ship so late, contrary to what is provided by the relevant legislation? Who ordered his transfer to the specific area? Why, while there was room for so many hours, was the huge cruise ship allowed to sink? (Gidarakos, 2011). The questions that arise around the whole time of the shipwreck of the Sea Diamond until its sinking are many and the "halves" and confusing answers given by the master, the ship-owning company, but also the Ministry of Shipping intensify the questions and suspicions around the case. Essentially the responsibilities went from one to the other without giving clear explanations (Giakoumatos and Kalogirou, 2020).

The shipowners, for their part, had stated that the master had requested another transfer point and they do not know who gave the order to go elsewhere. Port Authority sources state that the tow was left to the company and the master. The tugs, which tried to help and stayed until the end, found obstacles in their plan, as the stern cable given to them was untied and no one from the crew answered their repeated calls to drop another. It is typically stated that when they tried to communicate, it was as if there was suddenly no soul on the ship, and even the escalators had been pulled up (O’ Brien, 2010).

In July 2009, the Maritime Accident Investigation Board published the official report on the Sea Diamond shipwreck, attributing both the accident and its sinking to the negligence of those responsible (Giakoumatos and Kalogirou, 2020). The collision, the inflow of water, the anarchy, the abandonment, the sinking, the total loss and the existence of two missing passengers, which happened in the Sea Diamond S / C on April 5-6, 2007 in the sea area of the Caldera of the island of Thira Cyclades, are factors of a maritime accident due to negligence. The responsibilities naturally fell to Captain Ioannis Marinos, to the first engineer Emmanuel Patsos and to the three managers of the management company "Core Marine LTD", Christodoulos Mela, Georgios Koumpenas and Zacharia Siokouros (Giakoumatos and Kalogirou, 2020).

The report leaves clear and important implications even for the existence of deceit in this case, since it points out various questions and gaps, to which the testimonies of those involved did not give clear answers. It is reported that the ship was driven very close to the rocky shore following a course that no other ship had followed again, "with serious and obvious risks to its safety", while "basic rules of maritime art and practice" were not followed. According to the report, the master was using an incorrect reef map and the ship's sonar was not working (Gidarakos, 2011).

4.4.5 COSTA CONCORDIA

On January 13, 2012 at 9:45 pm, the Costa Concordia cruise ship crashed into a reef. In the tragic shipwreck 110 were injured and 32 lost their lives. Francesco Schettino, the former captain of the Concordia cruise vessel whose wreckage killed 32 people almost three years ago, said that the wreck could have been avoided if the crew had warned him "30 seconds" earlier. Schettino is charged with multiple homicides, abandonment of the ship and causing environmental damage after the shipwreck on the night of January 13, 2012. The accused, stated that it was the fault of the officers and the crew who were on the bridge on the night of the shipwreck, accusing them of not having given him the necessary information in time. The captain of the Costa Concordia Schettino has received much criticism from the press and even more from experts in the profession, for leaving the vessel before the passengers. But there is an important question that still exists. Would human lives could be saved if he had stayed on the ship's deck? Probably yes, but probably not (Piccinelli and Gubian, 2013).

An accident is the result of many small events and actions that went wrong. It is like a chain that if a link is broken then there is a serious accident. The first fatal mistake was possible in the training and organization of the bridge officers. The captain's job is to give orders and the officers must accept them but also understand them. Understanding is the most important thing. When Captain Schettino ordered the ship to leave the port and set the fateful course, the officer - whether he was a lieutenant or a second lieutenant - would have to check for any dangers such as shallows or anything else. Maneuvering such a large ship offshore is quite dangerous, but imagine how many ships around the world do the same thing every day. Will everything run aground or sink? Of course not. But why did this run aground? (Piccinelli and Gubian, 2013).

The most likely answer is that the officer at the time of the turn was abstract. The captain would have to follow a series of actions, he would have to send a distress signal and he would have to do everything to get the passengers on the lifeboats. It is generally accepted that on such ships, with so many passengers, it is difficult to have complete control. The most critical factor in such a catastrophic event is time (Piccinelli and Gubian, 2013).

4.4.6 TORREY CANYON

In clear and calm weather and at the moment of proceeding through the Scilly Islands, the TORREY CANYON vessel ran aground, spilling 100,000 tons of oil. At least three different human errors are considered to have a contribution to this accident.

The economic pressure, or in other words, the pressure to keep to schedule (pressure exerted on the master by management) took its toll on the grounding. The TORREY CANYON was loaded with cargo and headed for its deep-water terminal in Wales. The shipping agent had contacted the captain to warn him of decreasing tides at Milford Haven, the entrance to the terminal. The captain knew that if he didn’t make the next high tide, he might have to wait as much as five days before the water depth would be sufficient for the ship to enter. Therefore, there was intense anxiety and high levels of pressure under these circumstances for all crew members.

The master himself also made some wrong calls which deteriorated the situation. He decided, in order to save time, to go through the Scilly Islands, instead of around them as originally planned. He made this decision even though he did not have a copy of the Channel Pilot for that area, and even though he was not very familiar with the area.

Finally, and to make matters worse, there was an equipment design error. The steering selector switch was in the wrong position: it had been left on autopilot. Unfortunately, the design of the steering selector unit did not give any indication of its setting at the helm. So, when the captain ordered a turn into the western channel through the Scillies, the helmsman dutifully turned the wheel, but nothing happened. By the time they figured out the problem and got the steering selector back on “manual”, it was too late to make the turn, and the TORREY CANYON ran aground.

4.5 ACCIDENTS IN GREEK SHIPPING

According to the analysis of shipping accidents (Table 1), the most frequent type of accident was that of groundings (49.6%), followed by technical failures with a significant difference of occurrence (28.7%). The other accident types accounted for 21.6% in total and were all individually under 10%. Bulk carriers have suffered most accidents (33.2%), whereas general cargo carriers, tankers and Ro-Pax entered into the accident record at around 20%. In terms of age, the older (>27 years) and mid-aged (9–22 years) ships were involved in most accidents with 38.8% and 31.3%, respectively. The younger vessels (<9 years) suffered the least accidents (9.7%).

Type of Vessel	No.	%	Vessel Age Group (years)	No.	%	Type of Accident	No.	%
GEN. CARGO SHIP	47	17·5	<9	26	9·7	GROUNDING	133	49·6
BULKER	89	33·2	9–22	84	31·3	TECH. FAILURE	77	28·7
CONTAINER SHIP	13	4·9	23–26	54	20·2	FIRE/EXPLOSION	26	9·7
TANKER	56	20·9	>27	104	38·8	COLLISION	11	4·1
CRUISE SHIP	4	1·5	—	—	—	FLOODING	15	5·6
RO-PAX	59	22·0	—	—	—	OTHER	6	2·2
TOTAL	**268**	**100·0**	**TOTAL**	**268**	**100.0**	**TOTAL**	**268**	**100.0**

Table 4.2: Vessel type, age and type of accident (source: Tzannatos E., 2010)

By conducting a deeper analysis into the accident record, it is showed that although all vessel types suffered damages mostly from groundings, technical failures and fires or explosions followed, especially in the case of tankers and Ro-Pax ships. Additionally, the control of groundings was found to be non-related to the vessel's age, whereas technical failures were more very deep in the higher age group.

On an average basis, from the years 1993 to 2006, the human element was found to be responsible for 57.1% of the maritime accidents in the Greek seas, in contrast to random events, unidentified causes and acts of God, which accounted for 31.1%, 7.9% and 3.9%, respectively (Figure 1). Furthermore, a big percentage (78.5%) of the human element as a cause of maritime accidents was detected onboard, whereas human causes ashore, as well as onboard and ashore covered 12.6% and 8.9%, respectively, of all the human-caused disasters. By taking into account all the above-mentioned facts, both the overall and the onboard presence of the human element as a cause of shipping accidents is lower than the widely recognized to statistics of 80% and 65%, respectively. However, it must be noted that this analysis focuses on shipping accidents and not events. Relating to the effectiveness of the ISM Code putting into use in July 1998, it should be said that the human-caused accidents of the pre-ISM period and after-ISM period averaged 63.9% and 51.7%. This 12.2% reduction in the human-caused disasters, along with the good timeframe involved on every aspect of the ISM Code that was used, gives a trustworthy indication of its good effect upon the safety of Greek shipping.

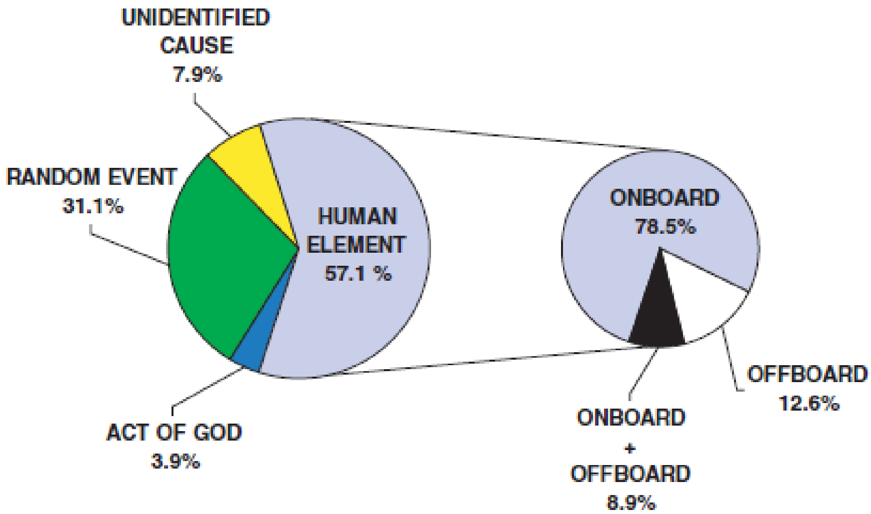

Table 4.3: General and human causes of Greek shipping accidents (source: Tzannatos E., 2010)

The Master of vessels was found to be the maritime accident's cause in 43.1% of all the accounted accidents, whereas the remaining 14% which makes the overall of all human causes (57.1%), was originated from other onboard and/or offboard personnel. Closely linked to the impact of ISM Code and its usage, the statistics of the ship's Master as a partial cause of crashes was reduced from a pre-ISM average of 43.8% to an after-ISM of 42.5%. This reduction of 1.3%, along with the reduction of 12.2% of all human caused accidents, shows that the ISM Code was adequate and aided in this reduction of human causes.

As it is presented in the below figure, amongst the accidents that occurred because of onboard human causes, the ship's Master had an involvement in 80.4% of the accidents, whereas the rest of the crew followed with 8.1%, 6.8% and 4.7%, respectively. Also, the ship's Master, was found to be the one and only responsible in 85.6% and in cooperation with other crew members in 14.4%, of the accidents studied. The overwhelming presence of the ship's Master as an onboard cause of accidents may be anticipated, due to his expected involvement in the highly occurring groundings (49.6%). Likewise, engine officers, either alone or along with the ship's Master, were found to be responsible for other types of common maritime accidents, such as technical failures (28.7%) and fires or explosions (9.7%).

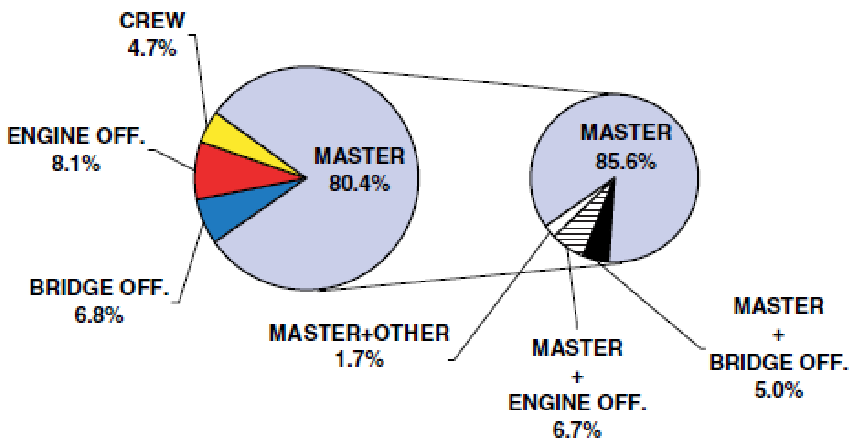

Table 4.4: Specification & distribution of onboard human causes (source: Tzannatos E., 2010)

The facts and figures of maritime accidents in Greek shipping in the years from 1993 to 2006 proved that groundings along with technical failures were the most common issues as far safety is concerned, while at the same time, it was noted that the older vessels suffered the vast majority of accidents. In addition, despite the reduction of human causes after the ISM Code implementation, the human element steadily remained the first and major cause of maritime accidents. The Master was found to be the most common cause of accidents in Greek shipping and in the majority of events, he was deemed to be the only one too.

CONCLUSION

The aim of this Dissertation was to examine the great importance of the human factor into the shipping industry. In addition, considering the fact that the majority of maritime accidents occur due to human error, this research aimed to identify the factors and the human mistakes that lead to these accidents. To achieve the aim of the Dissertation, a synthesis of relevant literature was selected as a research methodology. The sample used, contained a variety of academic articles, which have been published in high quality journals and a variety of segments from books from authors with great knowledge and experience in the shipping industry.

Without question, the term of safety for the shipping industry is of the utmost importance and by taking into account the fact that every single vessel is operated by people, it is necessary to provide the best conditions for every person either on board or on shore, in order to minimize the chance of error. Even the slightest mistake can lead to tragedies, therefore every crew should work like a team and never act independently. Although in this thesis only six accidents were mentioned, there are way more that took place due to human error, regardless of whether it was a small error or a big one.

The analysis of this Dissertation shows that over the years, there has been a significant progress towards the improvement of both safety on board and of human needs, especially for the on-board crew. The relevant legislation has adjusted many times, in order to come closer to the realistic needs of the industry and to provide better solutions for any case needed. However, there is always room for improvement and when planning the shipping industry of the future, it is necessary to review every inadequate measure of the present and correct it for the days to come. At absolutely no case should the rights of the people be violated, because this could lead to a significantly higher chances of a mistake, that could turn into an accident. Everyone should abide by the rules and has as a priority the smooth operation and passage of the vessels.

Human factor and in this case seafarers, are on the front line of the maritime industry, they are its heart and they deserve the right conditions to do their job and the right incentives to help them struggle with all the things that they leave behind, every time they embark on a vessel. By providing regular and on the job training, the rates of maritime accidents can be reduced.

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