UNIVERSITÀ POLITECNICA DELLE MARCHE

Department of Life and Environmental Sciences

Doctoral Curriculum in Civil and Environmental Protection

"Improving safety at sea through the implementation of a new emergency management model"

A Dissertation presented

by

CASAREALE CRISTINA

Tutor:

Prof. Fausto Marincioni

Co-Tutor:

Prof. James Kendra

Abstract

Accidents have been part of the maritime industry since its beginning. Early attempts to eliminate or reduce accidents were engineering in nature; however, accidents are often not due to equipment malfunctioning but increasingly to human error. Therefore, since the early 1990s the focus has progressively shifted on the role of human behavior and how that behavior factors into casualties. But, casualties still occur at an alarming rate in spite of all the laws, regulations, best practices and training that have been in place to guarantee safety improvements for more than a decade. Maritime accidents are rarely the result of a single massive error, so maritime safety has to be addressed on a systemic basis at all levels, regulatory, organizational, managerial and individual. On this vein, this dissertation approaches the human factor issue in an original way, proposing and discussing the application of a new emergency management model that consider human interactions among individual, organizational and managerial level, to give the regulatory level a new instrument to improve safety. Analyzing the Costa Concordia disaster, the first step towards the new model is the identification of the multilevel interactions that leaded to the accident and characterized the entire emergency. The analysis of the testimonies of the officers working on the Costa Concordia the night of the accident, highlights that errors and omissions at all levels determined the failure of the command and control model and a consequent crisis of communications. The second step is to deep the analysis of the leadership failure and measure its impact on communications. Through the combination of text analytics measures with social network analysis, it is possible to measure the emergence of an informal leadership structure on the Costa Concordia that partially confined the lacks in communications. Third step consist in identifying a possible alternative and more horizontal leadership structure that can be combined with the command and control vertical model. Mariners living the maritime system everyday are addressed to have real and useful indications on how to combine horizontal and vertical leadership in the maritime environment. Combining all the finding of these consequent steps the new model aims at improving safety at sea by introducing a semi-vertical leadership model in the maritime environment.

Abbreviations

ARPA	Automated Radar Plotting Aid
CAMM	Council of American Master Mariners
CCShip	Crisis Committee Shipside
CCShore	Crisis Committee Shoreside
COOW	Chief Officer of the Watch
FCC	Fleet Crisis Coordinator
GPS	Global Positioning System
HET	Human Error Theory
HRO	High Reliability Organizations
HROT	High Reliability Organizations Theory
IDE	Integrated Development Environment
IDF	Inverse Document Frequency
ILO	International Labour Organization
IMO	International Maritime Organization
ISM	International Safety Management
KSA	Knowledge, Skills, and Attitudes
MARPOL	Maritime Pollution
NAT	Normal Accident Theory
NI	Nautical Institute
OPA	Oil Pollution Act
P&I	Protection and Indemnity
PDI	Power Distance Index
PDM	Participative Decision Making

SCC	Ship Crisis Coordinator
SHEL	Software, Hardware, Environment, Liveware
SMS	Safety Management System
SNA	Social Network Analysis
SOLAS	Safety of Life at Sea
STCW	Standards for Training, Certification and Watchkeeping for Seafarers
USCG	U.S. Coastal Guard
VDR	Voyage Data Recorder

TABLE OF CONTENTS

ABSTRACT **1**

ABBREVIATIONS **2**

INTRODUCTION **7**

CHAPTER 1 – THE HUMAN FACTOR IN THE MARITIME DISASTERS **9**

1.1 History of the Human Factor in the maritime domain *9*
1.2 The complex dynamicity of the maritime domain *13*
1.3 Maritime organizations as sociotechnical systems *15*
1.4 Why and how analyze the Human Factor in maritime disasters *17*
1.5 General hypotheses, aim of the research and methodology *19*
1.6 Case study: The Costa Concordia disaster *21*
References *29*

CHAPTER 2 – THE COSTA CONCORDIA DISASTER AS ORGANIZATIONAL FAILURE **9**

2.1 Introduction *33*
2.1.1 Theories for the investigation of the human error 33
2.1.2 Costa Crociere Company Safety Regulations 40
2.2 Aim of the study and research questions *41*
2.3 Methodology *43*
2.4 Results *44*
2.4.1 Codes and Themes of the analysis 44
2.4.2 Individual contribution 47
2.4.3 Group contribution 50
2.4.4 Organizational contribution 52
2.4.5 Mutual influence 54
2.4.6 Communication 55
2.4.7 Expectation 57
2.4.8 Improvisation 58
2.4.9 Leadership 60
2.4.10 Teamwork 61
2.5 Discussion and Interpretation of results *62*
2.6 Conclusions *67*
References *69*

CHAPTER 3 – THE EMERGENCE OF THE INFORMAL NETWORK DURING THE COSTA CONCORDIA DISASTER: A SOCIAL NETWORK ANALYSIS APPROACH .. **29**

3.1 Introduction *74*
3.1.1 Formal and informal leadership 74
3.1.2 Social Network Analysis 76

3.1.3 Costa Concordia Emergency procedures ... 77
3.2 Aim of the study and research questions ... *79*
3.3 Methodology ... *80*
3.4 Results ... *82*
3.4.1 Stage 1: impact to general emergency ... 85
3.4.2 Stage 2: from general emergency to abandon ship ... 90
3.4.3 Stage 3: after abandon ship ... 94
3.5 Discussion and Interpretation of results ... *98*
3.6 Conclusions ... *104*
References ... *105*

CHAPTER 4 – MARITIME LEADERSHIP: THE MARINERS' POINT OF VIEW ... 105

4.1 Introduction ... *109*
4.1.1 The Command and Control model in the maritime environment ... 109
4.1.2 Safety Culture and Safety Climate in the maritime environment ... 111
4.2 Aim of the study and research questions ... *113*
4.3 Methodology ... *114*
4.4 Results ... *116*
4.4.1 Codes and Themes of the analysis ... 116
4.4.2 Participants ... 117
4.4.3 Culture and climate of error ... 119
4.4.4 Error isolation strategy ... 122
4.4.5 Friendly leader ... 124
4.4.6 Mentoring ... 126
4.4.7 Multiculturalism ... 127
4.4.8 Teamwork ... 129
4.5 Discussion and interpretation of results ... *130*
4.6 Conclusions ... *133*
References ... *135*

CHAPTER 5 – SHARING OR CENTRALIZING COMMAND? A NEW MODEL FOR MARITIME EMERGENCY MANAGEMENT ... 135

5.1 Integrating vertical and shared leadership ... *142*
5.2 A new model for maritime emergency management ... *146*
5.3 First application of the new model for maritime emergency management ... *154*
References ... *157*

CONCLUSIONS AND FUTURE DIRECTIONS ... 157

APPENDICES TO CHAPTER 2 ... 170

Appendix I: Names and roles of actors involved in the Costa Concordia emergency ... *170*

APPENDICES TO CHAPTER 3 ... 171

Appendix I: Names and roles of actors involved in communications during the Costa Concordia emergency *171*
Appendix II: IRB statement for the project "Costa Concordia disaster: communication network analysis" *172*

APPENDICES TO CHAPTER 4 173

Appendix I: IRB statement for the project "Maritime Leadership: A Qualitative Approach" *173*
Appendix II: Statement of informed consent for the study of maritime leadership *174*
Appendix III: Interview guide for the study of maritime leadership *175*

Introduction

After 100 years the RMS Titanic sank in the North Atlantic Ocean on April 15, 1912, the Costa Concordia faced the same destiny in the Tyrrhenian Sea on January 13, 2012. Many law improvements to make ships safer have been made during these hundred years between the two accidents, and vessels have been equipped with new and sophisticated technologies. Nevertheless, the sinking of the Costa Concordia is a clear example that the safety goals achieved till now are not sufficient to guarantee safety at sea, that something is missing and there is still room for improvement. Ships are still governed by people that can make mistakes even if regulations are implemented and technologies perfectly work. Humans and their interaction among them and with the built environment, make the difference between safe or unsafe outcomes. It has been estimated that human error continues to be a dominant factor in approximately 80 to 85% of maritime accidents, with about 50% of maritime accidents caused by human error and 30% associated with human error (Baker & McCafferty, 2005, p. 6). In a study of 268 casualties to Greek flagged vessels over 500 tons from 1993 to 2006 investigated by the Hellenic Coast Guard, the human element was found responsible for 57.1% of those casualties. Of that percentage, 78.8% was onboard error, 12.6% ashore error, 8.9% a combination of the two (Tzannatos, 2010, pp. 121–122).

What happened on January 13, 2012 off the coasts of the Giglio Island (Tuscany, Italy), suggests that the attention of safety related studies on safety at sea should be focused on people and the way they behave. Investigations conducted by the court of Grosseto, highlights that the Costa Concordia was a modern vessel carrying a full complement of experienced bridge officers and the most advanced navigational tools available, and that nothing had broken the day of the accident. How is it possible that a modern, sophisticated and perfectly functioning ship sunk causing the death of 23 people? What went wrong? What can we learn from this accident? How can we use what we learned to improve safety at sea?

In this dissertation both qualitative and quantitative methods are used to study the human factor in maritime disasters to try to find an answer to these questions. The Costa Concordia disaster is identified as case study from where to start the investigation because it shows the close and complex relations among the layers of the maritime system, in particular the ship and organizational layers, and allows to expand the knowledge on the still too unclear dynamics that lead to and characterize maritime accidents, providing the precious possibility to bring important improvements for safety.

In Chapter 1, is introduced the history of the human factor in the maritime system and how the concept evolved during time. The maritime system is described as sociotechnical system and all the relations among the different elements are defined, highlighting the positive and problematic elements of the system. At the end of the chapter, the Costa Concordia disaster is described in details and an explanation of its importance as case study is provided.

In Chapter 2, the Costa Concordia disaster is qualitatively studied as a failure of the whole system. The testimonies of the key officers onboard the Costa Concordia on January 13, 2012 collected by the Court of Grosseto are deeply analyzed and errors at individual, group and organizational level, as well as the influence among levels are highlighted. The results of the analysis point out how lacks in the command and control model caused above all improvisation and communications problems that negatively influenced the entire emergency management.

In Chapter 3, the communications recorded by the Voyage Data Recorder (VDR) on the Command Bridge of the Costa Concordia during the emergency are quantitatively analyzed as social network. A new approach to the study of communication is presented in the study and allows to measure that the failure of the command and control model negatively impacted the communication flow and lead to the emergence of an informal hierarchy that guaranteed to manage the emergency bringing useful information in the network during the emergency.

In Chapter 4, seafarers of two international associations are asked to answer questions related to life at sea, their approach to work and people and the relationship between ship and shipowner. Mariner's answers are qualitatively analyzed and themes emerging from the interviews are described and connected and show the possibility of a shift towards a more horizontal leadership model.

In the final chapter, Chapter 5, a new leadership model for maritime emergency management is proposed and discussed. Putting together all the results of the previous chapters, the strengths and weaknesses of different leadership models are presented and a new emergency management model integrating the current command and control system with the shared leadership model is proposed. The possible advantages derived from the application of the new model are described.

Each chapter contains a general introduction, the aim of the study and research questions, a complete description of the methodology used for the analysis, results and discussion, as well as limits of the study and suggestions for future research.

Chapter 1 – The human factor in the maritime disasters

1.1 History of the Human Factor in the maritime domain

Human element has been part of the maritime operations from its early days. Prior to mechanical propelled ships, being a mariner required skills such as great courage, dedication to work and crew, physical strength and endurance. Even though shipping was considered one of the most profitable jobs, seafarers were considered reckless and foolish, as the mariner and writer Joseph Conrad has written: "*[…] the sea has never been friendly to man […] the ocean has no compassion, no faith, no law, no memory.*" (Conrad, 1925, p. 135).

During the period from 1550 to 1650, historic sources point to losses from shipwrecks reaching alarming proportions (van Loon, 1989). Most of these shipwrecks occurred on the homeward journey, suggesting that most were overladen with cargo. Human error, although not mentioned explicitly, had already been identified as one of the primary factors contributing to these casualties. During this period there were so-called standing orders in place that contained stringent rules against "*overloading, improper stowage of cargo, abuse of berth and deck space, the enlistment of unqualified mariners, or their substitution by inexperienced men*" (Gomes, De Brito, Boxer, & Blackmore, 2001). These orders were introduced mainly as a curb to the large losses of galleons and their expensive, lavish cargo, rather than as a risk-reduction strategy for preventing any further loss of lives. In addition, a punishable offense was instituted for pilots found guilty of failing to communicate effectively with their colleagues on board. Printed regulations were also distributed to all ships on this route. However, ship losses continued. It was only after 1650 that records point to a sudden drop in shipwrecks. The main reason for this was attributed to the hanging of some ships' officers who were charged with misconduct over the loss of two galleons in the late 1650s. This may perhaps explain why a punitive attitude is still so deeply rooted in the maritime domain, although the domain does not go as far as hanging ships' crew anymore. The perception in this domain, even today, seems to be that punishment works (Grech, Horberry, & Koester, 2008).

Up to the mid-1800s, people avoided traveling by sea as much as possible, as it was well known to be a hazardous venture. Navigational aids were virtually non-existent, with mariners relying on crude implements to guide them. The 1850s hailed the arrival of iron and steel and steam engines, which provided the technology for the construction of larger, stronger, faster ships, considered to be more efficient for the transportation of goods on water (Kaukiainen, 2012), more controllable and less susceptible to damage. Such technical advances, however, introduced new hazards. Early

steam engines were not without their problems and did tend to explode sometimes, leaving behind huge death tolls, as in the explosion of the steamboat Sultana, April 27, 1865. Maritime safety standards were at best laissez faire in the mid-nineteenth century. Nevertheless, people's perception of sea travel changed dramatically, and by the late 1800s and early 1900s it became one of the most popular modes of travel. Advances in technology opened a market for passenger ships. Maritime transport was at this stage booming, so authorities stared exercising some kind of control via regulatory national safety standards available at the time, especially because the general population venturing to the sea had extended beyond the typical mariner. This period also heralded the birth of classification societies, which were private organizations that provided information to insurance companies on the quality of ships and their equipment. Accidents and major disasters encouraged various countries to cooperate more where introduction of certain maritime safety standards was concerned[1]. This sparked the start of a reactive maritime culture in which new safety rules were introduced following major accidents. One of the most discussed and well-known tragedies in history, the sinking of the RMS Titanic on April 14, 1912, initiated a significant campaign toward improved passenger ship safety standards. This tragedy created a media anxiety when the realization dawned that, had the vessel been fitted with adequate safety equipment, the death toll would have been significantly less. This sparked the First International Conference on Safety of Life at Sea (SOLAS) held in London in 1914[2]. The conference addressed safety technical issues that came out of the Titanic enquiry, such as the adequacy of lifeboats, hull subdivision, and radio communications equipment on passenger ships.

Reaction to high-profile accidents has historically resulted in the introduction of new regulatory measures. This trend continues even today within the international maritime community. Recently, however, there has been a shift in this approach and the international maritime community has finally come to realize that being proactive, rather than following a historically reactive approach, is the key to accident prevention.

World War II required people to perform more and more effectively and this necessity provided an impetus for further research work in the area of maritime human factors (including other domains such as aviation). Some of the more prominent work in maritime human factors was initiated by

[1] http://www.imo.org/en/About/HistoryOfIMO/Pages/Default.aspx

[2] http://www.imo.org/en/About/conventions/listofconventions/pages/international-convention-for-the-safety-of-life-at-sea-(solas),-1974.aspx

the United States with the establishment of the Committee on Undersea Warfare in 1946[3]. A Panel on Psychology and Physiology (National Research Council (U.S.), 1949) was appointed with a specific mandate to draw up an outline for a number of surveys in applied research on problems related to human factors in undersea warfare. Although wartime dictated that most of this work focused mainly on naval vessels, the intention was to allow cross transfer of research and development effort to other maritime platforms. The studies focused on such factors as visual and auditory problems, design and arrangement of operating equipment, habitability issues, and selection and training. This work prefigured a breakthrough in maritime human factors at the time.

During the 1970s, a number of minor human factor initiatives had started to hatch in Europe and the United States. Ship statistics in the 1970s indicated that more than one merchant ship per day was being lost at sea. This started alarm bells ringing, with the result that in the early 1970s, the U.S. Maritime Transportation Research Board commissioned research work in the area of human error, specifically looking at "*providing recommendations that will lead to the development of countermeasures against acts of commission or omission that lead to merchant marine casualties*" (Maritime Transportation Research Board, 1976, p. 2). Systematic and quantitative historical human error data were found to be lacking; hence, a collection of data was mainly conducted through the use of questionnaire surveys, utilizing expert judgment for evaluation. These studies identified a number of contributory human factors as either major or potential causes of casualties, and included such factors as "*inattention, inefficient bridge design, poor operational procedures, poor eyesight, excessive fatigue, ambiguous pilot-master relationship, excessive alcohol use, excessive personnel turnover, high level of calculated risk, inadequate lights and markers, misuse of radar, uncertain use of sound signals, and inadequacies of the rules and regulations*" (Maritime Transportation Research Board, 1976, pp. 7–14). Based on these factors, the panel recommended a number of improvements in these areas, mainly focused on crew error.

Throughout the 1980s initiatives related to maritime human factors were scarce. The concern and interest in the field of human factors was awaken by a spate of major disasters, such as the huge loss of life in the capsize of the passenger ferries Herald of Free Enterprise in 1987, and the Estonia in 1994, as well as major oil spills from the oil tankers Exxon Valdez in 1989, and the Erika in 1999 and many others (Messer-Bookman, 2015).

[3] http://www.public.navy.mil/subfor/cus/Pages/sosus_origins.aspx

Perhaps the 1990s can be seen as having reached a maximum number of maritime accidents, fatalities, and environmental pollution (Guha-Sapir, Below, & Hoyois, 2009), to the point that the maritime community strengthened its focus on developing safety rules as a result of such tragic disasters. One example is the Oil Pollution Act[4] (OPA 90), which came into force in the United States in 1990 following the Exxon Valdez disaster. The beginnings of the 1990s also saw the start of human factors definitions being publicized around the global maritime community. Analyses of casualty reports provided a method of somehow quantifying these "vague" human factor issues in such a way as to send the necessary warning signals of the existence of the problem. In 1993, the USCG reported that 80 percent of maritime accidents were caused by human error. On these grounds, the Prevention through People (PTP) program was initiated, which looked at developing a long-term safety strategy focusing on human error prevention (U.S. Coast Guard, 1995). In 1994, a U.K. Protection and Indemnity (P&I) club study on major P&I claims between 1987 and 1993 indicated that 63 percent of these incidents were caused by human error. In the same year, the International Maritime Organization (IMO) reported that more than 75 percent of ship accidents worldwide were due to human error. In this regard, the IMO recommended that the study of human factors (and in particular human error) would be an important focus for improving maritime safety. As a result, although initially largely reactive in its response, the IMO started to focus on introducing new regulations that incorporated a human element viewpoint. Examples include the International Safety Management (ISM) Code[5] and the revised Standards for Training, Certification and Watchkeeping for Seafarers (STCW) Convention[6]. The ISM code was adopted in an attempt to curb poor management practices in international shipping. The revised STCW Convention was adopted in 1995 and entered into force in 1997. This convention incorporated a new set of requirements for minimum training standards and competency for seafarers.

Today, there have been substantial developments in the area of human factors in the maritime domain. In the last few years, a quite large number of research groups and initiatives have been set up in Europe and the United States to discuss and collaborate on their research findings on the human factor related to maritime disasters. One such initiative already providing some valuable information and insight into the area of human factors is the International Maritime Human Element Forum[7], a Nautical Institute (NI) project sponsored by one of the major classification

[4] https://legcounsel.house.gov/Comps/Oil%20Pollution%20Act%20Of%201990.pdf
[5] http://www.imo.org/en/OurWork/humanelement/safetymanagement/pages/ismcode.aspx
[6] http://www.imo.org/en/OurWork/humanelement/trainingcertification/pages/stcw-convention.aspx
[7] http://www.nautinsthk.com/p23.html

societies, Lloyds Register of Shipping, with the aim of improving human element awareness in the maritime domain.

1.2 The complex dynamicity of the maritime domain

In spite of developments that have taken place in other forms of transport, such as air and road transport, the sea remains one of the most important connecting links between the nations. More than three quarters of world trade volume is moved by sea (George, 2013). Advances in design and construction technology have encouraged development of ship types that can satisfy growing economic demands, and this includes greater capacity, faster speeds, and more turnarounds. At the same time, the necessity to maintain these connections requires a considerable increase of the complexity of the sector.

Up to the early post-war (WWII) years, world shipping was dominated by the fleets of the traditional maritime nations, mainly the United Kingdom, the United States, France, Netherlands, and the Scandinavian countries (Fayle, 2006). However, from the 1950s onward a gradual change took place in the fleet distribution. The traditional maritime nations were no longer dominating the world tonnage figures. This was caused to some extent by a diversion of resources from the maritime sector resulting in a reduced amount of investment, but perhaps more significantly by the flight to the open registries (i.e. flags of convenience). A large number of shipping companies started changing the country of registry of their vessels from the traditional countries to these open registries. Attractiveness of these open registries stemmed from the fact that they provided benefits such as tax allowances. By 1999, about half of all registered merchant ships flew flags of convenience. While open registries are one phenomenon that points to a fundamental shift in the organization of international maritime transport, another one relates to ship management. A growing spurt in the shipping sector during the 1990s influenced more ship owners to hand over responsibility for ship operations to professional ship management organizations, a trend that had started during the 1980s. A very substantial portion of the international commercial fleet is today managed under such arrangements. The vessel situation became such that the owner could be located in one country, the ship management company located in a second country, and same vessel could be registered in a third country. It has thus become difficult to identify the true ownership of, and for that matter the accountability for, many vessels engaged in commercial shipping. The flag flown, and the port of registry do not any longer reveal conclusive evidence of ownership. Maritime transport has become a very complex industry indeed.

The international nature of the shipping industry has led to action being taken to improve safety in maritime operations, which is now enforced at the international level. This complexity is further increased by the influence of national and international regulations adopted by local and international bodies, notably the IMO, the International Labor Organization (ILO), as well as by the most influential classification societies. The IMO was established as a permanent international body to promote maritime safety more effectively and started off by adopting a new version of SOLAS, the most important of all treaties dealing with maritime safety. The IMO is made up of government departments and agencies from all over the world with a particular interest in shipping. These government departments and agencies usually regulate ship operation and safety under the IMO umbrella. Such agencies are also empowered to regulate environmental aspects of shipping under the Maritime Pollution (MARPOL) Convention. Today, the most important international conventions dealing with maritime safety, such as SOLAS and MARPOL, have been widely accepted and applied to more than 95 percent of the world's merchant shipping fleet. This means that it would be almost impossible to operate a ship that does not meet IMO agreed requirements or standards.

In many ways, the ship itself presents an unusual and sometimes very harsh work environment. Crewmembers are required to perform most of their tasks in a moving environment. In addition, the work environment is also characterized by lack of contact with family, by different cultures living together, and for the most part of the job by a high element of monotony. It is not uncommon for a ship to have crew hailing from different countries, speaking different languages, and coming from diverse cultural and social backgrounds. There are a number of reasons for this shift in crew demographics. First, the introduction of open registries set the scene for the employment of seafarers from different nationalities. Second, a seafaring career today is not looked on as favorably as it was thirty or so years ago. This could be the result of deteriorating crew conditions, short-term career prospects, and lack of opportunities when compared to shore-based jobs, with the consequence that people, especially those coming from the more traditional seafaring nations, have been discouraged to seek seagoing careers. Another reason is once again, a consequence of economics. To reduce costs, ship owners and ship operators are hiring crew from countries offering much lower wages and willing to accept poorer working conditions. This situation has created many challenges to shipboard crew. For starters, although communication issues have always had a niggling presence in ships' officer-pilot interaction component, today, it is not uncommon to have language and communication problems present even between crew of the same ship. English is

today widely accepted as the language at sea, and this has been accounted for within the STCW Convention. However, language problems today still play a contributory part in human and organizational error. These are actually some of the specific risk areas that the U.K. P&I Club has identified as causes of human error. Such communication problems also extend to interfacing issues between shipboard and shoreside personnel, both from within the company and also from dockside workers such as stevedores, etc. As is the trend globally, the use of multinational crew has also weakened, to some extent, company loyalty, perhaps adding another dimension, apart from the language barrier, to human factor issues on board, such as the seafarer attitudes, safety culture, and behavior toward their job.

The use of new technologies plays a controversial role in terms of safety. Traditionally, the international maritime community has approached maritime safety from a predominantly technical perspective. It was common practice to apply engineering and technological solutions such as radar, ARPA (Automated Radar Plotting Aid), and GPS (Global Positioning System) to promote safety and minimize the risks of accidents. The human element aspect was treated in a peripheral manner, with little or no consideration given to human and organizational errors. Despite the progress made in advancing technology, systems have not yet been developed that are immune to errors committed by those who operate them.

It is no surprise then, that this environment itself enhances the risk of errors. The human factor continues to play a major role in incident and accident causation. Hence, similar to other transport domains, it seems that human performance problems constitute a significant threat to system safety.

1.3 Maritime organizations as sociotechnical systems

Furnham describes sociotechnical systems as "*a set of interrelated elements that functions as a unit for a specific purpose*" (Furnham, 2005, p. 74). Considering the multitude of elements composing the system, organizations in the maritime domain are consistent with the sociotechnical systems perspective. A maritime organization could be the ship owner or shipping company and a part of the organization could be a specific ship. Ships can be analyzed as a combination of technology (the vessel, engine, equipment, instruments, etc.) and a social system (the crew, their culture, norms, habits, custom, practices, etc.).

The sociotechnical model advocates a more holistic systematic approach, compared to the "*reductionist strategic approach*" theorized by Vicente (2004) that led directly to our troubles with technology for dealing with relationships among various elements that forms a system.

The SHEL Model developed by Edwards (Edwards, 1972) and later modified into a 'building block' structure by (Hawkins, 1987), is the starting point that led to the development of the sociotechnical model. The SHEL model describes a system made up of interactions between human (liveware), technology (hardware), procedures (software), and work environment (environment). It provides four sets of interactions with the liveware, which represents the central human component, and these include: liveware–liveware, liveware–software, liveware–hardware, and liveware–environment. This is actually one of the most detailed, comprehensive, and advanced human factors taxonomy in use today. The SHEL model is also in use within the maritime domain where it has been incorporated into IMO Resolution A.884, which provides guidance for maritime accident investigations. Accordingly, although the SHEL model has had a significant impact on human factors principles and processes and has some clear advantages (e.g., its wide use and acceptance and its simple and intuitive feel), it also has some serious shortcomings. The difficulties are mainly associated with the meaning of concepts used in the model, such as hardware, software, and liveware, which can be hard to interpret and communicate. Hence, improvements to the SHEL model were undertaken to enhance interpretation and also to create a customized model usable within the maritime domain. This eventually led to the development of what we refer to now as the sociotechnical system model (Koester, 2007) shown in Figure 1.

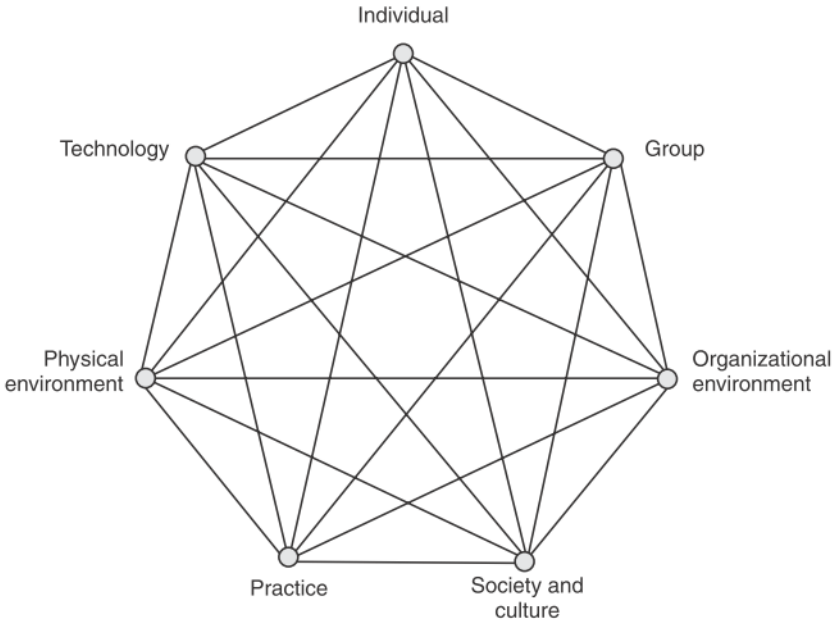

Figure 1 - The sociotechnical system model. The model is also called "The Septigon Model." Septigon refers to Society and Culture, Physical Environment, Practice, Technology, Individual, Group and Organizational Environment Network (Koester, 2007)

The sociotechnical system model is a systematic approach for viewing human factors; it indicates how various factors interact to influence system performance. By managing these factors, we can strive to ensure that the system as a whole operates within a safe boundary. As in Figure 1 the sociotechnical model comprises seven main domains: Individual, Practice, Technology, Group, Physical Environment, Organizational Environment, Society and Culture. Definitions for these domains originate from Rizzo and Save (Rizzo & Save, 1999):

- Individual: refers to the human component and incorporates such aspects as individual physical or sensory limitations, human physiology, psychological limitations, individual workload management and experience, skill, and knowledge.
- Practice: refers to such aspects as informal rules and customs that are not related to written procedures or instructions.
- Technology: refers to equipment, vehicles, tools, manuals, and signs, and the interaction between technology and the individual, which deals with such factors as equipment, tools, usability.
- Group: refers to the relational and communication aspects, such as communication, interactions, team skills, crew/team resource management training, supervision, and regulatory activities. The group factor, which is also the individual–individual interaction factor, deals with such issues as leadership, communication and teamwork.
- Physical Environment: refers to the surrounding working environment and includes such aspects as weather/visibility conditions, obstructions to vision, and physical workspace environment (such as air quality, temperature, lighting conditions, noise, smoke/fumes, vibration, ship motion, and anthropometric space).
- Organizational Environment: refers to company and management and includes such factors as procedures, polices, norms and formal rules.
- Society and Culture: refers to the sociopolitical and economic environment in which the organization operates.

1.4 Why and how analyze the Human Factor in maritime disasters

Like many other complex sociotechnical systems, the current paradigm in maritime risk management involves developing safe systems of work, rather than looking purely at operator behavior ‘at the sharp end’. Human factors data and operator performance information are not related just to accidents and incidents; other uses include the evaluation of the effectiveness of

training or maritime equipment usability testing. The human element is a key aspect of maritime operations; therefore, collecting, analyzing, and finally applying human factors data, is vital to develop safer and more efficient and more motivating maritime systems.

There is still no widespread agreement on concepts or techniques and many different methods have been used to investigate maritime accidents (Akyuz, 2017; Akyuz & Celik, 2014; Celik & Cebi, 2009; Chauvin, Lardjane, Morel, Clostermann, & Langard, 2013; Chen et al., 2013; Dekker, 2002; Michelle R Grech, Horberry, & Smith, 2002; Hetherington, Flin, & Mearns, 2006). However, the conclusions about what happened, why it happened, what should be done about it in the future, and how those recommendations are put into action should be similar irrespective of the exact analysis technique used. Human error is cited as a cause of a large number of maritime incidents and accidents (Baker & McCafferty, 2005; M. Barnett, Gatfield, & Pekcan, 2003; Barnett, 2005; Ermal & Lapa, 2010; Martins & Maturana, 2010); as such, investigations need to take into account what is known on the origins of, and antecedents to, both human and organizational error.

One of the challenges to accurately assess maritime risk and consequently provide suggestions to improve maritime safety, is the fact that statistics from which realistic conclusions can be drown are too sparse to be meaningful. This is due to the complexity of all the elements that have to be considered: ships are like floating buildings (Casareale, Bernardini, Bartolucci, Marincioni, & D'Orazio, 2017) where interpersonal dynamics determine whether crew members work as teams and accomplish to bring the ship from point A to point B, or not. Within these dynamics, the captain is on duty for everything. As a captain[8] explained "*You are a police man, you are a fireman, you are a lawyer, you are a doctor, you are a nurse, you are a psychologist, you are a priest. There is no other*". To add complexity to already complex dynamics, two external factors must be considered: weather conditions and organization. The second one is directly linked to shipboard life, because decisions made at the shore side strongly influence work at the ship side. A 1996 Massachusetts Institute of Technology engineering study of tanker environmental risk commented: "*until there is better understanding of accidents mechanics, any attempt to minimize accidents based on statistics alone is reactionary, with questionable effectiveness*" (Amrozowicz, 1996). For this reason, qualitative research is a valuable method that can be used to provide a rich description of accident causation and development, by giving voice to those whose views are rarely heard,

[8] Captain's name is not cited because he is one of the participants of the study on maritime leadership, presented in Chapter 4, so his name must remain confidential.

conducting initial explorations to develop theories and to generate hypotheses that can be quantitatively tested (Sofaer, 1999).

The results of both qualitative and quantitative investigations should be used to implement effective risk reduction strategies to help guard against future negative events, or at least to mitigate their severity.

1.5 General hypotheses, aim of the research and methodology

When systems fail, it is commonly assumed that the entire crisis is only due to the actions of one 'bad apple'. When thinking about an organization's management and leadership competence (individual, collective and systemic), it is the individual who inevitably becomes the first port of call. However, accidents are quite often the result of the whole maritime system' cultural traditions and procedures. The lack of studies and statistics on maritime disasters, especially when the organization is analyzed as a whole, fosters the idea that accidents are caused by a single individual or a small group of individuals that work in the front line and makes the study carried out in this dissertation essential to increase the knowledge of how maritime disasters are the result of an organizational failure. The Costa Concordia disaster represents a perfect case study due to the peculiarity of elements that interlocked before and during the emergency: informal practices (e.g. the 'salute') accepted by the entire organization united to the misapplication of formal procedures (e.g. the obligation for the officers to question the captain if necessary) lead the ship to hit the rock, highlighting organizational lacks (e.g. communication problems) with the uncertainty and hesitation showed by the captain as leader entailed delays in the emergency management and the consequent death of 32 people.

Starting from such assumption, a simple general hypothesis is at the base of this dissertation:

> Hypothesis 1: The human factor at different levels caused and contributed to the Costa Concordia disaster.

In order to demonstrate that the human factor characterized the Costa Concordia disaster before the ship hit the rock, both qualitative and quantitative methods are necessary. Therefore, the general hypothesis is divided into two sub hypotheses:

> Sub-hypothesis 1: Individual, group and organizational errors caused and fueled the emergency.

Sub-hypothesis 2: The informal command structure has replaced the formal structure, ensuring informative communications that allowed to manage the emergency.

The aim of the study is to deeply understand what happened on the Costa Concordia, focusing on leadership, and applying the lesson learned to bring an effective improvement in the maritime system addressed to enhance safety.

The necessity to use both a qualitative and quantitative approach is due to the general lack of information on maritime disasters approached as failure of a system and the nature of the hypothesis that has to be tested[9].

Sub-hypothesis 1 requires a qualitative approach to the analysis. The analysis of the Costa Concordia disaster is conducted to answer "*'how' and 'why' questions*" (Yin, 2014, p. 2) useful "*for developing action strategies that will allow for some measure of control*" (Strauss & Corbin, 1990, p. 9) over the maritime system. The way actions can be developed is to unfold elements and behaviors that characterized the entire emergency. In this sense qualitative analysis can help to build data when information is missing. In particular document analysis is extremely useful because "*documents of all types can help the researcher uncover meaning, develop understanding, and discover insights relevant to the research problems*" (Merriam, 1988, p. 118).

Sub-hypothesis 2 requires a quantitative analysis because in order to establish whether or not the informal structure allows a better communication, it is necessary to measure the information exchanged. The application of social network analysis and text analytics techniques allow to extrapolate words from communications and weigh the use of each word.

Results obtained from each analysis suggest which elements of the maritime system need to be renewed. Therefore, a new proposition is at the base of the third study carried out in this dissertation:

Hypothesis 2: The current vertical leadership model must be flattened and integrated with a shared leadership model.

Hypothesis 2 requires a qualitative approach. Data about mariners' necessities, worries and suggestions about the leadership model used in the maritime domain are not currently available

[9] A better explanation of the methodology used for each analysis is provided in the reference chapter. Here the intention is to provide a general illustration of the research project.

and must be created, taking the actor's point of view as central focus and bring to the surface issues that are important but still omitted (Bryman, Bresnen, Beardsworth, & Keil, 1988).

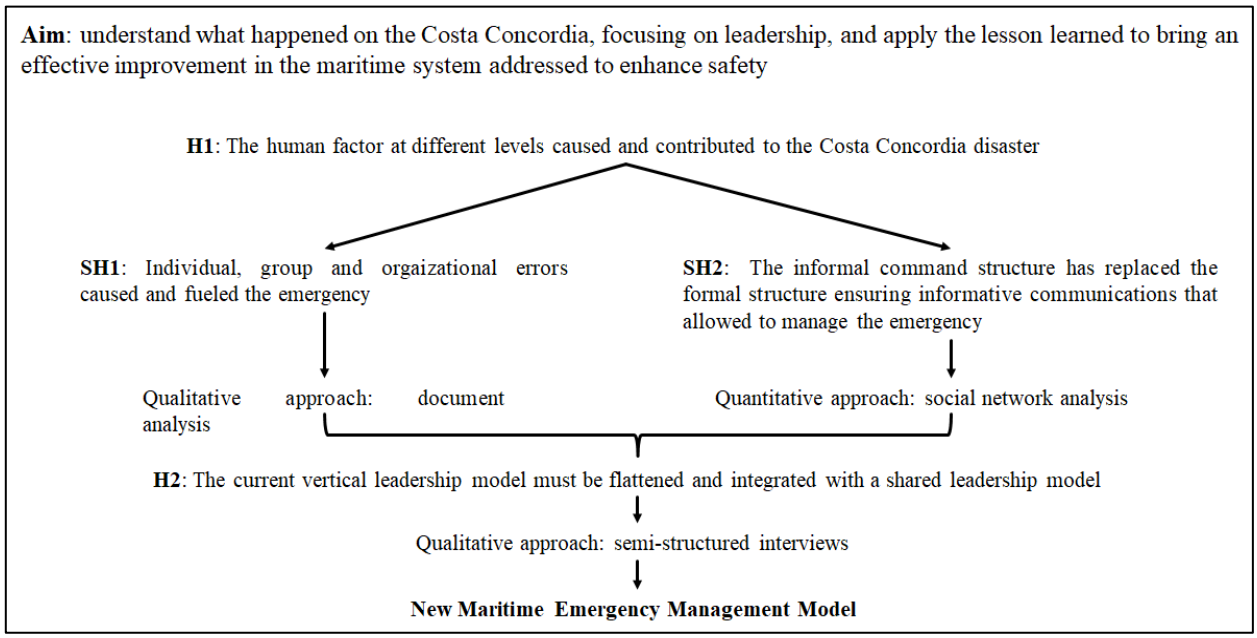

Figure 2 - Graphic summary of the analysis process

Semi-structured interviews are the qualitative method that better fit the necessity to build this data because they directly ask mariners what they think are the weaknesses of the current model, posing the same questions to the respondents and having complete answers for each person on the topics addressed in the interview (Patton, 2015).

In order to accomplish the aim of the dissertation, findings of the three studies conducted are put together to build a new emergency management model. Figure 2 summarizes the analysis process.

The three analyses have been carried out in collaboration with the University of Delaware and the Northwestern University. The first qualitative analysis to test the sub-hypothesis 1 has been performed at the Università Politecnica delle Marche; the quantitative analysis to test sub-hypothesis 2 was performed at the Science of Network in Communities (SONIC) Lab, laboratory of the School of Communication at Northwestern University (Evanston, Illinois); the second qualitative analysis to test hypothesis 2 was performed at the Disaster Research Center (DRC), research center of the College of Arts & Sciences at University of Delaware (Newark, Delaware).

1.6 Case study: The Costa Concordia disaster

In January 2012, the Costa Concordia was carrying out the cruise called 'Profumo di Agrumi', whose program included the departure, on January 7, from Savona with six stops in the

Mediterranean before returning to Savona (Italy). On January 13, the ship was departing from Civitavecchia (Italy) to return to Savona. At the time of departure from Civitavecchia, the ship was in compliance with current legislation and in possession of all necessary authorizations and/or certifications.

At 5:27pm UTC of that January 13, Captain Schettino asked the Planning Officer Canessa to change the original route in order to make a closer passage to the Isola del Giglio. The original route, planned by the Coast Management Company for the final route Civitavecchia-Savona and regularly communicated, via ARES message, to the Maritime Authority at 5:21pm UTC, provided to pass about halfway between the Isola del Giglio and the Argentario Promontory. About half an hour before departure Schettino ordered the Planning Officer to draw a new route. The new route was planned using the nautical chart n.6 of the "Istituto Idrografico della Marina Militare", which did not contain the detail of the coast and the presence of any rock formations. The reason for which this change of course has been made, is to do a favor both to the Maître d'Hotel Antonello Tievoli, who would have landed the next day, and to Palombo, a Captain of the Company under whose command Schettino had moved his first steps as an officer.

At 7:01pm UTC, there was a change of the guard on the bridge between the Second Officer Ambrosio substituting the First Officer Iaccarino, who informed him about the change in the route made by the Captain. Captain Schettino was getting ready to go to the restaurant at deck 11 for dinner. Before going to dinner at 7:04pm UTC, Schettino went back on board to look for his cell phone, ordering to Ambrosio to call him on the phone five NM before arriving at the Giglio. At 7:18pm UTC, Schettino called Ambrosio again to ask about the situation and Ambrosio communicated the speed, about sixteen knots, and the estimated time of arrival to Giglio, 8:30pm UTC. At this point Schettino asked to arrive for 8:45pm UTC, in order to finish the dinner with ease.

At 8:19pm UTC, Ambrosio called Schettino to advise him that they were six miles from Giglio, at the time requested by the Captain. Ambrosio immediately after that phone called the Second Engineer Fiorito in the engine room to warn that they were coming to the coast and to decrease the speed of the engine. Schettino did not immediately arrive to the bridge, but showed about fifteen minutes later, when the ship had already traveled four miles and was now 2.54 miles from the coast.

At 8:34 pm UTC, the Captain entered the bridge and asked Ambrosio, who was still the holder of the Guard on the bridge, the speed held at that time, 15.5 knots, and then ordered to put the helm

by hand. The order was immediately executed by the first officer who at 8:35pm UTC, repeated it aloud and immediately ordered the Helmsman Rusli Bin to start the approach. Schettino, although he had not yet formally assumed command of the maneuver, at 8:36:38pm UTC ordered Ambrosio a CPA (Closest Point of Approach - probability of collision between two boats) of 0.5. At 8:38pm UTC, Schettino begun the telephone conversation with Captain Palombo, in which he informed him that the ship was about to pass under the Giglio and asked him if it would be safe to pass under the island with a CPA of 0.3 or 0.4.

At the end of the conversation with Palombo, Schettino took command of the ship, pronouncing the phrase "*Master I ... take the conn*" and straight after Ambrosio repeated aloud "*Master takes the conn*". With the pronunciation of the phrase "*I take the conn*", Schettino became the person in charge of the maneuver and of the operation of the maneuver. From 8:39:31pm UTC, Schettino gave a series of orders to the helmsman, aimed at approaching the Giglio. These orders were repeatedly misunderstood and corrected by Ambrosio and Schettino himself. Just over a minute from the impact on the bridge there was still no sign of tension among officers on the bridge, they joked about the fact that the ship was passing very close to the coast.

At 8:45:07pm UTC, the Costa Concordia, with its 289.59 meters in length and the gross tonnage of 114.147 GT, proceeding at a speed of 14.2 knots, struck with the low rocky bottom at 0.15 miles from the coast, at a depth of about eight meters. The rock cut the hull causing deformations and tears in the area of the left knee, before a section of the boulder was detached remaining stuck between the sheets, thus avoiding cutting the whole side of the ship. The main gash was about 36 meters long. In addition to this, there were five further minor lacerations, four of which as an extension of the main gash and one ahead of the latter (Figure 3). The main laceration affected the watertight compartments from n.4 to n.7 (extremes included), while the minor one produced a waterway in compartment n.8. In some compartments (4, 5 and 6) the speed of flooding was very high, as they were affected for the entire length by the greater laceration, while the one concerning the remaining compartments was smaller (7, only marginally affected by the main gash, and 8, affected by one of the minor lacerations). As a result, since in some of the aforesaid compartments there were machines essential for the functionality of the ship, in a very short time the flooding put out of use the electric propulsion engines, the main diesel-generators and the main electrical panel. The flooding of five contiguous compartments involved the irreparable compromise of the buoyancy and stability of the ship, which would certainly have sunk had the wind not pushed it to lean on the cliff.

Figure 3 - Overview of the impact of the Costa Concordia with the Scole rocks. the points where the ship collides with the rocks are highlighted by red circles (Source: final judgment in the first instance criminal proceedings against Francesco Schettino).

In the seconds following the impact, the ship continued to approach the right due to the inertia caused by the high speed, while in the meantime the alarms concerning the rudder pumps and the main engines for propulsion were activated on the dashboard. At 8:45:17pm UTC, there was a lack of propulsion and only two seconds later the blackout occurred.

At 8:49 pm UTC, there was the first important communication between the Captain and the chief Engineer Pilon, in which the Chief Engineer communicated to Schettino the presence of the leak and the waterway. At 8:51:53pm UTC, began another conversation between the two and Pilon told Schettino about the inability to start the ship because the emergency power system was flooded. Although he had the certainty of the existence of a large flaw, the Captain did not forward any communication to the Maritime Direction of Livorno. Instead, he moved to a wing of the bridge to call Ferrarini, FCC (Fleet Crisis Coordinator) of Costa Crociere, with his cell phone, informing him of the impact and telling him about the situation he had just been communicated from the engine room. At 8:58 pm UTC, while Schettino was on the phone with Ferrarini, Christidis, Staff Captain working alongside Bosio, from the engine room explained to Bosio, on the bridge, that they could not start the pumps because they were underwater. During the phone call, Christidis was joined by Iaccarino who provided him with further information. At 9:00pm UTC, Iaccarino informed the bridge that the PEM and the DGs 1, 2 and 3 are flooded. Since the PEM

and DGs 1, 2 and 3 concerned two different compartments, with this information the bridge was informed that at least two compartments were already affected by the flooding. Despite the seriousness of the news already received on the bridge, the Captain two minutes later told Ambrosio to respond to the Port Authority of Civitavecchia that there had been a blackout, that they needed a tug and that they were evaluating the situation, deliberately omitting to communicate both the existence of the leak and the flooding of the main electrical panel.

At 9:10pm UTC, the third conversation between Schettino and the Chief Engineer Pilon began; Pilon informed Schettino of the flooding of the DG 1, 2 and 3 and DG 4, 5 and 6. The information sent to the bridge just before by Iaccarino (local PEM and DG 1, 2 and 3 flooded, located respectively in compartments 5 and 7), and those supplied by Pilon directly to the Captain in the latter conversation (flooding also of DGs 4, 5 and 6, positioned in compartment 6) confirmed that three adjacent watertight compartments were flooded: this meant that the buoyancy reserve indicated in the on-board documentation had already been exceeded.

A few minutes later the Cruise Director Raccomandato informed that there were a lot of people at the muster stations, revealing their fear of the possibility of accidents and asking Schettino to be able to make an announcement to passengers to gather them in the salons. Few seconds after the announcement to passengers, there was another call from the Livorno Coast Guard (9:13pm UTC): despite the alarming news received directly from the Chief Engineer, Schettino suggested to Bongiovanni (Safety Trainer) not to report the leak and to confirm that the ship had only had a blackout. Conversely, the situation that Schettino painted in Ferrarini few minutes later (9:17pm UTC) was that they had electric engines and two compartments totally flooded, specifying that they were better assessing the situation and that with two flooded compartments the ship would still float. A few minutes later (9:24pm UTC), Iaccarino informed the bridge again that the main engines and the PEM were flooded, stating that the emergency pumps were powerless. At 9:25pm UTC, to the umpteenth call of the Livorno Coast Guard, Schettino reported having a waterway that they were assessing the entity, returning to seek assistance through a tug. Later, from the engine room, officers communicated to the bridge that the water came out from deck 0 and they were evacuating. Immediately after, Schettino again contacted Ferrarini: he was forced to admit that things were getting bad, because there were machine rooms and three flooded compartments. At this point, officers solicited the general emergency, but the Captain explained that he wanted to hear Ferrarini first.

While the Captain began another phone call with Ferrarini, there were moments of extreme excitement in the rest of the bridge. At 9:33pm UTC, Bongiovanni crushed the red button of the general emergency. The whistles of the general emergency (seven whistles of one second each, followed by an eighth whistle of six seconds), however, were not followed by the related announcements foreseen by the Company Procedure.

The excitement on the bridge increased more and more: there were requests for general emergencies and ship abandonment. At 9:45 pm UTC, the Captain said: "*We leave the ship*". There were several voices that replied, almost with relief: "*Let's abandon the ship!*". Schettino, however, immediately stated that it was first necessary to go to the coast but gave permission to start sending some life boats to the ground. The bridge was again contacted by the Livorno Coast Guard (9:38pm UTC) for an update. Canessa provided the requested information, stating that there was a total of 4231 people, including passengers and crew, and confirming that they were affected by a flaw. At this point, urged by Bosio, Schettino agreed to let the life crafts be lowered, even though he did not give the official abandonment order. So Bosio, addressing the Safety, ordered to begin to embark on the life boats and get them out. A few seconds later, someone was asking aloud to give the ship abandonment; Schettino, despite a few moments before he had given permission to lower a few spears, took time, then immediately ordered to lower the anchor and start the abandonment to starboard. At that point, the command bridge (by the Staff Captain Bosio) and muster bridge (through Bongiovanni) began to communicate proceeding with evacuation plans. So, Schettino explained to Bosio that it was necessary to start from the stern life boats, trying to do as soon as possible, before the ship ended up on the rocks, but without personally giving the official order as per the procedure. Immediately after, Bosio communicating with someone on the bridge, asked to be updated on the operations of lowering the starboard life boats, giving the order to board the passengers and to go down with the boats in the water. At 9:54pm UTC, the Staff Captain gave the announcement to leave the ship; at this point Canessa asked Schettino to communicate by radio that they were abandoning the ship and then it was communicated to the authorities who are evacuating the passengers.

Schettino returned to call Roberto Ferrarini to inform him that they were evacuating the passengers and that everything was going well; he also pointed out that the inclination of the ship was twenty degrees, but that it was stopping, and that, even if they were embarking on water, the ship would have run aground in the shallow waters. In the following minutes, after being informed of the position of the ship on the cliff, the Captain told the other officers to follow him off the bridge. So,

they all came out of the command bridge, except for the Staff Captain Bosio, who would still be there for a few minutes to manage contacts with the patrol boats that had come to the scene to provide relief.

Rescue operations ended the day after, January 14, 2012 at around 4:45am, when Canessa left the ship after checking that all passengers and crew members had been rescued from accessible areas.

The Costa Concordia disaster gives the opportunity to investigate how the human factor can affect safety at sea. Specifically, the disaster suggests that the current leadership system, the command and control model, is no more sufficient to guarantee safety both of passengers and crew.

Reading the account of what happened on Costa Concordia, it seems that the Captain was impaired by the impact with the rock and seems to not be able to manage the situation and the amount of information he receives. The Staff Captain seemed to be more active, and able to replace the Captain in his role: he often took the initiative to try to respond to Officers' requests and face the evolving emergency conditions. The Staff Captain realized that the Captain was not able to manage the situation soon after he reached the Command Bridge and decided to take control of the emergency management. The presence of two people being in command created confusion in the crew because even if Staff Captain informally took charge of the emergency management, Captain was still officially in command.

The presence of two leaders slowed the management of the emergency because requests and communications had to be first addressed to the Captain and then turned to Staff Captain, who must wait for any possible order issued by the Captain before making decisions. This dualism was created because the Captain was not totally estranged from the management of the emergency but focused his attention on the relationship with the company.

Captain's behavior suggests interesting insights for investigations in the maritime sector. First, it shows how the command and control model may not be totally effective for the management of maritime emergencies because when the top of the pyramid vacillates, the model is not flexible enough to allow a timely adaptation of the leadership. Second, it highlights the relationship between formal and informal leadership and highlights how the flow of communications is strongly influenced by the dualism formal leader-informal leader. Third, it suggests observing the relationship between ship and company and brings out the presence of critical issues in the

relationship between the captain and the company that reflect on the management of the ship and on the attention to safety.

The Costa Concordia disaster is certainly not the first case in which these problematics are at least partially highlighted by the way crisis following an accident have been managed. In past accidents, for example, the role of the captain as 'God of the ship' has been questioned by the captain himself. In 1991, the captain of the Greek ship M/V Oceanos abandoned his ship that was sinking off the east coast of Africa, while some of the 160 passengers were still on board, leaving a void in command. He claimed he left the ship to better coordinate evacuation from ashore, but he also stated that: "*when I order 'abandon ship', it doesn't matter what time I leave. Abandon is for everybody. If some people are likely to stay, they can stay*"[10].

Even if the captain's statement can be considered a sort of excuse for not respecting the laws, at the same time it represents a first red flag for what then occurred also on the Costa Concordia and in 2014 in Korea, when the Sewol ferry sinks off the South Korean coast, suggesting that much work must still be done.

What makes Costa Concordia disaster a unique opportunity for investigations is therefore the combination of several different factors that contribute to the development of the entire emergency. In particular two important aspects characterize the event itself: crisis of leadership resulting in a crisis of communication, which caused the death of 32 people.

[10] See www.time.com/time/printout/0,8816,973632,00html

References

Akyuz, E. (2017). A marine accident analysing model to evaluate potential operational causes in cargo ships. *Safety Science*, *92*, 17–25.

Akyuz, E., & Celik, M. (2014). Utilisation of cognitive map in modelling human error in marine accident analysis and prevention. *Safety Science*, *70*, 19–28.

Amrozowicz, M. D. (1996). *The Quantitative Risk of Oil Tanker Groundings.* Massachusetts Institute of Technology Cambridge.

Baker, C., & McCafferty, D. (2005). Accident database review of human-element concerns: What do the results mean for classification? In *International Conference - Human Factors in Ship Design, Safety and Operation, RINA* (pp. 65–71).

Barnett, M., Gatfield, D., & Pekcan, C. (2003). Non-technical skills : the vital ingredient in world maritime technology ? *Proceedings of the International Conference on World Maritime Technology*.

Barnett, M. L. (2005). Searching for the root causes of maritime casualties: - Individual competence or organisational culture? *WMU Journal of Maritime Affairs*, *4*(2), 131–145.

Bryman, A., Bresnen, M., Beardsworth, A., & Keil, T. (1988). Qualitative Research and the Study of Leadership. *Human Relations*, *41*(1), 13–29.

Casareale, C., Bernardini, G., Bartolucci, A., Marincioni, F., & D'Orazio, M. (2017). Cruise ships like buildings: Wayfinding solutions to improve emergency evacuation. *Building Simulation*, 1–15.

Celik, M., & Cebi, S. (2009). Analytical HFACS for investigating human errors in shipping accidents. *Accident; Analysis and Prevention*, *41*(1), 66–75.

Chauvin, C., Lardjane, S., Morel, G., Clostermann, J.-P., & Langard, B. (2013). Human and organisational factors in maritime accidents: analysis of collisions at sea using the HFACS. *Accident; Analysis and Prevention*, *59*, 26–37.

Chen, S. T., Wall, A., Davies, P., Yang, Z., Wang, J., & Chou, Y. H. (2013). A Human and Organisational Factors (HOFs) analysis method for marine casualties using HFACS-Maritime Accidents (HFACS-MA). *Safety Science*, *60*, 105–114.

Conrad, J. (1925). *The Mirror of the Sea: Memories and Impressions*. (L. J.M. Dent and Sons, Ed.). London.

Dekker, S. W. A. (2002). Reconstructing human contributions to accidents: the new view on error and performance. *Journal of Safety Research*.

Edwards, E. (1972). Man and machine: Systems for safety. In B. A. P. Associations (Ed.), *Proceedings of British Airline Pilots Associations Technical Symposium* (pp. 21–36). London.

Ermal, X., & Lapa, K. (2010). The role of human fatigue factor towards maritime casualties. *Maritime Transport & Navigation Journal*, *2*(2), 10.

Fayle, E. C. (2006). *A Short History of the World's Shipping Industry*. Routledge.

Furnham, A. (2005). *The Psychology of Behaviour at Work: The Individual in the Organization*. Routledge.

George, R. (2013). *Ninety Percent of Everything: Inside Shipping, the Invisible Industry That Puts Clothes on Your Back, Gas in Your Car, and Food on Your Plate*.

Gomes, C. R., De Brito, C., Boxer, R., & Blackmore, J. (2001). *The tragic history of the sea*. *Society* (Vol. 50). University of Minnesota Press.

Grech, M. R., Horberry, T. J., & Koester, T. (2008). *Human Factors in the Maritime Domain*. CRC Press.

Grech, M. R., Horberry, T., & Smith, A. (2002). Human Error in Maritime Operations: Analyses of Accident Reports Using the Leximancer Tool. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *46*(19), 1718–1721.

Guha-Sapir, D., Below, R., & Hoyois, P. (2009). *EM-DAT: The CRED/OFDA International Disaster Database*. Université Catholique de Louvain, Brussels, Belgium. Retrieved from www.emdat.be

Hawkins, F. H. (1987). *Human factors in flight*. Aldershot, UK: Grower Technical Press.

Hetherington, C., Flin, R., & Mearns, K. (2006). Safety in shipping: The human element. *Journal of Safety Research*, *37*(4), 401–411.

Kaukiainen, Y. (2012). The advantages of water carriage: Scale economies and shipping

technology, c. 1870-2000. In G. Harlaftis, S. Tenold, & J. V. Valdaliso (Eds.), *The World's Key Industry: History and Economics of International Shipping* (pp. 64–87). London: Palgrave Macmillan UK.

Koester, T. (2007). *Terminology Work in Maritime Human Factors: Situations and Socio-Technical Systems*. Copenhagen: Frydenlund Publishers.

Maritime Transportation Research Board. (1976). *Human Error in Merchant Marine Safety*. Washington, DC: National Academy of Sciences.

Martins, M. R., & Maturana, M. C. (2010). Human error contribution in collision and grounding of oil tankers. *Risk Analysis*, *30*(4), 674–698.

Merriam, B. S. (1988). Case study research in education: a qualitative approach. San Francisco, CA: Jossey-Bass.

Messer-Bookman, T. A. (2015). *Maritime Casualties: causes and consequences* (1st ed.). Schiffer Publishing.

National Research Council (U.S.). (1949). *A survey report on human factors in undersea warfare*. Washington.

Patton, M. Q. (2015). *Qualitative research & evaluation methods : integrating theory and practice*. SAGE Publications.

Rizzo, A., & Save, L. (1999). SHELFS: A proactive method for managing safety issues. In *RTO HFM Workshop on "The human factor in system reliability-Is human performance predictabe?"* Siena: RTO MP-032.

Sofaer, S. (1999). Qualitative methods: what are they and why use them? *Health Services Research*, *34*(5 Pt 2), 1101–1118.

Strauss, A., & Corbin, J. (1990). *Basics of Qualitative Research: Grounded Theory Procedures and Techniques*. Sage Publications.

U.S. Coast Guard. (1995). *Prevention Through People*. Washington, DC: Department of Transportation, Quality Action Team.

van Loon, H. W. (1989). *Ships & How They Sailed the Seven Seas, 5000 B.C.-A.D. 1935. [With illustrations.]*. Tynron Press.

Vicente, K. J. (2004). *The human factor: Revolutionizing the way people live with technology*. Routledge.

Yin, R. K. (2014). *Case study research: design and methods* (Fifth edit). SAGE.

Chapter 2 – The Costa Concordia disaster as organizational failure

2.1 Introduction

2.1.1 Theories for the investigation of the human error

For many years, accident analyses within the maritime domain followed an individualistic approach to human error. Failures originating from 'operator error' dominated the main concerns of maritime accident investigators and regulators. Such methods substantially changed following the roll-on/roll-off passenger ferry Herald of Free Enterprise casualty, occurred on March 27, 1978. The ferry was sailing form Zeebrugge (Belgium) to Dover (England). Shortly after leaving the harbor, water started flooding the car decks because the bow doors had been left open. The vessel listed to starboard and the ship rapidly filled with water resulting in the vessel capsizing. More than 190 people lost their lives and many others were injured. The initial conclusion by the company's management was that the ferry sank for one simple reason: one of the crew was sleeping in the cabin and left the loading doors open. However, Goulielmos and Goulielmos (2005) found in their study that not only the error of the crew caused the wreck, but also the company played a role in the disaster. The Herald of Free Enterprise conclusion spread the view that safety widens beyond the individual human error and embraces organizational factors, which in turn influence operator performance. The accident of the Herald of Free Enterprise can be more widely explained with the fact that "*accidents occur because humans who operates and manage complex systems are themselves not sufficiently complex to sense and anticipate the problems generated by those systems*" (Weick, 1987, p. 1). Similarly, some researchers (Davidson, 1990; Keeble, 1991; Roberts & Moore, 1993) argue that the Exxon Valdez accident was the result of a number of policies and behaviors engaged in not only by Exxon Shipping Company but by the State of Alaska, the United States Coast Guard, and Alyeska pipeline.

Accidents occur for a variety of reasons and are the result of basic or root causes, such as inadequate operator knowledge, skills or abilities, or the lack of a safety management system in an organization (Grabowski et al., 2009). Accidents could result from immediate causes or personnel issues, such as a failure to apply basic knowledge, skills, or abilities, stress, situational awareness, communication and training, or organizational and management issues, such as safety culture, safety climate and safety training (Hetherington et al., 2006). Incidents are unwanted events that may or may not result in accidents; accidents are unwanted events that have either immediate or delayed consequences. Immediate consequences could include injuries, loss of life, property

damage, and persons in peril; delayed consequences could include further loss of life, environmental damage, and financial costs (Grabowski, Merrick, Harrald, Mazzuchi, & Van Dorp, 2000). With absent risk reduction measures to interrupt the error chain, basic causes can develop into immediate causes, which can progress into an incident, which can trigger an accident. The key to risk mitigation, therefore, is to introduce risk reduction interventions at appropriate points in the error chain so as to prevent the cascade (Grabowski et al., 2009). Manuel (2017) concludes, after extensive research into ship officers and shipping companies, that achieving continual high safety standards and performance is based on management commitment and a greater consideration of all potential risks, particularly by operators. Events like the capsizing of the Herald of Free Enterprise and the sinking of the Exxon Valdez, as well as many accidents in other complex industries like space navigation (Vaughan, 1997), suggest that the roots of accident causation may be more complex in complex systems, involving non-linear interdependencies among organizational, group and individual factors in the system. In addition, systemic views of risk and accident causation (Hollnagel, 2004; Hollnagel, Nemeth, & Dekker, 2008) view accidents as emergent phenomena that arise from the variability of organizational, group and individual performance, with roots in processes at each of those levels. In all of these approaches to evaluating and assessing risk, however, the need to consider the role of human and organizational error is clear (Popova & Sharpanskykh, 2007; Rasmussen, 1983, 1986, James Reason, 1990, 1997a; Swain, 1987; Swain & Guttmann, 1983; Zuidberg & Vinkx, 2017).

Nevertheless, the idea that a single person or a small group of people are the main cause of accidents is still spread today. It is not uncommon for shipmasters and crew to be blamed and arrested by authorities immediately following shipping casualties. "*From the individual perspective, masters of ships traditionally are compelled to feel ultimately responsible for the vessel and its crew, and in most cases, they expect and are expected to take the blame when things go wrong. In the case of some organizations there is considerable advantage in being able to separate individual fallibility from corporate responsibility. Furthermore, attributing liability to a single source is often seen to be more expedient and desirable. Political pressure also plays a part in this blame cycle. Public outcry may compel authorities to assign blame to people at the operational end of a system, as this is the more visible and easier to identify cause*" (Grech, Horberry, & Koester, 2008, p. 131).

Fortunately, IMO is embracing the view of collective or organizational factors as causes of maritime disasters: in 1997, Resolution 849[11] was adopted to give member states guidance on maritime casualty investigation. The heart of this IMO code actually specifies that casualty investigations should be carried out to identify contributing factors and provide recommendations without apportioning blame or determining liability. On the contrary, often investigations in the maritime domain conclude that people in the operational part of the system failed in their role (e.g., did not follow procedures or missed important information). Some accident reports imply that the individual consciously chose an error prone course of action, further compounding a culture of blame and scapegoating. Dekker refers to this as "*The Bad Apple Theory*" (Dekker, 2013) and provides multiple reasons why regression to the bad apple theory occurs:

- *Resource constraints on investigations. Findings may need to be produced in a few months' time, and money is limited;*
- *Reactions to failure, which make it difficult not to be judgmental about seemingly bad performance;*
- *The hindsight bias, which confuses our reality with the one that surrounded the people we investigate;*
- *Political distaste of deeper probing into sources of failure, which may de facto limit access to certain data or discourage certain kinds of recommendations;*
- *Limited human factors knowledge on part of investigators. While wanting to probe the deeper sources behind human errors, investigators may not really know where or how to look.*

  (Dekker, 2013, p. 6).

The first contemporary theoretical account of organizational vulnerability to disaster was the "*Man-made Disasters*" model (Turner & Pidgeon, 1997) that provided much of the conceptual foundation for all work that has contributed to the present theoretical understanding of industrial catastrophe and crisis as managerial and administrative in origin. The theory starts from the observation that disasters in large-scale technological systems are neither chance events, nor 'Acts of God'. Nor can they be described purely in technological terms. Rather, Turner argued that disasters arise from an interaction between the human and organizational arrangements of the sociotechnical systems

[11]http://www.imo.org/en/OurWork/MSAS/Casualties/Documents/Res.%20MSC.255(84)%20Casualty%20Iinvestigation%20Code.pdf

set up to manage complex and ill-structured risk problems. Indeed, a disaster is defined in the man-made disasters model not by its physical impacts at all, but in sociological terms, as a significant "*disruption or collapse of the existing cultural beliefs and norms*" (Pidgeon & O'Leary, 2000) about hazards, and for dealing with them and their impacts.

Starting from the theoretical background provided by Turner's theory, James Reason (Reason, 1997b) developed a solid and generally well accepted foundation for organizational failure theory and provides some suggestions on how to break free from the blame cycle. He provides some basic facts regarding human performance that need to be observed:

- *Human actions are almost always constrained by factors beyond an individual's immediate control;*
- *Within a skilled, experienced, and largely well-intentioned workforce, situations are more amenable to improvement than people;*
- *People cannot easily avoid those actions that they did not intend to perform in the first place;*
- *Errors have multiple causes: personal, task, situational, and organizational factors.* (Reason, 1997b, p. 128).

"*Complex, well defended, high technology systems are subject to rare but usually catastrophic organizational accidents in which a variety of contributing factors combine to breach the many barriers and safeguards*" (Reason, 2004, p. ii28). According to Reason's '*Human Error Theory*' (HET), better known as the '*Swiss Cheese Model*' (Reason, 1990, 1997b), shown in Figure 4, human errors activate accidents, but these errors embedded in latent conditions that make the disaster possible. Therefore, Reason distinguishes the conditions that brings to errors in '*active*' and '*latent*' (Reason, 1990).

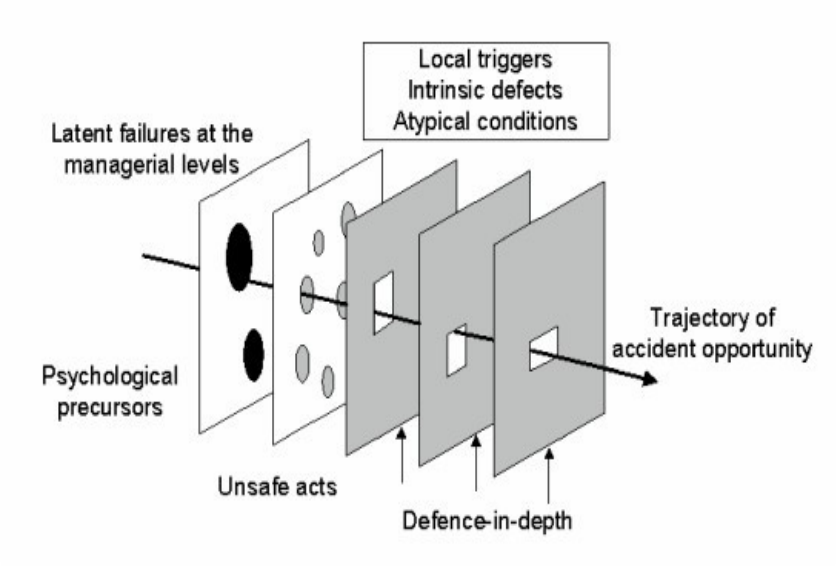

Figure 4 - The dynamic of incident causation, the Swiss Cheese Model, showing the trajectory of accident opportunity penetrating several defensive systems (Reason, 1990)

Active failures result in an immediate failure and these are usually committed by persons at the operational end of the system, the front-line or '*sharp-end*' personnel (such as shipboard crew). Latent failures, on the other hand, usually exist for protracted time and may remain quiescent for long periods prior to activating an accident sequence of events. An important aspect of latent failures is that they arise from high-level decisions, such as decisions made by regulators or ship management companies (Grech et al., 2008; Reason, 1993). In most cases latent failures provide the conditions for active failures to occur. For the most part, active failures on their own do not lead to any major consequences as they are usually captured by the system defenses and safeguards or are managed by the crew. However, these may sometimes surpass system defenses and safeguards and result in an incident or accident. Major accidents always arise from a combination of both active and latent failures (represented as *holes* in the system defenses), that create the *accident trajectory*.

However, prior to Reason, another theory, the '*Normal Accident Theory*' (NAT) (Perrow, 1984), was introduced by Charles Perrow. This theory emphasizes the inevitability of accidents in systems characterized by high complexity and tight coupling. In these organizations, accidents are normal not in the sense of being frequent or expected, but rather in the sense that "*given the system characteristics, multiple and unexpected interactions of failures are inevitable*" (Perrow, 1984, p. 5). It follows that if there is interactive complexity and tight coupling, the system will inevitably produce an accident. Figure 5 provides an overview of the relation among elements in the system

that can lead to accidents. According to Perrow (1984), marine transportation is an error inducing system because of its configuration (e.g. centralized organization and multiculturalism), and defeats the attempt to reduce errors (p. 172). It has a "*catastrophic potential*," and "*is beginning to require changes in organizational structure*" (Perrow, 1984, p. 199). The error inducing character of the maritime system lies in the social organization of the personnel on board (the role that the 'law of the sea' gives to the captain for example), the economic pressures operating (the need, for example, to bring the ship from point A to point B on time at any cost), the coexistence of national and international regulations (too often used to aid the courts in finding fault rather than aiding in avoiding accidents).

Shipping is a relatively simple system, in the sense that a combination of only two or three unsafe actions may be sufficient to bring about a serious accident.

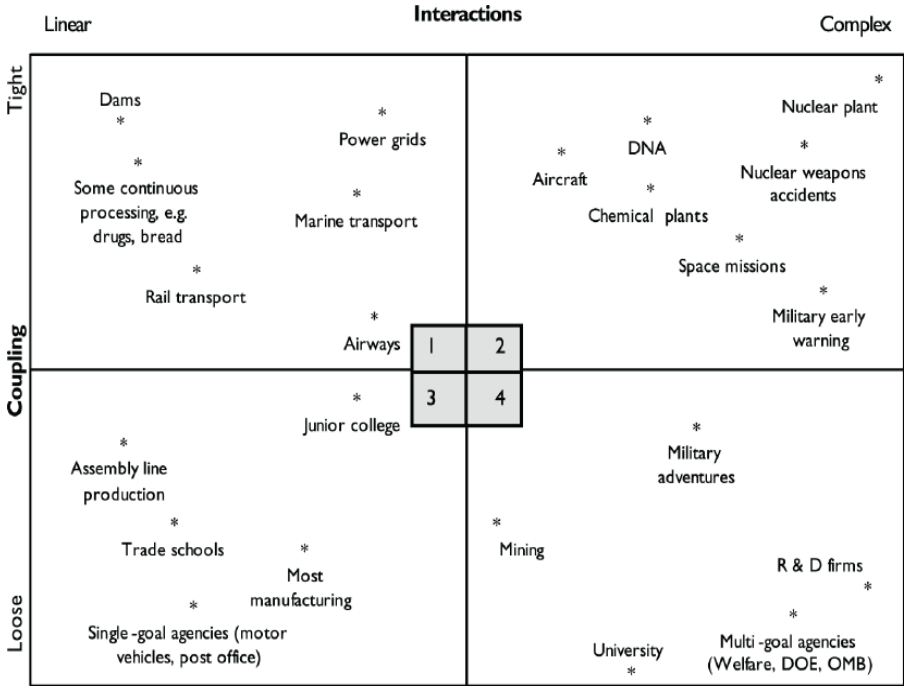

Figure 5 - Interaction/coupling chart at the base for the explanation of accidents in different complex systems (Perrow, 1984)

A step forward in the studies of organizational factors as source of errors was made with the introduction of the '*High Reliability Organizations Theory*' (HROT) (LaPorte & Consolini, 1994; Roberts, 1990, 1993; Roe & Schulman, 2008; Schulman, 1993; Weick, 1987, 1990; Weick & Sutcliffe, 2007; Weick, Sutcliffe, & Obstfeld, 1999). This theory studies successful complex organizations in search of clues for enhanced management of accidents. Researchers seek to detect cognitive and management processes which will enable high-risk organizations to reduce possible

errors and accidents. High Reliability Organizations Theory is applied to a particular type of organizations, High Reliability Organizations (HRO), which are particularly successful in avoiding errors, in sectors where errors might have catastrophic results. Reliability is the ability to constantly and efficiently manage work conditions even if they fluctuate widely and are extremely risky (Weick, Sutcliffe, & Obstfeld, 1999). Weick (Weick & Sutcliffe, 2007; Weick et al., 1999) argues that there are organizations that succeeds in having fewer accidents than expected and he attributes such success to the capacity of HRO to accomplish mindfulness, "*a rich awareness of discriminatory detail*" (Weick & Sutcliffe, 2007, p. 32). In order to accomplish mindfulness, organizations must have the following attributes: preoccupation with failure, reluctance to simplify, sensitivity to operations, commitment to resilience, and deference to expertise. Figure 6 summarizes the concept of mindfulness.

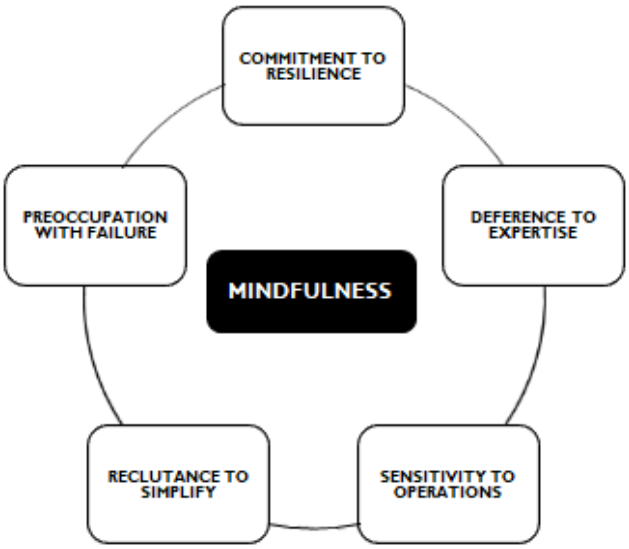

Figure 6 - The five elements characterizing mindfulness according to Weick's High Reliability Organizations Theory

The three theories approach organizational failure in different ways – HET and NAT focus more on failure, HROT focuses more on success – "*the difference in emphasis found in the tradition of studying failure and studying success naturally leads those who study failure to be pessimistic about the perfectibility of operational controls, and those who study reliability to be optimistic*" (Busby, 2006, p. 1378). Thus, the various theories should be combined (and not opposed) to study organizational factors in accident. Indeed, despite their theoretical and methodological differences, the three theories emphasize that failure has organizational roots.

2.1.2 Costa Crociere Company Safety Regulations

Costa Crociere is subject to IMO regulations as all the cruise companies. Specifically, the ISM code is concerned with setting safety standards on board for the specific purpose of ensuring safety at sea, preventing risks, guaranteeing the safety of people on board, and at the same time avoiding damage to the ship and safeguarding the environment. In other words, the ISM Code sets the foundations of safety culture. The ISM Code simply sets objectives and formulates general principles; therefore, the individual companies have the responsibility for adopting on-board safety management systems. In order to adhere to IMO requirements, Costa Crociere has developed a set of procedures in the Safety Management System (SMS) manual, called protocols, to face different kind of emergency and crisis.

ISM MAN 01 SMS – MANUALE SISTEMA DI GESTIONE AZIENDALE

This handbook defines the company general policies. In paragraph 5.5.3 it is specified that the possibility to properly communicate onboard is a priority to guarantee safety and the company only hire people able to communicate among them and understand orders during emergencies. The working language onboard is Italian, but key officers are required to know English, to have the possibility to communicate with foreign ships and foreign States in emergency.

P12.04 IO 01 – Compilazione del Ruolo d'Appello – Muster List

The procedure provides the standard to draw up the muster list, the table in which the safety officer reports the role assigned to each crew member for each of the possible emergencies (which can go from man to sea to ship abandonment, passing through fire and leak alarms and for the general emergency) and for which is appropriately trained. In addition to the role, the muster list reports the area of the ship to reach and the place to occupy in the area for each crew member. The captain is responsible for the implementation of the procedure, in collaboration with the safety officer, while the company is responsible for verifying crew members in the list are properly prepared for their duties. The muster list must be activated by the captain using proper signal for each emergency; only after the specific signal is issued crew members can perform their duties.

P12.04 IO 02 SMS Gestione sicurezza a bordo – Istruzione operativa – Decision support system for master

The protocol indicates the guidelines for the main operations necessary in case of emergency, providing a specific listing of the duties and conduct of each crew member. This procedure reiterates that the primary task of crew in the face of an emergency, is to safeguard the physical

integrity of the people on board, summarized in the maximum "*Safety First*" (i.e. safety first of all). The integrity of the ship and the economic needs of the shipowner as well as the protection of the environment come, therefore, after the safety of the people on board. The document contains a flowchart for the possible emergency scenarios that can possibly occur and that guides the captain to make decision in each step of the emergency.

P14 – MAN 01 SMS – Bridge Procedures

The procedure establishes that the officer on watch is still responsible for the safety and navigation even if the captain is present on the command bridge, unless the latter informs him expressly that he has taken over this responsibility. It also establishes that crew members must challenge decisions made by the captain that may affect safety and report any doubt during the navigation.

P15.6 IO 01 – Crisis Management Preparedness Plan – Operational & Reporting Procedure

This procedure aims at assisting personnel to adopt proper communications procedures before, during and after any crisis. The specific purposes of this plan are: define figures both on the ship and shore side that are responsible for and engaged in communication; establish a precise flow of communication during the crisis; provide the necessary technical and operational support to the vessel during an emergency situation. Two important figures in the emergency are the Ship Crisis Coordinator (SCC), in charge for all communications with the company and the Fleet Crisis Coordinator (FCC), who keeps the contact with the ship during all the crisis. The captain has the role of SCC, but he can delegate communications to the staff captain, the safety officer, or another ship officer (who always acts under the direct coordination of the captain), in case he is engaged in other activities connected with crisis management.

The procedure also envisages the establishment of an on-board crisis unit, the Crisis Committee Shipside (CCShip) mandatory for collisions and composed of the captain, the staff captain, the chief engineer, the hotel director, the SCC and, if necessary, other crew members. At the same time an on-shore crisis unit must be established a crisis unit, the Crisis Committee Shoreside (CCShore). The purpose of these crisis units is to guarantee the circularity of information, coming from the sectors of competence of each component, in order to better manage the current crisis.

2.2 Aim of the study and research questions

Many theories applied to the investigation of accidents tend to classify accidents in complex systems as a combination of failure at different levels, rather than focus the blame on the error of

a single individual. The IMO Resolution.A884 (21) (IMO, 2000) focus on the investigation of human factors as an instrument to investigate maritime casualties. The resolution provides a systematic approach to considering the human element, based on established human error frameworks and provides a guideline for the analysis of accident in complex systems as a combination of active failures and errors at the sharp end.

The Italian law, the "Codice della navigazione", Costa Crociere protocols and the ISM code provided by IMO, define the captain as the highest authority on the ship. In addition, Costa Crociere procedure P14.01 SMS Bridge Procedure, formally requires that any crew member aware of the risk associated with a decision made by the captain, challenges his decision. Costa Crociere procedure P16.01 SMS Crisis Management Preparedness Plan Operational & Reporting Procedures, establishes the figure of the Fleet Crisis Coordinator (FCC), as representative of the company in charge of helping the captain make safety-related decisions during emergencies.

In order to understand if the Costa Concordia accident is the result of errors made by a single person or a combination of errors at different levels, sub hypothesis 1 is tested.

> Sub hypothesis 1: Individual, group and organizational errors caused and fueled the emergency.

Documents of the trial against Francesco Schettino, the captain of the Costa Concordia, are collected to answer the following research questions:

- To what extent actions of single individuals contributed to the emergency?
- To what extent actions of groups contributed to the emergency?
- To what extent decisions made at the organizational level contributed to the emergency?
- Do the actions and decisions at the individual, group and organizational level influenced each other and contributed to the emergency?

Answers to these questions may help to widen the knowledge to maritime accident causation and may provide a starting point for further research on the study of the maritime system as complex system. This approach may help to define efficient strategies to learn from errors and increase the resilience of maritime organizations.

2.3 Methodology

Evidence of the accident of the Costa Concordia have been directly accessed and collected thanks to the kind permission of the Court of Grosseto, in charge for the trial against captain Francesco Schettino that started immediately after the accident and ended on May 12, 2017. The Court of Grosseto released a digital copy of the official documents used in the trial. Documents collected are related to the first phase of the trial, ended on February 11, 2015. Such choice is intentionally made for the following reasons: 1) people related to the accident and called to testify may add or remove details from the report of the accident in order to respond to specific needs of the trial, 2) the nature of the research requires as much detail as possible and human mind tends to remove details about something that happened during time (Greco, 2010). Collecting information recorded soon after the accident allows to minimize the memory factor.

Document analysis has been chosen as method for the study because in-person interviews with people under investigation has not been possible. Document analysis is a process of evaluating documents in order to produce empirical knowledge and develop understanding (Bowen, 2009). Furthermore, as Merriam (1988) pointed out "*documents of all types can help the researcher uncover meaning, develop understanding, and discover insights relevant to the research problems*" (p. 118).

The documents consist of 1590 pages, divided in three categories:

- First Technical Report redacted by the Court of Grosseto, released on September 2012 (271 pages)
- 35 written depositions of the officers (higher levels) and 1 deposition of the FCC, collected by the Court of Grosseto between February 2012 and December 2014 (766 pages)
- Final judgement of the trial against Francesco Schettino, released on February 2015 (553 pages)

The data used in the qualitative study are analyzed using a multilevel (micro, meso, macro) analysis model pointing out failures at different levels which jointly caused the accident:

- Individual level: actions of the single person at the 'sharp end'
- Group level: actions of a team working at the 'sharp end'
- Organizational level: latent factors related to choices made by the organization
- Cross-level: helps to explain interaction of the three above mentioned levels

Actors names and roles can be freely used in this research, thanks to the permission of the Court of Grosseto and are summarized in Appendix I to this chapter. Therefore, there is no anticipated risk for this analysis.

Documents are analyzed qualitatively, using the software Atlas.ti, a proprietary software that allows to analyze complex phenomena using unstructured data (texts, videos...). Secondary data can be analyzed through the attribution of codes that represent the attributes to be searched in the document and that allows to determine the meaning of words and group each part of the document into different categories and obtain results. The definition of the codes is taken from the literature on human error, in particular, from Reason's categorization of human factors contributing to accidents (Reason, 1997b, pp. 61–83) and Weick and Sutcliffe definition of mindfulness (Weick & Sutcliffe, 2007, pp. 9–18). A preliminary exploratory analysis (Creswell, 2002) was conducted to obtain a general sense of the data's content and direction. The preliminary exploratory analysis provided general orientation to data trends and confirmation of the presence of enough data to continue the analysis. The typological data coding method was employed for the analysis. This method requires to divide data sets into groups using typological categories in order to find patterns and develop themes (Hatch, 2002).

2.4 Results

The analysis shows that a combination of different errors made on the ship and latent conditions contributed to cause the disaster and characterized the whole emergency.

2.4.1 Codes and Themes of the analysis

The initial coding effort found 15 total code words. After reviewing the documents for the second time, codes were revised, and the number decreased to 14. A summary of the codes is reported in Table 1. Four main themes have been defined in order to answer the research questions. In addition, five more themes emerged from the texts.

*Table 1 - Codes and themes. Main themes are identified with the symbol +, while emerging themes are identified with the symbol *.*

Initial codes	Final codes	Themes
Commitment to resilience	Commitment to resilience	Individual contribution+
Correct performance	Correct performance	Group contribution+
Correct compliance	Correct violation	Organizational contribution+
Correct violation	Deference to expertise	Mutual influence+

Correct improvisation	Improvisation	Communication*
Deference to expertise	Lapse	Expectation*
Knowledge-based mistake	Latent condition	Improvisation*
Lapse	Mispliance	Leadership*
Mispliance	Misvention	Teamwork*
Misvention	Preoccupation with failure	
Mistake	Reluctance to simplify	
Preoccupation with failure	Rule-based mistake	
Reluctance to simplify	Sensitivity to operations	
Sensitivity to operations	Slip	
Slip		

Figure 7 represents a summary of the sequence of relevant errors and facts related to the Costa Concordia and shows how they all are interrelated, reported in chronological sequence.

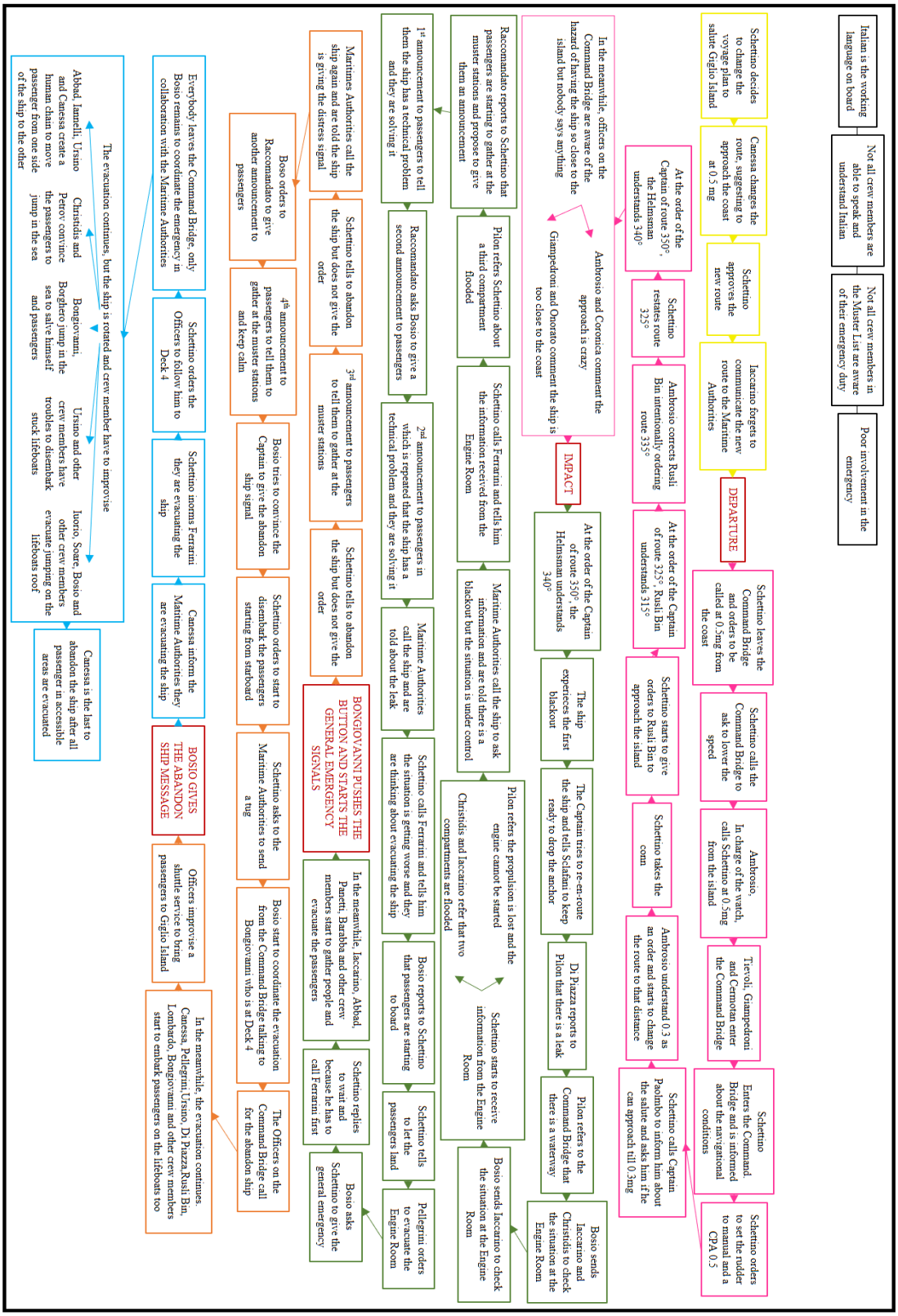

Figure 7 - Conceptual map of active failures and latent conditions in the Costa Concordia accident. The different colors of the boxes indicate the different stages of the emergency: Latent conditions are reported in black, active failures before the impact are in yellow boxes, active failures between the impact and the general emergency are in pink boxes, active failure between general emergency and abandon ship are in green boxes, active failures after the abandon ship are in blue boxes.

2.4.2 Individual contribution

Fourteen main mistakes were made and contributed to the emergency from the departure at individual level.

The first error was made by Captain Schettino because he allowed the ship to start the voyage with an incomplete Muster List. As the Safety Trainer Bongiovanni declared: "*At the moment of the accident the most important phases had been completed, but some roles were missing*" (Safety Trainer's deposition, 01-27-2014, p. 21).

The second error was made about 30 minutes before the departure by Captain Schettino when he decided to change the original voyage plan, without notifying local authorities. The legislation did not prohibit approaches if made in safe conditions, but the 'inchino' was regulated by informal procedures, so as stated by the captain "*the captain is entitled to change the route, but he does not have the obligation to inform the owner*" (Captain's deposition, 12-02-2014, p. 12). However, the First Officer Iaccarino added that "*in the twelve-hour journeys the Italian system requires that the route be communicated to the maritime authority, to which therefore the route was fifteen miles from Giglio and not half a mile [from the island]*" (First Officer's deposition, 10-07-2013 p. 13).

The third error was made by the Planning Officer Canessa when he suggested the Captain to sail at a distance of about half a mile from the Giglio Island, sure that the distance was sufficient for a safe navigation: "*Can we... Captain, half a mile is good from… that port? So, there is the depth here, right?*" (Final Judgement, 02-11-2015, p. 133).

The fourth error was committed by the captain, when he approved the new plan without making sure the Planning Officer changed the route using the wright maps, as required by the SOLAS Convention. Both the Captain and the Planning Officer confirmed the captain approved the new route. The Planning Officer declared that "*The new route has been checked and approved by Schettino"* (Planning Officer's deposition, 10-08-2013, p. 14), and the Captain confirmed "*the route planned by Canessa has been approved by me*" (Captain's deposition, 12-02-2014, p. 12).

The fifth error was made by the First Officer Iaccarino. His duty was to inform the Maritime Authority about possible changes made to the planned voyage. On January 13, the officer forgot to inform the authorities: "*It was my duty to communicate to the maritime authorities variations of the route […] I should have communicated the variation, but I forgot*" (First Officer's deposition, 10-07-2013, p. 21).

The sixth error was committed by the Second Officer Ambrosio, Chief Officer of the Watch (COOW), when he allowed the captain to give orders before he officially took the command, executing his orders and keeping giving orders after the Captain officially took the command. As stated by the COOW:

> *As Schettino arrived [on the Command Bridge], the first activity was to turn the command into the manual mode […] At that moment I thought I had been relieved of my command even though the Captain had not pronounced the formal formula, in English, expected in case the command was taken. […] Once the helmsman went to the rudder no one remained on the lookout, I did not object*
> (Second Officer's deposition, 12-17-2013, pp. 14-15).

After the Captain took the command, the COOW kept giving orders, ordering the Helmsman to change the route first and reinforcing the lookout later:

> *I told the Helmsman 335 instead of 315 [degrees] not for mere mistake but because I thought I was facilitating the approach. […] After the first error by the Helmsman I ordered Ursino and Iannelli to move behind him, the Captain did not say anything in this regard*
> (Second Officer's deposition, 12-17-2013, p. 17).

The seventh error was made by the Helmsman, because he misunderstood the orders received by the Captain:

> *The order '325' of Captain Schettino, however, is not well understood by the Helmsman who answers with '315'. Ambrosio intervenes immediately to correct the helmsman by saying '335' but, Schettino intervenes by reiterating '325'. At this point the Helmsman correctly understands and repeats '325'. […] After few seconds [Schettino] orders '350' but the Helmsman does not understand for the second time in fact he replies with '340'*
> (First Technical Report, 09-11-2012, p. 82).

The eighth error was made after the impact by the Staff Captain Bosio when he decided to send Iaccarino first and Christidis after, to check the situation in the Engine Room, role attributed to him by Muster List:

> *I ordered Christidis and Iaccarino to go to deck zero and check; I did not go personally because I thought this was the right decision, Iaccarino knew the ship perfectly and Christidis was expert, even more than me, and he would have replaced me in a few hours, so I thought my choice was correct*
> (Staff Captain's deposition, 02-11-2014, p. 12).

The ninth error was committed by the Captain because he did not alert the maritime authorities at first and provides them wrong information:

> *The maritime authority, the Port Authority of Livorno, asked us through channel 16, news about the state of the ship, I replied what I was ordered by the Captain, that we had a blackout on board and that we were verifying the situation; at that moment we were already aware of the presence of the waterway*
> (Safety Trainer's deposition, 01-27-2014, p. 22).

The tenth error was committed by the Safety Officer Pellegrini when he gave the order to abandon the engine room before the general emergency and the abandon ship signals had been given: "*I gave the instruction to abandon the engine room.*" (Safety Officer's deposition, 12-10-2013, p. 17). The Staff Engineer confirmed the instruction was given by the Safety Officer: "*Pellegrini told us to leave.*" (Staff Engineer's deposition, 11-12-2013, p. 21).

The eleventh error was made by the Captain because he lingers to activate the Muster List. As reported by the Captain "*I should have given the leak emergency, I did not do it because in the meantime two long whistles were sounded as it was the leak emergency, and then I thought it was given. […] The vibration has alerted the passengers, it actually substituted the leak alarm*" (Captain's deposition, 12-02-2014, p. 17). With regard to the general emergency the Planning Officer reported that:

> *After we suggested him to give the general emergency, [the Captain] isolated himself by moving away from us and began to make phone calls, disregarding our suggestions […] It was requested continuously, until a couple of times we were there to give the general emergency, but then the order was suddenly canceled with a sort of on again, off again*
> (Planning Officer's deposition part II, 10-08-2013, p. 34).

The Cruise Director Raccomandato explained how the Captain made the decision to give the general emergency:

> *I remember that we came to give the general emergency after a series of requests, including those of the alarms that were constantly sounding, Bosio spoke with Schettino and they came to this decision, also because many officers kept begging it loud enough. I remember that Bosio insistently asked to give the emergency, and the officers too begged it loudly*
> (Cruise Director's deposition, 11-25-2013, p. 20).

The abandon ship emergency was given by the Staff Captain as declared by Second Officer Ursino: "*The order to abandon the ship was given via intercom from the Command Bridge, the voice was that of Bosio; as a rule, the order must be given only by the Captain.*" (Second Officer's deposition, 10-28-2013, p. 16).

The twelfth error was made by the Safety Trainer Bongiovanni because he pushed the button used to give the general emergency before the Captain gave him the order "*When the situation started to fall, I claimed the general emergency, also because the passengers were already on the M[uster] S[tations], so I instinctively pushed the general emergency button, although no one had given me the order to do so.*" (Safety Trainer's deposition, 01-27-2014, p. 22).

The thirteenth error was made by the Staff Captain because he gave the abandon ship signal, which is a Captain's duty: "*I gave the abandon ship many times.*" (Staff Captain's deposition, 02-11-2014, p. 15).

The Fourteenth error was made by the Captain because he has not been the last person to abandon the ship. As the Second Officer Canessa reported: "*When everyone was safe, I was the last one to abandon the ship at around 04:45, after I verified that nobody remained on board, at least in the accessible areas.*" (Second Officer's deposition, 03-01-2012, p. 7).

2.4.3 Group contribution

Errors at group level can be found in all the stages of the emergency.

As reported by the Second Officer Ambrosio, the officers on the Command Bridge were aware of the dangerousness of the approach maneuver but failed in advising the Captain: "*We made some comments in Neapolitan; we thought [the maneuver] was crazy.*" (Second Officer's deposition, 12-17-2013, p. 12). Similarly, the Hotel Director Giampedroni repored that: *"... on the wing I found the maître Ciro Onorato, with him I commented that the ship seemed too close to the rocks, Ciro told me that Schettino was good, but I replied that we were too close anyway and in fact [the ship] immediately impacted*." (Hotel Director's deposition, 04-15-2014, p. 12).

After the impact officers started the emergency procedures before orders were issued. Second Officer Ursino declared:

> *Many passengers, even before the order of abandonment, had already taken place in the [life]boats; this is not a regular procedure since the sequence requires the evacuation of the cabins, the gathering*

of passengers and then their boarding in the lifeboats, that only at that point can be disembarked. This still presupposes the order of abandonment

(Second Officer's deposition, 10-28-2013, p. 16).

First officer Iaccarino declared that "*My colleagues and I worked [to help passengers] even before the emergency signal was issued.*" (First Officer's deposition, 10-07-2013, p. 19). Second Officer Canessa testified that he was working with other officers:

[…] I took command of the operations of the lifeboat n.10 by letting some people get out, ordering those who remained to move on the left side, at the same time ordering Borghero and Garrone to release the brakes of the suspension cables.

(Second Officer's deposition, 10-08-2013, p. 6).

The Cadet Sanitation officer Iannelli reported that: "*We heard that on starboard it was still possible to disembark passengers so Ursino, Canessa and I organized a human chain in order to move people towards the starboard side […]*" (Cadet Sanitation Officer's deposition, 11-11-2013, p. 15). Second Officer Ursino testified that:

Two rafts got stuck, I went down on deck four and climbed on a tender that had recovered Bongiovanni, who had jumped the water, and with this I managed to unhook the stuck rafts, then I went back on board while my colleagues kept inflating the rafts, trying to land as many people as possible

(Second Officer's deposition, 10-28-2013, pp. 16-17).

The Director of Services Barabba describes how his group managed the situation:

An Indian passed me a rope, I threw one end inside the passage, that now was a pit, and I started to pull up people; I asked Mario Pellegrini to give me a hand and together with the doctor we started to pull them up

(Director of Services' deposition, 11-26-2013, p. 28).

Chief Radio Officer Spadavecchia described the tender service improvised during the emergency: "*I disembarked [passengers], but I kept the 'paranchisti' since I had the intention to go back; I also embarked my assistant who was on the dock, so we came back alongside to save as many people as possible.*" (Chief Radio Officer's deposition, 11-18-2013. p. 18). First Officer Iaccarino provided a similar description: "*I drove my tender to the port of Giglio, I disembarked my passengers and some crew members who were panicked, I embarked 4 Giglio fishermen and we went towards the ship, on the way we recovered some people who had jumped into the water.*"

(First Officer's deposition, 10-07-2013, p. 24). Chief Engineer Pilon reported how he adapted to the situation: "*We noticed Iaccarino and others who were helping, so we did the same, so we climbed on the lifeboat and we landed, and then we returned to the ship to embark the passengers*." (Chief Engineer's deposition, 11-18-2013, p. 23).

2.4.4 Organizational contribution

The company's contribution to the emergency is attributable to a lack of conformity with laws compliance.

According to the company's procedure ISM MAN 01 SMS, the working language on board ships was Italian. Different officers reported that many crew members had troubles understanding and speaking Italian, so other languages were used on board. The Captain reported that "*On board certainly Hispanics and Rumanians spoke good Italian, a good part of the crew were Asians who did not even speak English that well, let's say that they were able to make themselves understood and knew the ritual phrases*" (Captain's deposition, 12-11-2014, p. 14). The Safety Officer referred that "*Part of the personnel did not speak Italian, it happened that some of them were not even able to speak English or Spanish*." (Safety Officer's deposition, 12-10-2013, p. 19), and the First Officer Electrician affirmed that "*The electricians in my team were not all Italian, I used to communicate in English or Spanish with them*." (First Officer Electrician's deposition, 11-18-2013, p. 13). The First Officer added information about training procedures: "*The training took place in a language that was understandable to the staff, so the messages were divulged in Spanish for one group and English for the other*" (First Officer's deposition, 10-07-2013, p. 23).

With regard to training, the Captain reported that the company did not ensure a proper preparation:

> *Crew training is necessary and must be continuous; at the time of the events there were a number of changes taking place in the staff that was often replaced for economic reasons, I had also written a letter in which I expressed my doubts about the preparation of the crew. […] I sent comments about the training and progression of staff to the company, but I never received any answers*
> (Captain's deposition, 12-02-2014, p. 17).

The investigations carried out by the Court of Grosseto confirmed Captain's words: "*Captain Schettino reported with regard to the 'general drill' of October 15, 2011 a sufficient but worsening crew preparation that highlights some critical issues; in this regard, there is no evidence of an analysis by the company and the possible adoption of corrective measures.*" (First Technical Report, 09-11-2012, p. 51). The Captain also added that "*Costa's staff could sometimes not have*

the appropriate experience for the various career advancements, I thought in fact that the officers had a too fast career [progress]." (Captain's deposition, 12-11-2014, p. 16).

Another error made by the company was the failure to ensure that ships procedures were complying with the company's principle of "*Safety First*" stated in the P12.04 IO 02 SMS procedure. In particular the First Technical Report redacted by the court of Grosseto reported that the company failed to control that the officers embarked (that had an emergency role) were aware of their duties:

> *The immediate inclusion in the 'Muster List', in the absence of adequate familiarization with the assignment in case of emergency, according to the procedures dictated by the Management Company, and the shortcomings on the training of the above-mentioned crew, have had a negative reflection on the preparation and efficiency of the crew as emerged from the following testimonies:*
>
> - *Remiggi and Pilon have shown that they do not know their role as from Muster List;*
> - *the 3rd Engineer Nicotra, has demonstrated the partial knowledge of his duties in case of emergency;*
> - *the 3rd Engineer Di Piazza reported that he did not know the ship's depletion plants, and that he did not know exactly the task assigned by the Muster List;*
> - *Pellegrini, Petrov, Gennaro and Fiorito are convinced that they have different tasks than those reported in the Muster List;*
> - *Di Lena and Garrone have no proper knowledge of the lifeboat or raft where to embark*
>
> (First Technical Report, 09-11-2012, p. 52).

In addition, in the Final Judgement of the trial is reported that "*no personnel were assigned to the operation of the raft 34, motorists were not provided for lifeboats n.25 and n.26.*" (Final Judgement, 02-11-2015, p. 115).

The company had an active involvement in the emergency through the figure of the FCC, who's duty is to support the captain, as stated in the P15.6 IO 01 procedure. The Captain complaint "*I do not think I received adequate support from the crisis unit*" (Captain's deposition, 12-11-2014, p. 14). Captain's testimony is supported by the FCC who declared that: "*Our attitude was to allow the Captain to manage the emergency in full autonomy.*" (Fleet Crisis Coordinator's deposition, 04-14-2014, pp. 16). "*I did not advise the Captain, I should not have done it. The crisis unit gives general support.*" (Fleet Crisis Coordinator's deposition, 04-14-2014, p. 20).

2.4.5 Mutual influence

Errors at individual, group and organizational level influenced each other and contributed to the emergency. Lack in communication is indicated by the Captain as being the cause of the disaster: "*The genesis of the disaster has been some nonsense, it would have been sufficient talk and make things clear.*" (Captain's deposition, 12-02-2014, p. 13). The company has a role in this lack because it employed personnel unable to speak the work language and allowed these people to be added in the Muster List and have emergency roles. In this sense, the First Engineer Petrov when asked if he is totally able to understand emergency orders in Italian replied: "*Not hundred percent.*" (First Engineer's deposition, 03-20-2012, p. 4). Some Crew members were reported not to be aware of their role during the emergency and this added confusion during the emergency. The Safety Officer said: "*I don't know if my lifeboat has been put in water or not, I was busy with the other lifeboats.*" (Safety Officer's deposition, 12-10-2013, p. 20).

The company's attitude towards work influenced the behavior on the ship. The relationship between company and ship is reported in an episode happened eight years before the accident:

> *There was an episode in which a Captain was reprimanded for having given the alarm too early; I remember that in 2004, while I was in Genoa, I heard Captain Palombo yelling on the phone, he had given the emergency signal after a strap, during the maiden voyage with the journalists on board, had produced smoke and had created chaos, I remember that Foschi*[12] *had blamed Palombo precisely because he acted too hastily*
>
> (Captain's deposition, 12-11-2014, p. 15).

The Captain felt the pressure of the company on his role and felt he did not receive the adequate support from the company. In this regard, the Staff Captain highlighted Captain's feelings soon after the impact: "*The Captain told me 'I goofed now they're firing me', so I realized that I had to take the situation in because I realized that Schettino was in trouble.*" (Staff Captain's deposition, 02-11-2014, p. 12). The Second Officer Canessa reported that the Captain "*Seemed lucid and aware of what he was doing, even if it seemed he did not want to accept the situation.*" (Second Officer's deposition, 03-01-2012, p. 5). The Staff Captain Christidis also testified that "*The Captain seemed to be lucid, master of his own self, but static, as he was waiting for something.*", and he adds that: "*Maybe in that moment it would have been better to make Bosio understand he*

[12] Costa Crociere's former CEO

understood correctly the information [about the situation]". (Staff Captain's deposition 11-19-2013, p. 22). The Cruise Director Raccomandato reported:

> *I remember that before the general emergency announcement, since the Captain was not close to me, I addressed to Bosio who confirmed to me that the passengers has to be sent to the MS and had to wear the jacket. I turned to Bosio because he was the second in command and he was close to me and could pay attention to me. I thought the Captain, who was on the phone, had more to do than talk with me, so I turned to Bosio*
>
> (Cruise Director's deposition, 11-25-2013, p. 19).

Finally, the distance between the company and the captain also influenced communications with maritime authorities. According the ISM P12.04 IO06 SMS procedure, maritime have to be informed by the captain in case of emergency, or alternatively they can be informed by the FCC. Captain Schettino told Ferrarini he did not inform the authorities "*I called the company to tell them about the incident, Ferrarini asked me who I had informed, and I replied that I had only called him.*" (Captain's deposition, 12-02-2013, p. 18); nevertheless, Ferrarini said that the Captain:

> *… informed me that he had a big problem having hit a big backdrop. I noticed that he was quite excited, and I tried not to exasperate his concern. He told me that he still had to do the risk assessment and he synthetically justified why he was in that position, even if at the time I did not give importance to the thing*
>
> (FCC's deposition, 04-14-2014, p. 14).

2.4.6 Communication

Communication at different levels is reported to have played a role in the emergency since the departure. The Captain reported that before the departure "*I did not ask anything to Ambrosio also because I thought that we were much further than the real position*" (Captain's deposition, 12-02-2014, p. 14). He also stated that "*The genesis of the disaster was a foolishness, it was sufficient to talk and clarify, and I thought about that for all this time*" (Captain's deposition, 12-02-2014, p. 13), and about his officers added that:

> *I gave orders and I decided to move to 0.5 [miles], it is unthinkable that such an event occurred because they have not spoken, and I cannot think that they have let me go on the rocks without saying a word. The negative enchantment that had occurred on the bridge broke the moment I spotted the foam*
>
> (Captain's deposition, 12-13-2014, p. 13).

The Second Officer Ursino reported problems in understanding between the Captain and the Helmsman due to communication barriers:

> *After a few minutes the Captain gave the first order indicating the route 300, the Helmsman started to put the helm to starboard to reach the required route, the orders were formulated in English, because the helmsman did not speak Italian. [...] so the Captain ordered 320, I remember that also the second order was misunderstood by the helmsman but also in this case he was promptly corrected* (Second Officer's deposition, 10-28-2013, p. 13).

During the emergency, communications were not properly provided to the maritime authorities. The Environmental Officer illustrated the lack of communications with the authorities: "*The leak alarm was not given, nor the Captain ordered to call the Coast Guard. When they called, Schettino instructed Canessa to answer that we were solving our problems and that everything under control. They also spoke about a blackout*." (Environmental Officer's deposition, 11-25-2013, p. 30). The Cruise Director explained how communications with the Costal Guard were managed: "*I remember a communication of the Coast Guard with Ambrosio. He hung up the phone because he did not know what to say*." (Cruise Director's deposition, 11-25-2013, p. 21). The Safety Officer also confirmed the intermittence of communications with the maritime authorities: "*A the beginning Schettino did not share the information about the collision with the maritime authorities.*" (Safety Officer's deposition, 12-12-2013, p. 18).

Inversely, communications with the Company were constantly ensured. Captain Schettino stated that he "*Transmitted to Ferrarini the information that the electric panel was flooded*" and he also added that he "*did not considered important to tell my officers such datum because I erroneously associated the electric panel astern.*" (Captain's deposition, 12-02-2013, p. 18). The Fleet Crisis Coordinator reported that "*I received a fifth call from Schettino, at 10.33pm*[13]*. The call was particularly serious because Schettino communicated the intention of evacuating the ship; the role of the company in this phase was only marginal to not interfere with the Captain's autonomy.*" (Fleet Crisis Coordinator's deposition, 04-14-2014, p. 15). Even if information was provided to the company, there have been misunderstandings between the captain and the FCC, and in this case, communication was not properly ensured to overcome difficulties. The FCC referred that "*I did not ask if the ship was drifting, the Captain had been clear saying that he was going to anchor [the*

[13] UTC time

ship] and this reassured me, although the sentence pronounced [by the Captain] 'for a while' we are not going down." (Fleet Crisis Coordinator's deposition, 04-14-2014, p. 13).

On board the ship communications were also intermittent. The Planning Officer declared that after the impact "*Iaccarino was referring to Bosio about the flooding in the engine room, more precisely in the generators room of the bow, stern and PEM (compartments n° 5, 6, 7). Bosio took note of the communication but gave no instructions to Iaccarino.*" (Planning Officer's deposition, 03-01-2012, p. 4). The First Officer Iaccarino confirmed that "*there were no communications via intercom nor we had received any kind of indications from the bridge. Therefore, I was convinced that the situation was under control. I was sure that the ship was about to sink but I thought that rescue had already intervened.*" (First Officer's deposition, 10-07-2013, pp. 16-17). The Staff Captain Bosio reported that "*The other officers were invoking the emergency signal, they asked me to insist with the Captain. I agreed, and, in this sense, I was putting pressure on the Captain, who kept saying 'wait, wait'*" (Staff Captain's deposition, 02-11-2014, p. 13). The Administrative Director Nonnis stated that during the emergency "*I had the radio, but I did not use it to communicate because I did not have the time, our only concern was to throw the passengers inside the life boats.*" (Administrative Director's deposition, 11-26-2013, p. 25).

Finally, communications were often intercepted and not intentionally provided to the person receiving them, as reported by the Cruise Director Raccomandato:

> *I remember that I found a radio with which I heard a conversation by Bosio saying that they were still boarding on the starboard side aft. Immediately afterwards, I heard another communication saying that there was no time and we had to jump into the sea but that was not possible because we would have ended up on the side of the ship*
> (Cruise Director's deposition, 25-11-2013, p. 21).

2.4.7 Expectation

Expectation has emerged as a constant element during the emergency. The Staff Captain Bosio explained that all officers on the Command Bridge were waiting for Captain's orders:

> *Some officers were upset, surely Bongiovanni, Pellegrini, and Canessa; Ambrosio was perhaps a little calmer. Some of them even cursed, complaining that we were wasting time and that the general emergency was not given although the situation was clearly serious*
> (Staff Captain's deposition, 02-11-2014, p. 14).

Such expectation is confirmed by the Safety trainer Bongiovanni: "*Pellegrini and I have long insisted, both with Schettino and with the Staff Captain, invoking the general emergency aloud.*" (Safety Trainer's deposition, 01-27-2014, p. 22). The Safety Trainer Pellegrini and the Cruise Director Raccomandato add more details about how the officers were expecting orders from the Captain. The Safety Trainer declared that "*At that point I took Christidis by the arm and told him to tell the Captain that we had to leave the ship, the others were pushing for a similar decision.*" (Safety Trainer's deposition, 12-10-2013, p. 17). Third Officer Scarpato stated that after the Staff Captain reported of the flooded compartments, "*No indication of what to do was provided by Captain Schettino following the communication from Bosio. I was expecting he would have said something about what to do, but it did not happen.*" (Third Officer's deposition, 03-30-2012, p. 3). The Electronics Officer Iosso added that even after the emergency signals were given, the crew was expecting to receive indications:

> *At deck 4 there were crew members who were waiting for the call for the life boats; we were all waiting for orders that did not arrive. I was convinced that after the abandon ship signal I would not have found anybody else at the bridges, but they were all there standing still*
> (Electronics Officer's deposition, 12-16-2013, p. 13).

Third Engineer Di Piazza reports the situation perceived in the Engine Room: "*We communicated the situation of each room, trying to portray the seriousness of the situation, although we did not receive any orders.*" (Third Engineer's deposition, 11-12-2013, p. 15).

2.4.8 Improvisation

Improvisation has characterized the entire emergency. Officers reported to have started emergency procedures before the emergency signals were issued. The Cadet Officer Calissi stated that with other officers "*we moved to our boarding points and took care of the passengers. The general alarm had not yet been given.*" (Cadet Officer's deposition, 12-10-2013, p. 24). The Hotel Director Giampedroni added that:

> *We met crew members with lifebuoys, I objected that maybe it was too early for such an activity, but many people already did it and therefore I did not insist [...] the crew members had already taken action, although the general emergency had not yet been given*
> (Hotel Director's deposition, 04-15-2014, p. 12).

The Director of Services Barabba reported that "*Having received no provisions and although in the absence of a general emergency, I independently started the procedure as if the signal had been*

given; the situation was now unmanageable, there was no light on and the ship was skidded." (Director of Services' deposition, 11-21-2013, p. 27). Officers report that the emergency signals have been improvised. The Planning Officer referred that "*The abandon ship signal was given after a few minutes and different solicitations. At that moment, many life boats starboard were already going back and forth from Giglio Island.*" (Planning Officer's deposition, 03-01-2012, p. 6). The Safety Trainer reported about the general emergency that:

> *When the situation started tumbling down, I praised the general emergency, also because the passengers were already at the muster stations. So, I instinctively pushed the general emergency signal [button], although no one had given me the order to do so*
> (Safety Trainer's deposition, 01-27-2014, p. 22).

The Staff Captain Bosio added information about the hypothesized decision to give the emergency signals: "*We were talking about abandoning the ship even before the general emergency [signal was issued], which is absolutely against every rule. […] There were even life boats already lowered even before the [general emergency] signal, it was a crazy situation.*" (Staff Captain's deposition, 02-11-2014, p. 21).

Improvisation has played a role during the evacuation, as reported by the Officers. The Environmental Officer Di Lena referred that "*Before embarking I helped to move the life boats and to board passengers, until it was no longer possible to proceed. Then I climbed on the tender, in which we also hoisted people who were in the water.*" (Environmental Officer's deposition, 11-25-2013, p. 30). The Cadet Sanitation Officer reported that "*at this stage I also worked with Borghero, with whom I went starboard, where we noticed that the glass was collapsing, and we were forced to jump on the life boat's roof.*" (Cadet Sanitation Officer's deposition, 11-11-2013, p. 12). The Chief Radio Officer narrated that: "*I went back and forth from the ship to the port ten or twenty times, at the end I arrived at the ladder at port side and I helped people that were disembarking from there.*" (Chief Radio Officer's deposition, 11-18-2013, p. 18). The Staff Captain Christidis added that "*At a certain point the raft got stuck under the crane and it was no more possible to use it. Therefore, I realized the water reached my feet, I started screaming and I encouraged everyone to swim.*" (Staff Captain's deposition, 11-19-2013, p. 16). The Cruise Director reported that "*After the abandon ship order I walked away from the Command Bridge. I was supposed to go to raft 33 starboard, but the conditions of the ship did not allow me to go, so I went down the stairs and I*

reached the muster station in the bow area central part of the ship." (Cruise Director's deposition, 11-25-2013, p. 21). The Electrician Officer stated that:

> *[...] I noticed that there were no life boats and my raft was unusable. There was a ladder on the bow right side, at deck 4, we used it to go down and asked life boat nine, which was in the area, to pick us up. Because it was full, I stayed on the roof. At the port, we dropped people and with that life boat I went back, and I went back and forth till three in the morning*
> (Electrician Officer's deposition, 12-16-2013, p. 15).

Finally, First Engineer Petrov stated that "*I started to shout to the lifeboats to come. One of them, nr.27, approached and the five crewmembers inside gave me the rope. I connected the rope and the boat to the deck 3 and then the British family carne inside directly, as well many people later.*" (First Engineer's deposition, 03-20-2012, p. 3).

2.4.9 Leadership

Officers' depositions highlight that leadership has been an issue during the emergency. The Planning Officer reported that after the impact "*from the radar I realized that the ship was beginning to drift to the ground, I immediately informed Schettino that checking another radar said it was not true.*" (Planning Officer's deposition, 03-01-2012, p. 5). The Staff Captain affirmed that officers on the Command Bridge requested orders from the Captain instead of receiving instructions: "*I remember we were told that the water was rising till deck zero. This increased our perception of the problem, the information came from Iaccarino, so we all started insist with the Captain to give the general emergency.*" (Staff Captain's deposition, 02-11-2014, p. 13). The Staff Captain also added that he decided to give the general emergency signal first and the abandon ship later:

> *I gave the order because the Captain did not decide. I did not do it before because until the arrival of Borghero I did not have the exact knowledge of the situation. After the communication f three compartments flooded, in a few minutes I issued the emergency [signal] [...] I gave the announcement to abandon the ship more than once*
> (Staff Captain's deposition, 02-11-2014, p. 17).

The Environmental Officer Di Lena reported that during the evacuation "*I did not receive orders from Schettino, all instructions were provided by Bosio.*" (Environmental Officer's deposition, 11-25-2013, p. 30). The Environmental Officer's deposition is confirmed by the Staff Captain's account of the evacuation phases:

After the abandonment I went to the cabin, I quickly grabbed my personal vhs radio and a jacket, so I went to deck four and I helped people to move down to deck three, which was very close to the water. I tried to bring the life boats closer, but I did not get an answer, so I called the police patrol boat through channel sixteen, and the police ensured a radio contact with the life boats and channeled them on the straight side of deck three, from there we loaded people directly on the life boats' roofs and we managed to disembark many passengers
(Staff Captain's deposition, 02-11-2014, p. 15).

The Safety Officer Pellegrini declared that "*I authorized the evacuation before the abandon ship signal because the situation was no more under control […] Later I asked Bosio, who was the only one who answered in the Command Bridge, if we could lower the life boats and he authorized me, so we started the operations from the stern.*" (Safety Officer's deposition, 12-10-2013, p. 17).

The Nurse Soare reported the Captain's and Staff Captain's attitude during the emergency:

Schettino was very sad. He seemed shocked and was looking straight ahead, Bosio was helping people to embark. [...] Bosio asked me to help him and I replied that I would not move because I thought the ship was the safest place. I asked him to ensure that the ship would not overturned. Bosio told me to stay there and that if the ship turned upside down, I would have to jump into the sea and he would save me
(Nurse's deposition, 12-10-2013, p. 22).

The Staff Captain Christidis summarized his feelings about how the Captain managed the emergency:

The Captain seemed lucid, master of himself but static, as if he was waiting I do not know what. He did not share his thoughts with me, I tried repeatedly to push him, to convince him to make decisions, trying not to prevaricate, since he was the Captain and I am used to respecting roles
(Staff Captain's deposition, 11-19-2013, p. 15).

2.4.10 Teamwork

Officers declared there had been troubles for the crew to work as a team. The Captain recognizes that "*The Captain takes over the navigation with the team and the resources at his disposal.*" (Captain's deposition, 12-11-2014, p. 13).

The Electronics Officer affirmed that "*I was joined by Muscas, who told me that there was nothing left to do, so we decided that we had manually to force the system to give a minimum of electricity [to the ship]. With a screwdriver we disassembled the mask and Antonio [Muscas] took a cable to*

make the connection." (Electronics Officer's deposition, 12-16-2013, p. 12). The Cadet Sanitation Officer Iannelli reported that during the evacuation "*the Helmsman was panicking, and he was not able to perform orders. Therefore, Ursino and I took the command of the operations and we lowered the life boat.*" (Cadet Sanitation Officer's, 11-11-2013, p. 14). The First Officer said that during the emergency "*I noticed the hotel personnel were working really hard, there has been a lack of coordination.*" (First Officer's deposition, 10-07-2013, p. 22). The Second Officer Ursino reported that together with other officers "*We created a human chain so that passengers have been able to move from the left to the right side.*" (Second Officer's deposition, 10-28-2013, p. 17). The Crew Purser Cashier Panetti reported that "*Barabba and I decided to return to the left side of the bridge; we crossed the corridor and I was trapped on deck 4, with the water already lapping at my feet, until the Director pulled me out with a rope.*" (Crew Purser Cashier's deposition, 11-26-2013, p. 12). The Director of Services reported he worked with the Bosun to help passengers "*In my opinion, the missed outreach of the raft was due to the excessive inclination [of the ship]. I asked the Bosun for help because I wanted to rescue the passengers and he could help me to understand the problem.*" (Director of Services' deposition, 11-26-2013, p. 30).

2.5 Discussion and Interpretation of results

The Costa Concordia disaster can certainly be considered an organizational failure, because actions and decisions on board the ship (individual and group level) and deficiencies at the shoreside (organizational level) influenced each other (cross-level) and contributed to cause and prolong the emergency. The disaster can also be defined as *normal* but *unexpected*. According to Perrow's definition, the event is normal because as reported by some officers, a week before the conditions that lead to the disaster were already present in the system: the 'inchino', the maneuver to approach a coast made varying the original route, was supposed to happen in a previous voyage. In that case, the maneuver was only hypothesized and was not accurately planned using maps. The 'inchino' was postponed because of bad weather conditions and because when the Captain agreed to salute the coast the island had already been overpassed. According to Weick and Sutcliffe definition, the event is unexpected because the officers assume that the Captain is able to guarantee a safe navigation and also after the impact they assume he is able to manage the situation and act as leader of the emergency management. Figure 8 provides a global understanding the effects of the different elements emerged in the analysis.

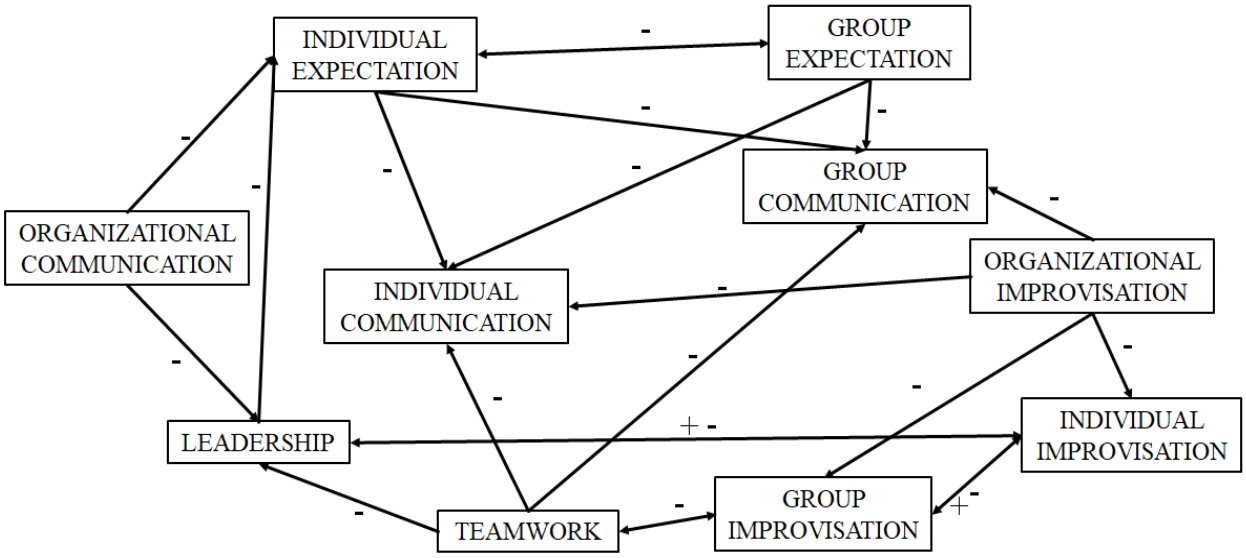

Figure 8 - Schematic view of the relations among the themes emerged in the analysis of leadership. The symbol + indicate a positive relation between the connected themes; the symbol – indicate a negative relation. The links are directed, showing what theme positively or negatively influences the other

As emerged from officers' depositions a combination of few essential elements combined at all levels characterized the entire emergency: expectation, improvisation, lack of teamwork, poor communication and poor leadership. As Weick and Sutcliffe pointed out, "*Strong expectation influence what people see, what they choose to take for granted, what they choose to ignore, and the length of time it takes to recognize small problems that are growing*" (2007, p. 66). In the Costa Concordia, accident expectation (Ferrin & Dirks, 2002) played a role at individual level before the departure, because the Planning Officer proposed to approach the Giglio at 0.5 mg because he was sure the maneuver was safe, the captain consent to approach because he trusted the Planning Officer's expertise and both did not recognize the necessity to better check the environmental conditions before starting the voyage. At group level, officers on the Command Bridge did not question the maneuver because they were aware of the Captain's experience and ability to steer the ship, even if they perceived the risks of bringing the ship so close to the coast. During these phases, communication has been the missing piece that could have avoided the accident. The absolute certainty to navigate in safe conditions, tarnished the Captain's ability to recognize the severity of the damage after the impact. Captain's expectations influenced his ability to construct a solid mental model of what was happening. In other words, expectations affected his situational awareness, i.e. his perception of the elements of the environment, the leak, the comprehension of the meaning, danger and necessity to activate the procedures, and the projection in the future status, necessity to gather people and get ready to evacuate the ship. The organizational level did not help

the captain to develop a correct understanding of the situation because they did not support the Captain as they were supposed to do; they were sure the Captain was able to manage the situation and they did not want to interfere with his decisions. In this sense, the company's attitude towards the emergency is part of what is known as complacency (Leveson & Nancy, 2000). The company showed poor communication and a poor cooperative relationship with the Captain and this partially influenced the leadership capacity of the Captain as demonstrated by his inadequate decisions and inefficient actions throughout the emergency. In a wider sense the company did not motivate the Captain, did not help him to concentrate on the situation and showed its detachment assuming that the Captain would have taken care of the problems on board (Montes, Ruiz Moreno, & García Morales, 2005). Captain's lack in situational awareness also influenced officers' expectations. From the depositions of some of the officers emerged that the picture of how the situation was evolving was well drawn in their minds, but officers were expecting orders and decisions from the Captain, so they waited before acting even if they knew what to do. Such expectation reflected in the improvised behavior and teamwork. Improvisation on board the Costa Concordia reflected improvisation at organizational level. Personnel working on Costa Concordia were all selected by the company but were not all well trained and aware of their duties. The frivolity demonstrated by the company when assembling the crew designated to work on the ship, favored improvised behaviors during the emergency in different ways: some officers reported they reached the muster point but they did not find their lifeboat, therefore they had to find other ways to help passengers; others reported they performed correctly on the life craft they thought they were assigned, that revealed to be actually assigned to other officers. In addition, the company had been repeatedly warned by the Captain about the inadequacy of some mariners to perform their emergency duty, but the company preferred to take the risk (i.e. improvise) instead of better train its personnel. At ship level improvisation had both the individual and the group dimension. At individual level, officers decided to trust their experience more than instructions received from a superintendent or a more expert officer. On the Command Bridge, for example, the Staff Captain decided to take the responsibility of the emergency coordination and partially replace the Captain in his role as a leader. In this sense, improvisation had the positive effect of nourishing the whole organizational capacity of resilience (van der Vegt, Essens, Wahlstrom, & George, 2015; Vogus, Sutcliffe, & Weick, 2010) because helped the ship layer to face the unexpected situation. However, improvisation also highlighted a negative aspect at group level that is strongly related to the organizational level: the difficulties of the crew to work as a team. During one of his hearing, the

Captain declared that personnel turnover on ships belonging to the company is too fast; in addition, some of the officers declared they had started work few days before or that same day the accident happened. Therefore, the Costa Concordia crew did not have the time to meet the traditional steps of group development of forming, storming, norming and performing (Tuckman, 1965) and grow "*strong enough as a true team to perform beyond a minimum level of proficiency*" (Snook, 2002, p. 104). To work effectively together, team members must possess specific knowledge, skills, and attitudes (KSAs), such as the skill in monitoring each other's performance, knowledge of their own and teammate's task responsibilities, and a positive disposition toward working in a team (Baker, Day, & Salas, 2006). During the emergency, the condition created by the high turnover reflected in almost inexistent teams, composed by people working in the same group but do not mature in an actual team. Katzenbach and Smith (1993) differentiate between levels of performing groups and suggest that performance is influenced by the degree of team effectiveness. In Katzenbach and Smith language, Costa Concordia personnel were working as a *working group* because officers interacted primarily to share information, to help each other perform within their area of responsibility (Katzenbach & Smith, 1993, p. 91). They did not show a realistic commitment to form a real team, although they had the potential to evolve into a real team because they demonstrated to share the common goal to save passengers. The combination of improvisation and weak team performance has also been stoked by a poor leadership. In the command and control model used on ships, the crew is organized in a highly formalized way, where autonomy in decisions is not contemplated. The Costa Concordia emergency exacerbated a common characteristic of complex organizations that in the Costa Concordia disaster is strongly related to the way the emergency has been managed: develop informal structures that somehow help formal ones to accomplish common goals. During the emergency, the Captain showed the inability to properly coordinate the crew and deliver information that would have fastened the evacuation. His hesitation to activate the Muster List forced the Officers to get around the Captain and simply inform the Captain about decisions already made. The Captain failed in being the main character of the emergency and he mostly behaved as a background actor. However, his being informed of all decisions highlights an important organizational aspect that negatively influenced the emergency: the fear of showing dissent. The Captain has been depicted as severe and strongly relying on regulations. This created in the officers the fear of object Captain's orders and decisions even if Company's specified that the crew had to arise any doubt about decisions that could have somehow affected safety. In this sense, safety climate (ship perception of safety) and safety culture

(organizational perception of safety) were far from being aligned and the natural consequence has been officer's hesitation in timely follow alternative (informal) procedures and speed up the evacuation procedures. The entire emergency has been characterized by misunderstandings and communication failures that have been the fuel as well as the consequence for improvisation. Communication is one of the core skills central to effective and safe production and performance that influences team situational awareness as well as team working and effective decision-making (Hetherington et al., 2006). During the emergency, communications were made difficult because the organization failed in providing to the crew access to a common media for the dialogue: a common spoken and understood work language. The company, in fact, established that Italian is the work language on its ships but on Costa Concordia did not provide adequate training to ensure a proper dialogue beyond common standard phrases. On board the ship, the Captain worsened communication barriers both inside the ship and with authorities (Shattuck & Woods, 2000). He limited information exchange to technical codes and did not share concerns with his crew, nor he requested help or support. Additionally, he forbade the Officers to communicate correct information to the authorities and only shared misleading information until too late to build a proper joint evacuation. On the contrary, he clearly addressed to the company that did not understand the severity of the situation and did not actively engage in the emergency management.

In conclusion, the emergency communications on the ship were made difficult because of Captain's confused picture of what was happening and his inability to be focused and active during the emergency. In addition, officers' expectation and the necessity to respect roles determined their scarce support to the Captain and influenced the way they worked as a team. The company played an important role in the emergency because it has not ensured that all crew members were able to speak the working language and failed to give support to the Captain. As emerged from the testimonies, improvisation characterized the entire emergency and informal procedures often replaced standards. The Captain was still able to make decisions[14] but was mostly replaced by the second in command and by officers considered capable to make the right choices. The informal structure reflects in the communications exchanged during the emergency and depicts an overreliance on bad applied organizational operating procedures. In this sense the entire organization, both shipside and shoreside demonstrated to not be mindful enough and turned an

[14] The Italian Condice della Navigazione art. 293 defines under what conditions the captain is considered to not be able to make decisions: "*In case of death, absence or impediment of the captain*"

evitable mistake into a disaster, highlighting that human beings are the element that characterized the entire emergency.

2.6 Conclusions

The analysis has been carried out only using archival data as input, a stronger analysis would have been possible directly interviewing the actors involved in the emergency. An attempt to interview these actors has been made contacting the lawyers working on the case and listed in the first pages of the final judgement, but this possibility has been denied. An important consideration has to be made with regards to the testimonies used for the analysis: the documents collected and used in this analysis can be biased by the purpose to which they are created. Robnson (2011) stated that fundamental to analysis of documents is identifying the context of the document, establishing who wrote it and for what purpose. As indicated by the title of the final judgement 'First instance criminal proceedings against Schettino Francesco', the documents aim at determining the guilt of one person. In addition, the Skagerrak Safety Foundation (an ONG established by survivors of the Scandinavian Star disaster, that aimed at reducing society's vulnerability to disasters), accused the Italian judicial system of not having considered that a "*complex organization failed to protect the life of 32 people*" and not having "*fulfil[led] the criteria and requirements of the IMO and EU directive 2009/18/EC*" in the trial[15]. The intention of ascertaining if laws have been applied correctly or not is beyond the purpose of this study and the documents have been used with the only purpose to objectively investigate the human contribution to the disaster relying on the testimony of individuals involved in the emergency.

This study opens to the possibility of further researches. In his testimony, Captain Schettino declares: "*I was very loyal to the rules, so my operators sometimes did not report to things that would have displeased me*" but then adds: "*Even today I cannot explain why the bridge has remained silent and no one has said a word while the ship was heading towards the rocks*". Such statements are important because they highlight a communication problem between captain and crew due to the captain's authoritarianism and suggests deepening the studies about the relationship between the captain and his crew. Possible research questions can be (a) does captain's approach to leadership affect crew's performance during emergencies? (b) does captain's approach to leadership affect the emergence and establishment of an informal structure? (c) how is the informal

[15] The document can be retrieved from: https://www.scandinavianstar.no/pdf/SKAGERRAK%20COSTA%20CONCORDIA%20ITALY%20pdf%20ENG%20-%20120117.pdf

structure shaped? Is it still hierarchical? (d) can communication issues between captain and crew predict if the formal hierarchy will be substituted by the informal structure? (e) can communication issues during emergencies on ship be quantified and results predict how the informal structure will be shaped?

References

Baker, D. P., Day, R., & Salas, E. (2006). Teamwork as an essential component of high-reliability organizations. *Health Services Research*, *41*(4 II), 1576–1598.

Bowen, G. A. (2009). Document Analysis as a Qualitative Research Method. *Qualitative Research Journal*, *9*(2), 27–40.

Busby, J. S. (2006). Failure to mobilize in reliability-seeking organizations: Two cases from the UK railway. *Journal of Management Studies*, *43*(6), 1375–1393.

Creswell, J. W. (2002). *Educational research: planning, conducting, and evaluating quantitative and qualitative research*. Pearson Education Inc.

Davidson, A. (1990). *In the wake of the Exxon Valdez : the devastating impact of the Alaska oil spill*. Sierra Club Books.

Dekker, S. W. A. (2013). *The field guide to understanding "human error."* Ashgate.

Ferrin, D. L., & Dirks, K. T. (2002). Trust in leadership: Meta-analytic findings and implications for research and practice. *Journal of Applied Psychology*, *87*(4), 611–628.

Goulielmos, A. M., & Goulielmos, M. A. (2005). The accident of m/v Herald of Free Enterprise: A failure of the ship or of the management? *Disaster Prevention and Management: An International Journal*, *14*(4), 479–492.

Grabowski, M., Merrick, J. R. W., Harrald, J. R., Mazzuchi, T. A., & Van Dorp, J. R. (2000). Risk modeling in distributed, large-scale systems. *IEEE Transactions on Systems, Man, and Cybernetics Part A:Systems and Humans.*, *30*(6), 651–660.

Grabowski, M., You, Z., Zhou, Z., Song, H., Steward, M., & Steward, B. (2009). Human and organizational error data challenges in complex, large-scale systems. *Safety Science*, *47*(8), 1185–1194.

Grech, M. R., Horberry, T. J., & Koester, T. (2008). *Human Factors in the Maritime Domain*. CRC Press.

Greco, R. (2010). Prova testimoniale e fallacia della memoria. *Rivista Online Della Scuola Superiore Dell'economia e Delle Finanze*.

Hatch, J. A. (2002). *Doing Qualitative Research in Education Settings*. State University of New

York Press.

Hetherington, C., Flin, R., & Mearns, K. (2006). Safety in shipping: The human element. *Journal of Safety Research*, *37*(4), 401–411.

Hollnagel, E. (2004). *Barriers and accident prevention*. Ashgate.

Hollnagel, E., Nemeth, C. P., & Dekker, S. (2008). *Resilience engineering perspectives*. Ashgate.

IMO. (2000). Resolution A.884(21) - Amendments to the code for the Investigation of Marine Casualties and Incidents. London: IMO.

Katzenbach, J. R., & Smith, D. K. (1993). *The Wisdom of Teams*. Harvard Business School Press.

Keeble, J. (1991). *Out of the Channel: The Exxon Valdez Oil Spill in Prince William Sound*. Eastern Washington University Press.

LaPorte, T. R., & Consolini, P. M. (1994). Working in practice but not in theory: theoretical challenges of high reliability organizations. *Journal of Public Administration Research and Theory*, *1*, 19–47.

Leveson, K. M., & Nancy, G. (2000). Archetypes for Organisational Safety. *System*, 1–16.

Manuel, M. E. (2017). *Maritime Risk and Organizational Learning*. CRC Press.

Merriam, B. S. (1988). Case study research in education: a qualitative approach. San Francisco, CA: Jossey-Bass.

Montes, F. J. L., Ruiz Moreno, A., & García Morales, V. (2005). Influence of support leadership and teamwork cohesion on organizational learning, innovation and performance: An empirical examination. *Technovation*, *25*(10), 1159–1172.

Perrow, C. (1984). *Normal Accidents. Living with High-Risk Technologies*. New York: Basic Books.

Pidgeon, N., & O'Leary, M. (2000). Man-made disasters: Why technology and organizations (sometimes) fail. *Safety Science*, *34*(1–3), 15–30.

Popova, V., & Sharpanskykh, A. (2007). A Formal Framework for Modeling and Analysis of Organizations. In *Situational Method Engineering: Fundamentals and Experiences* (pp. 343–358). Boston, MA: Springer US.

Rasmussen, J. (1983). Skills, rules, and knowledge; signals, signs, and symbols, and other distinctions in human performance models. *IEEE Transactions on Systems, Man, and Cybernetics*, (3), 257–266.

Rasmussen, J. (1986). *Information processing and human-machine interaction: an approach to cognitive engineering*. North-Holland.

Reason, J. (1990). *Human Error*. Cambridge University Press.

Reason, J. (1993). The identification of latent organizational failures in complex systems. *Verification and Validation of Complex Systems : Human Factors Issues. NATO ASI Series. Series F. Computer and Systems Sciences ; Vol. 110*, 222–237.

Reason, J. (1997a). *Managing the Human and Organizational Response to Accidents*. Ashgate Publishing.

Reason, J. (1997b). *Managing the Risks of Organizational Accidents*. Ashgate.

Reason, J. (2004). Beyond the organisational accident: The need for "error wisdom" on the frontline. *Quality and Safety in Health Care*, *13*(SUPPL. 2), ii28-33.

Roberts, K. H. (1990). Some Characteristics of High Reliability Organizations. *Organization Science*, *1*(2), 160–177.

Roberts, K. H. (1993). *New challenges to understanding organizations*. Macmillan.

Roberts, K. H., & Moore, W. H. (1993). Bligh Reef dead ahead: The grounding of the Exxon Valdez. In *New challenges to understanding organizations* (pp. 231–249). New York: Macmillan.

Robson, C. (2011). *Real world research : a resource for users of social research methods in applied settings*. *Real world research : a resource for social scientists and practitioner-researchers*. Wiley.

Roe, E., & Schulman, P. R. (2008). *High reliability management : operating on the edge*. Stanford Business Books, an imprint of Stanford University Press.

Schulman, P. R. (1993). The analysis of high reliability organizations: A comparative framework. *New Challenges to Understanding Organizations*, 33–54.

Shattuck, L. G., & Woods, D. D. (2000). Communication Of Intent In Military Command and Control Systems. In *The Human in Command: Exploring the Modern Military Experience* (pp. 279–292).

Snook, S. A. (2002). *Friendly fire: The accidental shootdown of US Blackhawks over northern Iraq*. Princeton University Press.

Swain, A. D. (1987). *Accident Sequence Evaluation Program: Human Reliability Analysis Procedure*.

Swain, A. D., & Guttmann, H. E. (1983). *Handbook of human-reliability analysis with emphasis on nuclear power plant applications. Final report*. Albuquerque, NM, and Livermore, CA (United States).

Tuckman, B. W. (1965). Developmental sequence in small groups. *Psychological Bulletin*, *63*(6), 384–399.

Turner, B. A., & Pidgeon, N. F. (1997). *Man-made disasters*. Wykeham Publications.

van der Vegt, G. S., Essens, P., Wahlstrom, M., & George, G. (2015). Managing Risk and Resilience. *Academy of Management Journal*, *58*(4), 971–980.

Vaughan, D. (1997). *The Challenger Launch Decision: Risky Technology, Culture, and Deviance at NASA*. University of Chicago Press.

Vogus, T. j., Sutcliffe, K. M., & Weick, K. E. (2010). Doing no harm: *Academy of Management Perspective*, *24*(4), 60–77.

Weick, K. E. (1987). Organizational culture as a source of high reliability. *California Management Review*, *29*(2), 112–127.

Weick, K. E. (1990). The Vulnerable System: An Analysis of the Tenerife Air Disaster. *Journal of Management*, *16*(3), 571–593.

Weick, K. E., & Sutcliffe, K. M. (2007). *Managing the unexpected : resilient performance in an age of uncertainty*. Jossey-Bass.

Weick, K. E., Sutcliffe, K. M., & Obstfeld, D. (1999). Organizing for high reliability: Processes of collective mindfulness. In B. M. Staw & R. I. . Sutton (Eds.), *Organizational Behavior* (Vol. 21, pp. 81–123). Greenwich, Ct: Jay.

Zuidberg, J., & Vinkx, K. (2017). *Capacity demand at Schiphol Airport*. *Eurocontrol Innovative Research Workshop*. Bretigny sur Orge.

Chapter 3 – The emergence of the informal network during the Costa Concordia disaster: a social network analysis approach

3.1 Introduction

3.1.1 Formal and informal leadership

The command structure on the Costa Concordia reflects the typical hierarchical structures on board ships. According to Weber (1978), '*hierarchy*' can be understood as vertical formal integration of official positions within one explicit organizational structure whereby each position or office is under the control and supervision of a higher one. Following this tradition, formal hierarchical order can be defined as an official system of unequal person-independent roles and positions which are linked via lines of top-down command and control (Laumann, Siegel, & Hodge, 1970; Mousiner, 1973). Such definition reflects the pyramidal structure on board ships where the captain is on top of the command and control structure and officers' authority diminishes moving towards the bottom of the pyramid. Command is the authority vested in an individual for the direction, coordination, and control. Commanders, as ship captains, are responsible for everything their units do or fail to do. Control is the set of doctrine, tactics, techniques and procedures that create the supplemental coordinating mechanism designed to synchronize the complex details of day-to-day operations (Snook, 2002). In a formal hierarchy, the official roles and positions of all members of the system are clearly defined and demarcated from each other by a strong authority gradient (Sasou & Reason, 1999). Social relationships within organizations are institutionalized and legitimized first and foremost, if not exclusively, as hierarchical relations (Zeitlin, 1974, p. 1090). The captain is put on top of the organization of the ship by regulations, for example, and decision rights in such relations are allocated asymmetrically, with the involvement of both superordinate and subordinate parties having different roles. The nature of the tie and the content flowing through it is based on the execution of the formal structure, which is composed of asymmetric, one-way flows (Soda & Zaheer, 2012): superordinate provide orders and subordinates execute them.

Although the hierarchical structure is designed to be extremely efficient in any situation, it can fail; structural holes in the authority network are harmful to performance because disconnections in the authority network make it more likely that the concerned individuals receive discordant cues that hurt their performance (Podolny & Baron, 1997). If the captain is not able to provide directives, the other officers cannot step in and act autonomously. The possibility of having structural holes is made more possible in the event of a crisis. Uncertainty, the degree to which future states of the

environment cannot be anticipated and accurately predicted, challenges the forecasting capability of leaders and may inhibit decisions and actions (Pfeffer & Salancik, 2003). When leaders wait or fail to make decisions during increasing uncertainty, they enter a downward cycle: searching for data to confirm previous choices, discovering new environmental changes, and restarting the decision making process (Eisenhardt, 1989). In these situations, new connections based on problem solving issues, personal and cultural similarities, trust, are being made between individuals (Guimerà, Danon, Díaz-Guilera, Giralt, & Arenas, 2006), as happened on Costa Concordia.

Research has only recently begun to explore the organizational consequences of the simultaneous existence and interplay between formal and informal elements of organizations, where the informal refers to "*the emergent patterns of individual behavior and interactions between individuals*" (Gulati & Puranam, 2009, p. 427). Although some recent research has begun to explore this idea (Gulati & Puranam, 2009; Jansen, Tempelaar, van den Bosch, & Volberda, 2009), the theoretical and empirical consequences of the interplay between the formal and informal components of organizational architectures have yet to be thoroughly understood. What is known is that organizational integration based on informal social mechanisms increases collaborative problem solving (De Cremer, Van Knippenberg, Van Dijk, & Van Leeuwen, 2008). The connections that informally link organizational members allow them to access information cues in a sensemaking process (Maitlis, 2005), particularly in the face of uncertainty (e.g. emergency situations). Social information processing theory suggests that organizational members seek cues from formal and informal sources in order to make sense of their reality because behaviors are largely driven by socially shared interpretations of events and actions (Festinger, 1954).

Emergency situations can provide the perfect environment to deepen the studies on the interaction of formal and informal structures. During an emergency, in fact, the correct and efficient functioning of the formal network is essential because the time factor plays an essential role in positive or negative outcomes. This means, '*closed-loop communication*' (Grech et al., 2002): the superordinate must give clear and straight instructions, the subordinate has to repeat the message to confirm the correct reception of orders and the superordinate confirms that the repeated message is correct. The new context imposed by an emergency situation transforms not only the social milieu in which leadership is embedded (Osborn, Hunt, & Jauch, 2002), but also the cognitive processes, resources and strategies that must be utilized by leaders to resolve the crisis (Mumford, Friedrich, Caughron, & Byrne, 2007). Is such context, the ability of a leader to establish a shared mental model, to coordinate tasks, to centralize the flow of information, to establish a structure,

and to stabilize emotions must emerge (St. Pierre, Hofinger, & Buerschaper, 2007). Such ability in the captain was missing during the Costa Concordia emergency: the captain was making assumptions and decisions without considering information that would have helped him to have a clear vision of the ongoing situation. Verbal communication is the chief way that these vital goals are addressed during a crisis (Pronovost et al., 2003; St. Pierre et al., 2007; Sutcliffe, Lewton, & Rosenthal, 2004). This is definitely true in emergencies in dangerous environments, like a listing sinking passenger ship, defined as those in which leaders or their followers are personally faced with highly dynamic and unpredictable situations and where the outcomes of leadership may result in severe physical or psychological injury (or death) to unit members (Campbell, Hannah, & Matthews, 2010) and in which sharing and dissemination of information is both critical and problematic, beginning with whom to trust in unfamiliar settings (Manoj & Baker, 2007). The failure of performing in the role required by the leader and his inability to provide real reliable information, can bring the informal network to emerge in order to compensate for the inability of the formal network to deal with specific problems and, in this sense, act to overcome the constraints and limitations of formal network structures (Nickerson & Zenger, 2002; Simon, 1997). As Diefenbach and Sillince pointed out, indeed, "*whenever formal hierarchy decreases, informal hierarchy increases*" (2011, p. 1530).

3.1.2 Social Network Analysis

Social network analysis (SNA) is a widely used tool for exploring the existence and strength of connections among groups of actors within an organization. It was originally introduced by Moreno in 1934 (Moreno, 1960) and since then it has been deployed for researching a great variety of subjects. SNA has the ability to illustrate patterns of relationships within groups, outline the flow of information and generate 'what if' scenarios (Garton, Haythornthwaite, & Wellman, 2006). Thereafter, the total activity inside a network can be mapped on a graph format where actors (persons, organizations, concepts, etc.) become nodes and information exchanged becomes edges, links or ties in it (Borgatti, Everett, & Johnson, 2013). SNA has been therefore useful in determining the type of the transferred information, as well as the parties involved and the delivery type (Pekericli, Akinci, & Karaesmen, 2004). Furthermore, having the ability to apply mathematical analysis to network information exchange, SNA provides measurements for analyzing the effectiveness and weaknesses of the group being studied (Alba, 1982). Through the use of network theory analysis and related software, a great variety of relationships could be depicted, able to mathematically and visually represent almost all kinds of differing relationships

including knowledge transfer, learning, trust, and communication (Taylor, Levitt, Fellow, & Levitt, 2004). When applying SNA concept to leadership studies, one of the more powerful measures is certainly centrality, "*the measure of the contribution the node makes to the structure of the network*" (Borgatti et al., 2013, p. 164). By way of the motivation of safety, in fact, the informal networks can develop leaders that match the norms and culture of the informal network, but may or may not match the norms or culture of the formal network defined by the organization (Kadushin, 2012).

Social power is a fundamental property that can be analyzed to describe the way informal networks can arise and be grafted into formal ones (Krackhardt, 1994). Centrality represents the closest concept to social power among SNA measures (Hannemann & Riddle, 2001). There are many distinct notions and related measures of centrality; degree centrality, betweenness centrality, closeness centrality and eigenvector centrality are probably the most widely used (Butts, 2008).

Degree centrality: measures how connected a node is by counting the number of direct edges each node has to others in the network. This measure allows to reply to the question "*Which are the most important or central vertices in a network?*" (Newman, 2010, p. 168). In directed networks degree centrality is divided in In-Degree, directional edges to a node from other nodes; and Out-Degree, directional edges form a node to other nodes.

Betweenness centrality: measures the number of paths that pass through each node in the network. In other words, measures the capacity of a node to link different groups in the network (Borgatti et al., 2013; Freeman, 1978).

Closeness centrality: measures the proximity of a node to the other nodes in the social network, that is the mean distance from a node to other nodes (Newman, 2010).

Eigenvector centrality: represents an extension of the concept of degree centrality, and measures how connected node is and how much direct influence it might have over other connected nodes in the network. Eigenvector centrality gives each node a score proportional to the sum of the scores of its neighbors (Borgatti et al., 2013; Newman, 2010).

3.1.3 Costa Concordia Emergency procedures

The roles and positions of each crew member in case of emergency, as well as the specific person each crew member is supposed to give information and the one they should receive it from, is defined in the Costa Crociere's prcedure "P12.04 IO 01 – Compilazione del Ruolo d'Appello –

Muster List". The procedure provides the standard to draw up the muster list, the table in which the safety officer reports the role each crew member has for each of the possible emergencies (which can go from man to sea to ship abandonment, passing through fire and leak alarms and for the emergency general) and for which is appropriately trained. In addition to the role, the muster list reports the area of the ship to reach and the place to occupy in the area for each crew member.

Crew members are divided into different groups that operate during each different stage of the emergency, that conventionally involve an increasing number of personnel as the emergency worsen. In case of fire or leak, the groups composed by people with technical skills (as engineers and electricians) are activated in order to detect the problem and possibly confine it. If the problem cannot be confined and there is the possibility that the ship must be evacuated, groups designated to gather the passengers are activated. In case the possibility that the ship must be evacuated becomes real, the personnel are reorganized to allow a coordinated and fluid evacuation.

Figure 9 provides an overview of how the crew on Costa Concordia is organized to perform in case of emergency.

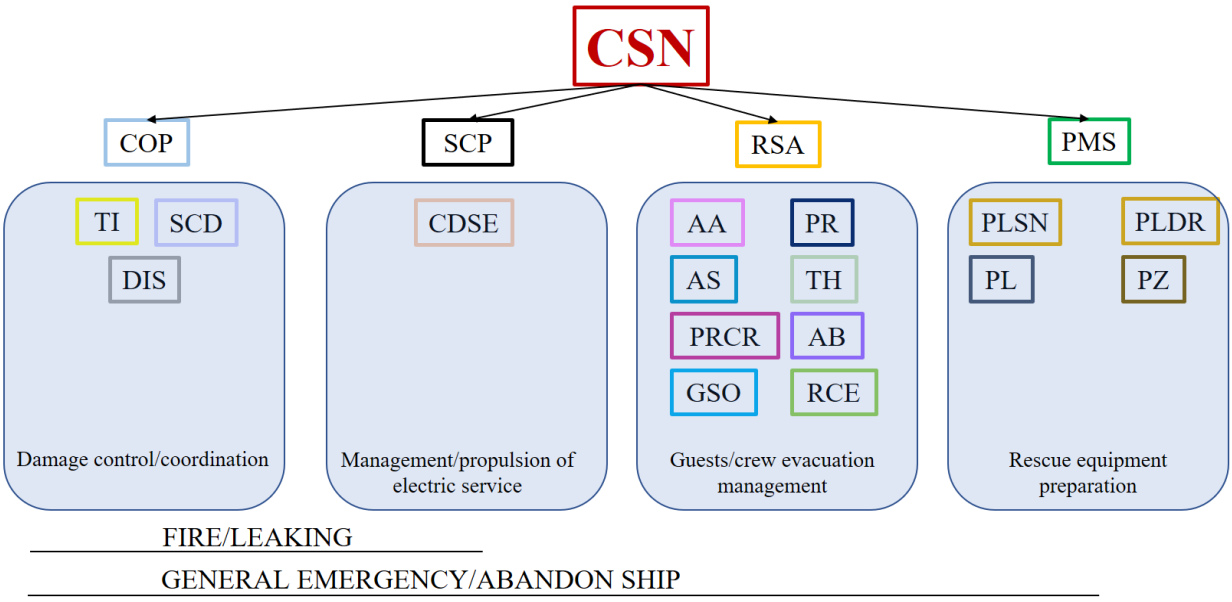

Figure 9 -Muster List: division of the crew members in the different groups as required by procedure P12.04 IO 01 for each stage of the emergency. Each abbreviation indicates a group: ***AA*** *- Passenger Directing;* ***AB*** *- Children Assistance;* ***AS*** *- Cabin Evacuation;* ***CDSE*** *- Electric Service Leading;* ***COP*** *- Operational Central Station;* ***CSN*** *- Navigation Station;* ***DIS*** *- Person at disposition of SCD of Vertical Zone;* ***GSO*** *- Guest Service Operator;* ***PL*** *- Lifeboat Preparation;* ***PZ*** *- Life craft Preparation;* ***PLDR*** *- Lifeboat Preparation Team Starboard Side;* ***PLSN*** *- Lifeboat Preparation Team Port Side;* ***PMS*** *- Preparation of Life-Saving Equipment;* ***PR*** *- Muster Station Group Members;* ***PRCR*** *- Personnel Without Specific Duties;* ***RCE*** *- Responsible for Crew Check;*

***RSA** - Responsible for Evacuation; **SCD** - Damage Control Team; **SCP** - Central Propulsion Station; **TH** - Transportation of Disabled: **TI** - Transportation of Injured*

3.2 Aim of the study and research questions

Communication plays a peculiar role in emergency management. It is the main tool people have to make evacuation effective. This is particularly true for maritime emergency, due to the characteristic ship environment: ships are floating buildings, but contrary to a town building, ships do not offer the same possibilities to escape in case of emergency. The second aspect that can make the difference in emergency on ships, is leadership. Due to the static and strict nature of the maritime system, every action and every decision have to be made by the captain. Without his order, the other crew members cannot operate, even if they are trained and aware of which is the best action to take. The Costa Concordia disaster shows that communication is not always effective, and the captain is not always able to lead during an emergency, highlighting his human nature. The aim of this study is to understand how the crew acts when the captain is not able to make prompt decisions and provide effective information.

In order to study crew's reaction to captain's uncertainty and the consequences on information exchange, sub hypothesis 2 is tested.

> Sub Hypothesis 2: The informal command structure has replaced the formal structure, ensuring informative communications that allowed to manage the emergency.

The transcription of the communications recorded by the VDR the night the Costa Concordia hit the rock on January 13, 2012 has been quantitatively analyzed as social network to answer the following questions:

- What happens when the captain of a ship is still formally in charge of the emergency but is not able to provide useful information?
- Does the crew perform as provided by regulations, remain passive and wait orders or reorganizes in an alternative structure?
    - Who composes the informal structure?
    - Who plays the key role in making decisions?
    - Is the informal structure more effective than the formal structure in providing useful information?
- Who are the main figures able to replace the captain and make decisions?

- Is the informal structure created following roles or is the new structure created ranking crew members according to their experience?

The results of this study may provide interesting evidences regarding how information is exchanged in maritime emergencies when the formal hierarchy is still working in the background, but an informal structure emerges in order to correct deficiencies in the formal structure. The Costa Concordia disaster is not the only example in which formal and informal network co-exist during emergencies, the same situation was observed in the Sewol disaster (Kwon & Leveson, 2017), suggesting that more research is needed in this field.

3.3 Methodology

The analysis of the communications exchanged during the emergency on the Costa Concordia on January 13, 2012 is primarily based on, archival data, a largely used source in social network analysis (Bearman, 1993; Kent, 1978; Padgett & Ansell, 1993). The document used is the transcription of the communications exchanged with the command bridge and recorded in the VDR. The document consists of 83 pages and contains the communications from 5:00 pm[16], time of departure, till 10:34 pm, when the last communication is recorded. As support to this document, the written testimonies of the officers collected by the Court of Grosseto till December 2014 have been used when sender and receiver of the communication recorded was not clearly specified.

Communications have been manually inspected to extract communications exchanged from the time of the impact till the last conversation is recorded. The emergency has been divided into three stages. Stage1: from impact to general emergency; Stage 2: from general emergency to abandon ship; Stage 3: after abandonment. This choice has been made considering the amount of information available, in order to obtain reliable results. Information prior to the impact has not been considered in the analysis.

The Inverse Document Frequency (IDF) statistic has been applied in the analysis. This methodology is commonly used in Information Retrieval to search for information in a document, searching for documents themselves, and also searching for metadata that describe data, and for databases of texts, images or sounds (Zhai & Massung, 2016). The inverse document frequency is a measure of how much information the word provides, that is, whether the term is common or rare across all documents. It is the logarithmically scaled inverse fraction of the documents that contain

[16] UTC time

the word, obtained by dividing the total number of documents by the number of documents containing the term, and then taking the logarithm of that quotient, as represented in equation 1:

$$(1)\ IDF(t, D) = lo\ g(|N|/\{|d \in D{:}t \in d|\})\ if |D|$$

With:

- N: total number of documents in the corpus N = |D|
- {|d∈D:t∈d|} number of documents where the term *t* appears

In this study each communication in the VDR transcription is considered as a document and the IDF is applied to analyze to measure how much new information is provided by the officers on duty on Costa Concordia. Analysis have been performed using the software RStudio[17], a free and open-source integrated development environment (IDE) for R. In order to do so Receiver IDF and Dyadic IDF have been measured:

Receiver IDF measures the amount of all information received by Y, that means the words Y receives have been already used in previous messages, including the one that is being analyzed, as represented in equations 2 and 3.

$$(2)\ IDF(t, D) = lo\ g(|D|/\{|d \in D{:}t \in d|\})\ if |D| > 1$$

$$= 1 \text{ [first message received by Y]}$$

Where D = All the messages received by Y including M

$$(3)\ IDF(M, Y) = \sum t \in M\ IDF(t)/|M|$$

Dyadic IDF measures the amount of all information received by Y from X, that means the words Y receives have been already used in previous messages from X, including the one that is being analyzed, as represented in equations 4 and 5.

$$(4)\ IDF(t, D) = lo\ g(|D|/\{|d \in D{:}t \in d|\})\ if |D| > 1$$

$$= 1 \text{ [first from X to Y]}$$

Where D = All the messages received by Y from X including M

$$(5)\ IDF(M, \mathrm{X}, Y) = \sum t \in M\ IDF(t)/|M|$$

[17] Available at https://www.rstudio.com/

The values obtained have been visualized as network using the software Gephi[18], an open-source network analysis and visualization software package written in Java, and have been compared with the formal network structure obtained examining the Costa Crociere Procedure P14.04 – IO 06 SM, which provides complete and exhaustive information about how the crew of their ships are organized and work in case of emergency. The networks have been created using the Costa Crociere procedure as baseline to visualize the differences between formal and informal hierarchy. Centrality measures, Closeness centrality, Betweenness centrality, In-Degree centrality, Out-Degree centrality and Eigenvector Centrality are used to compare the networks. Three different networks are generated for each stage of the emergency: the first network represents the formal structure as indicated in the Muster List; the second network shows the total amount of communications exchanged during the analyzed stage, only showing formal and informal connection without considering the content of the information exchanged; the third network considers the novelty of the information exchanged, built adding an edge between two networks if:

$$\text{Dyadic-IDF} - \text{Receiver-IDF} \geq 0$$

Since the content of the communication is essential for the analysis, edges are considered informal when they meet one of the following conditions:

- The person sending the message is performing according the Muster List, but the message is directed to a person performing a different role than the one assigned by Muster List;
- The person receiving the message is performing according the Muster List, but the message is sent by a person performing a different role than the one assigned by Muster List;
- The direction of the communication is inverted, meaning that the message is sent by the person supposed to receive it.

There was no anticipated risk to all participants as the study makes use of public documents, which are not deemed sensitive in nature and posed no threat to the individual. Actors names and roles can be freely used in this research, thanks to the permission of the Court of Grosseto and are summarized in Appendix I to this chapter.

3.4 Results

Figure 10 shows how formal and informal hierarchy appear and disappear during the whole emergency. As is possible to see from the picture, the emergency has been predominantly

[18] Available at https://gephi.org/

characterized by informal connections among actors (fuchsia areas in the figures). The graph on the right in figure 10, graph (a), summarizes all communication occurred throughout the emergency; the graph on the left, graph (b), summarizes all communications where a new element useful for the emergency management has been introduced. 388 total communications occurred during the emergency, 37.67% of which were formal and 62.33% were informal. 52.08% of the total amount of communication introduced novel information useful for the emergency; 26.6% of these communications were formal and 73.4% were informal.

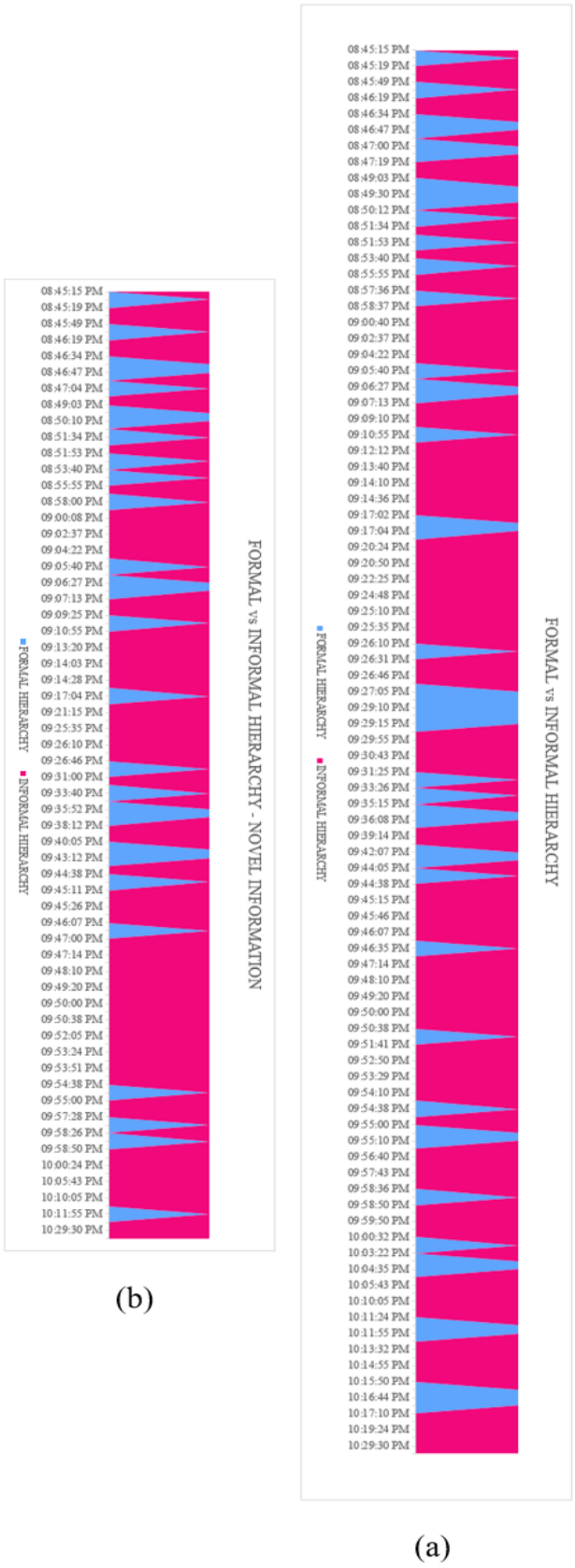

Figure 10 - Representation of how formal and informal hierarchy appear and disappear during the emergency. The light blue area represents the formal hierarchy, while the fuchsia area represents the informal network.

3.4.1 Stage 1: impact to general emergency

Formal network characteristics

- Nodes: 23
- Edges: 25

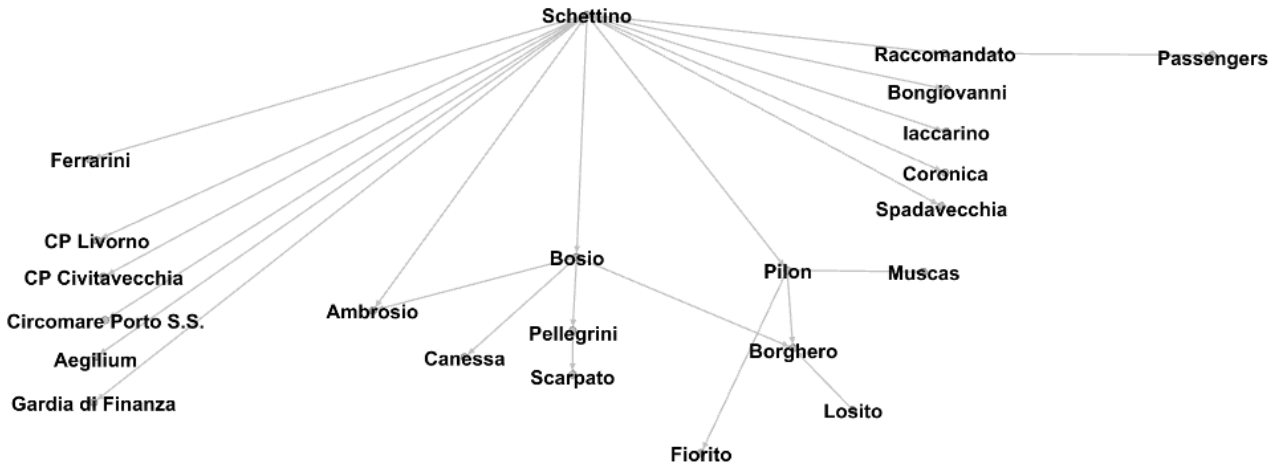

Figure 11 - Formal roles provided by the Muster List for the actors involved in Stage 1 of the emergency

Table 2 - Centrality measures for the nodes in the formal network of Stage 1

NODE NAME	IN-DEG	OUT-DEG	CLOSENESS	BETWEENNESS	EIGENVECTOR
Aegilium	1	0	0	0	0.57
Ambrosio	2	1	0.429	0.035	1
Bongiovanni	1	0	0	0	0.57
Borghero	3	0	0	0	0.868
Bosio	1	4	0.375	0.015	0.57
Canessa	1	0	0	0	0.43
Circomare Porto S.S.	1	0	0	0	0.57
Coronica	1	0	0	0	0.57
CP Civitavecchia	1	0	0	0	0.57
CP Livorno	1	0	0	0	0.57
Ferrarini	1	0	0	0	0.57
Fiorito	1	0	0	0	0.43
Gardia di Finanza	1	0	0	0	0.57
Iaccarino	1	0	0	0	0.57
Losito	0	1	1	0	0
Muscas	1	0	0	0	0.43
Passengers	1	0	0	0	0.43

Pellegrini	1	1	1	0.006	0.43
Pilon	1	3	1	0.015	0.57
Raccomandato	1	1	1	0.006	0.57
Scarpato	1	0	0	0	0.333
Schettino	1	14	0.724	0.076	0.755
Spadavecchia	1	0	0	0	0.57

Emergency network characteristics

- Nodes:35
- Edges: 208

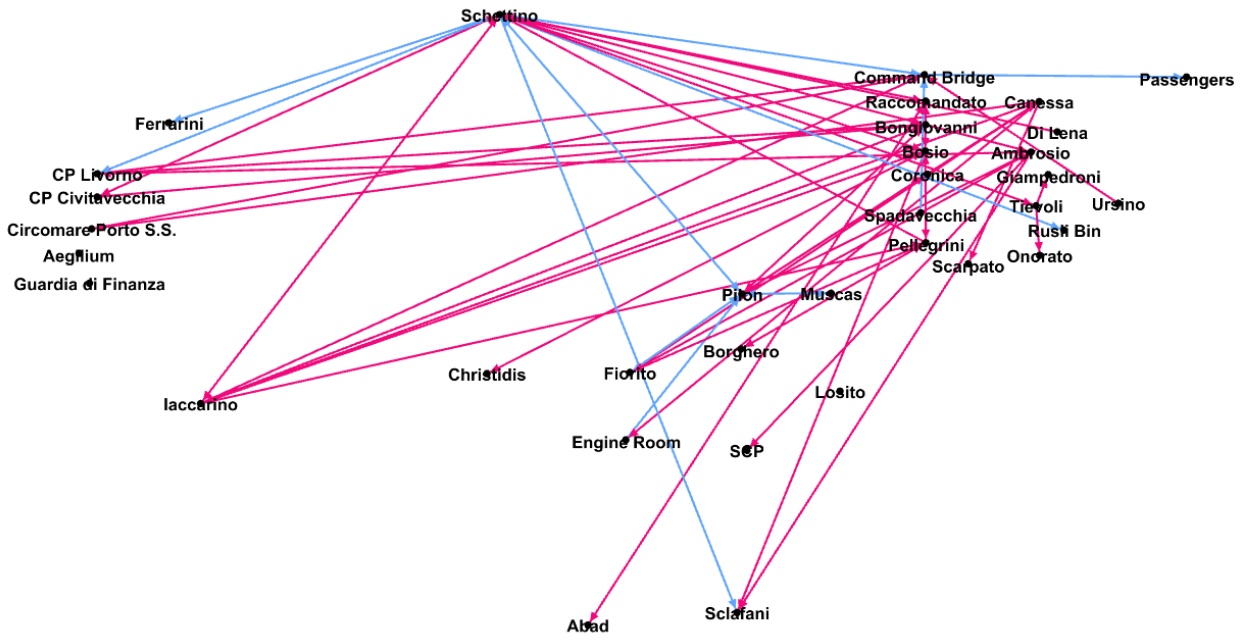

Figure 12 - Emergency network showing communications exchanged during Stage 1 of the emergency. Light blue edges indicate formal communications, while fuchsia edges indicate informal communication

Table 3 - Centrality measures for the nodes in the emergency network of Stage 1

NODE NAME	IN-DEG	OUT-DEG	CLOSENESS	BETWEENNESS	EIGENVECTOR
Abad	3	1	0.287	0	0.008
Aegilium	1	0	0	0	0.003
Ambrosio	4	11	0.468	0.078	0.086
Bongiovanni	7	8	0.446	0.056	0.136
Borghero	6	7	0.312	0	0.020
Bosio	19	26	0.475	0.062	0.362
Canessa	5	10	0.408	0.062	0.070
Christidis	4	4	0.326	0	0.060
Circomare Porto S.S.	1	1	0.218	0	0.003

Command Bridge	8	3	0.266	0.095	0.105
Coronica	1	0	0	0	0.037
CP Civitavecchia	1	2	0.382	0	0.039
CP Livorno	10	4	0.349	0.099	0.085
Di Lena	0	1	0.380	0	0
Engine Room	1	1	0.333	0	0.003
Fiorito	6	5	0.408	0.025	0.054
Ferrarini	5	0	0	0	0.197
Guardia di Finanza	0	0	0	0	0
Giampedroni	1	0	0	0	0.002
Iaccarino	16	18	0.492	0.054	0.234
Losito	0	0	0	0	0
Onorato	1	0	0	0	0.002
Muscas	3	2	0.330	0	0.110
Passengers	2	0	0	0	0.010
Pellegrini	12	10	0.446	0.049	0.053
Pilon	31	29	0.483	0.138	0.937
Raccomandato	3	5	0.397	0.064	0.055
Rusli Bin	3	3	0.377	0	0.118
Scarpato	0	1	0	0	0.003
Schettino	45	52	0.592	0.339	1
Sclafani	6	0	0	0	0.039
SCP	1	0	0	0	0.004
Spadavecchia	0	1	0.216	0	0
Tievoli	1	3	0.397	0.041	0.039
Ursino	0	1	0.216	0	0

Novelty network characteristics

- Nodes: 35
- Edges: 93

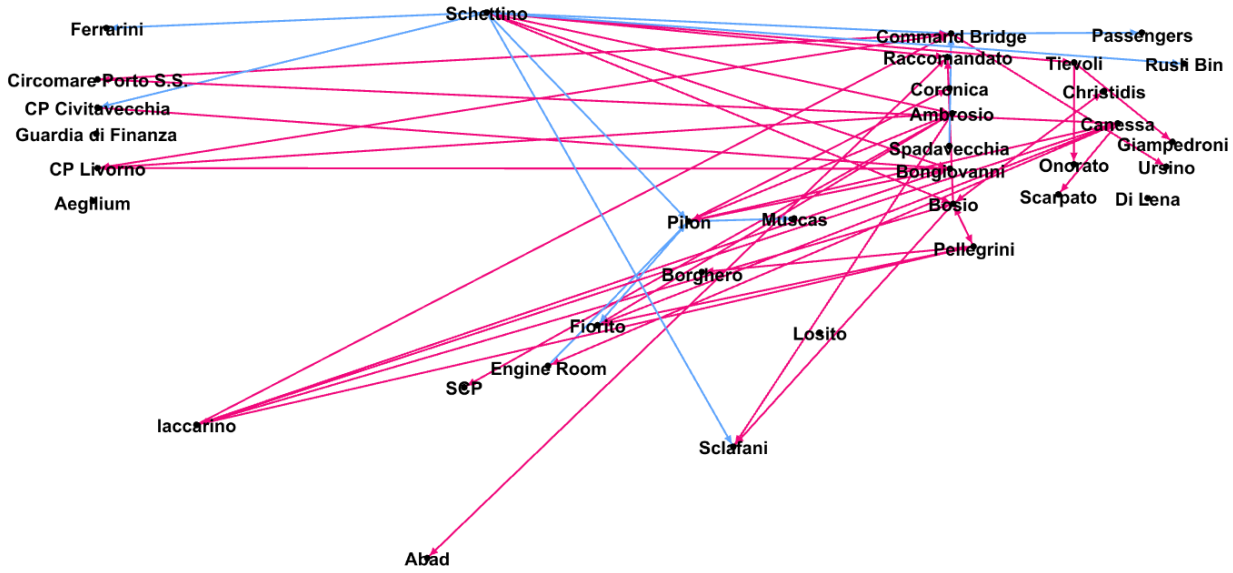

Figure 13 - Informal network showing communications adding novel information exchanged during Stage 1 of the emergency. Light blue edges indicate formal communications, while fuchsia edges indicate informal communication

Table 4 - Centrality measures for the nodes in the novelty network of Stage 1

NODE NAME	IN-DEG	OUT-DEG	CLOSENESS	BETWEENNESS	EIGENVECTOR
Abad	3	1	1	0	0.285
Aegilium	0	0	0	0	0
Ambrosio	4	8	0.467	0.202	0.491
Bongiovanni	5	5	0.259	0.038	0.657
Borghero	6	0	0	0	0.635
Bosio	5	12	0.326	0.064	0.735
Canessa	3	6	0.378	0.064	0.434
Christidis	4	1	0.248	0	0.655
Circomare Porto S.S.	1	1	0.217	0.002	0.1
Command Bridge	5	3	0.264	0.064	0.537
Coronica	1	0	0	0	0.125
CP Civitavecchia	1	1	0.212	0	0.079
CP Livorno	7	3	0.346	0.126	1
Di Lena	0	0	0	0	0
Engine Room	1	1	0.264	0	0.1
Ferrarini	4	0	0	0	0.315

Fiorito	4	3	0.394	0.089	0.447
Giampedroni	1	0	0	0	0.022
Guardia di Finanza	0	0	0	0	0
Iaccarino	6	6	0.354	0.033	0.919
Losito	0	0	0	0	0
Muscas	3	0	0	0	0.376
Onorato	1	0	0	0	0.022
Passengers	2	0	0	0	0.249
Pellegrini	3	8	0.337	0.038	0.472
Pilon	6	7	0.35	0.083	0.515
Raccomandato	4	3	1	0.016	0.392
Rusli Bin	3	1	0.368	0	0.236
Scarpato	1	0	0	0	0.1
Schettino	4	19	0.571	0.161	0.315
Sclafani	3	0	0	0	0.358
SCP	1	0	0	0	0.116
Spadavecchia	0	0	0	0	0
Tievoli	1	3	0.389	0.03	0.079
Ursino	0	1	0.215	0	0.285

3.4.2 Stage 2: from general emergency to abandon ship

Formal network characteristics

- Nodes: 32
- Edges: 33

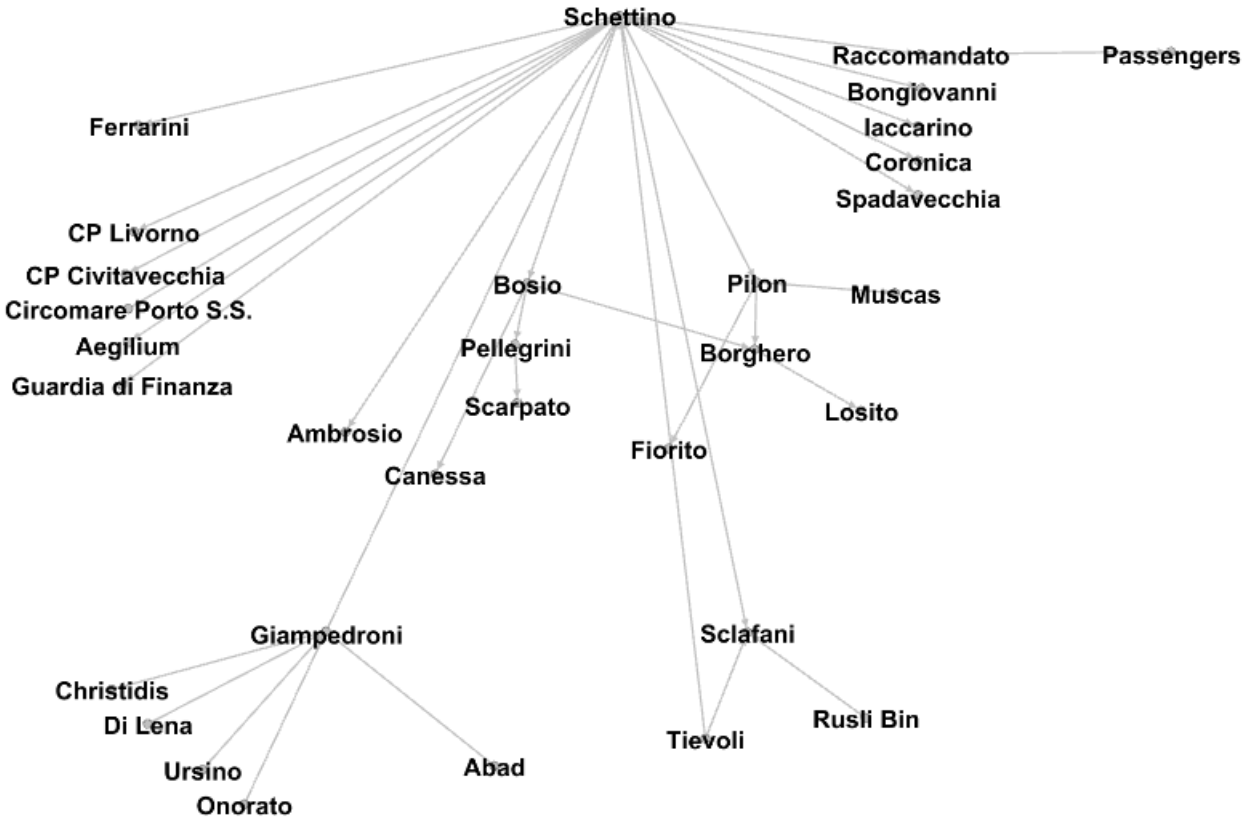

Figure 14 - Formal roles provided by the Muster List for the actors involved in Stage 2 of the emergency

Table 5 - Centrality measures for the nodes in the formal network of Stage 2

NODE NAME	IN-DEG	OUT-DEG	CLOSENESS	BETWEENNESS	EIGENVECTOR
Abad	0	1	0.305	0	0
Aegilium	1	0	0	0	0.382
Ambrosio	1	0	0	0	0.382
Bongiovanni	1	0	0	0	0.382
Borghero	2	1	1	0.011	0.995
Bosio	1	3	0.714	0.034	0.382
Canessa	1	0	0	0	0.498
Christidis	0	1	0.305	0	0
Circomare Porto S.S.	1	0	0	0	0.382

Coronica	1	0	0	0	0.382
CP Civitavecchia	1	0	0	0	0.382
CP Livorno	1	0	0	0	0.382
Di Lena	0	1	0.305	0	0
Ferrarini	1	0	0	0	0.382
Fiorito	1	0	0	0	0.498
Giampedroni	5	1	0.421	0.129	0.051
Guardia di Finanza	1	0	0	0	0.382
Iaccarino	1	0	0	0	0.382
Losito	1	0	0	0	1
Muscas	1	0	0	0	0.498
Onorato	0	1	0.305	0	0
Passengers	1	0	0	0	0.498
Pellegrini	1	1	1	0.01	0.498
Pilon	1	3	0.8	0.026	0.382
Raccomandato	1	1	1	0.009	0.382
Rusli Bin	0	1	1	0	0
Scarpato	1	0	0	0	0.505
Schettino	2	15	0.697	0.172	0.198
Sclafani	3	0	0	0	0.403
Spadavecchia	1	0	0	0	0.382
Tievoli	0	2	0.429	0	0
Ursino	0	1	0.305	0	0

Emergency network characteristics

- Nodes: 18
- Edges: 54

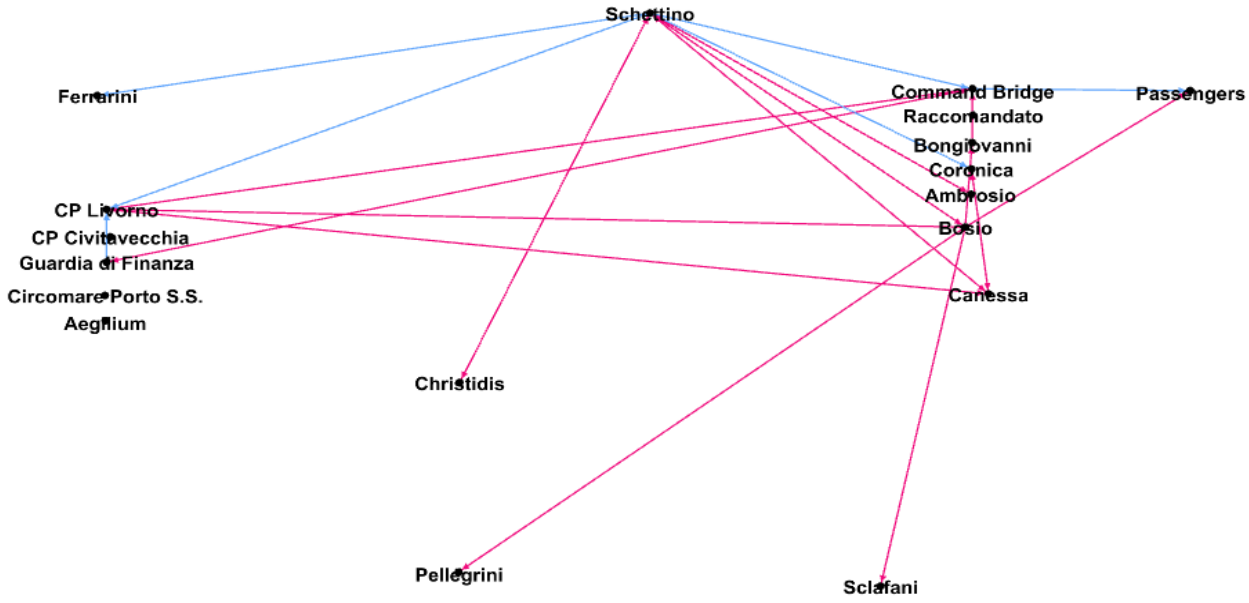

Figure 15 - Emergency network showing communications exchanged during Stage 2 of the emergency. Light blue edges indicate formal communications, while fuchsia edges indicate informal communication

Table 6 - Centrality measures for the nodes in the emergency network of Stage 2

NODE NAME	IN-DEG	OUT-DEG	CLOSENESS	BETWEENNESS	EIGENVECTOR
Aegilium	0	0	0	0	0
Ambrosio	2	1	0.433	0	0.25
Bongiovanni	3	1	0.217	0.002	0.495
Bosio	8	17	0.619	0.106	1
Canessa	5	5	0.464	0.173	0.499
Christidis	1	2	0.433	0	0.125
Circomare Porto S.S.	0	0	0	0	0
Command Bridge	6	3	0.245	0.086	0.58
Coronica	2	1	0.325	0	0.209
CP Civitavecchia	0	0	0	0	0
CP Livorno	6	3	0.382	0.114	0.641
Ferrarini	1	0	0	0	0.125
Guardia di Finanza	1	2	0.302	0.077	0.097

Passengers	3	0	0	0	0.359
Pellegrini	3	0	0	0	0.495
Raccomandato	0	0	0	0	0
Schettino	8	19	0.722	0.278	0.75
Sclafani	5	0	0	0	0.826

Novelty network characteristics

- Nodes: 18
- Edges: 47

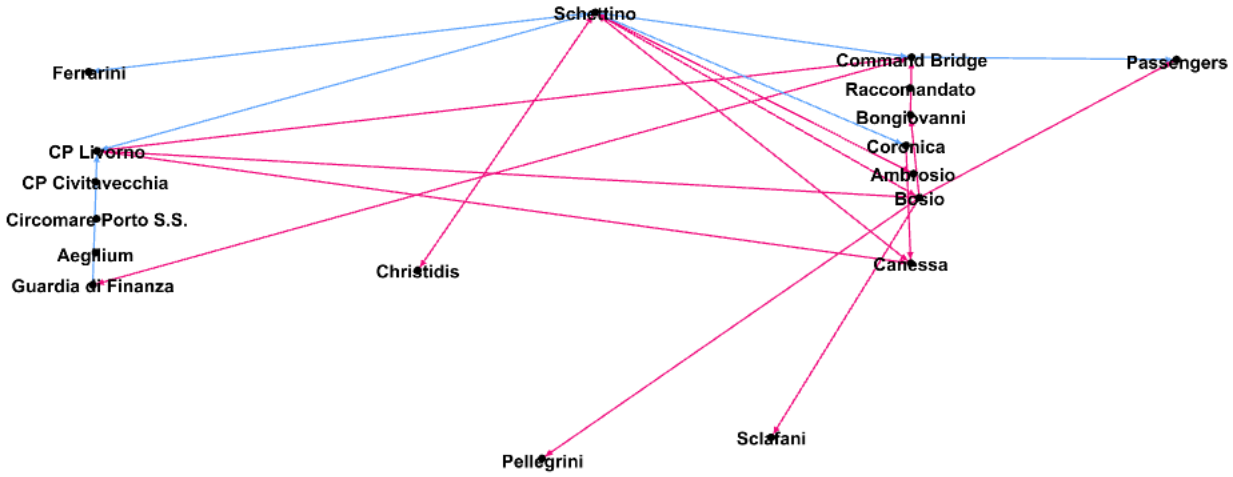

Figure 16 - Informal network showing communications adding novel information exchanged during Stage 2 of the emergency. Light blue edges indicate formal communications, while fuchsia edges indicate informal communication

Table 7 - Centrality measures for the nodes in the novelty network of Stage 2

NODE NAME	IN-DEG	OUT-DEG	CLOSENESS	BETWEENNESS	EIGENVECTOR
Aegilium	0	0	0	0	0
Ambrosio	2	1	0.433	0	0.196
Bongiovanni	3	1	0.213	0.004	0.600
Bosio	9	14	0.619	0.110	0.884
Canessa	4	4	0.448	0.173	0.339
Christidis	1	1	0.433	0	0.098
Circomare Porto S.S.	0	0	0	0	0
Command Bridge	4	3	0.241	0.081	0.357
Coronica	1	1	0.325	0	0.098

CP Civitavecchia	0	0	0	0	0
CP Livorno	5	3	0.371	0.119	0.475
Ferrarini	1	0	0	0	0.098
Guardia di Finanza	1	2	0.295	0.077	0.080
Passengers	3	0	0	0	0.361
Pellegrini	3	0	0	0	0.600
Raccomandato	0	0	0	0	0
Schettino	5	17	0.722	0.288	0.427
Sclafani	5	0	0	0	1

3.4.3 Stage 3: after abandon ship

Formal network characteristics

- Nodes: 31
- Edges: 30

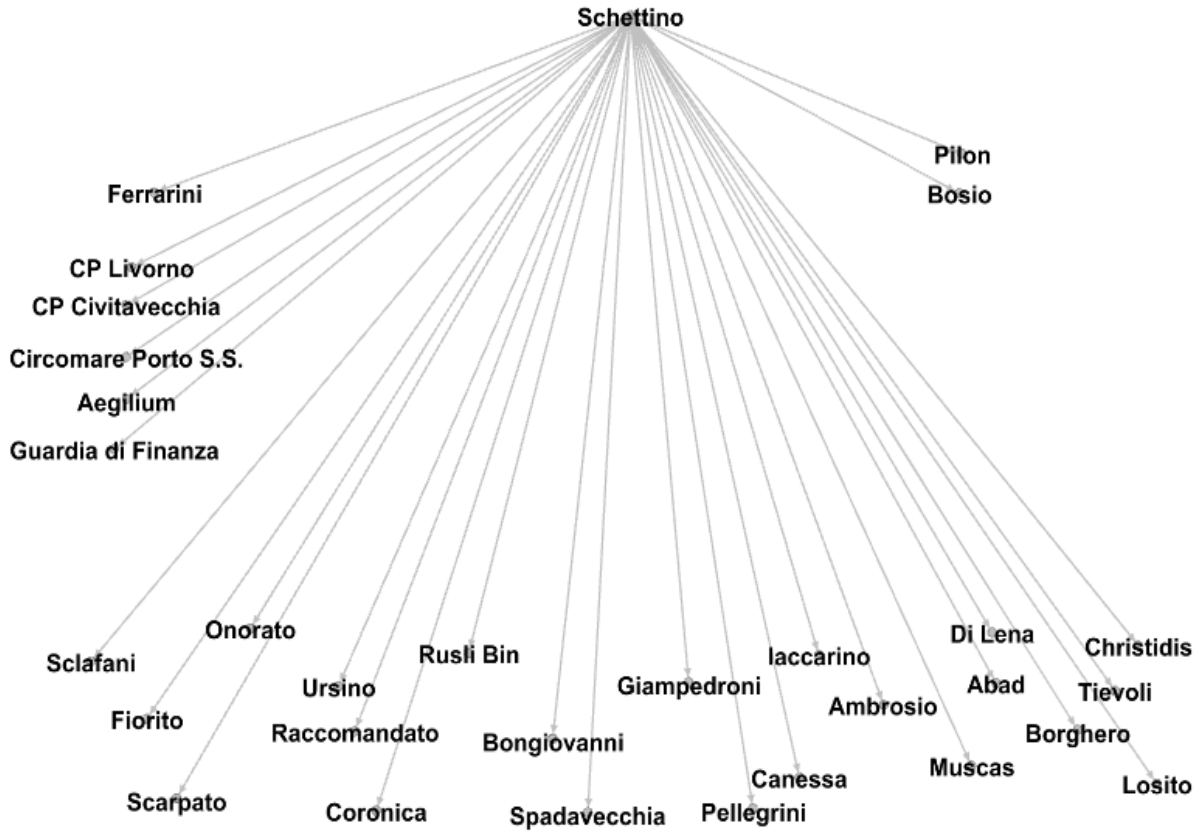

Figure 17 - Formal roles provided by the Muster List for the actors involved in Stage 3 of the emergency

Table 8 - Centrality measures for the nodes in the formal network of Stage 3

NODE NAME	IN-DEG	OUT-DEG	CLOSENESS	BETWEENNESS	EIGENVECTOR
Abad	1	0	0	0	1
Aegilium	1	0	0	0	1
Ambrosio	1	0	0	0	1
Bongiovanni	1	0	0	0	1
Borghero	1	0	0	0	1
Bosio	1	0	0	0	1
Canessa	1	0	0	0	1
Christidis	1	0	0	0	1
Circomare Porto S.S.	1	0	0	0	1
Coronica	1	0	0	0	1
CP Civitavecchia	1	0	0	0	1
CP Livorno	1	0	0	0	1
Di Lena	1	0	0	0	1
Ferrarini	1	0	0	0	1
Fiorito	1	0	0	0	1
Giampedroni	1	0	0	0	1
Guardia di Finanza	1	0	0	0	1
Iaccarino	1	0	0	0	1
Losito	1	0	0	0	1
Muscas	1	0	0	0	1
Onorato	1	0	0	0	1
Pellegrini	1	0	0	0	1
Pilon	1	0	0	0	1
Raccomandato	1	0	0	0	1
Rusli Bin	1	0	0	0	1
Scarpato	1	0	0	0	1
Schettino	0	30	1	0	0
Sclafani	1	0	0	0	1
Spadavecchia	1	0	0	0	1
Tievoli	1	0	0	0	1
Ursino	1	0	0	0	1

Emergency network characteristics

- Nodes: 32
- Edges: 99

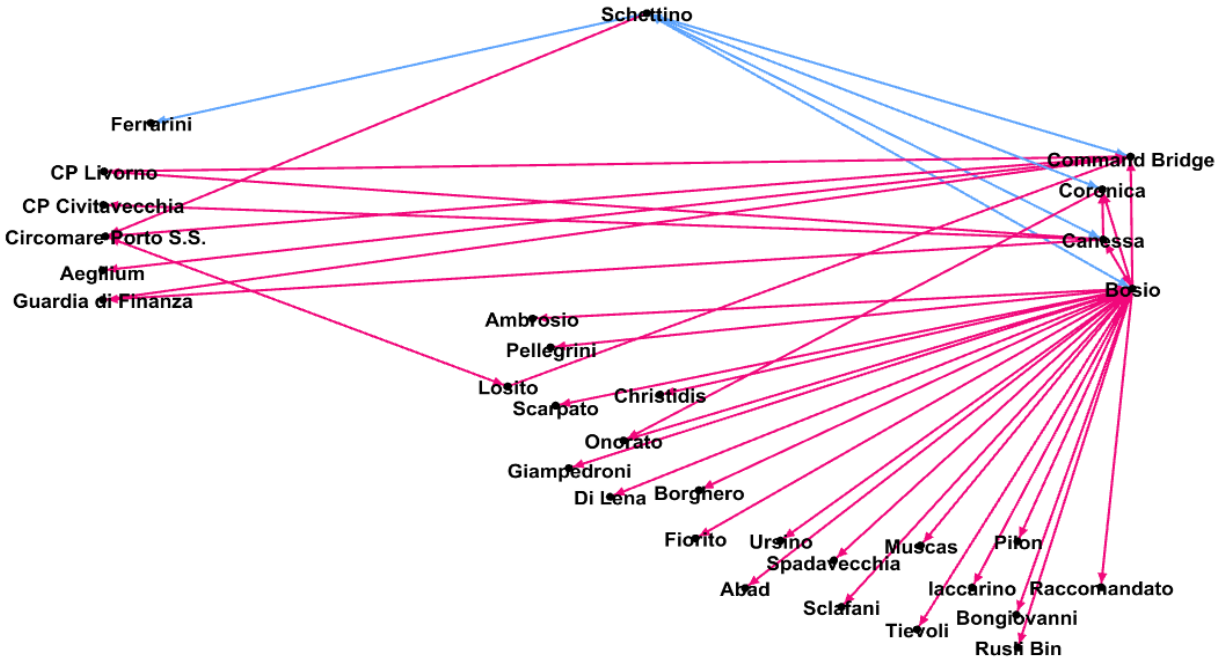

Figure 18 - Emergency network showing communications exchanged during Stage 3 of the emergency. Light blue edges indicate formal communications, while fuchsia edges indicate informal communication

Table 9 - Centrality measures for the nodes in the emergency network of Stage 3

NODE NAME	IN-DEG	OUT-DEG	CLOSENESS	BETWEENNESS	EIGENVECTOR
Abad	1	0	0	0	0.089
Aegilium	1	1	1	0	0.022
Ambrosio	2	1	0.449	0	0.178
Bongiovanni	2	2	0.449	0	0.178
Borghero	1	0	0	0	0.089
Bosio	16	44	0.795	0.192	1
Canessa	10	13	0.534	0.023	0.767
Christidis	1	0	0	0	0.089
Command Bridge	8	1	1	0.013	0.220
Corcomare Porto S.S.	4	3	0.750	0.009	0.156
Coronica	3	2	0.369	0.001	0.232
CP Civitavecchia	1	0	0	0	0.068
CP Livorno	2	1	0.667	0	0.136

Di Lena	1	0	0	0	0.089
Ferrarini	2	0	0	0	0.151
Fiorito	1	0	0	0	0.089
Giampedroni	1	0	0	0	0.089
Guardia di Finanza	1	1	0.667	0	0.068
Iaccarino	1	0	0	0	0.089
Losito	1	3	0.750	0	0.015
Muscas	1	0	0	0	0.089
Onorato	2	0	0	0	0.110
Pellegrini	9	2	0.449	0	0.799
Pilon	1	0	0	0	0.089
Raccomandato	1	0	0	0	0.089
Rusli Bin	1	0	0	0	0.089
Scarpato	1	0	0	0	0.089
Schettino	12	24	0.554	0.052	0.851
Sclafani	8	1	0.449	0	0.710
Spadavecchia	1	0	0	0	0.089
Tievoli	1	0	0	0	0.089
Ursino	1	0	0	0	0.089

Novelty network characteristics

- Nodes: 32
- Edges: 48

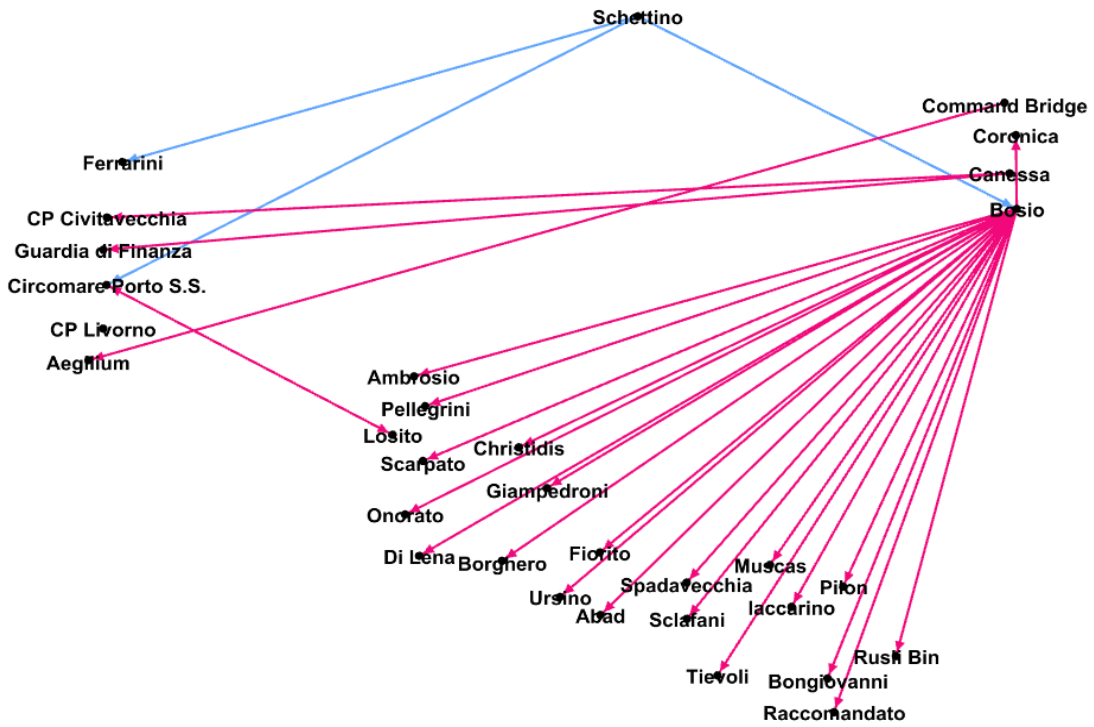

Figure 19 - Informal network showing communications adding novel information exchanged during Stage 3 of the emergency. Light blue edges indicate formal communications, while fuchsia edges indicate informal communication

Table 10 - Centrality measures for the nodes in the novelty network of Stage 3

NODE NAME	IN-DEG	OUT-DEG	CLOSENESS	BETWEENNESS	EIGENVECTOR
Abad	1	0	0	0	0.067
Aegilium	1	0	0	0	0.010
Ambrosio	1	0	0	0	0.067
Bongiovanni	2	0	0	0	0.134
Borghero	1	0	0	0	0.067
Bosio	2	36	1	0.023	0.021
Canessa	0	2	1	0	0
Christidis	1	0	0	0	0.067
Circomare Porto S.S.	3	1	1	0.001	1
Command Bridge	0	1	1	0	0
Coronica	1	1	1	0	0.067
CP Civitavecchia	1	0	0	0	0.010
CP Livorno	0	0	0	0	0
Di Lena	1	0	0	0	0.067
Ferrarini	2	0	0	0	0.021
Fiorito	1	0	0	0	0.067
Giampedroni	1	0	0	0	0.067
Guardia di Finanza	1	0	0	0	0.010
Iaccarino	1	0	0	0	0.067
Losito	1	2	1	0	0.707
Muscas	1	0	0	0	0.067
Onorato	2	0	0	0	0.183
Pellegrini	9	0	0	0	0.604
Pilon	1	0	0	0	0.067
Raccomandato	1	0	0	0	0.067
Rusli Bin	1	0	0	0	0.067
Scarpato	1	0	0	0	0.067
Schettino	0	5	0.532	0	0
Sclafani	7	0	0	0	0.470
Spadavecchia	1	0	0	0	0.067
Tievoli	1	0	0	0	0.067
Ursino	1	0	0	0	0.067

3.5 Discussion and Interpretation of results

The dualism and coexistence of formal and informal hierarchy is clearly visible in the Costa Concordia disaster and is highlighted by the communication exchanged during the emergency. The

predominance of the fuchsia areas over the blue areas in both graph (a) and graph (b) in figure 10 clearly suggests that not only have procedures been scarcely followed during the emergency, but also that informative communications have been mainly guaranteed by informal connections. The network analysis of the communications confirms these findings.

Stage 1 of the emergency is dedicated to the understanding of what alerted the crew. During this stage, Costa Crociere procedures require that specific teams are sent to pre-assigned portions of the ship to find the problem and, coordinated by the Command Bridge, confine it. The crew is therefore structured in small groups that involve both Engine and Bridge Crew. Passengers are only briefly notified about the situation in this stage, so the Cabin crew is not activated. The formal crew composition in Stage 1 is shown in figure 11. The Captain represents the starting point of all communications between the Command Bridge and the different areas of the ship, the company and maritime authorities. Figure 11 also shows the composition of some of the different groups that must be activated. In each group there is a referee (Ambrosio, Canessa, Pellegrini and Borghero in the figure) that is in contact with the Staff Captain, Bosio and reports the orders to the officers in the group. The Staff Captain guarantees the connection with the Command Bridge. Similarly, in the engine sector, the Chief Engineer, Pilon, reports all information provided by the personnel working in his group. In the Command Bridge, the Captain is supported by a group of officers (the nodes on the right in figure 11). Each officer has a different and specific role to support the Captain in the decision-making process during the emergency, because they provide him all the necessary information. In the formal network, four officers have a critical role, as indicated by their centrality measures. Schettino is the most powerful node in the network, as shown by his centrality scores reported in table 2. His out-degree is the highest, supporting his role as information provider from the Command Bridge. He is the major 'reference point', as indicated by his closeness centrality; he has the highest betweenness centrality value, meaning that he is the major broker in the network (the majority of communications pass through him), and he is connected with other influential nodes, as indicated by his high eigenvector centrality score. Bosio and Pilon have the second highest centrality values, indicating their power in their section.

The network representing the real emergency on January 13, 2012 (figure 12), show a quite different organization and the birth of the informal network starts to be revealed. The fuchsia edges, representing the informal communication are predominant over the blue edge. Two sets of communications, both involving the Captain, are reported as being formal. The first set represents communications with the Helmsman, Rusli Bin, while the second set represents the

communications with the Bosun, Sclafani. These communications occur soon after the impact and are intended to try to disengage the ship in the first case and secure the ship to the sea floor in the second case. It is therefore correct to assume that the Captain tried to put and keep the ship in a safe position before starting to assess the situation. Schettino keeps his position of most powerful node, maintaining the highest centrality scores as showed in table 3, as well as Pilon maintains his central role in the engine room. However, Bosio remains in the Command Bridge and Iaccarino is replacing him as referee in the Engine Room in the informal network, as shown by the different position of the two nodes in figure 12 compared to their position in figure 11. Iaccarino is providing information to the Command Bridge as indicated by his high out-degree, 16, and has a favored position in the communication exchange as indicated by his closeness centrality: his score is second only to Schettino, indicating that he can easily reach and can be easily reached by the other nodes in the network. A similar position is attributed to Pellegrini, the Safety Officer, which is reported to support the Staff Captain in the emergency coordination by the other officers in their depositions during the trial.

Captain's power seems to collapse in the novelty network, as shown by results summarized in table 4. The most relevant difference is his eigenvector centrality score which shifts from 1 to 0.315, meaning that the captain loses his connection with powerful nodes in the exchange of useful information (that are only the 44.71% of the total information exchanged). In other words, the captain was central in the communication network during the emergency, but he was connected to nodes that were not really relevant to the emergency management. Captain's role of most powerful node is mainly replaced by Bosio and Iaccarino. This result is consistent with officers' depositions reporting that, in absence of formal orders from the Captain to activate the leak emergency, Bosio decided to send Iaccarino to cover his role so he could remain in the Command Bridge to coordinate the emergency. Pellegrini's role as valuable support for the Staff Captain is confirmed in the novelty network by his almost unvaried centrality scores. In addition, results highlight how the informal network was guaranteeing useful information more than the formal one.

After the problem is identified and all the possible actions to confine it have unsuccessfully accomplished, the general emergency alarm is issued, and Stage 2 of the emergency starts. Passengers must be alerted and gathered and counted in deck 4, the Muster Bridge in order to be ready to possibly evacuate the ship if the abandon ship message is widespread. Figure 14 shows the crew's organization during Stage 2 of the emergency. In addition to the groups already activated during Stage 1 of the emergency, the Cabin crew start to work. This part of the personnel is also

divided in groups, but in this case each group member refers information to the referee, so the information flow goes from the bottom to the top. The referee role is to report to the Captain information about passengers. As in Stage 1 of the emergency, also in this stage the Captain is the most influential node in the network. He provides all necessary information to the Engine and Bridge Crew and receives all updates about passengers from the Cabin Crew. The Staff Captain Bosio is the main reference for communication with the crew assigned to technical assessment, and the Hotel Director Giampedroni is the main reference for communications about passengers. Their power positions are confirmed by their centrality scores as showed in table 5.

The emergency network confirms the Captain's and the Staff Captain's central position in the network but does not show any communication from the Hotel Director to the Command Bridge. Schettino has the highest betweenness centrality score, which means he lies in many of the shortest path linking the other nodes in the network and information pass through him. Bosio instead has the highest eigenvector centrality, meaning he is more connected than the Captain to well-connected (and more informed) nodes. Schettino guarantees formal connections with the company and maritime authorities as shown by the blue edges in figure 15, but communications on the ship are mostly maintained thanks to Bosio. The Staff Captain is supported in his informal role of coordinator by Pellegrini, who is reported to be on the Muster Bridge in officers' depositions, partially replacing Giampedroni. His in-degree centrality is the third highest score, meaning he receives information (from Bosio as indicated by the fuchsia edge in figure 15). The value 0 of his out-degree can be explained by the fact that Pellegrini is passing orders received by Bosio to the officers in the Muster Bridge (as confirmed by the officer's depositions), therefore his communications are not recorded by the VDR. Another important node in this network is Canessa, the Second Officer who supports the Staff Captain from the Command Bridge.

The Staff Captain's role as coordinator is more important considering the novelty network. 87.04% of all communication introduced in this stage new useful information and having Bosio as being the most influential node in the network, confirms again that the informal network has been essential in providing information. Schettino's disconnectedness to central nodes is better visible in this network, as indicted by his eigenvector centrality in table 7, which is drastically inferior to the value in the emergency network. The Second Officer's and the Safety Officer's centrality scores remain almost equal to the scores in the emergency network, confirming their roles as support for the Staff Captain.

Stage 3 of the emergency shows a totally different crew organization. The formal network highlights the role of the captain as 'star' of the network. In a star shaped network, the center node of the network has the most power because it has the highest value of centrality. In the formal network (figure 17), Schettino is in the central position of the network. His emergency role is to provide information to the company and to the maritime authorities and coordinate the evacuation. His closeness centrality value is the highest, since Schettino is the only node closer to all other nodes, as well as his outdegree, since, as captain, he represents the starting point of all communications. Given the particular structure of the formal network star, Schettino's betweenness centrality and eigenvector centrality are equal to 0. This value is consistent with the definition of the two centrality indices and the ship's organization in the evacuation stage. At this stage of the emergency in fact, all passengers are ready to abandon the ship so, after the captain gives the abandon ship emergency signal (the vocal announcement), what remains to do is to communicate to the maritime authorities and the company that the ship is being evacuated and give the relative indications for a systematic lowering of the life crafts. No communications are expected between the different life crafts, therefore in a network perspective Schettino does not lie between any other pairs of actors. His betweenness centrality is 0 and he is the only node to have a connection and his neighbors are not connected to any other node, so Schettino's eigenvector centrality is 0. On the contrary, all other nodes have closeness centrality 0 because they are not close to other nodes in the network, and their eigenvector centrality equal to 1 because they are all connected to the only one node connected to other nodes, the central node. Considering in-degree centrality, Schettino's score is 0 and all the other nodes' value is 1 because Schettino is not receiving communications and the other nodes are all receiving communications from the central node; conversely, all the nodes have out-degree centrality score 0 because they are not supposed to give information, while Schettino's score is 30 because he is communicating with all the other nodes.

Moving the attention to the real emergency, centrality scores show drastically different results. The informal network shows that Bosio replaced Schettino as coordinator of the evacuation. Schettino only kept his role of communicating with the company, as shown in figure 17, by the blue edge directed from Schettino to Ferrarini, and partially exchanging information in the Command Bridge. The Staff Captain has the highest value of both in-degree and out-degree centrality compared to the Captain, suggesting that he played a more important role in the emergency. He has been the center of the flow of communications on board, as shown by his closeness centrality, and has been more efficient in delivering timely messages, as shown by his betweenness centrality score. His

centrality in the communications exchange is highlighted by his high eigenvector centrality score, indicating that during the emergency he was connected with better connected officers, so he had better access to information. Canessa had supported the communication flow, as showed by all his centrality scores, almost equal to Captain's results.

The Staff Captain's role as 'center of the star' is even clearer in the novelty network. Even if the amount of useful information is only 48% of the total amount of communication exchanged, Bosio kept being central in the network as shown by his still high out-degree and closeness centrality scores. Betweenness and eigenvector centrality scores are consistently lower in the novelty network compared to the informal network but are still higher compared to Schettino's scores. The Captain kept his closeness centrality score in the novelty network almost unchanged compared to the informal network, meaning he still has connections with other nodes in the network, but lost his ability to efficiently exchange information and be connected with influential nodes, as shown respectively by his betweenness and eigenvector centrality, both equal to 0. The Safety Officer, third highest officer in the formal hierarchy, has the second highest eigenvector centrality score, suggesting that he was connected with well-connected nodes. His eigenvector centrality score, as well as his in-degree score (unvaried from is in-degree in the informal network as shown in table 10), is in line with what was reported by officer's testimonies that described Pellegrini as reference person on the Muster Bridge during the evacuation: Pellegrini was the connection between Muster Bridge and Command Bridge, receiving from here, in particular from Bosio, useful information for the evacuation. The value 0 of his out-degree centrality is easily justified by the fact that being on the Muster Bridge, communications from Pellegrini to other officers have not been recorded by the VDR. The results in the novelty networks confirm what was already shown in the informal network: informal connection allowed the exchange of more useful information compared to formal ties.

In conclusion, the analysis shows the essential role that formal and informal connections played during the management of the Costa Concordia emergency on January 13, 2012. The formal hierarchical structure has been replaced by an informal less hierarchical one (Guimerà et al., 2006), where captain's duties have been carried out by the Staff Captain, the most influential figure in the emergency, assisted by the officers in higher positions in the formal hierarchy. The persistence of the informal structure has been guaranteed by the novel information provided by informal connections that have determined the possibility to coordinate the emergency. These results are particularly important considering that after hitting the rock, the Costa Concordia got stuck on the

coast profile and did not slide down or capsize, therefore the officers had the time to reorganize in the informal structure and guarantee the information flow. The informal structure emerged during the emergency, shows the partial failure of the command and control structure, opening to the possibility to reorganize the leadership structure onboard ships.

3.6 Conclusions

The analysis shows how the IDF measure can be applied to network analysis of archival documents in order to find information on how formal and informal leadership emerged and disappeared in the Costa Concordia disaster. The development of the two IDF sub-measures, Receiver-IDF and Dyadic-IDF, to find relevant information in a single document represents a new application, therefore has limits and certainly needs to be improved.

A possible additional step in the measure refinement can be to focus on words used by the sender and eliminate these words from the calculation, in order to accurately determine the novelty of each word used in the communication the sender sends to the receiver.

References

Alba, R. (1982). Taking stock of network analysis: a decade's result. *Research in the Sociology of Organizations*, *1*(1), 39–74.

Bearman, P. S. (1993). *Relations Into Rhetorics: Local Elite Social Structure in Norfolk, England, 1540-1640*. Rutgers University Press.

Borgatti, S. P., Everett, M. G., & Johnson, J. C. (2013). *Analyzing Social Network* (1st ed.). SAGE Publications.

Butts, C. T. (2008). Social network analysis: A methodological introduction. *Asian Journal of Social Psychology*, *11*(1), 13–41.

Campbell, D., Hannah, S., & Matthews, M. D. (2010). Leadership in Military and Other Dangerous Contexts: Introduction to the Special Topic Issue. *Military Psychology*, *22*(1), S1–S14.

De Cremer, D., Van Knippenberg, D., Van Dijk, E., & Van Leeuwen, E. (2008). Cooperating if one's goals are collective-based: Social identification effects in social dilemmas as a function of goal transformation. *Journal of Applied Social Psychology*, *38*(6), 1562–1579.

Diefenbach, T., & Sillince, J. A. A. (2011). Formal and informal hierarchy in different types of organization. *Organization Studies*, *32*(11), 1515–1537.

Eisenhardt, K. M. (1989). Building Theories from Case Study Research. *The Academy of Management Review*, *14*(4), 532.

Festinger, L. (1954). A Theory of Social Comparison Processes. *Human Relations*, *7*(2), 117–140.

Freeman, L. C. (1978). *Centrality in social networks: Conceptual clarification*. *Social Networks* (Vol. 1).

Garton, L., Haythornthwaite, C., & Wellman, B. (2006). Studying Online Social Networks. *Journal of Computer-Mediated Communication*, *3*(1), 0–0.

Grech, M. R., Horberry, T., & Smith, A. (2002). Human Error in Maritime Operations: Analyses of Accident Reports Using the Leximancer Tool. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *46*(19), 1718–1721.

Guimerà, R., Danon, L., Díaz-Guilera, A., Giralt, F., & Arenas, A. (2006). The real communication network behind the formal chart: Community structure in organizations. *Journal of Economic*

Behavior and Organization, *61*(4), 653–667.

Gulati, R., & Puranam, P. (2009). Renewal Through Reorganization: The Value of Inconsistencies Between Formal and Informal Organization. *Organization Science*, *20*(2), 422–440.

Hannemann, R. A., & Riddle, M. (2001). *Introduction to social network methods*. Department of Sociology, University of California.

Jansen, J. J. P., Tempelaar, M. P., van den Bosch, F. A. J., & Volberda, H. W. (2009). Structural Differentiation and Ambidexterity: The Mediating Role of Integration Mechanisms. *Organization Science*, *20*(4), 797–811.

Kadushin, C. (2012). *Understanding Social Networks Theories, Concepts, and Findings*. *The effects of brief mindfulness intervention on acute pain experience: An examination of individual difference* (Vol. 1). New York: Oxford University Press.

Kent, D. V. (1978). *The rise of the Medici : faction in Florence, 1426-1434*. Oxford University Press.

Krackhardt, D. (1994). Graph Theoretical Dimensions of Informal Organizations. In K. M. Carley & M. J. Prietula (Eds.), *Computational Orgnization Theory* (pp. 107–130). New York: Psychology Press.

Kwon, Y., & Leveson, N. (2017). System Theoretic Safety Analysis of the Sewol-Ho Ferry Accident in South Korea. *INCOSE International Symposium*, *27*(1), 461–476.

Laumann, E. O., Siegel, P. M., & Hodge, R. W. (Eds.). (1970). *The logic of social hierarchies*. Markham.

Maitlis, S. (2005). The social processes of organizational sensemaking. *Academy of Management Journal*, *48*(1), 21–49.

Manoj, B. S., & Baker, A. H. (2007). Communication challenges in emergency response. *Communications of the ACM*, *50*(3), 51.

Moreno, J. L. (1960). *The Sociometry Reader*. New York, NY: Free Press.

Mousiner, R. (1973). *Social hierarchies*. New York: Schocken Books.

Mumford, M. D., Friedrich, T. L., Caughron, J. J., & Byrne, C. L. (2007). Leader cognition in real-

world settings: How do leaders think about crises? *Leadership Quarterly*, *18*(6), 515–543.

Newman, M. E. J. (2010). *Networks : an introduction*. Oxford University Press.

Nickerson, J. A., & Zenger, T. R. (2002). Being Efficiently Fickle: A Dynamic Theory of Organizational Choice. *Organization Science*, *13*(5), 547–566.

Osborn, R. N., Hunt, J. G., & Jauch, L. R. (2002). Toward a contextual theory of leadership. *Leadership Quarterly*, *13*(6), 797–837.

Padgett, J. F., & Ansell, C. K. (1993). Robust Action and the Rise of the Medici, 1400-1434. *American Journal of Sociology*, *98*(6), 1259–1319.

Pekericli, M. K., Akinci, B., & Karaesmen, I. (2004). Modeling Information Dependencies in Construction Project Network Organizations. *4th Joint International Symposium on Information Technology in Civil Engineering*, *40704*(November), 1–13.

Pfeffer, J., & Salancik, G. R. (2003). *The external control of organizations: A resouce dependence perspective*. Stanford, CA: Stanford University Press.

Podolny, J. M., & Baron, J. N. (1997). Resources and Relationships: Social Networks and Mobility in the Workplace. *American Sociological Review*, *62*(5), 673.

Pronovost, P., Berenholtz, S., Dorman, T., Lipsett, P. A., Simmonds, T., & Haraden, C. (2003). Improving communication in the ICU using daily goals. *Journal of Critical Care*, *18*(2), 71–75.

Sasou, K., & Reason, J. (1999). Team errors: definition and taxonomy. *Reliability Engineering & System Safety*, *65*(1), 1–9.

Simon, H. A. (1997). *Administrative Behavior: A study of decision- making processes in administrative organizations*.

Snook, S. A. (2002). *Friendly fire: The accidental shootdown of US Blackhawks over northern Iraq*. Princeton University Press.

Soda, G., & Zaheer, A. (2012). A network perspective on organizational architecture: Performance effects of the interplay of formal and informal organization. *Strategic Management Journal*.

St. Pierre, M., Hofinger, G., & Buerschaper, C. (2007). *Crisis Management in Acute Care Settings:*

Human Factors and Team Psychology in a High Stakes Environment. Springer.

Sutcliffe, K. M., Lewton, E., & Rosenthal, M. M. (2004). Communication failures: an insidious contributor to medical mishaps. *Academic Medicine : Journal of the Association of American Medical Colleges*, *79*(2), 186–194.

Taylor, J. E., Levitt, R. E., Fellow, L. G., & Levitt, R. E. (2004). Understanding and managing systemic innovation in project-based industries. *Innovations: Project Management Research 2004*, 17.

Weber, M. (1978). *Economy and Society: An Outline of Interpretive Sociology, eds.* (R. Guenther & W. Claus, Eds.). University of California Press.

Zeitlin, M. (1974). Cororate Ownershipand Control: The Large Corporation and the Capitalist Class. *American Journal of Sociology*, *79*(5), 1073–1119.

Zhai, C., & Massung, S. (2016). *Text Data Management and Analysis: A Practical Introduction to Information Retrieval and Text Mining*.

Chapter 4 – Maritime Leadership: the mariners' point of view

4.1 Introduction

4.1.1 The Command and Control model in the maritime environment

Charles Perrow defines the maritime industry as "*error-inducing*" in that "*the configuration of its many components induces errors and defeats attempts at error reduction*" and suggests "*only a wholesale reconfiguration could make the parts to fit together in an error-neutral or an error-avoiding manner*" (Perrow, 1984, p. 172). But 'wholesale reconfiguration' of the globalized maritime industry could not or would not eliminate error, nor is likely because "*the seafaring community was and still is very conservative and not in favor of change. There are always some fears that change may be negative for their profession.*" (Veiga, 2002, p. 21).

Complex organizations, including maritime organizations, are facing an increasing number of challenges nowadays: cultural difference (Harms, Han, & Chen, 2012; Matkin & Barbuto, 2012; Ramthun & Matkin, 2012), dynamically changing work environment (Dool, 2010; Gundersen, Hellesøy, & Raeder, 2012; Henderson & Stern, 2004), complexity (Gronn, 2000, 2002, Uhl-Bien & Marion, 2008, 2009) and dangerous operating environments (Hannah, Campbell, & Matthews, 2010; Hannah, Uhl-Bien, Avolio, & Cavarretta, 2009). Therefore, despite these fears these challenges highlight an urgent change. Campbell et al. (2010) have defined dangerous environment as "*those in which leaders or their followers are personally faced with highly dynamic and unpredictable situations and where the outcomes of leadership may result in severe physical or psychological injury (or death) to unit members*" (p. S3). According to this definition, sinking ships can be counted among dangerous environments. The Costa Concordia disaster, as well as many other disasters prior to and after the sinking of the cruise ship in 2012 (e.g. sinking of M/V Oceanos in 1999, the sinking of M/V Sewol in 2014, the sinking of SS El Faro in 2015), suggests that the hierarchical system – the command and control model – historically used to govern ships, is not totally suitable in modern complex ships. The leadership myth that hovers around the captain, presumes power and the right to command, to control, to dominate. In safety-critical domains, such as modern ships, the leadership myth is outright dangerous (Adams, Owen, Scott, & Parsons, 2017). Command and control describes the power of superiors over juniors, the power of supervisors over subordinates. The success of command and control relates to task accomplishment, to meeting budgets and to checking boxes that bureaucracy wants checked. To the person exercising command, it doesn't matter that the exercise of command is inspirational or

not, or if people are committed or not. Exercising command, nothing matters except that people do as they are told, and that the tasks are accomplished efficiently, on time and on budget (Adams et al., 2017). The command and control model used on passengers and cargo ships derived from the military field: from the lowest private to the Commander in Chief, there is an unbroken chain of command (Snook, 2002). Command is the authority vested in an individual of the armed forces for the direction, coordination, and control of the military forces. Commanders are responsible for everything their units do or fail to do. Control set of doctrine, tactics, techniques and procedures that create the supplemental coordinating mechanism designed to synchronize the complex details of day-to-day operations (Snook, 2002). Command and control requires loyalty to seniors, "*serving them efficiently and well; not in any way undermining their authority or prestige by any word or action of your own*" (Montor, Ciotti, & Wolfe, 1984, p. 108).

Literature shows that the terms command and control are antiquated and no longer fit twenty-first military and civilian institutions (Alberts, 2007). Therefore, rather than using rigid hierarchies of leadership to solely direct work efforts and meet objective (Kozlowski & Bell, 2003), teams (as the crew of a ship) should rely on one another and exhibit leadership when appropriate based on their knowledge, skills, abilities, experience, and the situation (Pearce, 2004; Pearce, Manz, & Sims, 2009). By broadly sharing power and influence with team members – rather than centralizing leadership around a single, hierarchical leader – teams may achieve a variety of positive outcomes (Bergman, Rentsch, Small, Davenport, & Bergman, 2012; Khasawneh, 2011; Pearce, 1997; Pearce & Conger, 2003; Shamir & Lapidot, 2003) and greater performance (Avolio, Jung, Murry, & Sivasubramaniam, 1996; Carson, Tesluk, & Marrone, 2007; Pearce & Sims Jr, 2002). This team-multidirectional-influence approach is called shared leadership, defined by Pearce and Conger as a "*dynamic interactive influence process among individuals in groups for which the objective is to lead one another to the achievement of group or organizational goals or both*" (Pearce & Conger, 2003, p. 1). Management researchers view shared leadership as an emergent property (Pearce & Sims Jr, 2002) resulting from distribution of leadership influence across multiple team members (Carson et al., 2007). Unlike traditional models of vertical leadership – the process of centralizing power and influence through a hierarchical leader (Pearce et al., 2009) as in the command and control system used to govern ships – shared leadership uses decentralization and sharing of power and influence among team members to achieve effectiveness (Pearce, Conger, & Locke, 2008). In teams characterized by vertical leadership, the organization's structure may represent the primary contributing factor to the influence process (Conger & Kanungo, 1998); however, when leadership

is shared, the influence process may emerge due to situational factors (Pearce & Conger, 2003; Pearce et al., 2009). As a result, shared leadership may act as complement to vertical leadership when structure fails to achieve leadership effectiveness (Pearce, Manz, & Sims, 2008). Shared leadership, supporting mutual influence rooted in the social interactions among group members, significantly improves team and organizational performance (Carson et al., 2007; Day, Gronn, & Salas, 2004; Ensley, Pearce, & Hmieleski, 2006; Pearce & Sims Jr, 2002; Pearce, Yoo, & Alavi, 2004; Perry, Pearce, & Sims, 1999). Additionally, investigations of shared leadership have found significant links to other positive outcomes, such as team potency and trust (Boies, Lvina, & Martens, 2010) and sustainably (Manz, Manz, Adams, & Shipper, 2011).

4.1.2 Safety Culture and Safety Climate in the maritime environment

A threshold issue in the discussion of implementing shared leadership in the maritime system, must be the relationship between an organization's safety culture and shipboard safety climate. Safety culture is widely recognized as the product of individual and group values, attitudes, perceptions, competencies and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization's health and safety management (Schein, 2016), whereas safety climate refers to the unique shipboard environment, peculiar to each individual ship within a fleet, into which the safety culture is received and integrated (Nagl, 2005). Therefore, even if the two concepts are distinct, the cumulative ship's safety climate may be said to be the measure in practice of the organization's safety culture (Gadd & Collins, 2002). The maritime industry is especially vulnerable to variable safety climates arising because of the nature of ships (e.g. people forming the crew on a certain ship vary during time) and their remoteness from shore side management. Different shipping companies have different organizational cultures; however, the linkage between poor maritime safety culture and increased accident liability is now generally well accepted (Choudhry, Fang, & Mohamed, 2007; Clarke, 2006; Lee & Harrison, 2000; Zohar, 1980). A ship is a living micro-culture, micro-political system in motion (Gilroy, 1993) reflected in and influencing the safety climate of the ship. Groups, such as ship crews, are recognized as viewing safety through their own subcultures, instead of sharing an overall organizational view of safety. "*For the safety culture of an organization to penetrate the on-board safety climate, the ship's personnel must have a sense of ownership in proper safety procedures, but too often the prevailing on-board attitude is one of 'company's procedures, not ours'*" (Gill, 2011, p. 68). A rationale for such an attitude may derive from conflicting orientations between management and shipboard. To confirm this, a survey conducted by Gadd and Collins revealed that 50% of mariners admit to

regularly breaching safety procedures (Gadd & Collins, 2002). This suggests that often managers and workers have different and incompatible views regarding the organization's safety culture and safety climate (Ciavarelli, 1997). This is alarming because a safety climate is an important indicator of the strength or the weakness of the safety culture umbrella and shows evidences of communication disconnect between organization and ships. Managers in all industries play a critical role in the formation of attitudes and behavior toward safety, but in the maritime industry, distance from shore side management increases the importance and influence in this area of shipboard senior officers as managers. Because of his position as apex in the command and control structure, the captain can make the difference in exacerbating or mitigating the adverse effects of high level decisions, and can also introduce failures into the system and influence officers' perception and the prevailing attitudes of the experienced personnel (Brown & Amrozowicz, 1996). Therefore, the company should be more aware of the safety climate the captain establishes onboard his ship and help him to harmonize the ships' climate with the company's culture. A possible obstacle to the implementation of safety culture in the ship's safety climate is the concept of '*destructive obedience'*. This term was coined by Stanley Milgram (1963) to emphasize the danger of deliberate or slavish acquiescence to orders or practices recognized as unsafe or contrary to standing orders or procedures. Destructive obedience may result from power distance arising from cultural differences, or command distance created by an intimidating senior officer, or the confidence of a junior officer in the senior's competence or experience. Whatever the cause, the consequence is that destructive obedience can lead to a failure. The most effective defense to destructive obedience is proactive encouraged appropriate monitoring and challenging. A study of United States and European male and female aircraft pilots and co-pilots evaluated the effectiveness of crew communication strategies in monitoring and challenging situations of varying complexity and stress (Fischer, 1999). The underlying premise was that error or omission intervention should be explicit and direct, but those criteria have been determined to underestimate the profound impact of social considerations arising out of the superior/subordinate relation, personalities and national culture. This impact is channeled through two components of verbal communication: the referential component, which defines which kind of information is exchanged (Yule, 2013) – what is said, and the relational component (Parks, 1977), which defines the relationship between the speaker and the audience – how it is said. Success of the of the communication depends critically upon this combination of what and how. The findings of Fisher's study on aviation can be easily applied in the maritime sector: the most effective communicative

strategy overall was neither too direct (commanding) nor too indirect (asking permission) but was in the nature of 'crew obligation statement', specifying a joint crew responsibility to perform a definite action compelled by some external necessity, without being authoritarian. A crew obligation statement is similar to commands, in the sense that is explicit in declaring what needs to be done, but contrary to a command, it addresses an issue without disrupting the concept of working as a team and appeals to crew's shared responsibility that a problem should be confronted and resolved.

4.2 Aim of the study and research questions

What emerged from the analysis of the Costa Concordia disaster related to leadership and informal communication, suggests the necessity to bring a change in the leadership structure.

The model currently used to manage ships is the pyramidal Command and Control System (chain of command) derived from the military system. This hierarchical model is traditionally perceived as infallible, but in reality "*fallible people are part of the command and control, especially considering the complexity of the modern ships*" (Oettinger, 1990, p. 5). In order to bring a change and help captains and subordinates in their jobs, this chapter aims at understanding how mariners and captains above all, perceive their role in the system. The final aim is to understand if people working at the first-line need and are ready to make changes in their working environment, that can be done integrating the shared leadership model, to the command and control model.

To understand if changes in the actual command and control structure are needed and are possible or not, hypothesis 2 is tested.

> Hypothesis 2: The current vertical leadership model should be flattened and integrated with a shared leadership model.

Semi-structured interviews are conducted to answer the following research questions:

- How do mariners perceive their job?
- How do mariners feel about the leadership style?
- How do mariners face emergencies?
- How is the company's safety culture related to the ship's safety climate?
- Do mariners require changes in their working environment? If yes, what kind of change do they require?

The outcome of this research may provide a starting point for further researches and further improvement for safety at sea.

4.3 Methodology

Captains and mariners from two of the main maritime organizations in the world have been interviewed for this research: the Council of American Master Mariners (CAMM) and the Nautical Institute. During the period April - December 2017, 35 members of the CAMM and 26 members of the Nautical Institute have been contacted by email and by phone to schedule the interview. The sapling method chosen to collect information is the expert sampling, because it is recognized to provide an in-depth investigation of a topic that is qualitatively valid, reliable, and culturally generalizable; experts in fact, tend to agree about the vast majority of their subject area, and also provide virtually the whole explanation of the variability in expert views (Romney, Weller, & Batchelder, 1986).

Skype interviews have been conducted with captain and mariners belonging to the two organizations, in order to understand if shared leadership can be introduced in the current command and control system. The choice of Skype interviews is due to the international nature of the two organizations: people interviewed live and work in different countries in the world and in-person interviews would have consistently increased the costs of the study. Skype interviews can partially recover for these gaps, thanks to the use of the camera.

The interviews lasted about 90 minutes. The data used in the qualitative study were gathered through the use of semi-structured Skype interviews examining issues associated with the three main characteristics of shared leadership: leadership, goals and cultural environment. Thus, the interview guide was structured in four parts aiming at collecting information about:

- Understanding of leadership
- Roles and duties
- Management of past experiences
- Culture of error

A schematic summary of the connection between the pillars of the shared leadership model and the interview guide is represented in figure 20.

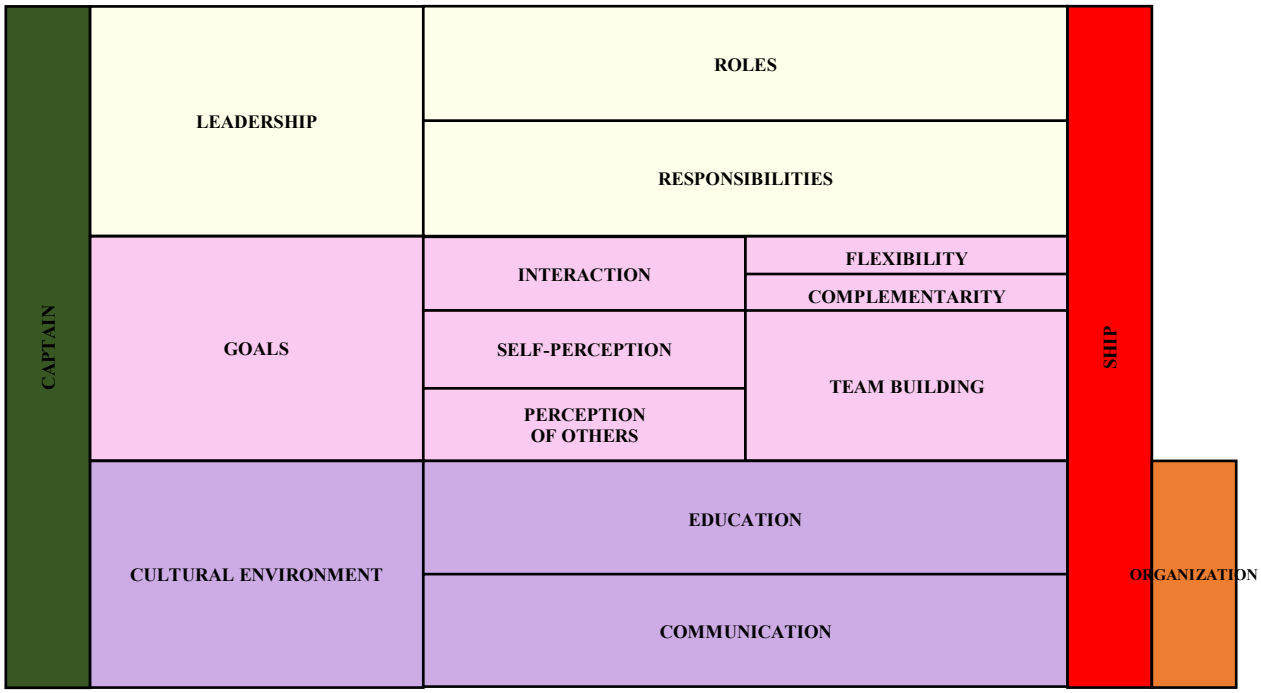

Figure 20 - Connections between the three pillars of shared leadership and the interview guide

There was no anticipated risk to all participants as the study sought self-reported knowledge that was not deemed sensitive in nature and posed no threat to the individual. The benefit to participation in the study would allow the understanding of the current leadership system and organizational culture in order to gather information to use to develop a new model for emergency management. An introduction letter accompanied the interview, explaining several things to the participants: the study was described, along with the intended use of the results and it was explained that the study was an academic requirement for a doctoral project. The participation in the study was voluntary and without compensation. Participants might refuse to answer any specific question raised during the interview without giving a reason or explanation for doing so and without any effect on the relationship with the Università Politecnica delle Marche or the other researchers involved. The interviews have been audiotaped. Interviewees names will not be used in published articles and reports but references to the interviewees are indicated through their role and the organization they belong. Interviews are qualitatively analyzed using the software Atlas.ti, a proprietary software that allows to analyze complex phenomena using unstructured data (texts, videos...). Primary documents can be analyzed through the attribution of codes that represent the attributes to be searched in the document and that allows to determine the meaning of words and group each part of the document into different categories and obtain results. This study employed a simultaneous data collection and analysis strategy (Merriam & Tisdell, 2015). As the interviews

were individually completed, rudimentary analyses were conducted in order to narrow the focus prior to final analysis, develop improved analytic questions, and test emerging themes on participants (Bodgan & Biklen, 2003). Once the data collection phase was completed, the raw data were organized in order to facilitate a systematic interrogation to discover patterns, ideas, and themes. All interview data were transcribed from verbal digital recordings into computer type documents. With these tasks complete, a preliminary exploratory analysis (Creswell, 2002) was conducted to obtain a general sense of the data's content and direction. The preliminary exploratory analysis provided general orientation to data trends and confirmation of the presence of enough data to continue the analysis. The typological data coding method was employed for the analysis. This method requires the data set to be divided into groups using typological categories in order to find patterns and develop themes (Hatch, 2002).

4.4 Results

4.4.1 Codes and Themes of the analysis

The initial coding effort found 32 total code words. These were compared for overlapping trends in meaning and redundancy; this reduced the total number of codes to 18. A final review reduced the codes in six total themes answering research questions. A summary of codes and themes is reported in table 11.

Table 11 - Codes and themes

Initial codes	Final codes	Themes
Adaptation	Advices	Culture and climate of error
Approach to leadership	Appraisal	Error isolation strategy
Checking performance	Changes from past experiences	Friendly leader
Communication	Error sharing friendly environment	Mentoring
Decision making	Freedom to talk	Multiculturalism
Education	Interaction during work	Teamwork
Emergence	Laws improvement	
Error strategy	Mentoring	
Hierarchy	More collaboration-captain	
Improvement	More collaboration-company	
Improvisation	More collaboration-team	
Information prioritization	Motivation	

Information sharing	Multiculturalism
Inspiration	Pressure
Knowledge	Promotion of safety
Lead	Request/provide help
Meaning of leadership	Support from the company
Multiculturalism	Team/work alone
Object orders	
Perception	
Qualification	
Relationship	
Resilience	
Respect orders	
Risk, Threat, Danger	
Self-confidence	
Situational awareness	
Support	
Team	
Teamwork	
Trust	
Understanding of safety	

4.4.2 Participants

20 (12,2%) of the 61 mariners contacted replied and 11 (6,7%) accepted to be interviewed. Two of them are members of the CAMM and 9 are members of the NI. All participants have dedicated their entire life to the shipping industry, although they worked on different typologies of ships and covered different positions: 9 interviewees are captains, one is an engineer and one is a second officer. Six of them had a short experience as military (two years), four never joined the army and one preferred to not provide this information. All mariners interviewed are male and are ages 38 – 62 years (mean 53.27, SD 8.955). Participants 1 and 2 belong to the CAMM, while all other participants belong to the Nautical Institute.

Participant 1

This participant has a long experience in the shipping sector. He worked for 41 years in the industry and sailed 4 years as master on container ships. He is 61years old and owns a BSc from the

Maritime College, State University of New York. He is currently Operations Assistant at Marlow Navigations.

Participant 2

This participant worked for 25 years in the industry, 10 of which he worked as master. He worked on different types of vessels, namely container ship, tankers, break-bulk, tug boat, passenger boat, fish boat, seismographic boat, oil supply boat. He is 62 years old and owns a degree from the California Maritime Academy. He is currently Master of an American container ship.

Participant 3

This captain worked in the sector for 36 years on many different types of vessels: dredger, cable ships, coast guard ships, icebreakers, buoy tender, search and rescue ships. He worked many years as first officer before he was promoted to captain. He is 59 years old and got his master's degree from the Canadian Coast Guard College. He is currently retired.

Participant 4

This participant worked 2 years as second officer on cruise ships and had no previous or other experiences at sea, even if he studied to become captain. He is 38 years old and owns a Captain License. He is currently working as Master on a dredger.

Participant 5

This participant worked 2 years as captain on cargo ships, containers and bulk carriers and has been working in the maritime industry for 34 years. He got a degree in a marine university and is 51 years old. He is currently Head of Training Department of Internship Navigation.

Participant 6

This participant worked as officer and captain on oil tankers for 20 years. He studied at the Novorossiysk state academy and got a MBA. He is 49 years old. He is currently working as Deputy fleet manager, Senior Operations Superintendent at SOFCLON.

Participant 7

This participant in the sector for 13 years, three of which as captain. He worked on platform supply vessels, anchor handling tug supply, cargo vessels, container vessels, ro-ro ferries and tankers. He is 47 and got his MSc and engineer diploma from the Maritime Academy in Gdynia. He is currently Managing Director and COO at Österreichischer Lloyd.

Participant 8

This participant worked in the sector for 13 years, three and a half of which as captain. He is 39 years old and owns a BSc from the University of Rijeka Faculty of Maritime Studies. He is currently Quality Health Safety Environment and Marine Superintendent at Columbia Ship Management LTD.

Participant 9

This participant worked for 44 years in the industry, 27 of which spent on ships working also as captain. He worked on cargo ships and buoy tenders. He is 62 years old and owns a master's degree from the National Maritime College in Ireland. He is currently working as Director of Operations and Navigation Services.

Participant 10

This participant worked 13 years as captain on cargo ships, passenger ships, heavy-lift ships and reefer ships and has been working in the maritime industry for 48 years. He does not have a maritime-related degree but has an MBA and is 65 years old. He currently works as Marine and Quality Manager at Maestro Shipmanagement LTD.

Participant 11

This participant worked in the sector for 25 years and on cruise ships and cargo ships as engineer for 9 years. He is 53 years old owns a master's degree. He currently works as Marine and Offshore Business Manager for Lloyd's Register.

4.4.3 Culture and climate of error

The relationship between company and shipside is described as controversial by participants. Mariners recognize the role of the company in promoting safety related procedures but complain about the lack of a real involvement in safety.

Participant 2 says that:

> *I have to say I'm trained pretty well. The United States Coast Guard, under the UN or under the International Maritime Organization they try, even though they are not signed on the treaty, the Coast Guard tries to enforce the UN mandates and the IMO mandates, so we spend lot of time doing those things […]. [The culture] of the company influences the incidence of errors and reports a personal experience. One example, we went into the shipyard and we had... on the hatch covers there are places we put the cones for locking in the container, that secure containers to the ship, and this particular things were, they weren't in good repair, and we put there in the list to fix. And this got, I mean it got pretty bad and we weren't able to carry a full load and when they finally realized that my*

ship did not carry a full load due to the disrepair, then it became an issue to fix them as quickly as possible, because they didn't understand, they didn't want to take my work for it so, just gotta go forward, you know

Participant 5 explains that there are economic reasons behind the company inefficiency in preventing the incidence of error and promoting safety: "*There's a big change to 20, 30, 50 years ago in shipping. But safety is playing a much bigger role. Saying that, we are still… our biggest enemy are the costs.*".

Participant 8 distinguishes between bigger and smaller companies saying that:

The leading companies, the big companies, um, do have a very very strong safety culture. For smaller companies, unfortunately, the safety is not really always at the top. Safety is not for free, in fact, the safety is quite expensive. So many companies that are small and need to make it profitable at all will compromise on the safety in order to increase the profit margin.

He adds that on the ship side there is sometimes poor consideration for safety, but this is due to company's requirements:

So, there are issues with the safety there but it's not for the lack of want. People do want to be more safe and you talk to the shipboard people and you ask them, 'Do you want to come home without injury, without finger being cut off, without broken leg? Do you want to come healthy so that next time you can go back to feed your family?' Everybody will say, 'Yes'. That's not an issue but even they on board the ship they know that sometimes in order to please their owners they will cut corners to make things faster, to make things better, to earn more money for the owner because many times they do it thinking that they are doing a good thing, what the owner wants.

Participants report that there is a difference between how safety is promoted by the company and how the shipside perceive errors. For participant 5, this is due to a lack in education in the company about "*What is a ship? What are we doing? What size of ships? What ranks? [because] from the technical department there is no one actually, really, educated in shipping".*

Participant 10 explains that this difference is due to a misunderstanding from the company of the work on a ship: "*In the office we don't appreciate the day to day work that people are doing on board, and we expect or perhaps we have unreasonable expectations of what can be done and what can't be done*".

Participants recognize the importance for mariners to be controlled and appraised by the company regardless of their rank. For participant 3, everyone has to be appraised because:

> *It doesn't matter what area of industry you're working at, performance assessment is a very necessary tool and for, you know, primarily for company purposes and keeping certain standards, but it's obviously for the individual who's getting the assessment to make corrections to their practices and also to give them some guidance in their career, whether in their life and how to make them better performers*

For participant 8, it is important that mariners are appraised:

> *in order for everybody to have the same understanding, the performance appraisal is not a tool to punish. I can punish at any given time, but I want to give a constructive-structured feedback, so that a person can improve and in this is supposed to be seen as a possibility to improve, not a punishment tool*.

For the participants, performance appraisal is affected by subjectivity and companies do not always give the results the right weight. Participant 1 explains this concept in a personal experience:

> *I know masters in the past that needed an assessment very badly, because they were living in a very… were creating a very divisive atmosphere onboard the ship and that lead to consequences the owner control, and in one case the ship master, his ship go aground, because he… he was improperly assessed at some point…. and the company knew it, they knew that he had issues and knew… and they didn't properly, they should have assessed him, and they didn't, they do lost the ship*.

Participant 3 adds that he:

> *find[s] so difficult to be objective, you know, when you're making a performance where we're all human being and we're all very subjective and we have likes and dislikes and some people personalities and we get along with another personality we don't get along with, that shouldn't affect the actual objective assessment of their work, and that's very hard to do*.

Participants recognize the role of the captain as support for the company in promoting safety on ships. Participant 10 states that:

> *[safety culture] changes so often. You have, depending on the, the boss, the captain, the manager, the director whatever, and it very often and it's influenced by how they view things. [It is a captain's duty to] promote the safety on board, to try and create a safety culture*.

For participant 9:

The captain has to take a responsibility first and has to have a real active interest in it. If he doesn't, nobody else will. If the captain doesn't show good example and safety [...] well, then nobody else will. So, the captain, the chief officer, the boatswain, in terms of their crew, the chief engineer, they're the ones who have to show the good example. And certainly, in the case of the captain, if he's breaking the rules, why would anyone else follow it? But he has to be the example first.

Conversely, participants perceive pressure by the company on captain's job and position on the ship. For participant 2:

[The] organization, looks after the master, the criminalization of the masters becoming very prevalent nowadays. [The organization] is putting a lot of responsibility on the captain, and, they want to pro… somebody has to hang. Somebody has to get prosecuted for anything that happens and the captain is overall responsible for anything that goes on the ship, even though he didn't do these things.

For participant 9, the possibility for the captain to correctly promote safety is implemented by "*the volume of paperwork that they have to deal with, and not just in safety.*".

4.4.4 Error isolation strategy

The participants describe different strategies they use, or they would like to be implemented to reduce errors and learn from mistakes in order to reduce the impact of future events.

Participant 1 says that:

My particular company has been practicing a very intense performance metric system and in addition to the ship's mechanical and budgetary performance, they also monitor safety performance and the numbers that come out of that monitoring are summarized and published every month, and we communicate that to the crew and whenever there's a deficiency or an indication of a losing ground or a deficiency that come up the previous month, we try to take corrective action or we point out to the crew what corrective action we have to do to bring up our safety standard.

For participant 2, the strategy to isolate errors is:

[to do] emergency drills, every week we had to do drills, we spent an hour, maybe sometimes two hours in doing drills, that's always fun. Firefighting, enclosed space, evacuations, boat drills operations, boat in the water, emergency diesel generators, engine room fires, you name it.

Participant 5 provides a strategy he personally adopted called:

Reflective learning and learning engagement. This is done in crew meetings of variable sizes of crew members, could be 5 crew members, could be 10, could be more. So, what we do as company, we give

every quarter a safety subject. I give the scenario, and I demand from our ships that they report back to me the result of this scenario. For instance, lifeboat accident was discussed within the quarter.

For participant 7, in order to reduce errors:

[The] company should be in driver's seat. But of course, on board the ship, the master being company representative should be fully responsible, so that there is let's say, interaction, [among] company, master, senior officers as well.

Also, participant 9 explains that:

My strategy has always been to say to people, "If you see something wrong, put your hand up. I won't bite you. If you need me, call me". Speaking up early and finding that you were wrong is better than speaking up late when the ship is aground, or there's a collision, or somebody is injured.

Participant 10 suggests a particular strategy that should enhance collaboration between company and captain:

I'd like to see more people coming from the ships and working in the office and then going back to the ships. It would be much better if there was more of a free movement of people between the ships and the office.

Participant 8 provides an example of a strategy adopted by some companies but failed its attempt to reduce errors:

A couple of years ago the bigger companies, more advanced companies, were generally almost all operating on the policy of no blame. And that was very strong in the industry. So, no blame culture was promoted very strongly. It originated from the tanker segment and permeated throughout the industry. Well, it was kind of pushed. Not everybody liked it. Definitely not all the generations. Ah, younger generation like me was in love with it. So, we were all pushing our people to report everything without fear, so literally no blame policy. However, that had a negative effect. Because apart from people reporting now freely, everything gets them to start caring less. To start making stupid mistakes with a notion of whatever happens, never mind no blame. So, unfortunately it degenerated into a part of, well, why would you care? Who cares if it damages, if it's broken? Never mind. No blame. Company said no blame. No issue. No worries.

He also describes the solution that should spur mariners to share errors and near-misses and actually reduce the incidence of errors:

So, now the industry has moved into something called just and fair culture or it's moved toward accountability. Where we still promote the culture of no blame when there is a mistake, when there is an accident that happens. So, there is no blame. However, when there is neglect, when there is intentionally something done wrong, then of course there must be an accountability for it.

Participant 3 explains the conflicting relations between the captain and the company in actuating the strategy to reduce errors:

When I first came on this vessel [...] there was no written procedure, mean, we had written company procedures that were very general for the company, but we had no specific procedures on the vessel for any specific risks that we were going on, so right from the very first, you know, couple of months I started, you know, every time we came up on an operation that was new, I would have a meeting, talk to the crew, ask their opinion, and we started producing, you know, specific procedures for the vessel, […], and also having the safety meeting every couple of weeks, we would have a safety meeting and also those discussions during the safety meetings were enabling to discuss close calls, and also the way to communicate certain reinsurance to the crew that ok, you know, it doesn't matter what it is, it doesn't matter what happens, report it, you're not goanna be single doubted, you're the good guy for reporting the accident or the incident or the close call. [...] So with the years now they're more comfortable now, knowing that there's no problem reporting anything even if they're the ones involved, and they came with the close call, we're going to take the incident under consideration and try to make the situation better by reducing the risk of that particular situation, so it won't happen again. [The company did] nothing, it was all of the captain. They get copies of each new procedure, or modification is sent to the office and they have copies of all the specific procedures, but as far as inputs it's concern, very little input unless there's something that is more general procedure, safety wise and, once in a while we get some input from the safety officer of the company but is very rare.

4.4.5 Friendly leader

The participants stated that the captain should be open towards the crew, but at the same time he also should be strict. In particular, they make a clear distinction between everyday activities and emergencies.

Participant 6 describes the captain as:

a manager, it's also… he is a father for the crew and uh, you should have a good experience, good education and a good nature, you know, because of the people at sea go to you and ask uh, questions, ask advice and so. If they have a home problem, far from family and uh, it's like uh, like a manager and also like a father, it depends. You should be [a father], you know, because the crew is uh,

always… they want to have advice from you. [The captain has to] "have a friendly relation and be inside [the team], [but sometimes he needs] to press the crew, to push the crew, to act […].

Different is his view of the captain during emergencies: "*the captain is a leader. Yes, simply a leader, yes. Simply a leader.*". For participant 1, the captain should lead his crew by example: "*they're all important jobs, so I'm respectful to their positions, I treat them as individuals, and usually I get similar treatment in return.*". For participant 5, being a captain is "*primarily an achievement*, *try to achieve respect by working, not by demanding respect.*".

Some participants stated that a captain also has to be an example for the crew. Participant 5 reported his personal experience as captain:

I would be probably still the first one to go down and at least try to give an example [to the crew]; I'm among them and I know what they are doing, and I know, I appreciate their hard work, um, but I would keep some little pressure on them but not only pressure.

For participant 7, being the captain:

you have to understand that you are not only the captain, but you are like, uh, like father on board the ship for your crew. Um, a Master needs to be always fair. He has to listen to the crew, um, but the final decision is always, um, belong to the captain. Uh, captains are, you know, with crew. I was, you know, like a chief on board. You suggest, you know, the general comparison. And they're just looking at you and at your decision. Um, so this is like, like a job to me sometimes. So much into fairness, yes, the master must be always fair. [The captain has to have his] doors always open for everybody on board. So, I was listening to them. I was listening to their ideas. So, they can come to me anytime and they can discuss. They can tell me everything and I have not let any single item unattended from my sight.

Participant 8 explains that:

I prefer to trust to my crew unless I get disproven, so I give trust, implicit trust to begin with. With a lot of supervision and control and as long as the people are true to their work and they can do their stuff I will not interfere too much on how they will do it. When something new has to be done, when something that is out of ordinary, then I will prefer to be in a forefront. I will lead by example. If I want my crew to change their behavior or change the way how they do things I will make sure that I am an example of how things supposed to be done. I strongly disagree with requesting something from your subordinates which you yourself do not do.

Participant 4 explained the captain's attitude with the crew in his personal experience as crew member:

> *A captain was very friendly… We check the master, the master respects those people [the crew]. This, this was a pleasure*", and adds "*with the captain that was friendly, you would like to make a meeting before approach. There you can say all of your opinion, without protesting and without to say to him 'You don't', I mean 'this is a better way to do I'. But after finishing the approaching, yeah, that time was a good time to say something, that this is a better way or is not the correct way*.

4.4.6 Mentoring

Mentoring is defined as one of the main abilities that a captain should have to be a good leader. Participant 9 explains his idea of mentoring as:

> *I say to young people all the time that what they have to be is the best master mariner that they can be. You won't be the same as I am, and I won't be the same as somebody else, but you have to be the best master you can be. [He involves his crew in] planning operations and how you would do things, I would take a more collaborative view and involve all the officers and then the deck crew, and the boss, and who manages the deck crew in the operations much more [than captains in the past].*

Participant 10 describes mentoring as a daily duty:

> *I tried not to be a captain that just sat in his office and you only saw him when things were going wrong or when things weren't right. So that's why I tried to get around the ship see people, where they were working, say particularly on the deck side, I'd be out on deck seeing where they are, going to the galley talk to the cook. Just on a general daily basis. So that people were, um, were comfortable.*

Participant 5 highlights that his possibility of being a mentor is influenced by the workload:

> *Uh, on the bigger ships I was at bridge, but I did not take the command of the watch. I was just supervising or helping my young officers. Uh, you are more mentoring on a bigger ship. Yeah, you have the time to mentor because we don't need to sleep while the other people are working. But, in the smaller ship, it's a little bit different, your time constraint is bigger. You have not so much time because your time for mentoring is less. [Mentoring means] appreciate their hard work, but I would keep some little pressure on them.*

Participant 6 explains the importance of a good mentoring process for risk assessment:

> *I tried to teach my crew, to mentoring my crew, if you go to start some not usually job for you, start assessing the risk, what you're gonna need. If you are not sure, ask great people, not go. Not go, not go, but just ask and discuss. Very successful. This is very important. This era some people think the*

risk assessment is complete in the form, complete in the paper, no. If you have this in your head, no need for papers.

Participant 11 describes the possible challenges for mentor and be mentored in the modern maritime system:

These days people on board the ships, they are moving much faster on the ranks. So, they don't get the chance to be exposed to many accidents so that they learn. And they also don't have the luxury of having older officers teaching them, so that their experience can come from one generation to the next one.

4.4.7 Multiculturalism

The participants have quite a negative opinion about the efficiency and safety of working in teams composed by many different cultures. Even though education and experience can make the difference and partially stem diversity, participants find that cultural background can obstacle communication and become a barrier to safety.

Participant 11 describes the difficulty of working with mariners from different cultural backgrounds:

Well [a multicultural team] makes things even more complicated. Because in a multicultural environment, especially if the people are not coming, at least from uh, the same area that… if they were all Europeans, it would be possibly easier or, if they are all Asian, or at least Asians from certain countries where they have, similar standards and mentalities, then it may be okay. But if you have on the same ship Europeans, Asians, and Americans and I mean, quite different culture is not as easy on a ship to work together

Participant 3's opinion is that "*The problem, I think, or the challenge with multicultural crews is the communication obviously and the language barriers.*".

For participant 5, multiculturalism:

can play a big role in safety […] *Filipinos, Asians are more obedient. If I come there as a white German with four stripes on my shoulder, I can demand everything, and most Filipinos do everything I say, even to complete the wrong thing. So, European leaders, European officers need to be aware of, cultural differences, because Filipinos or Asians are more obeying to orders and they will not ask a question like any middle European would do. 'Captain, are you sure about this?' No Filipino would ask this question 'Captain, are you sure?' They would do it if I command a thing*.

Participant 8 focuses on the way orders are perceived by different cultures:

there is significant difference, when you were talking about the control, about the issues of leadership […] Europeans tend to be quite loud. That is perceived as rude and aggressive. And if you have a Filipino, Chinese, uh, Vietnamese, Burmese person there, the curtains simply fall down, and everything is shut down. There is no communication. You can shout at me as much as you want, and I will most likely not even hear what you are telling me. So, those cultural differences can be very, very strong.

He also explains how multiculturalism affects team performance:

When it comes to a group work and the teamwork, again, very strong. With European nationals on the bridge, you do not have a big power difference. In many Asian cultures it doesn't work like that. People will not even dream of speaking to a person who is higher by rank. God forbid to challenge that person. So, if you are higher rank than me and you say something, and I can see that it is obviously wrong, I cannot challenge you, especially not in front of the other person. That is another thing. To shame somebody in front of the other person is ultimate mistake that you can do with Asian cultures. So, to overcome this part as a-as a captain, as a bridge team leader or bridge team manager, to get integrated people from different cultures, to all participate in freely, can be very, very difficult task because there are some cultural issues that are very difficult to overcome.

For participant 4, the way mariners perceive safety is influenced by their culture:

It depends on the people and nationality. For example, the Latin people, they are the more lazy, for example. Filipino crew follow their regulation. They don't like to make great problems, also Indian. Greek crew after many years they say that 'Okay, I know everything' But you know, with the Greek people when you start to make questions 'how you make this? how you make that?' then they have no answer.

Participant 7 reports his personal experience as captain working with multicultural teams: "*From my past experience, the majority of the challenges were related to the crew, because I used to work with, uh, different, um, nationals with different religions.*".

Participant 6 goes further than participant 7's statement and describes how the captain can overcome this obstacle and help good performances in multicultural teams:

I don't believe it's so bad. I have experience working in uh Ex-Soviet Union, for people like Ukraine, Byelorussia, Russia, and there were many Filipino people in the group. Uh, we study each other, we teach each other and of course, you'll exchange the experience. It's not so bad and of course if there's somebody and, most important, the leader has a good education, uh, is a good leader and may control

the situation […] Even with the same language you have sometimes problems, so imagine the next level of difficulty when the mother tongues are not the same.

4.4.8 Teamwork

Teamwork is seen as essential for ship operations by participants. They describe the importance of teamwork and trust among team members both in normal activities and emergencies.

For participant 2:

You have to let the crew know what is coming up and see what they say, but once you became experienced enough they trust you" [In emergencies] you have to have the trust of the crew, you have to have the trust of the crew, I mean you have to lead them to follow you.

Participant 7 gives a real-life example of how teamwork helped to solve a real emergency:

I had no connection. Very bad connection also in the office. Uh, telephone connection […] We have also some issues in the anchor chain but at the time [someone] had an excellent idea. She had excellent idea together with the chief engineer and they said, 'Okay, guys. Well, it's better to think eight hours and make it in a one hour rather than make it immediately and then think what it went wrong'. So, we are sitting together discussing what I called cadets, everybody. So, we found solution, we found solution and workable and we have succeeded within very a short time.

Participant 6 explains the team is the main resource to face an emergency:

You rely on your experience, in your head you start realizing what kind of hazards you can encounter, you meet, in case of an emergency and what is the control actions to minimize the risk in case of an emergency. Uh, of course, your first force is about the group, about the people. Uh, people on board of your vessel or any who is in emergency. [The captain is a motivator within the team because] sometimes happened that you need to give an order, but I prefer the crew to understand what we need not just give an order here. If the crew worked from their soul, from their brain, you have better profits, better results.

Participant 10 describes his experience as crew member of working in an efficient team head by an expert captain:

H*e stayed on the bridge and really coordinated things and made sure that he was the main communication guy really, and so he made… he let people get on with their jobs, he didn't try and… because very often you're stuck in one place and you don't know what's happening around the rest of the ship. So, you can't interfere without knowing what's happening, so he was very good in that he took all the information in and just passed it on between people. So, it was a case of allowing the*

different teams to get on with their job and he was sort of like the coordinator between everyone. So, it was like an overview rather than getting too much in detail which is often a fault.

He also adds that this experience influenced the way he leads his crew as captain:

It very much influenced the way I tried to be afterwards when I was captain and that's more of stand back and see what's happening rather than try and do everything. It was a bad experience at the time, but it was a good learning experience.

4.5 Discussion and interpretation of results

Results show that the maritime industry is open to bringing changes in the organizational structure. Such openness is relevant if we consider the different background of participants belonging to the two organizations. Participants belonging to the Council of American Master Mariners only had experience working on board ships, while participants belonging to the Nautical Institute experienced the shipboard life and the office life, since they are working or worked on ships and hold important positions on the company they work for. This different background would suggest a different approach to changes of the members in the two companies, with CAMM members being more inclined to prioritize captain's and crew's needs and NI members highlighting more companies' concerns and necessities. Conversely, results show agreement in the replies of the participants, so many different considerations can be made with regard to the possibility of implementing shared leadership in the current management structure.

Figure 21 provides a global understanding the mutual effects of the different themes emerged in the analysis.

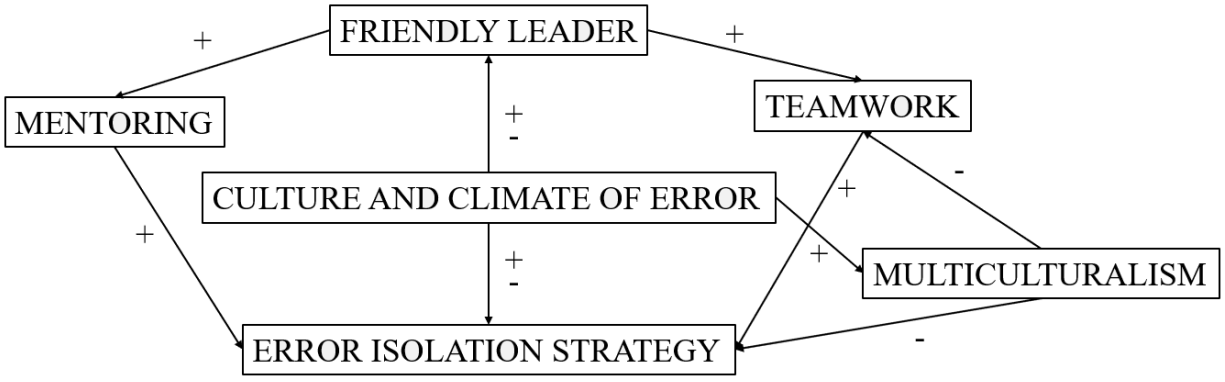

Figure 21 - Schematic view of the relations among the themes emerged in the analysis of leadership. The symbol + indicate a positive relation between the connected themes; the symbol – indicate a negative relation. The links are directed, showing what theme positively or negatively influences the other

The participants' definition of the role of the captain as father for the crew on the ship is emblematic and strongly diverge from the traditional view of captains as 'God on the ship'. The captain is still seen as having both the characteristics of a more authoritative leader that should make pressions on the crew but also has a new important definition of a friend to whom talk and report errors and near misses. The captain should be an example for the team and should give everybody the possibility to share ideas, concerns and be part of the decision-making process. The participants stress the need of reporting errors and near-misses in order to avoid accidents and recognize the captain as the figure that should listen and help the crew in this process both in formal and informal meetings. Seeing the captain as friendly leader has positive effects on the crew. First, the crew is more willing to share concerns, ideas and possibly challenge captain's decisions. Second, it opens the possibility for the captain to be a mentor and instructor for the crew, and for the crew to be mentored. On one side, the captain can give the crew the freedom to work, the possibility to make mistakes and the comfort to report any dangerous situation arising from work. On the other side, this creates the possibility to analyze any problem as a team and share the decision-making process that brings to its solution. In other words, it creates the possibility to share experiences and learn from own and other mistakes. Having the possibility to share and learn from errors, has a positive effect on the consolidation as a team of the crew working on the ship. Having a strong team in which the friendly captain is involved, has a positive influence on the definition of a strategy to isolate errors, because it will involve team discussions in both formal and informal meetings. Multiculturalism is seen by participant as potentially dangerous for safety because the way different cultures perceive authority and freedom is different. Hofstede and Hofstede (2005) use the Power Distance Index (PDI) to define the "*emotional distance*" (p. 41) that in different cultures separates subordinates from their bosses. Cultures having a low PDI, as European countries and United States, prefer consultation in the course of making a decision and there exist an interdependence seniors and subordinates wherein the subordinate feels comfortable to approach the hierarchical senior. Cultures having a high PDI, as Asian countries, view power as unequally distributed and the subordinate is unlikely to approach the hierarchical senior to offer input or contradiction, but instead expects to be told what to do. Translating this concept of high and low emotional distance to the results, mariners with high power index, coming from Eastern countries, have more concerns in reporting errors or complaints and follow instructions without even arising the doubt of the correctness of the order received from a senior officer. Mariners with low power index, coming from Western countries, feel more comfortable to challenge a senior officer, but on the other hand

tend to underestimate risks and overestimate their ability to face and manage errors. Participants recognize the importance of balancing the authority gradient, "*the difference in power between 2 or more people*" (Sasou & Reason, 1999) in order to spur crew members with high PDI to question decisions and report errors and crew members with low PDI to be less self-confident and rely more on teamwork. Given the power of PDI and authority gradient, the imprudence of not taking into consideration multiculturalism in defining the error isolation strategy, may foil the efforts to defeat errors: it does not matter how strong and detailed and tested strategies are, if a crew member is afraid to express concerns, question or simply clarify instructions, or if a crew member is certain to be able to face any situation without help, even a small mistake can turn into an accident.

Not only captains on board ships should be aware of cultural differences, but also companies must consider their effects while defining procedures. Participants believe that is not sufficient that the company puts in words that officers can challenge the captain, for example, they also require more effective involvement. In other words, safety culture and safety climate must be better aligned. Companies must be proactively engaged in error management and reduction, inducing conditions and effective assurance that the shipboard staff adheres to regulations. A good strategy is performance appraisal of all the mariners. Participants recognize the necessity of appraising performance at all levels, but they also denote a controversial use of appraisal results: companies too often interpret appraising performance as filling in forms instead of really taking it as an opportunity to better understand shipboard dynamics. Therefore, companies should enhance trust and cooperation between management and shipboard personnel throughout the implementation of non-punitive policy addressing unintentional errors, so they can have a clear knowledge of the dynamics on board ships. Without creating a long-lasting bond between companies and shipboard, the consequences in term of safety can be negatively irreversible. First, the shipboard can interpret company's priorities as being built environment (i.e. the ship) and goods, so the strategies ideated to prevent errors at the ship side can slightly diverge from strategies implemented at the shore side. Second, captains feel the pressure of the company and can feel forced to prioritize paperwork to mentoring or feel unfulfilled because they have to sacrifice time to spend with the crew to pursue companies' necessities.

In Pearce and Conger words, sharing leadership is "*interactive influence among individuals in groups for which the objective is to lead one another to the achievement of group or organizational goals or both*" (2003, p. 1). The mariners interviewed for this study see captains open to and in need of collaboration and dialogue with the crew, *lead one another*, to define error adaptation and

defeat strategies, the *group goals*. They see the role of the captain as mentor for the crew, giving officers the freedom to work without a constant pressure, but always supervising them. They recognize the importance of teambuilding and teamwork to safely achieve the *common organizational goal* of safety (Carmeli & Gittell, 2009) and express the need to have support from the company in translating safety culture in safety climate on board ships (Goulielmos & Androniki, 2012; Veiga, 2002; Vu & Cieri, 2014).

In conclusion, results suggest the maritime system is ready for the integration of shared leadership. Participants' answers reveal the dynamism of leadership, describing relations as collective activity and multidirectional influence. Collaboration and teamwork (Luria & Berson, 2013; Waugh & Streib, 2006) and a shift of the focus of leadership from the individual (the captain) to the team (the crew), are strongly desired, highlighting the need for a less hierarchical leadership structure. The shift cannot happen without considering social interactions like mutual learning and the cultural background of the individuals working on the ship, and certainly requires a consistent translation of the company's safety culture into the ship's safety climate.

4.6 Conclusions

This study represents only a preliminary explorative approach in the field of reforming leadership in the maritime sector, due to the novelty of the subject. Therefore, results should be considered a first step in the study of how to implement shared leadership in the hierarchical structure.

The following shrewdness should be used in future studies on how to apply the concept of shared leadership in maritime studies: First, research must involve a higher number of mariners. The limited number of mariners that accepted to be part of the study shows that their sensibility for the leadership issue is still unripe, suggesting the need of a bigger effort from researchers to directly involve mariners in leadership related studies. In addition, from this study is clearly visible a partial involvement of women in the maritime sector. All participant of this study were men, and this possibly limited the range of perspectives and fundamental elements that should be considered for the introduction of shred leadership in the maritime sector. Second, future studies must be addressed to shipping companies. Findings showed that the relation between safety culture and safety climate can either foster or obstacle the shift toward shared leadership, suggesting the need to collect more data about the organizational culture and politics influence the expression of shred leadership. Third, each of the themes can be further developed. For example, future studies can focus on how teams migrate from a vertical setting toward a shared one. Dig deep in each single

subject and/or understanding the relationship between two or more themes can facilitate the path or show challenges to the implementation of shared leadership. Finally, future research must be addressed to the relationship between shared and vertical leadership. To this extent, two different but related directions can be taken: studies can focus on the role of the captain as possible catalyst to the development of shared leadership, or research can try to explain if and how shared and vertical leadership can coexist during time, with particular focus on emergency situations.

References

Adams, R., Owen, C., Scott, C., & Parsons, D. (2017). *Beyond Command and Control: Leadership, Culture and Risk* (1 edition). CRC Press.

Alberts, D. S. (2007). Agility, Focus, and Convergence: The future of Command and Control. *The International C2 Journal*, *1*(1), 1–30.

Avolio, B., Jung, D., Murry, W., & Sivasubramaniam, N. (1996). Building highly developed teams: Focusing on shared leadership process, efficacy, trust, and performance. In M. M. Beyerlein & S. T. Johnson, D. A. Beyerlein (Eds.), *Advances in interdisciplinary studies of work teams* (pp. 173–209). Greenwich, Ct: JAI Press.

Bergman, J. Z., Rentsch, J. R., Small, E. E., Davenport, S. W., & Bergman, S. M. (2012). The shared leadership process in decision-making teams. *Journal of Social Psychology*, *152*(1), 17–42.

Bodgan, R. C., & Biklen, S. K. (2003). *Qualitative Research for Education: An Introduction to Theories and Methods*. Pearson A & B.

Boies, K., Lvina, E., & Martens, M. L. (2010). Shared leadership and team performance in a business strategy simulation. *Journal of Personnel Psychology*, *9*(4), 195–202.

Brown, A., & Amrozowicz, M. (1996). Tanker environmental risk-putting the pieces together. In *SNAME/SNAJ International Conference on Designs and Methodologies for Collision and Grounding Protection of Ships*.

Campbell, D., Hannah, S., & Matthews, M. D. (2010). Leadership in Military and Other Dangerous Contexts: Introduction to the Special Topic Issue. *Military Psychology*, *22*(1), S1–S14.

Carmeli, A., & Gittell, J. H. (2009). High-quality relationships, psychological safety, and learning from failures in work organizations. *Journal of Organizational Behavior*, *30*(6), 709–729.

Carson, J. B., Tesluk, P. E., & Marrone, J. A. (2007). Shared leadership in teams: An investigation of antecednt conditions and performance. *Academy of Management Journal*, *50*(5), 1217–1234.

Choudhry, R. M., Fang, D., & Mohamed, S. (2007). The nature of safety culture: A survey of the state-of-the-art. *Safety Science*, *45*(10), 993–1012.

Ciavarelli, A. P. (1997). *Safety climate and risk culture: How does your organization measure up? Human Factors Associates*.

Clarke, S. (2006). The relationship between safety climate and safety performance: A meta-analytic review. *Journal of Occupational Health Psychology*, *11*(4), 315–327.

Conger, J. A., & Kanungo, R. (1998). *Charismatic leadership in organizations*. Sage Publications.

Creswell, J. W. (2002). *Educational research: planning, conducting, and evaluating quantitative and qualitative research*. Pearson Education Inc.

Day, D. V., Gronn, P., & Salas, E. (2004, December 1). Leadership capacity in teams. *Leadership Quarterly*. JAI.

Dool, R. (2010). Lessons from the military: A new framework for managing change (c5). *Journal of Leadership and Organizational Studies*, *17*(3), 253–263.

Ensley, M. D., Pearce, C. L., & Hmieleski, K. M. (2006). The moderating effect of environmental dynamism on the relationship between entrepreneur leadership behavior and new venture performance. *Journal of Business Venturing*, *21*(2), 243–263.

Fischer, U. (1999). *Cultural Variability in Crew Discourse*. Atlanta.

Gadd, S., & Collins, M. (2002). Safety culture: a review of the literature. *Health and Safety Laboratory*. Sheffield.

Gill, G. W. (2011). *Maritime error management : discussing and remediating factors contributory to casualties*. Cornell Maritime Press.

Gilroy, P. (1993). *The Black Atlantic: Modernity and Double Consciousness. Contemporary Sociology*. Harvard University Press.

Goulielmos, A. M., & Androniki, G. (2012). THE ROLE OF A SHI P ' S MASTER IN THEORY AND PRACTICE : LESSONS FROM MARINE ACCIDENTS. *Journal of Critical Incident Analysis*, 55–78.

Gronn, P. (2000). Distributed Properties: A new archtecture for leadership. *Educational Management & Administration*, *28*(3), 317–338.

Gronn, P. (2002). Distributed leadership as a unit of analysis. *Leadership Quarterly*, *13*(4), 423–

451.

Gundersen, G., Hellesøy, B. T., & Raeder, S. (2012). Leading International Project Teams: The Effectiveness of Transformational Leadership in Dynamic Work Environments. *Journal of Leadership and Organizational Studies*, *19*(1), 46–57.

Hannah, S. T., Campbell, D. J., & Matthews, M. D. (2010). Advancing a research agenda for leadership in dangerous contexts. *Military Psychology*, *22*(SUPPL. 1), S157–S189.

Hannah, S. T., Uhl-Bien, M., Avolio, B. J., & Cavarretta, F. L. (2009). A framework for examining leadership in extreme contexts. *Leadership Quarterly*, *20*(6), 897–919.

Harms, P. D., Han, G., & Chen, H. (2012). Recognizing Leadership at a Distance: A Study of Leader Effectiveness Across Cultures. *Journal of Leadership and Organizational Studies*, *19*(2), 164–172.

Hatch, J. A. (2002). *Doing Qualitative Research in Education Settings*. State University of New York Press.

Henderson, A. D., & Stern, I. (2004). Selection-based Learning: The Coevolution of Internal and External Selection in High-velocity Environments. *Administrative Science Quarterly*, *49*(1), 39–75.

Hofstede, G., & Hofstede, G. J. (2005). *Cultures and Organizations: Software of the mind* (2nd ed.). McGraw-Hill.

Khasawneh, S. (2011). Shared Leadership and Organizational Citizenship Behaviour in Jordanian Public Universities: Developing a Global Workforce for the 21st Century. *Educational Management Administration & Leadership*, *39*(5), 621–634.

Kozlowski, S. W. J., & Bell, B. S. (2003). Work Groups and Teams in Organizations. In W. C. Borman, D. Ilgen, & R. Klimoski (Eds.), *Handbook of Psychology, Second Edition* (pp. 333–375). New York, NY: John Wiley & Sons, Inc.

Lee, T., & Harrison, K. (2000). Assessing safety culture in nuclear power stations. In *Safety Science* (Vol. 34, pp. 61–97). Elsevier.

Luria, G., & Berson, Y. (2013). How do leadership motives affect informal and formal leadership emergence? *Journal of Organizational Behavior*, *34*(7), 995–1015.

Manz, C. C., Manz, K. P., Adams, S. B., & Shipper, F. (2011). A model of values-based shared leadership and sustainable performance. *Journal of Personnel Psychology*, *9*(4), 212–217.

Matkin, G. S., & Barbuto, J. E. (2012). Demographic Similarity/Difference, Intercultural Sensitivity, and Leader-Member Exchange: A Multilevel Analysis. *Journal of Leadership and Organizational Studies*, *19*(3), 294–302.

Merriam, S. B., & Tisdell, E. J. (2015). *Qualitative Research: A Guide to Design and Implementation* (4th ed.). Jossey-Bass.

Milgram, S. (1963). Behavioral Study of obedience. *Journal of Abnormal and Social Psychology*, *67*(4), 371–378.

Montor, K., Ciotti, A. J., & Wolfe, M. E. (1984). *Fundamentals of naval leadership*. (United States Naval Academy. Department of Leadership and Law., Ed.). Annapolis, Maryland: Naval Institute Press.

Nagl, J. A. (2005). *Learning to eat soup with a knife : counterinsurgency lessons from Malaya and Vietnam*. University of Chicago Press.

Oettinger, A. (1990). Whence and whither intelligence, command, and control? the certainty of uncertainty. *Competitive Intelligence Review*, *1*(2), 2–3.

Parks, M. R. (1977). Relational communication: theory and research. *Human Communication Research*, *3*(4), 372–381.

Pearce, C. L. (1997). *The determinants of Change Management Teams (CMT) effectiveness: a longitudinal investigation*. University of Maryland College Park.

Pearce, C. L. (2004). The future of leadership: Combining vertical and shared leadership to transform knowledge work. *Academy of Management Executive*, *18*(1), 47–57.

Pearce, C. L., & Conger, J. A. (2003). *Shared leadership: Reframing the hows and whys of leadership*. Thousand Oaks, CA: Sage Publications.

Pearce, C. L., Conger, J. A., & Locke, E. A. (2008). Shared leadership theory. *Leadership Quarterly*, *19*(5), 622–628.

Pearce, C. L., Manz, C. C., & Sims, H. P. (2008). The roles of vertical and shared leadership in the enactment of executive corruption: Implications for research and practice. *Leadership*

Quarterly, *19*(3), 353–359.

Pearce, C. L., Manz, C. C., & Sims, H. P. (2009). Where Do We Go From Here? Is Shared Leadership the Key to Team Success? *Organizational Dynamics*, *38*(3), 234–238.

Pearce, C. L., & Sims Jr, H. P. (2002). Vertical versus shared leadership as predictors of effectiveness of chaneg management teams: An examination of aversivem directivem transactional, transformational and empowering leader behaviors. *Group Dynamics: Theory, Research, and Practice*, *6*(2), 172–197.

Pearce, C. L., Yoo, Y., & Alavi, M. (2004). Leadership, social work, and virtual teams: The relative influence of vertical versus shared leadership in the nonprofit sector. In R. E. Riggio & S. S. Orr (Eds.), *Riggio, R.; Smith Orr Sarah (Eds): Improving Leadership in Nonprofit Organizations* (pp. 180–203). San Francisco, CA: Jossey-Bass.

Perrow, C. (1984). *Normal Accidents. Living with High-Risk Technologies*. New York: Basic Books.

Perry, M. L., Pearce, C. L., & Sims, H. P. (1999). Empowered selling teams: How shared leadership can contribute to selling team outcomes. *Journal of Personal Selling and Sales Management*, *19*(3), 35–51.

Ramthun, A. J., & Matkin, G. S. (2012). Multicultural Shared Leadership: A Conceptual Model of Shared Leadership in Culturally Diverse Teams. *Journal of Leadership and Organizational Studies*.

Romney, A. K., Weller, S. C., & Batchelder, W. H. (1986). Culture as Consensus: A Theory of Culture and Informant Accuracy. *American Anthropologist*, *88*(2), 313–338.

Sasou, K., & Reason, J. (1999). Team errors: definition and taxonomy. *Reliability Engineering & System Safety*, *65*(1), 1–9.

Schein, E. H. (2016). *Organizational culture and leadership* (5 edition). Wiley.

Shamir, B., & Lapidot, Y. (2003). Shared leadership in the management of group boundaries. In J. A. C. Craig L Pearce (Ed.), *Shared Leadership* (pp. 235–249).

Snook, S. A. (2002). *Friendly fire: The accidental shootdown of US Blackhawks over northern Iraq*. Princeton University Press.

Uhl-Bien, M., & Marion, R. (2008). *Complexity leadership. Part 1, Conceptual foundations*. IAP, Information Age Pub.

Uhl-Bien, M., & Marion, R. (2009). Complexity leadership in bureaucratic forms of organizing: A meso model. *Leadership Quarterly*, *20*(4), 631–650.

Veiga, J. L. (2002). Safety culture in shipping. *WMU Journal of Maritime Affairs*, *1*(1), 17–31.

Vu, T., & Cieri, H. De. (2014). Safety culture and safety climate definitions suitable for a regulator : A systematic literature review, (April), 1–92.

Waugh, W. L., & Streib, G. (2006). Collaboration and Leadership for Effective Emergency Management. *Public Administration Review*, *66*(Special Issue: Collaborative Public Management), 131–140.

Yule, G. (2013). *Referential Communication Tasks*. Lawrence Erlbaum Associates.

Zohar, D. (1980). Safety climate in industrial organizations: Theoretical and applied implications. *Journal of Applied Psychology*, *65*(1), 96–102.

Chapter 5 – Sharing or centralizing command? A new model for maritime emergency management

Theories abound addressing and informing managers of theoretical aspirant organizational perfection (Bowen, Ledford Jr., & Nathan, 1991; Leithwood, Leonard, & Sharratt, 1998; Shadur, Kienzle, & Rodwell, 1999; Spreitzer, 1995), though only a relatively small portion of the literature concerns itself with wholly maritime organizations (Juda, 2007; Maarleveld, 2007).

Re-analysis of Maritime Transportation Research Board figures from as long ago as 1976 has "*suggested that for 86 percent of the event analyzed, the responsibility appeared to be at least partially organizational in nature*" (Bichler-Robertson, 2000). What clearly emerges as concerns maritime safety enhancement is that senior management must demonstrably invest, not only economically, if positive advance is to be gained.

The maritime industry is a particularly open system in the sense that every shipping company functions of necessity within an environment larger than itself. Each organization functions within the maritime environment, one that includes challenges imposed by the sea itself as well as national and international industry standards. Figure 22 represents the structure of the maritime environment as concentric circles.

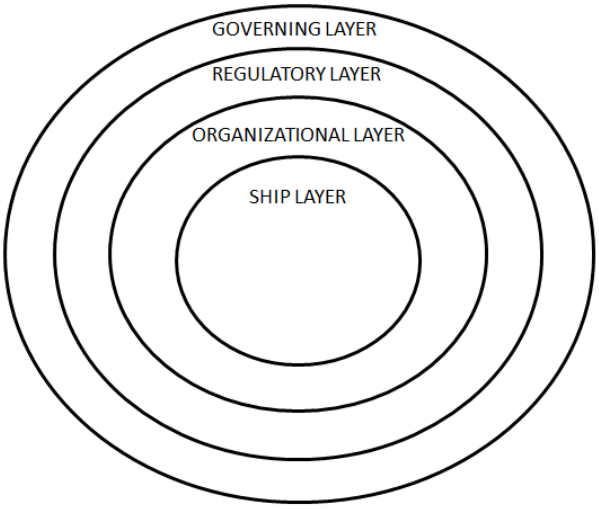

Figure 22 - Representation of the maritime environment

Outer-most is a governing layer, whose major concerns involve responsiveness to the concerns of society while also promoting economic growth. Next within is a regulatory layer, concerning with setting and enforcing industry standards. The organizational layer confronts the protection (safety)

versus profit choice, determined to be the main driver initially at the senior management level, where decisions must be made as to limited resources are to be allocated consistent with the industry standard set by the regulators. Decisions of an organization's upper management are presumed to be consistent with all applicable regulatory requirements and reflect primary concerns of the organization. Finally, the cumulative production from these various layers filters through the safety climate of the mariners tasked with accomplishing the job of getting ships safely from point A to point B, while maintaining the organization's profitability. Any strategy addressed to improvement of maritime management should consider all organizational functions.

Results emerged from the analysis of the disaster of the Costa Concordia in chapters 2 and 3 showed that an urgent issue is related to the current leadership structure, that seems not more sufficient to manage the complexity of modern ships. Results of chapter 4 suggest that integrating shared leadership in the vertical model can help mitigating leadership related issues.

5.1 Integrating vertical and shared leadership

The pyramidal structure reflects the top-down model (Figure (23a)) where the leader wants obedience and not disagreement from subordinates and is highly independent. The top-down leader makes all decisions alone, without really considering and appreciating teamwork (Locke, 2003). This model reflects the idea of the master as 'God on the ship' and does not give room (or too little) for effective collaboration. Sharing leadership model can be used as alternative model to apply for ships management, but the extent to which apply shared leadership in the maritime environment has to be carefully pondered.

As repeatedly mentioned in this dissertation, shared leadership is the "*dynamic, interactive influence process among individuals in groups for which the objective is to lead one another to the achievement of group or organizational goals or both*" (Pearce & Conger, 2003). This implies that in workplaces where leadership is shared, there is constant teamwork, people listen to one another and share information. Each team member influences the others equally, the team is empowered, and dynamic and final decisions are the result of a participative decision-making process (figure 23(b)). It is not senseless try to apply this idyllic model on ships, since the shared leadership model has already been applied in the military field (Ramthun & Matkin, 2014), from which the maritime leadership derives its current vertical model. However, implementing shared leadership in the maritime environment is not without challenges. Four main problems must be considered: (a) What would be the role of the captain? In the name of equality pursued by shared leadership principles,

the captain should be willing to step back and renounce not only his responsibility but also his authority and become simply a member of the team, potentially with the same decision-making power of a cadet. (b) Is a crew made by thousands of people (as on cruise ships) able to successfully make decisions together in any situation? Mathieu et a., emphasize the importance of team shared mental model to improve team performance and effectiveness (Mathieu, Goodwin, Heffner, Salas, & Cannon-Bowers, 2000), but shared mental models require valid knowledge. This issue recalls the concept of Participative Decision Making (PDM) that should promote sharing of relevant information between peers and between supervisors and subordinate (Latham, Winters, & Locke, 1994), and delete hierarchical inequalities (Locke & Schweiger, 1979). If participation in decision-making is desirable to achieve perfect team performance, making an effective decision will require time, so the process would be negatively critical to use in emergency, where time is the main constraint. Sharing mental models arises another issue, that is (c) whether equality among crew members can always be preserved or there will be a most influential person that stands out on others to a certain point. Equal influence among team members cannot always be achieved because most influential individuals most often emerge as leaders (Foti, Hauenstein, Sgro, & Johnson, 1996; Lord, DeVader, & Alliger, 1986; Morrow & Stern, 1990; Roberts, 1995). Difference in personal traits can obscure relevant knowledge that can be added in the decision-making process by individuals with weaker personalities. Giving as granted the possibility of overcoming all the previous obstacles to the implementation of shared leadership in the maritime sector, one more question remains unanswered: (d) Can each leadership task be shared? Locke identifies eight "*core tasks*" of leadership (2003, pp. 276–278):

1. *Vision - formulating the vision of what the company should be. This includes dealing with what business or businesses the company should be in and the competitive strategy it will use.*
2. *Core values - deciding what the company will stand for including its basic moral principles and shared values.*
3. *Structuring - making sure that the organization's structure supports its strategy.*
4. *Selection and training - hiring good people based on what the company needs and ensuring that they develop any further skills that they need.*
5. *Motivating employees - there are many aspects involved here, including the use of formal authority, role-modeling, building subordinate confidence, empowerment, goal setting, and performance appraisal.*

6. *Communicating - or fostering communication in every direction throughout the organization.*
7. *Team building - including and especially the top management team.*
8. *Promoting change - that has to be a continuously ongoing process.*

Not all these tasks can be shared in the maritime domain, due to the peculiar composition and characteristics of the system and the diversity of the maritime environment's components, with particular focus on ship layer and organizational layer, which are strongly linked. Vision and values must be defined and pushed from the organizational level: these two elements should incorporate the company's safety culture. Safety culture does not come from regulations, but rather can only come from high level managerial decisions. There must be management commitment to proactive reduction of error inducing conditions clearly defining safety as most important value. The organization must also make sure that the safety culture is reflected in the safety climate on the ship. The management level must be aware that at the ship level, the captain can exacerbate or mitigate the adverse effects of high level decisions, but the captain can also introduce other failures into the system; further, a conning officer's perception of importance will be directly influenced by the captain (Brown & Amrozowicz, 1996). Therefore, is an essential responsibility of the company to ensure that captains belonging to the organization constantly and effectively implement safety culture among crew members. In this sense, structuring cannot be shared, but is a task of the company. Selection and training can and should be shared between ship and organizational layers. The disaster of the Costa Concordia can suggest how to share selection and training: about 65% of the crew working on the ship the night of the accident was Asian and some of the mariners on board were not able to understand or speak neither the working language, Italian, nor English and this element concurred to the communication crisis on the ship. Nowadays, the organization composes the crew and should work with the captain. In addition, the captain notified the company of the decreased crew's ability of dealing with emergency during a drill done before the accident, but the company did not take into consideration captain's warning. For these reasons, ship side and shores side should work together to select qualified personnel and assess their performance. This is already partially done through performance assessment that the captain reports to the organization, but a complete collaboration between ship and shore side is not yet accomplished. Motivation, communication and team building must be shared at all levels within the ship layer. The role of the captain is peculiar: he should delegate and empower the subordinates, motivating them and fully using all their skills to accomplish safety. However, the extent to which motivation,

communication and team building should be shared is circumscribed: if there is a crisis the captain has to step in and make decisions to resolve it. Changes in the maritime environment are already required by people working in the organizational and ship layers, as emerged from the study in chapter 4 of this dissertation. Unfortunately, the maritime organization "*was and still is very conservative and not in favor of change. There are always some fears that changed may be negative for their profession*" (Veiga, 2002, p. 21). So simply disclosing the need for change among individuals at the ship layer (as part of sharing communication and team building) and discussing with the organizational layer, would be a good start to successfully bring a change.

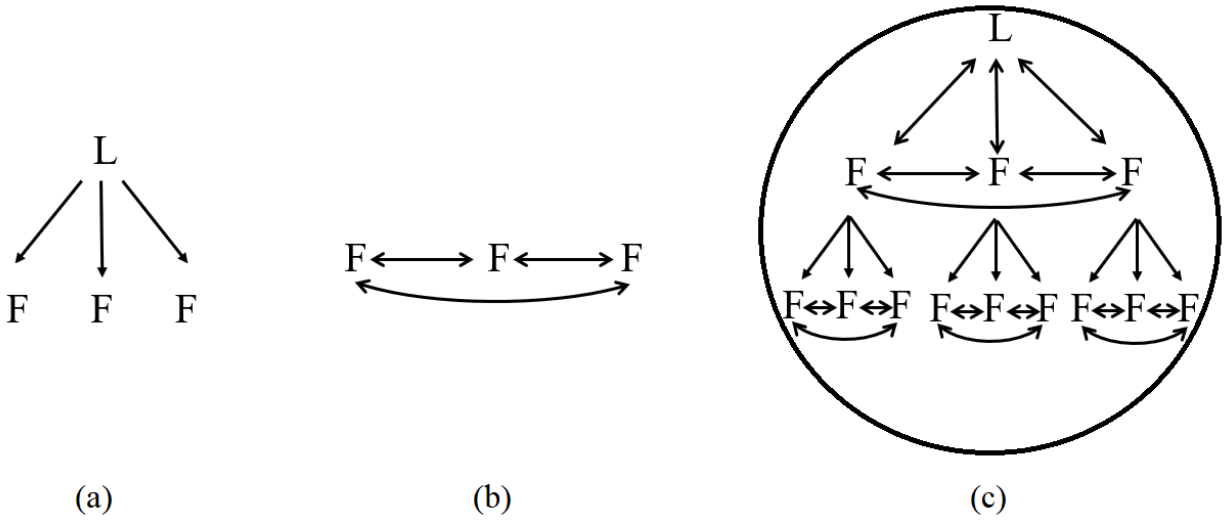

Figure 23 - Leadership models. The first picture on the left shows the top-down model, the picture in the middle shows the shared leadership model, the picture on le right shows the integrated model. 'L' and 'F' in all pictures respectively indicate Leader and Follower (Adapted from Edwin A Locke, 2003)

Shared leadership may not be effective in every situation or act as a sole replacement to vertical leadership (Pearce & Conger, 2003) and is certainly not effective for maritime leadership if not properly integrated with the current pyramidal structure. Followers lacking in situational knowledge, skills, and abilities may not be able to effectively contribute to the shared leadership process (Conger & Pearce, 2003). Pearce clearly assesses that vertical and shared leadership can be employed together in environments that achieve certain goals. Three fundamental questions he poses are "*(1) when is leadership most appropriately shared? (2) how does one develop shared leadership? and(3) how does one utilize both vertical and shared leadership to leverage the capabilities of knowledge workers?*" (Pearce, 2004, p. 55). The integrated model shown in figure 23(c) tries to answer these questions. The integrated model combines hierarchical approach with the shared leadership approach: there is still a leader that provides orders and instructions from the

top, but there is also a necessity and search for ideas from individuals at lower levels, that works as a team and refers to the upper level and final decisions are made after a process of consultation. The hierarchy cannot be replaced because of specific needs on ships: the division of the crew in three units (watch, engine and hotel services) must remain, as well as the hierarchy inside each sector. It is impossible to think, in fact, that the entire crew is able to discuss efficiently and effectively about safety. Therefore, the integrated model must be stratified, and each unit must discuss safety and needs with their leaders, the leaders must report and discuss with the captain about what emerged in their sector and finally report decisions to their sector. Leaders at all levels must foster shared leadership among team members, defining shared norms that encourage information sharing (e.g. the no blame if unintentional policy mentioned in chapter 4 of this dissertation). The top leader, the captain, can still develop a climate that is specific to the ship, but such climate must be inspired and must reinforce the organization's culture. Finally, the organization (represented in the picture by the black circle surrounding the model) must encourage and support the top leader and help him in this complex task.

5.2 A new model for maritime emergency management

A further step in the definition of a new management model is to understand how a leadership model that integrates shared leadership to command and control can practically be used in the maritime environment, with special care to emergencies. Clearly, a change in the leadership structure is not easy to push, nor can it be abrupt and drastic, but should be gradual and must involve all the layers of the maritime environment. The new model summarized in figure 24, even if only preliminary, shows that an *active, flexible multilayer management* of maritime emergencies is possible, because decisions are understood and accepted at all levels within the ship layer in a harmonious environment constantly guaranteed by the organizational layer.

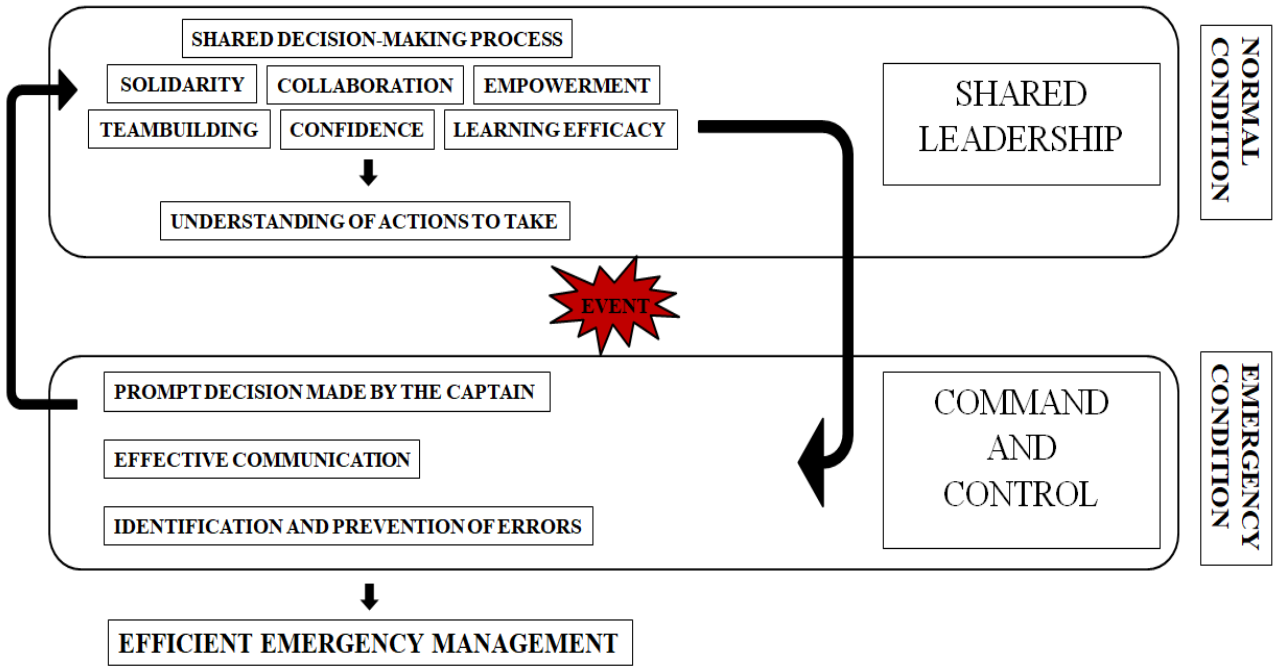

Figure 24 - New emergency management model for maritime emergencies

Integrating the principles of shared leadership into a highly hierarchical system such as the maritime environment is not easy and requires a strong effort by the seafarers and careful organizational planning strategy. Life on ships is characterized for the most part by routine activities, during which the possibility of making small mistakes is high (Chauvin et al., 2013; Dekker, 2002; James Reason, 1997a). Daily life, however, does not only represent a critical moment for the possibility of making mistakes, but also a paramount opportunity to implement the principles of shared leadership. When referring to such possibility, it is fundamental to consider the complexity that such integration involves. It is fundamental to take into account the different but complementary roles owned by the organizational level and the ship level.

At ship level, sharing leadership requires that the captain is able to accept that he is no longer efficiently able to autonomously manage the increasing complexity of the maritime system (e.g. ships more technological advanced than in the past decades), but he must open his mind to the idea of sharing his decision-making power and being consistently supported by the crew. This does not mean that he should renounce his authority and become a mariner at the same level of others; it means, indeed, the awareness of having a concrete support in case of necessity. With shared leadership, the leadership function does not simply reside in the hands of the nominal leader, the captain, but rather is structured as a group-level responsibility as the group moves together toward common objectives. In the maritime environment, the strong top-down organization often

dominates in ways that afford crew members little opportunity for meaning, purpose, self-efficacy or even dignity, as they follow the command of narcissistic superiors in order to simply keep their jobs (Winter, 1991). On the contrary, a variety of studies have supported the idea that sharing leadership among organizational members can have a powerful effect on the collective performance of individual employees (Avolio et al., 1996; D'Innocenzo, Mathieu, & Kukenberger, 2016; Hooker & Mihaly, 2003; Pearce & Conger, 2003; Shamir & Lapidot, 2003; Wang, Waldman, & Zhang, 2014). Shared leadership, indeed, can improve decision-making, empowerment, solidarity, collaboration, confidence, learning efficacy and teambuilding.

Decision research traditionally focuses on how decision makers use judgments and estimates to make optimal choices (Baron, 2008). The captain is traditionally alone in his decision-making function and this can carry with it threats to performance, including the difficulties that arise in identifying relevant options, reviewing available knowledge, identifying pertinent values, and integrating these pieces. Having more people involved means having more opportunities for views to evolve. For example, dividing information-processing responsibilities can reduce information over-load (Fischoff & Johnson, 1997) and can help catch mistakes by having someone else review one's work and sharing near misses and question decisions with the team. Even with unrestricted communication, indeed, discrepant views can go undetected if people fail to question critical assumptions. Although shared leadership is conceptualized as a group level phenomenon, its influence can flow not only laterally within the group, but also upward or downward through the organizational hierarchy thereby impacting individual behaviors as well as organizational norms and values (Pearce & Conger, 2003). As a group moves further away from strong hierarchical leadership toward true shared leadership, power differences between group members begin to become blurred (Houghton, Pearce, Manz, Courtright, & Stewart, 2015). Shared leadership is markedly different from the more traditional models of leadership where the influence and decision-making travels from the top to the bottom; that is, from the hierarchical leader to the followers (Day, Gronn, & Salas, 2006; Pearce & Conger, 2003).

Shared leadership also results in a stronger psychological empowerment climate, which in turn motivates group-level caring behavior. Shared power and influence should enhance feelings of meaning because individuals have a clearer sense for how their role as a fellow leader in the group fits with the goals and objectives of the team (Patterson, West, & Wall, 2004). Shared leadership increases a group's sense of autonomy and control because it gives group members the collective sense that they, rather than the captain as hierarchical superior, are in charge of their outcomes

(Hooker & Csikszentmihalyi, 2003). This sense of control helps groups to face challenges and learn skills that build collective efficacy or potency (Pearce & Ensley, 2004). Empirical evidence supports the notion that shared leadership can help to facilitate a climate of meaningfulness, competence, self-determination, and impact among group members. For example, Hoch (2013) reported that shared leadership resulted in more innovative behaviors among team members, which is likely to lead to greater perceptions of meaningfulness, competence and impact. People working in a psychologically empowered climate view the well-being of the group as being directly related to their own well-being and having implications for the self. Thus, individual contributors in a shared leadership setting are more likely to step outside the normal boundaries of their work roles and engage in behavior, which benefit other individuals in the group and the team as a whole (Pearce & Ensley, 2004). Unlike in a strict hierarchical leadership structure where groups are told how to execute a task and then told to do it, shared leadership allows a group to see their contributions as taken seriously by and important for the group, thereby increasing a collective sense of meaningfulness and impact (Houghton et al., 2015). The more a group's members experience a psychological empowerment climate, the stronger will be group members' identification with and commitment to the group and or organization (Kirkman & Rosen, 1999; Seibert, Wang, & Courtright, 2011). The result is a context where group-level caring is expected to occur because such behavior is a manifestation of the group members' collective identification with and commitment to the group. Empowerment behaviors refer to leader actions that emphasize the development of follower self-management or self-leadership skills, such as coaching, monitoring, and feedback behavior, that are pillars of shared leadership (Pearce & Conger, 2003). Such behaviors have been argued to facilitate effective team process, teamwork, and team performance outcomes through the promotion of team learning and adaptation (Burke, Stagl, Salas, Pierce, & Kendall, 2006; Edmondson, 1999; Hackman, 2002; Hackman & Wageman, 2005; Salas, Sims, & Shawn Burke, 2005; Swezey & Salas, 1992). Sharing leadership allows an increase in solidarity among team members, promoting mutual trust, affective regard, social unity, and commitment between members of a group (Molm, Collett, & Schaefer, 2007). Shared leadership should increase mutual trust because trust is greater in groups where a greater diffusion of power exists (Lawler & Yoon, 1996), because shared leadership requires that group members share influence and power. Power-dependence theory (Emerson, 1962) suggests that distributed power structures create a sense of mutual dependence between group members. With a sense of mutual dependence, individuals who, for instance, withhold information from or intentionally undermine

their peers do so at their own peril because such behavior results in forfeiting social rewards, status conferral, and influence in the group (Ferres, Connell, & Travaglione, 2004). (Lawler & Yoon, 1996) found that equal power and mutual trust increase the frequency and the quality of exchange between group members because it tends to resolve conflict more effectively than groups with power differences. Additional studies provide further empirical support for this idea, showing that teams in which shared leadership has been established tend to have lower relational conflict than teams not engaged in shared leadership, and became more cooperative and mutually committed in executing group tasks (Bergman et al., 2012; Ferres et al., 2004; Lawler & Yoon, 1996; Solansky, 2008).

Shared leadership should result in greater social integration and unity, cooperation, deep listening, motivation and reliability (Balthazard, Waldman, & Howell, 2004; Bergman et al., 2012; Burke, Stagl, Klein, et al., 2006; Kahn, 1993; Klein, Orasanu, Calderwood, & Zsambok, 1993; LePine, Erez, & Johnson, 2002; Mayeroff, 1965; Skovholt, 2005; Solansky, 2008) in the face of group tasks and situational pressures. In addition, shared leadership should result in a greater common commitment to maintain the group (Perry, Pearce, & Sims, 1999; Steinheider, Wuestewald, & Bayerl, 2006; Wang, Waldman, & Zhang, 2014). Finally, Lawler and Yoon (1996) found that members of groups marked by equalized power, high-quality exchange, affective regard, mutual commitment, and cooperation provided benefits to each other beyond those necessary to maintain the relationships, such as proactively caring for one another. Social exchange theory (Cropanzano & Mitchell, 2005) and the norm of reciprocity (Gouldner, 1960) provide theoretical justification for the idea that the more a group is characterized by mutual trust, affective regard, social unity, and a common commitment, the more likely group members will be willing to reciprocate with proactive caring behaviors.

Collaborative capacity is comprised of the personal characteristics of group members that facilitate the sharing of leadership, power, and influence (Houghton et al., 2015). In order for shared leadership processes to operate effectively, individuals need to develop the ability to lead and manage themselves. Neck and Manz (Neck & Manz, 2007) broadly define self-leadership as the process of influencing oneself. If group members lack the ability to practice individual self-management and self-leadership skills, then the effects of shared leadership on psychological empowerment climate and group solidarity will be lessened, because shared leadership, by its very nature, is most effective when there are high levels of self-direction from individual group members (Houghton, Neck, & Manz, 2003). As Houghton et al. (2003) suggest, self-management and self-

leadership processes are likely to result in increased self-efficacy beliefs for sharing leadership roles within a team, leading to positive attitudes toward shared leadership and ultimately more shared leadership processes. Consequently, organizations wishing to maximize the impact of shared leadership should provide self-management and self-leadership training, which has been shown to increase group members' abilities to develop and use self-direction skills and strategies (Stewart, Carson, & Cardy, 1996). Even if a team proactively attempts to engage in shared leadership processes, if members lack critical abilities to lead and manage themselves or if key members of the team have a pro-self or personalized need for power rather than a prosocial communion striving orientation, then the effectiveness of the shared leadership will be minimized. In short, collaborative capacity is a key enabler of shared leadership that moderates the relationships between shared leadership and the two mediators such that when collaborative capacity is high, shared leadership will have a stronger impact on psychological empowerment culture and group solidarity than when collaborative capacity is low (Houghton et al., 2015).

Given the challenging complexity of the modern system, it would be hard to imagine anyone following or being positively influenced by leaders who do not welcome or accept such challenges. The current conditions require leaders to continually "step up" to meet complex challenges and have the requisite agency to positively influence their followers and the organization's culture, climate, and performance. To mobilize groups toward collective performance, leaders have to both exercise high levels of personal confidence and create similar levels of confidence in those individuals they are leading by proxy (Bandura, 2000). Hannah, Woolfolk and Lord (2009) and Hannah & Luthans (Hannah & Luthans, 2008) have recently proposed that positive psychological states such as confidence directly promote effective leader engagement, flexibility and adaptability across the varying challenges characterizing complex organizational contexts. This is because higher levels of self-confidence provide the internal guidance and drive to create the confidence needed to pursue challenging tasks and opportunities successfully (Carver & Scheier, 1998; Cropanzano, Keith, & Maryalice, 1993; Lord & Brown, 2004; Mischel & Shoda, 1998; Shamir, House, & Arthur, 1993). When leadership is shared, and leaders help team members to develop their own self-confidence, the concept of self-confidence is strongly separated from the concept of overconfidence, the negative feature that can make a leader willing to take risks. Confidence is potentially a great value in building a more comprehensive understanding of the contribution of leader efficacy in building collective leadership efficacy. When leaders and followers share a positive view of their abilities to constructively influence each other, then support each other and

perform well, leadership efficacy is positively impacted over time (Hannah, Avolio, Luthans, & Harms, 2008). Related to leadership efficacy is the learning efficacy, a predictor of a person's ability to acquire complex skills (Kanfer & Ackerman, 1989). Persuasion and emotional arousal are important sources of efficacy development. This is important in building leadership efficacy, as we know that leaders can have emotional contagion effects where leaders communicate positive emotions to followers (Bono & Ilies, 2006; Naidoo & Lord, 2008) further increasing the attractiveness of the leader. As leaders and followers interact in dyads, they reciprocally can learn from each other. Specifically, a follower's efficacy at critical times may reinforce the leader to continue forward, which in turn may bolster the follower's efficacy, resulting in a pattern with each collectively strengthening the efficacy of the other. Indeed, the display of efficacious behaviors by followers and a demonstration of their skills to face a given task would not only serve a role modeling function and source of social persuasion for the leader (Bandura, 1997), but can also serve to raise the collective efficacy of the group (Bandura, 2000) and the follower's own efficacy (Phillips, 2001).

With shared leadership integrated to the traditional hierarchical form of leadership, the maritime environment is supplemented with more cooperative forms of mutual influence (Yukl, 2005). Clearly, the organizational layer must enhance the good success of meetings, by embracing the concept of fair and just culture (Frankel, Leonard, & Denham, 2006) and entrench it into its culture, in order to create a "fair" environment, favorable to exchange of opinions. Recent theory and research have identified organizational support structures as important for the effective operation of shared leadership. Indeed, (Carson et al., 2007) found empirical evidence supporting the role of both internal support structures (e.g., shared purpose, social support, and voice) and external support structures (e.g., coaching) in enabling shared leadership processes to be most effective. Consequently, when the appropriate support structures are in place, the effects of shared leadership on psychological empowerment climate and group solidarity will be intensified. Align safety culture with safety climate requires consideration of all the variables that characterize the maritime environment as a whole, which is made by people from different cultures and backgrounds that directly or indirectly use their personal experiences and education in everyday activities and can increase or hinder safety. In this sense, culture and climate both supply a frame of reference for behavior (Schein, 2016; Schneider, 1975). Therefore, the organizational layer should be able to constantly keep the focus of ships' climates on the common denominator (Jones & James, 1979) that all crewmembers share (Glick, 1985; Schein, 2016), which is safety. The result would be an

increased capacity to report criticisms and challenge each other, without considering the role, but rather the experience and the capacity to recognize when an action or a decision can lead to an accident. In this sense, the organization must reach the HRO "mindfulness" level according to Weick definition (Weick & Sutcliffe, 2007).

Emergencies do not offer the possibility of discussing democratically regarding decisions to be taken, therefore it is fundamental that the captain remains the final decision-maker that gives orders. In this sense, the vertical structure should be dominant on the more horizontal one. However, emergencies add uncertainty and difficulties of intuitive judgment, such as misperception of causality, inappropriate confidence in the extent of one's knowledge. The process of discussion and definition of solutions shared within the policy of 'fair culture', guarantees to break the wall of fear between captain and subordinates and make a real use of the formal decentralized structure created in normal conditions, through sharing the decision-making process, and teambuilding, by way of anticipation of extreme vulnerabilities associated with centralization of authority that may arise during the crisis ('t Hart, Rosenthal, & Kouzmin, 1993).

Centralization and tight coupling of operations can be a potential liability in crisis prevention and management (Kouzmin & Jarman, 1990; Lagadec, 1982; Perrow, 1984; Turner & Pidgeon, 1997; Wildavsky, Center, & Policy, 1988). In highly tight and centralized systems, disruption to one part of the system, let alone the system's core, can have a cumulative effect, triggering chains of component failures that are hard to stop or reverse (Perrow, 1984). As Quarantelli suggested, "*organizational officials should be asking more than telling, requesting rather than ordering, delegating and decentralizing rather than narrowing and centralizing at the height of the emergency*" (Quarantelli, 1988, p. 382). Nevertheless, it cannot be hypothesized to totally replace the centralized structure with the decentralized one in the maritime environment. During emergencies the pyramidal structure is essential to guarantee a prompt decision provided by each sector of the ship (engine, watch and hotel) as a hierarchical flow of reporting to the captain to receive orders to manage the next step of the crisis. But having a predominant hierarchical structure does not impede to also have a more decentralized structure working in the background as support for enhancing the hierarchical leadership performance. The Costa Concordia disaster confirmed what has already been identified by Diefenbach and Sillince (Diefenbach & Sillince, 2011), that an informal hierarchical structure has an informal structure associated with it that can emerge during an emergency. What the study of the Costa Concordia disaster highlighted is that even if the informal structure still maintains its prevailing hierarchical nature, necessities arose from the

emergency, as the captain's paralysis, can naturally integrate a more decentralized structure in the informal hierarchy. Physiological and psychological effects of high stress, particularly when stress continues over a sustained period of time, may amount to behavioral disorders promoting passivity (Hopple, 1980, 1982; Wiegele, 1973). The process of sharing decisions and strategies and reporting near misses, can certainly allow a fluent exchange of information, useful to the management of the emergency. In this way, the emergency can be managed in a more effective way, since improvisation (if necessary) can be defined as a "*conscious improvisation*", based on previous discussions and understanding the problems.

In order for the new model to be effectively applied, a joint effort by all the levels of the maritime industry is necessary. Ship and organizational layers have to make the biggest effort in the promotion of the new model, but the regulatory level has to recognize the need and importance of such a sensitive and complex change and help the implementation promoting the model in the new protocols and guidelines. At present, the benefits of the new integrated model can only be theoretically shown, but future applications of the model will possibly show a reduction in number and effects of accidents, improvement in safety on ships, positively impacting the economic and social sectors in the long term. Therefore, the governing layer must be able to accept and support this low but essential change.

5.3 First application of the new model for maritime emergency management

The presented model has all the potential to ensure greater effectiveness in the management of maritime emergencies. The model encompasses concepts of collaboration, team building, empowerment and trust, and links these concepts of sharing ideas of authority and strong decision-making power of the single individual.

At present, it is not possible to measure the effectiveness of the model, nor to evaluate any improvements resulting from the need for adaptation defined by applications in the field. What can be done, however, is to assess the acceptance of the model by the mariners' community, which, as repeatedly stated, is not inclined to changes of this magnitude. Any acceptance of the model by the maritime environment would represent a first success of the model and would give incentive to continue with real applications in the field. In order to verify whether the model can be accepted or not by the maritime industry, it is necessary to critically consider what level of the maritime environment to present the model to test its reception. A key element in the definition of the model is the collaboration between the ship level and the organizational level in creating the conditions

for the integration of vertical leadership and distributed leadership and ensuring the shift from the hierarchical structure to the more horizontal one, when necessary. In addition, the model is designed to become an important tool available to future generations of seafarers to prevent possible errors and deal more effectively with any emergencies that may arise.

Taking these precautions into account, the first application of the model was carried out at the Cyprus Institute of Marketing based in Limassol, Cyprus. The choice of this school was made taking into consideration different elements. The island of Cyprus has a strong seafaring tradition and a particular attention to the study of the elements that influence the interaction between man and ship. It is no coincidence that the Cyprus Branch of the Nautical Institute hosted the Nautical Institute Command Seminar on November 3, 2017 with the theme 'Navigation Accidents and their Causes' to discuss how the human element is still strongly persistent in the maritime industry and what improvements can be introduced to limit its effects. The city of Limassol is home to the main tourist port of the island and also houses a campus of the Cyprus Institute of Marketing, the leading business school in Cyprus. This institute prepares young seafarers to work in the maritime business sector, providing them programs in strategic, leadership or management challenges among a team, within a division, or throughout the entire maritime organization. Therefore, the Cyprus Institute of Marketing represents the link between organizational layer and ship layer, the core actors for the application of the new maritime emergency management model in the maritime industry.

On November 2, 2017, the new emergency management model had been presented to undergraduate and graduate students in a three-hour lecture during which the model had been introduced to the students and all the elements that compose the model accurately explained. Students were expected to offer their expertise to possibly challenge the model provide suggestions for improvements deriving from their actual needs. The aim of the lecture has been to understand whether the proposed model could be accepted and effectively applied in real life operations or needs a profound improvement.

First, the students have been introduced to the concepts of shared leadership and the strengths and weaknesses of the horizontal model. Second, a comparison between the shared leadership model and the hierarchical model had been provided in order for the students to build their own idea about the possibility to introduce the shared leadership principles in the maritime command structure.

Following the theoretical introduction, an open discussion had given the students the possibility to challenge the model and share their thoughts and ideas about a real application of the new model.

After skepticism about the possibility of bringing any change in the maritime environment, the students started to discover the potential improvements that sharing power and responsibilities can bring in the emergency management. In addition, the students recognized the importance of having the support of the company for sharing mistakes, which is in line with the concept of creating the fair and just environment theorized in the model. On the other hand, the students recognized the challenges that a change of such magnitude can bring with it. The students stressed the necessity to involve the regulatory layer in the affirmation of the new emergency model, recognizing its role to practically introduce new standards in the maritime environment.

Therefore, despite the potential powerful effects that can follow such a change in the leadership structure and the consequent change in the emergency management, young mariners are positive that the new model can effectively help confine the impact of errors, reduce the number of casualties and increase the resilience of the maritime sector.

References

't Hart, P., Rosenthal, U., & Kouzmin, A. (1993). Crisis decision making: The centralization thesis revisited. *Administration & Society*, *25*(1), 12–45.

Avolio, B., Jung, D., Murry, W., & Sivasubramaniam, N. (1996). Building highly developed teams: Focusing on shared leadership process, efficacy, trust, and performance. In M. M. Beyerlein & S. T. Johnson, D. A. Beyerlein (Eds.), *Advances in interdisciplinary studies of work teams* (pp. 173–209). Greenwich, Ct: JAI Press.

Balthazard, P., Waldman, D., & Howell, J. (2004). Shared leadership and group interaction styles in problem-solving virtual teams. *Proceedings of Hawaii International Conference on System Sciences*, *00*(C), 1–10.

Bandura, A. (1997). *Self-efficacy: the exercise of control*. Worth Publishers.

Bandura, A. (2000). Exercise of human agency through collective efficacy. *Current Directions in Psychological Science*, *9*(3), 75–78.

Baron, J. (2008). *Thinking and deciding*. Cambridge University Press.

Bergman, J. Z., Rentsch, J. R., Small, E. E., Davenport, S. W., & Bergman, S. M. (2012). The shared leadership process in decision-making teams. *Journal of Social Psychology*, *152*(1), 17–42.

Bichler-Robertson, G. M. (2000). *Maritime Commercial Passenger Ship Casualties, 1950-1998: An Analysis of Negligent Corporate Risk-Taking and System Hazard*. The State University of New Jersey.

Bono, J. E., & Ilies, R. (2006). Charisma, positive emotions and mood contagion. *Leadership Quarterly*, *17*(4), 317–334.

Bowen, D. E., Ledford Jr., G. E., & Nathan, B. R. (1991). Hiring for the organization, not the job. *The Executive*, *5*(4), 35–51.

Brown, A., & Amrozowicz, M. (1996). Tanker environmental risk-putting the pieces together. In *SNAME/SNAJ International Conference on Designs and Methodologies for Collision and Grounding Protection of Ships*.

Burke, C. S., Stagl, K. C., Klein, C., Goodwin, G. F., Salas, E., & Halpin, S. M. (2006). What type

of leadership behaviors are functional in teams? A meta-analysis. *Leadership Quarterly*, *17*(3), 288–307.

Burke, C. S., Stagl, K. C., Salas, E., Pierce, L., & Kendall, D. (2006). Understanding team adaptation: A conceptual analysis and model. *Journal of Applied Psychology*, *91*(6), 1189–1207.

Carson, J. B., Tesluk, P. E., & Marrone, J. A. (2007). Shared leadership in teams: An investigation of antecednt conditions and performance. *Academy of Management Journal*, *50*(5), 1217–1234.

Carver, C. S., & Scheier, M. (1998). *On the self-regulation of behavior*. Cambridge University Press.

Chauvin, C., Lardjane, S., Morel, G., Clostermann, J.-P., & Langard, B. (2013). Human and organisational factors in maritime accidents: analysis of collisions at sea using the HFACS. *Accident; Analysis and Prevention*, *59*, 26–37.

Conger, J. A., & Pearce, C. L. (2003). A Landscape of Opprotunities: Future Research on Shared Leadership. In Pearce Craig L. & J. A. Conger (Eds.), *Shared Leadership Reframing the Hows and Whys of Leadership* (pp. 285–303). Thousand Oaks, CA: Sage Publications.

Cropanzano, R., Keith, J., & Maryalice, C. (1993). A goal hierarchy model of personality, motivation, and leadership. *Research in Organizational Behavior*, *15*, 267–322.

Cropanzano, R., & Mitchell, M. S. (2005, December 1). Social exchange theory: An Interdisciplinary review. *Journal of Management*. Sage PublicationsSage CA: Thousand Oaks, CA.

D'Innocenzo, L., Mathieu, J. E., & Kukenberger, M. R. (2016). A Meta-Analysis of Different Forms of Shared Leadership–Team Performance Relations. *Journal of Management*, *42*(7), 1964–1991.

Day, D. V., Gronn, P., & Salas, E. (2006). Leadership in team-based organizations: On the threshold of a new era. *Leadership Quarterly*, *17*(3), 211–216.

Dekker, S. W. A. (2002). Reconstructing human contributions to accidents: the new view on error and performance. *Journal of Safety Research*.

Diefenbach, T., & Sillince, J. A. A. (2011). Formal and informal hierarchy in different types of organization. *Organization Studies*, *32*(11), 1515–1537.

Edmondson, A. (1999). Psychological Safety and Learning Behavior in Work Teams. *Administrative Science Quarterly*, *44*(2), 350.

Emerson, R. M. (1962). Power-Dependence Relations. *American Sociological Review*, *27*(1), 31.

Ferres, N., Connell, J., & Travaglione, A. (2004). Co-worker trust as a social catalyst for constructive employee attitudes. *Journal of Managerial Psychology*, *19*(6), 608–622.

Fischoff, B., & Johnson, S. (1997). The possibility of distributed decision making. In Z. Shapira (Ed.), *Organizational decision making* (pp. 216–237). Cambridge University Press.

Foti, R. J., Hauenstein, N. M. A., Sgro, J. A., & Johnson, E. M. (1996). Linking Leadership Emergence to Leadership Effectiveness and Team Performance in a Military Population. (R. Foti, Ed.). San diego, CA.

Frankel, A. S., Leonard, M. W., & Denham, C. R. (2006). Fair and just culture, team behavior, and leadership engagement: The tools to achieve high reliability. *Health Services Research*, *41*(4 II), 1690–1709.

Glick, W. H. (1985). Conceptualizing and Measuring Organizational and Psychological Climate: Pitfalls in Multilevel Research. *Academy of Management Review*, *10*(3), 601–616.

Gouldner, A. W. (1960). he Norm of Reciprocity: A Preliminary Statement. *American Sociological Reviews*, *25*(2), 53–62.

Hackman, J. R. (2002). *Leading Teams: Setting the Stage for Great Performances*. *Administrative Science Quarterly*. Boston: Harvard Business School Press.

Hackman, J. R., & Wageman, R. (2005). A theory of team coaching. *Academy of Management Review*, *30*(2), 269–287.

Hannah, S. T., Avolio, B. J., Luthans, F., & Harms, P. D. (2008). Leadership efficacy: Review and future directions. *Leadership Quarterly*, *19*(6), 669–692.

Hannah, S. T., & Luthans, R. (2008). A cognitive affective processing explanation of positive leadership. In R. H. Humphrey (Ed.), *Affect and Emotion: New Directions in Management Theory and Research* (pp. 97–136). Information Age Publishing.

Hannah, S. T., Woolfolk, R. L., & Lord, R. G. (2009). Leader self-structure: A framework for positive leadership. *Journal of Organizational Behavior*, *30*(2), 269–290.

Hoch, J. E. (2013). Shared Leadership and Innovation: The Role of Vertical Leadership and Employee Integrity. *Journal of Business and Psychology*, *28*(2), 159–174.

Hooker, C., & Csikszentmihalyi, M. (2003). Flow, creativity, and shared leadership: Rethinking the motivation and structuring of knowledge work. In *Shared leadership: Reframing the hows and whys of leadership* (pp. 217–234).

Hooker, C., & Mihaly, C. (2003). Flow, creativity, and shared leadership. In *Shared leadership: Reframing the hows and whys of leadership* (pp. 217–234).

Houghton, J. D., Neck, C. P., & Manz, C. C. (2003). Self-leadership and superleadership: The heart and art of creating shared leadership in teams. In *Shared Leadership: Reframing the Hows and Whys of Leadership* (pp. 123–140). 2455 Teller Road, Thousand Oaks California 91320 United States: SAGE Publications, Inc.

Houghton, J. D., Pearce, C. L., Manz, C. C., Courtright, S., & Stewart, G. L. (2015). Sharing is caring: Toward a model of proactive caring through shared leadership. *Human Resource Management Review*, *25*(3), 313–327.

Jones, A. P., & James, L. R. (1979). Psychological climate: Dimensions and relationships of individual and aggregated work environment perceptions. *Organizational Behavior and Human Performance*, *23*(2), 201–250.

Juda, L. (2007). The European Union and Ocean Use Management: The Marine Strategy and the Maritime Policy. *Ocean Development & International Law*, *38*(3), 259–282.

Kahn, W. A. (1993). Caring for the Caregivers: Patterns of Organizational Caregiving. *Administrative Science Quarterly*, *38*(4), 539.

Kirkman, B. L., & Rosen, B. (1999). Beyond self-management: Antecedents and consequences of team empowerment. *Academy of Management Journal*, *42*(1), 58–74.

Klein, G. A., Orasanu, J., Calderwood, R., & Zsambok, C. . (1993). *Decision making in action: Models and methods*. Norwood, NJ: Ablex.

Kouzmin, A., & Jarman, A. M. G. (1990). Towards comprehensive planning in Australian crisis

management. *Asian Review of Public Administration*, *2*(1–2), 92–113.

Lagadec, P. (1982). *Major technological risk: an assessment of industrial disasters*. Pergamon Press.

Latham, G. P., Winters, D. C., & Locke, E. A. (1994). Cognitive and motivational effects of participation: A mediator study. *Journal of Organizational Behavior*, *15*(1), 49–63.

Lawler, E. J., & Yoon, J. (1996). Commitment in Exchange Relations: Test of a Theory of Relational Cohesion. *American Sociological Review*, *61*(1), 89.

Leithwood, K., Leonard, L., & Sharratt, L. (1998). Conditions Fostering Organizational Learning in Schools. *Educational Administration Quarterly*, *34*(2), 243–276.

LePine, J. A., Erez, A., & Johnson, D. E. (2002). The nature and dimensionality of organizational citizenship behavior. *Journal of Applied Psychology*, *87*(1), 52–65.

Locke, E. A. (2003). Leadership: starting at the top. In C. L. Pearce & J. A. Conger (Eds.), *Shared Leadership Reframing the Hows and Whys of Leadership* (pp. 271–284).

Locke, E. A., & Schweiger, D. M. (1979). Participation in decision-making: one more look. *Research in Organizational Behavior*, *1*, 265–339.

Lord, R., DeVader, C., & Alliger, G. (1986). A Meta-Analysis of the Relation Between Personality Traits and Leadership Perceptions: An... *Journal of Applied Psychology*, *71*(3), 402–410.

Lord, R. G., & Brown, D. J. (2004). *Leadership processes and follower self-identity*. Psychology Press.

Maarleveld, T. (2007). Maritime management matters. In J. Satchell & P. Palma (Eds.), *Council for British Archaeology Research Reports* (Vol. 153, pp. 49–57). AAAI Press.

Mathieu, J. E., Goodwin, G. F., Heffner, T. S., Salas, E., & Cannon-Bowers, J. A. (2000). The influence of shared mental models on team process and performance. *Journal of Applied Psychology*.

Mayeroff, M. (1965). On Caring. *International Philosophical Quarterly*, *5*(3), 462–474.

Mischel, W., & Shoda, Y. (1998). Reconciling processing dynamics and personality dispositions. *Annual Review of Psychology*, *49*(1), 229–258.

Molm, L. D., Collett, J. L., & Schaefer, D. R. (2007). Building Solidarity through Generalized Exchange: A Theory of Reciprocity. *American Journal of Sociology*, *113*(1), 205–242.

Morrow, I. J., & Stern, M. (1990). Stars, adversaries, producers, and phantoms at work: A new leadership typology. In K. E. Clark & M. B. Clark (Eds.), *Measures of leadership* (pp. 419–439). West Orange, NJ: Leadership Library of America.

Naidoo, L. J., & Lord, R. G. (2008). Speech imagery and perceptions of charisma: The mediating role of positive affect. *Leadership Quarterly*, *19*(3), 283–296.

Neck, C. P., & Manz, C. C. (2007). *Mastering self-leadership: empowering yourself for personal excellence*. Pearson/Prentice Hall.

Patterson, M. G., West, M. A., & Wall, T. D. (2004, August 1). Integrated manufacturing, empowerment, and company performance. *Journal of Organizational Behavior*. Wiley-Blackwell.

Pearce, C. L. (2004). The future of leadership: Combining vertical and shared leadership to transform knowledge work. *Academy of Management Executive*, *18*(1), 47–57.

Pearce, C. L., & Conger, J. A. (2003). *Shared leadership: Reframing the hows and whys of leadership*. Thousand Oaks, CA: Sage Publications.

Pearce, C. L., & Ensley, M. D. (2004). A reciprocal and longitudinal investigation of the innovation process: The central role of shared vision in product and process innovation teams (PPITs). *Journal of Organizational Behavior*, *25*(2), 259–278.

Perrow, C. (1984). *Normal Accidents. Living with High-Risk Technologies*. New York: Basic Books.

Perry, M. L., Pearce, C. L., & Sims, H. P. (1999). Empowered selling teams: How shared leadership can contribute to selling team outcomes. *Journal of Personal Selling and Sales Management*, *19*(3), 35–51.

Phillips, J. M. (2001). The Role of Decision Influence and Team Performance in Member Self-Efficacy, Withdrawal, Satisfaction with the Leader, and Willingness to Return. *Organizational Behavior and Human Decision Processes*, *84*(1), 122–147.

Quarantelli, E. L. (1988). Disaster crisis management a summary of research findings. *Journal of*

Management Studies, *25*(4), 373–385.

Ramthun, A. J., & Matkin, G. S. (2014). Leading Dangerously: A Case Study of Military Teams and Shared Leadership in Dangerous Environments. *Journal of Leadership and Organizational Studies*, *21*(3), 244–256.

Reason, J. (1997). *Managing the Human and Organizational Response to Accidents*. Ashgate Publishing.

Roberts, H. E. (1995). *Investigating the role of personal attributes in leadership emergence*.

Salas, E., Sims, D. E., & Shawn Burke, C. (2005). Is there A "big five" in teamwork? *Small Group Research*, *36*(5), 555–599.

Schein, E. H. (2016). *Organizational culture and leadership* (5 edition). Wiley.

Schneider, B. (1975). Organizational climates: an essay. *Personnel Psychology*, *28*(4), 447–479.

Seibert, S. E., Wang, G., & Courtright, S. H. (2011). Antecedents and consequences of psychological and team empowerment in organizations: a meta-analytic review. *Journal of Applied Psychology*, *96*(5), 987–1003.

Shadur, M. A., Kienzle, R., & Rodwell, J. J. (1999). The Relationship between Organizational Climate and Employee Perceptions of Involvement: The Importance of Support. *Group and Organization Management*, *24*(4), 479–503.

Shamir, B., House, R. J., & Arthur, M. B. (1993). The Motivational Effects of Charismatic Leadership: A Self-Concept Based Theory. *Organizational Science*, *4*(4), 1–17.

Shamir, B., & Lapidot, Y. (2003). Shared leadership in the management of group boundaries. In J. A. C. Craig L Pearce (Ed.), *Shared Leadership* (pp. 235–249).

Skovholt, T. M. (2005). The cycle of caring: A model of expertise in the helping professions. *Journal of Mental Health Counseling*, *27*(1), 82–93.

Solansky, S. T. (2008). Leadership style and team processes in self-managed teams. *Journal of Leadership and Organizational Studies*, *14*(4), 332–341.

Spreitzer, G. M. (1995). Psychological Empowerment In the Workplace: Dimensons, Measurement and Validation. *Academy of Management Journal*, *38*(5), 1442–1465.

Steinheider, B., Wuestewald, T., & Bayerl, P. S. (2006). When twelve heads are better than one: implementing a shared leadership concept in a police agency. *Academy of Management Proceedings*, *2006*(1), L1–L6.

Stewart, G. L., Carson, K. P., & Cardy, R. L. (1996). The joint effects of conscientiousness and self-leadership training on employee self-directed behavior in a service setting. *Personnel Psychology*, *49*(1), 143–164.

Swezey, R. W., & Salas, E. (1992). *Teams Their training and performance*. Norwood, NJ: Ablex Pub. Corp.

Turner, B. A., & Pidgeon, N. F. (1997). *Man-made disasters*. Wykeham Publications.

Veiga, J. L. (2002). Safety culture in shipping. *WMU Journal of Maritime Affairs*, *1*(1), 17–31.

Wang, D., Waldman, D. A., & Zhang, Z. (2014). A meta-analysis of shared leadership and team effectiveness. *Journal of Applied Psychology*, *99*(2), 181–198.

Weick, K. E., & Sutcliffe, K. M. (2007). *Managing the unexpected : resilient performance in an age of uncertainty*. Jossey-Bass.

Wildavsky, Center, B. G. S. U. S. P., & Policy. (1988). *Searching for safety*. Transaction Books.

Winter, D. G. (1991). A motivational model of leadership: Predicting long-term management success from TAT measures of power motivation and responsibility. *The Leadership Quarterly*, *2*(2), 67–80.

Yukl, G. (2005). *Leadership in organizations*. *Leadership Quaterly Journal*. Pearson/Prentice Hall.

Conclusions and future directions

Errors cannot be removed from the maritime environment, since they are an embedded attribute of the human condition.

The technological progress has increased the problems related to human errors because the difficulties of the man-machine interactions have been amplified. Related problems have been partially addressed by the International Maritime Organization which introduced new regulations following the most serious accidents, but its response is mainly reactive and cannot truly anticipate the error. The SOLAS Convention is introduced in 1914 following the incident of the Titanic happening two years before and represents the first attempt to establish a common regulation framework for all countries, which aims at harmonizing the different individual national safety-related laws. During the years, the SOLAS Convention has experienced a series of updates to respond to the problems emerged by new events. After the Costa Concordia accident in 2012, new elements to facilitate on-board communication have been integrated in the Convention. The STCW Convention represents the first step towards the consideration of the human element as a cause of maritime accidents and is aimed to standardize crew training. It was introduced in 1984, a few years after the incident of MV Amoco Cadiz in 1978, one of the most severe oil spills in history, partially provoked by Captain's hesitations to face a ships technical problem. The ISM Code had been incorporated into SOLAS in 1989 after the incident of the Herald of Free Enterprise in 1987 and shifts the attention on the managerial dimension as a co-factor of maritime accidents. The code provides that the organizational level provides support and aid to the ship to maintain high standards for safety and pollution prevention.

Despite the progress in the studies that considers the human element in every single aspect (multilayer approach) as the main cause of the maritime disasters, the fact that serious accidents still happen nowadays, suggest that there is still space for further improvements.

The maritime environment is recognized to be a little inclined to changes and to bring innovation to the system requires time and the cleverness to encourage the new generations of mariners to recognize the need to increase the safety in a sector that is certainly subject to different hazards. The possibility to make a change to the ship management model is a brand-new approach that can create safer codes for mariners on board ships, ensure success in carrying the ship safely from port to port (guaranteeing therefore an economic success for companies) and improve the relationship between company and ship (working on safety culture and climate) (Goulielmos & Androniki,

2012). In order to become a real instrument that encourages promotion of security, this model must be discussed together with the legislative level, because, as said in Chapter 1, more than 95% of the world ships are subject to IMO regulations. It is not therefore sufficient to theorize a new management model, but it is essential that the new model is carefully valued and accepted by mariners. In this sense, the collaboration with the Cyprus Institute of Marketing represents a step towards the acceptance of the model, because young seafarers have been (probably for the first time) challenged to face a new problem in the maritime sector: think about the limits of the leadership model that has been used in the maritime sector since its birth. The positive and proactive response of the students gives hope that the mariners of tomorrow, both on shore and on board, will embrace the change with enthusiasm and will be promoters of the sharing of the decisional power as a means for the achievement of the common safety objectives, safety of people first, but also environmental, ships and goods safety.

Certainly, in the 21st century, it is difficult to stop or limit the technological advancement on board ships and make the interaction human-machine less complex (Uhl-Bien, Marion, & McKelvey, 2007). What can be changed is the conditions under which human beings make decisions and perform their tasks (Reason, 2000; Reason, 1997). The sinking of the Costa Concordia and many other disasters prior to and after the sinking of the Italian cruise ship, as well as the needs and concerns highlighted in the studies in the field of maritime leadership carried out in this dissertation, show the necessity to bring this change.

The analysis of the Costa Concordia disaster carried out in Chapter 2 clearly shows a multilayer involvement in the accident (Dekker, 2002; Kwon & Leveson, 2017; Reason, 2004). During the emergency, communications on the ship were made difficult because of the Captain's inability to be focused and active during the crisis ('t Hart et al., 1993), pressure and scarce support to the captain (Montes et al., 2005) and officers' expectation (Ferrin & Dirks, 2002) due to the necessity to respect roles (Sasou & Reason, 1999). The company played an important role in the emergency because it failed to guarantee safety standard and support to the ship during the emergency. These elements have promoted the emergence of informal semi-hierarchical structure with the staff captain in charge of command, helped by other officers ready to manage the emergency. The informal structure reflects on the emergency and demonstrates an overreliance on bad applied organizational operating procedures. The analysis shows the necessity to deepen the studies on the relationship between formal and informal leadership structure in emergency management and understand how communications are influenced by this dualism. The lack of timely

communication, in fact, has been recognized to be the key element that lead to bad emergency management (Shattuck & Woods, 2000).

Chapter 3 recalled the leadership-related issues that emerged in Chapter 2. The analysis allowed to measure the essential role that formal and informal connections played during the management of the Costa Concordia emergency on January 13, 2012. The formal hierarchical structure has been replaced by an informal less hierarchical one (Guimerà et al., 2006), where captain's duties have been carried out by the Staff Captain, the most influential figure in the emergency, assisted by the officers in higher positions in the formal hierarchy. The persistence of the informal structure has been guaranteed by the novelty of information provided by informal connections that have determined the possibility to coordinate the emergency. The emerged informal structure shows the partial failure of the command and control structure (Oettinger, 1990), opening the possibility to reorganize the leadership structure onboard ships as an instrument to enhance safety (Carmeli & Gittell, 2009).

Chapter 4 opened the possibility of reorganizing the command structure, asking for hints and considering indications provided by individuals to which such change is addressed: the mariners that live every day in contact with the sea both on ships, and in the companies' offices. The answers of mariners interviewed suggested a positive approach to the change. The need for collaboration and teamwork (Luria & Berson, 2013; Waugh & Streib, 2006) highlighted the possibility to implement a less hierarchical leadership structure, that considers mariner's cultural background (Fischer, 1999) and preview strong interactions among people working on the ship (Frankel et al., 2006). The change cannot happen without the support from the company that has to translate its safety culture into the ship's safety climate (Goulielmos & Androniki, 2012; Veiga, 2002; Vu & Cieri, 2014).

The new maritime emergency management model proposed in chapter 5 of this dissertation can be a good start providing a consistent and progressive change in the maritime environment. Moving the focus from the individual leader to the group can increase not only group performance in emergency, but also the capacity of the captain as a leader to better perform and lead the team (Bono & Ilies, 2006; Burke, Stagl, Klein, et al., 2006; Epitropaki & Martin, 2004; Naidoo & Lord, 2008). Therefore, sharing leadership can also improve vertical leadership. In order to achieve safety, it is essential that the organizational level helps the ship to align safety climate to safety

culture creating the fair and just environment necessary to integrate shared leadership (Frankel et al., 2006).

However, the new model certainly requires more studies and the involvement of the entire maritime system. Therefore, future research should aim to find answers to different questions: (a) would the model *truly* be accepted in the maritime environment? (b) are captains *actually* ready and willing to step back and share not only responsibilities but also authority? (c) Are the subordinates *really* able to feel unintimidated by the role of the captain and constantly report errors and near misses? (d) Is the organizational layer *actually* able to create the 'fair' environment for discussions?

In order to effectively make this model useful and beneficial, it is necessary that the ship layer and the organizational layer work together with the regulatory layer in a joint action between the three levels to renew the maritime system. The model implementation must be the result of the lessons learned by past accidents and of testing the model on the field. Future research should consider the possibility of joining the efforts of researchers and the maritime industry. In this sense researchers should investigate other disaster and verify what conditions caused the accident and contributed to the emergency. Findings should be used to further examine what mariners need for better performing in emergencies and improve the new emergency management model. In the same way, more data on life at sea should be collected. In particular, future research should be addressed to the investigation of the relationship between safety culture and safety climate, probably the most sensitive element for sharing leadership. Ad hoc trainings should be scheduled by the organizational layer to test the real possibility of sharing leadership. A possible training can be a role exchange. For example, the personnel working at companies' officers can periodically spend time on ships and work with seafarers. In this way, seafarers and companies' employees can respectively understand the difficulties of working on ships and ashore. This 'cultural' exchange can possibly help align safety culture and safety climate. Researchers can measure the way the relationship between company and ships varies during time and add these results in the new management model or use the finding as a starting point for conducting further analyses. Similarly, specific training should consider the possibility of exchanging captain's and subordinates' roles and measure the effects of sharing leadership during time.

Additionally, research can be addressed to future generations and their capacity to accept and adapt to the new leadership model. The first application of the model highlighted a positive reception of the model. Such important finding should be used to introduce the concepts of shared leadership in

maritime academies. Sharing leadership in a highly hierarchical environment can be difficult and requires a big effort of mariners to adapt to the integrated model. Therefore, teaching leadership and shared leadership in particular, can possibly increase seafarers' resilience and as a consequence increase safety of the entire maritime system.

Appendices to Chapter 2

Appendix I: Names and roles of actors involved in the Costa Concordia emergency

Officer Name	Officer Role
Abad Quine Jaqueline Elizabeth	Assistant Cruise Director
Ambrosio Ciro	Second Officer
Barabba Lorenzo	Director of Services
Bongiovanni Andrea	Safety Trainer
Borghero Tonio	Staff Engineer
Bosio Roberto	Staff Captain
Calisssi Andrea	Cadet Officer
Canessa Simone	Second Officer
Christidis Dimitros	Staff Captain
Di Lena Alessandro	Environmental Officer
Di Piazza Hugo	Third Engineer
Ferrarini Roberto	Fleet Crisis Coordinator
Fiorito Alberto	Second Engineer
Garrone Carlos Vicente	Hotel Engineer
Giampedroni Manrico	Hotel Director
Iaccarino Giovanni	First Officer
Iannelli Stefano	Cadet Sanitation Officer
Iosso Ciro	Electronics Officer
Iuorio Sergio	Electrician Officer
Lombardo Arrigo	Assistant Administrative Director
Muscas Antonio	First Officer Electrician
Nicotra Andrea	Third Engineer
Nonnis Giovanni	Administrative Director
Panetti Fiorella Silvana	Crew Purser Cashier
Pellegrini Martino	Safety Officer
Petrov Petar Manolov	First Engineer (Engines)
Pilon Giuseppe	Chief Engineer
Raccomandato Francesco	Cruise Director
Rusli Bin Jacob	Helmsman
Scarpato Diego	Third Officer
Schettino Francesco	Captain
Soare Raulca	Nurse
Spadavecchia Flavio	Cadet Sanitation Officer
Ursino Salvatore	Second Officer
Usman Oji	Electrician Officer

Appendices to Chapter 3

Appendix I: Names and roles of actors involved in communications during the Costa Concordia emergency

Officer Name	Officer Role
Abad Quine Jaqueline Elizabeth	Assistant Cruise Director
Aegilium	Search and Rescue
Ambrosio Ciro	Second Officer
Bongiovanni Andrea	Safety Trainer
Borghero Tonio	Staff Engineer
Bosio Roberto	Staff Captain
Canessa Simone	Second Officer
Christidis Dimitros	Staff Captain
Circomare Porto Santo Stefano	Search and Rescue
Coronica Silvia	Third Officer
CP Civitavecchia	Search and Rescue
CP Livorno	Search and Rescue
Di Lena Alessandro	Environmental Officer
Ferrarini Roberto	Fleet Crisis Coordinator
Fiorito Alberto	Second Engineer
Giampedroni Manrico	Hotel Director
Guardia di Finanza	Search and Rescue
Iaccarino Giovanni	First Officer
Losito Claudio	Third Engineer
Muscas Antonio	First Officer Electrician
Onorato Ciro	First Maître d'Hotel
Pellegrini Martino	Safety Officer
Pilon Giuseppe	Chief Engineer
Raccomandato Francesco	Cruise Director
Rusli Bin Jacob	Helmsman
Scarpato Diego	Third Officer
Schettino Francesco	Captain
Sclafani Vincenzo	First Bosun
Spadavecchia Flavio	Cadet Sanitation Officer
Tievoli Antonello	First Maître d'Hotel
Ursino Salvatore	Second Officer

Appendix II: IRB statement for the project "Costa Concordia disaster: communication network analysis"

Northwestern | RESEARCH

Northwestern University
Institutional Review Board
Biomedical IRB
750 N. Lake Shore Dr., 7th Fl.
Chicago, Illinois 60611

irb@northwestern.edu
Office 312. 503. 9338

Social & Behavorial Sciences IRB
600 Foster St., 2nd Floor
Evanston, Illinois 60208

sbsirb@northwestern.edu
Office 847. 467. 1723

NOT HUMAN RESEARCH

DATE: May 23, 2018

TO: Noshir Contractor
FROM: Office of the IRB

DETERMINATION DATE: 5/23/2018

The Northwestern University IRB reviewed the submission described below and determined that the proposed activity is not research involving human subjects. Further IRB review and approval is not required.

Type of Submission:	Initial Study
Review Level:	
Title of Study:	Costa Concordia disaster: communication network analysis
Investigator:	Noshir Contractor
IRB ID:	STU00207624
Funding Source:	Name: Northwestern University (NU)
Grant ID:	
IND, IDE, or HDE:	None
Documents Reviewed:	• HRP-503-Human Research Determination protocol.docx, Category: IRB Protocol;

This determination applies only to the activities described in the eIRB+ submission and does not apply should any changes be made. If changes are being considered and there are questions about whether IRB review is needed, please contact the IRB Office to discuss those changes. You may be asked to submit a new study in eIRB+ for a determination.

This determination does not constitute or guarantee institutional approval and/or support. Investigators and study team members must comply with all applicable federal, state, and local laws, as well as NU Policies and Procedures, which may include obtaining approval for your research activities from other individuals or entities.

For IRB-related questions, please consult the NU IRB website at http://irb.northwestern.edu. For general research questions, please consult the NU Office for Research website at www.research.northwestern.edu.

Appendices to Chapter 4

Appendix I: IRB statement for the project "Maritime Leadership: A Qualitative Approach"

UNIVERSITY OF DELAWARE
RESEARCH OFFICE
210 Hullihen Hall
University of Delaware
Newark, Delaware 19716-1551
Ph: 302/831-2136
Fax: 302/831-2828

DATE:	April 12, 2017
TO:	Cristina Casareale, Ms
FROM:	University of Delaware IRB
STUDY TITLE:	[1048031-1] Maritime Leadership: A Qualitative Approach
SUBMISSION TYPE:	New Project
ACTION:	DETERMINATION OF EXEMPT STATUS
DECISION DATE:	April 12, 2017
REVIEW CATEGORY:	Exemption category # *(2)*

Thank you for your submission of New Project materials for this research study. The University of Delaware IRB has determined this project is EXEMPT FROM IRB REVIEW according to federal regulations.

We will put a copy of this correspondence on file in our office. Please remember to notify us if you make any substantial changes to the project.

If you have any questions, please contact Nicole Farnese-McFarlane at (302) 831-1119 or nicolefm@udel.edu. Please include your study title and reference number in all correspondence with this office.

Appendix II: Statement of informed consent for the study of maritime leadership

STATEMENT OF INFORMED CONSENT

Maritime Leadership: A Qualitative Approach

You are invited to participate in an interview to discuss how crewmembers perceive the leadership attitude in their personal work environment. The researcher is at the Università Politecnica delle Marche (Italy) and is presently a visiting scholar at the University of Delaware. Approximately 10-20 interviews will be conducted with a range of personnel who work in the maritime sector. You have been asked to participate because of your professional experience in this sector. There are no anticipated risks associated with this study. The interview will last approximately 90 minutes. The information collected will be used for research and educational purposes.

We will ask you to share information regarding your personal experience as mariners and your opinion about the current leadership system and organizational culture. The information collected may be used to develop new protocols

We will not use your name in reports or publications, but the name of your organization and your position or job title may be used. Direct quotes may also be used in publications.

The interviews will be audio recorded.

Your participation in this study is voluntary. You may refuse to answer any specific questions raised during the interview. If you wish to withdraw from the study, you may do so at any time during the interview.

If you have any questions or concerns, you may contact Cristina Casareale, M.S, at the Università Politecnica delle Marche (c.casareale.pm@univpm.it), or James Kendra, Ph.D., at the Disaster Research Center, University of Delaware (302-831-6618). Alternatively, if you have any questions about your rights as a participant in this study, you may contact the University of Delaware's Chairperson of the Institutional Review Board (302-831-2137).

By signing below, you indicate that you understand your rights as a research subject, had the opportunity to ask questions and have your questions answered, received a copy of this form, voluntarily consent to participate in this study, and consent to be audio recorded.

Participant name (printed): _____

Participant signature: _____Date: _____

Interviewer signature: _____ Date: _____

Appendix III: Interview guide for the study of maritime leadership

MARITIME LEADERSHIP: A QUALITATIVE APPROACH

Administrative Information

Title:

Job Title:

Type of vessel:

Years of experience:

Previous experiences:

Military experience:

Maritime Academy Graduate:

Date of Interview:

Location of Interview:

Introduction

In order to continuously improve safety during navigation operations, this questionnaire has been developed to gather feedback regarding leadership performance and safety culture in the maritime system. Your experience as mariner would be valuable for the purpose of this study. The interview will last approximately 90 minutes and all the information will not be shared outside the research team. The information collected will be used for research and educational purposes.

PART A: <u>UNDERSTANDING OF LEADERSHIP</u>

1. **What does it mean to be the chief mate of a large ship?**

Tell me about…

a. What are your responsibilities?
b. How you spend your day?
c. What are the major challenges you face every day?
d. How you interact with others?

2. **How do/would you lead a crew?**

Tell me about…

a. Your approach to leadership,
b. Your relationship with the other members of your team,
c. The responsibilities of the leader within the team:
    i. Should he just give orders?
    ii. Should he create cohesion among team members? How?
    iii. Should he consult the team before making a decision?
    iv. Should he favor the communication process?
    v. Should he be part of the team or should he coordinate it maintaining an outside position?
    vi. Should he give support to team members?

PART B: <u>ROLES AND DUTIES</u>

3. **Which is your main role during normal activities? Which is the main role of the captain during normal activities?**
    a. Sharing the mission of the team among team members?
    b. Defining training programs?
    c. Enhance communication?

4. **Which is your main role during an emergency? Which is the main role of the captain during an emergency?**
    a. Support the team during emergency activities?
    b. Create the links to ensure the effectiveness of communication?

c. Be the one who makes all decision and gives orders?

PART C: <u>MANAGEMENT OF PAST EXPERIENCES</u>

5. **Did you ever experience a fire or grounding emergency? What was your approach to that situation?**

Please feel free to talk about the management of the emergency and try to touch all the following points:

a. Who did give orders? Did you give orders?
b. Did you receive orders from your superior/anyone in higher position in the hierarchy?
c. Did the ship communicate with land? Who started the communications?
d. Did the ship communicate with the company? Who started the communication?
e. Which individual or group characteristics promoted communication during the emergency?
f. Have the other crew mates been supportive?
g. Have you been supportive?
h. Did the other crew mates respect the order received or did they try to object to the order?
i. Did the leadership style vary during the worsening of the emergency?
    i. Did the captain become more strong and authoritative?
    ii. Did the captain become more collaborative?
    iii. Did the captain maintain his leading position?
j. Did you respect the order received or did you try to object to the order?
k. Did the other crew mates respect the procedures provided in the safety plan?
l. Did you respect the procedures provided in the safety plan?
m. Did the safety plan work properly during the development of the emergency?
n. Which was your perception of the teamwork?
o. Did the members of your team succeed in being complementary and flexible during the emergency?
p. Did the leader show the capacity to be reactive and improvise during the emergency?
    i. Did you appreciate this ability?

ii. Did his way to face the emergency inspire your actions?

q. Did that experience change the way you lead/work now? How?

6. Did you ever experience a general emergency? What was your approach to that situation?

Please feel free to talk about the management of the emergency and try to touch all the following points:

a. Who did give orders? Did you give orders?
b. Did you receive orders from your superior/anyone in higher position in the hierarchy?
c. Did the ship communicate with land? Who started the communications?
d. Did the ship communicate with the company? Who started the communication?
e. Which individual or group characteristics promoted communication during the emergency?
f. Have the other crew mates been supportive?
   Have you been supportive?
g. Did the other crew mates respect the order received or did they try to object to the order?
h. Did the leadership style vary during the worsening of the emergency?
   i. Did the captain become more strong and authoritative?
   ii. Did the captain become more collaborative?
   iii. Did the captain maintain his leading position?
i. Did you respect the order received or did you try to object to the order?
j. Did the other crew mates respect the procedures provided in the safety plan?
k. Did you respect the procedures provided in the safety plan?
l. Did the safety plan work properly during the development of the emergency?
m. Which was your perception of the teamwork?
n. Did the members of your team succeed in being complementary and flexible during the emergency?
o. Did the leader show the capacity to be reactive and improvise during the emergency?
   i. Did you appreciate this ability?
   ii. Did his way to face the emergency inspire your actions?
p. Did that experience change the way you lead/work now? How?

7. **Did you ever experience an abandon ship? What was your approach to that situation?**

Please feel free to talk about the management of the emergency and try to touch all the following points:

a. Who did give orders? Did you give orders?
b. Did you receive orders from your superior/anyone in higher position in the hierarchy?
c. Did the ship communicate with land? Who started the communications?
d. Did the ship communicate with the company? Who started the communication?
e. Which individual or group characteristics promoted communication during the emergency?
f. Have the other crew mates been supportive?
g. Have you been supportive?
h. Did the other crew mates respect the order received or did they try to object to the order?
i. Did the leadership style vary during the worsening of the emergency?
    i. Did the captain become more strong and pretentious?
    ii. Did the captain become more collaborative?
    iii. Did the captain maintain his leading position?
j. Did you respect the order received or did you try to object to the order?
k. Did the other crew mates respect the procedures provided in the safety plan?
l. Did you respect the procedures provided in the safety plan?
m. Did the safety plan work properly during the development of the emergency?
n. Which was your perception of the teamwork?
o. Did the members of your team succeed in being complementary and flexible during the emergency?
p. Did the leader show the capacity to be reactive and improvise during the emergency?
    i. Did you appreciate this ability?
    ii. Did his way to face the emergency inspire your actions?
q. Did that experience change the way you lead/work now? How?

PART D: <u>CULTURE OF ERROR</u>

8. **Do you think that your working environment is characterized by a positive safety culture?**
    a. Who should promote safety culture? How?
    b. Do you think stress or fatigue can affect safety?
    c. Do you think stress or fatigue can affect your performance?
    d. Do you ask for help when you feel stressed or fatigued?
    e. Do you think the training you receive is adequate to promote safety culture?
    f. Do you think coworkers or supervisors should encourage people to report any unsafe situation observed?
    g. Do you think that a multicultural team can affect your performance or the performance of the whole team? In which way?

9. **What is your strategy for avoiding mistakes or helping others to avoid mistakes?**
    a. Is the leader's approach to the error clearly explained before the occurrence of an error or does he share it only a posteriori?
    b. Do you help other officers to avoiding mistakes? How?
    c. Do you feel comfortable to report the leader about an imminent error or an error that just occurred?
    d. Do you feel comfortable to share your different opinion about a decision made by the leader about the management of a certain aspect of the emergency?
    e. Do you think there are some organizational factors that have an indirect influence on the incidence or management of errors? What are these factors?

10. **Do you periodically have meetings to discuss about safety?**
    a. Who participates in these meetings?
    b. Do you feel free to share error experiences during these meetings?
    c. Do you share the experiences gained during emergencies?
    d. Do you think your suggestions are taken into consideration?

11. **Do you think more education is needed? Do you have any suggestion to provide to improve education?**

a. Revise bridge team management?
b. Academy curriculum?
c. Revise the error management policy of the company?
d. Improve communication?
e. Improve collaboration within a group?
f. Revise captain's position within the group?

12. Do you think the performance of each crewmember should be continuously checked?

a. Who should check the adequacy of the performances?
b. Should the performance be checked only during emergency situations?
c. Should the performance be checked only during everyday activities?
d. How do you feel about been checked?
e. Do you think the control should diminish with the career advancement?
f. Do you think captain's performance should be also checked?

Demographic Information

Age:

Grade of Education:

Professional Experience:

Gender:

Race: