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Development of a Safety Culture Assessment and Improvement Framework to Enhance Maritime Safety

by

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A thesis presented in fulfilment of the requirements for the degree of Doctor of Philosophy

Glasgow, UK

2018

Signed: Volkan Arslan Date: 26.11.2017

This thesis is dedicated to the memory of my father, Sadık Arslan, who lost his life on the 26th of January 2017.

Acknowledgements

First of all, I would like to express my sincere and deepest appreciation to my first supervisor, Professor Osman Turan, who has been an excellent mentor for me during my PhD journey. It wouldn't be possible to accomplish my PhD and improve my research abilities without his tremendous support and guidance. I would like to also acknowledge the support and help of my second supervisor, Dr Evangelos Boulougouris. In addition to this, I would like to express my appreciation to Dr R. Emek Kurt, for his precious advice and support to enhance the quality of this thesis.

Moreover, I gratefully acknowledge that the research presented in this thesis was partially generated as part of the EU funded FP7 project SEAHORSE (Safety Enhancements in transport by Achieving Human Orientated Resilient Shipping Environment, Project number 605639, FP7-SST-2013-RTD-1). Thanks are also due to project partners and funding from the EU FP7 SEAHORSE Project. I would also like to thank the University of Strathclyde Faculty of Engineering for giving a PhD Scholarship to support my PhD research.

I would like to acknowledge the support of my colleagues during my PhD studies in Glasgow, in alphabetical order: Dr. Elif Oguz, Dr Emma Comrie, Kurt Mizzi, Omar Badokhon, Dr Paula Kellett, S. Anil Gunbeyaz, Dr Tahsin Tezdogan, Dr Tuba Kececi, Yiannis Raptodimos and Dr Yigit K. Demirel. I would like to also acknowledge the support of Louis De Wolff, Ben Wood, Sanjay Patil, Melisa Ozen and Evangelos Tsoumpos for their support to accomplish my PhD successfully.

I would like to thank my family members: my mother, Sabriye Arslan and my brother, Huseyin S. Arslan for always supporting me, encouraging me and believing in me. I couldn't have completed this thesis without their tremendous support. I very much wish my father could see me now I have completed my PhD. I would like to also thank my cousins: Kayhan Yesil for his support in the UK and Ali Ihsan Hora for his company in my visits to Istanbul.

Last, but certainly not least, I would like to thank Dr Charlotte Monteith for all her encouragement and support to finalise my thesis successfully, for not only being a supportive partner, but also bringing joy to my life as a best friend.

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Abstract

The maritime industry has experienced numerous catastrophic accidents and these accidents are traditionally attributed to human and organizational factors. Recently, the shipping industry aims to implement an effective safety culture in order to avoid reoccurrence of these events as requested by the IMO International Safety Management (ISM) Code. However, the ISM Code does not provide a structured assessment and improvement methodology to address this issue and therefore the envisaged impact has not yet been achieved due to a lack of structured approach to enhance maritime safety culture.

Therefore, this thesis aims to develop a novel safety culture assessment and improvement framework to identify safety related problems of any shipping company, address the vulnerabilities and develop improvement strategies to enhance safety culture maturity levels. Such a comprehensive and structured framework which seeks improvement areas via the combinations of the subjective and objective assessments along with action plans does not exist in the maritime domain.

The framework proposes three assessments and one improvement sub methods, namely: Safety Climate Assessment, Key Performance Indicators (KPIs) Assessment, Overt Observations and Improvement Methods & Action Plans

Firstly, safety culture assessment questionnaires are distributed to the shipping companies and these surveys are supported by semi-structured interviews in order to capture attitude and perceptions of the employees towards safety. Secondly, company key performance indicators are collected and correlated with the survey data for further clarification. KPI data are also used for trend analysis to capture the KPIs which have a positive impact on safety performance of a shipping company. Finally, on board observation studies take place to capture the main drivers of the safety performance of a shipping company. When all the assessments are completed, the action plans and improvement methodologies are proposed to address the identified gaps.

1 Introduction

1.1 Chapter Overview

This chapter defines the general perspectives of the subjects covered in this thesis, and outlines the structure of this thesis.

1.2 General Perspectives

90% of the world cargo transportation is the seaborne (Fang, 2013) and the seaborne transportation is expected to increase in alignment with the world merchandise trade (UNCTAD, 2017) (See Figure 1-1).

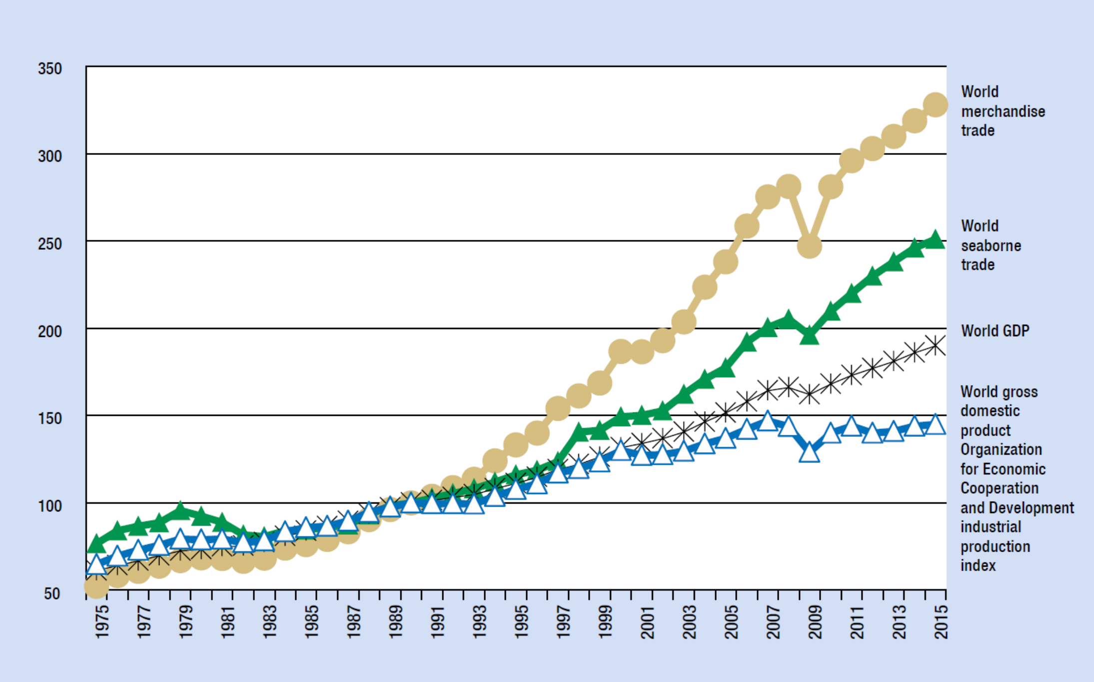

Figure 1-1 World Seaborne Transport (UNCTAD, 2017) © UNCTAD

The safety of seafarers and the cargo are of utmost importance in our society and this is highlighted by Oltedal (2011) as “without shipping, half the world would starve and the other half would freeze”.

Several accidents raised significant public awareness throughout the history and the maritime stakeholders tried to understand the factors contributing to these accidents

(Pike et al., 2015). Several studies were conducted after each catastrophic accident to identify the root causes and accident investigation reports attribute the 70-80% of marine accidents to human error (Perrow, 2011). The general approach within the shipping industry was that, crew members were blamed and punished for the errors, however, recent studies identified that the accidents are shaped and provoked by the organizational factors that affect the choices of the individuals (Chauvin, 2011). The individual factors together with the safety management system in a shipping organization form the prevalent safety culture (IMO, 2010).

The shipping industry experienced fatal accidents which are directly attributed to inadequate maritime safety culture such as the Estonia, Scandinavian Star and the Herald of Free Enterprise. The majority of the seafarers who are involved in these accidents are also known to be highly trained, experienced and competent to perform their duties, however they fail to follow the established procedures (ICS, 2013).

As a reaction to these accidents, the IMO developed the International Safety Management Code to support and encourage the development of the safety culture in shipping companies (Lappalainen, 2016). The ISM Code came into force in 1998 and it became mandatory in 2002 for all ships above 500 gross tons (IMO, 2014). The ISM Code is the first regulation that defines safety management responsibilities for the shipping companies.

A safety culture can be defined as the shared attitudes, perceptions, values and belief amongst employees in a company (Cox and Cox, 1991). The safety culture approach describes human as a means for improving safety rather than someone to blame for failure. A positive safety culture with commitment from all levels in the company can achieve the envisaged and required safety levels in the maritime industry. Safety culture is simply defined as “the way we do things around here”.

Organizations with strong safety culture are more likely to avoid accidents in their safety critical operations (Oltedal and Wadsworth, 2010). When a shipping company has a strong and generative safety culture, seafarers and managers will continuously follow the standard operating procedures, prioritize safety in all of their operations and also look for means to further improve the safety.

Currently, the maritime industry is starting to implement proactive approaches and has tried to identify problems by utilizing safety culture assessment tools. Even though, the ISM Code encourages shipping companies to implement safety culture in their organizations, there is not a well-established guideline or document to perform a comprehensive assessment and define the improvement areas accordingly.

Therefore, within this research the maritime safety culture assessment and improvement framework is developed to identify the strengths and weaknesses of the companies by utilizing an integrated assessment framework and propose the appropriate action plans according to the assessments to improve the maturity of the safety culture within an organisation.

1.3 Structure of this Thesis

The structure of this thesis is summarised below:

- Chapter 1 outlines the background information about the safety culture concept and outputs of the thesis.

- Chapter 2 details the motivation behind the study, the aims and the objectives of the research conducted.

- Chapter 3 presents the literature review on safety culture from a critical point of view, identify the existing safety culture maturity levels and also identify strengths and weaknesses of current assessment and improvement methods in use to enhance safety in the maritime and other sectors.

- Chapter 4 presents the safety culture assessment and implementation methodology of the thesis. In addition to this, interactions between sub-methods are demonstrated.

- Chapter 5 presents the details of the each sub-method as well as their development phases.

- Chapter 6 presents the results of three safety climate assessment case studies held in three different shipping companies. Each company's safety performance results were compared to the benchmark. The strengths and weaknesses of the each company were analysed under 10 safety culture dimensions while the semi-structure interview results were also provided as complementary to the questionnaire assessments.

- Chapter 7 details the Key Performance Indicators (KPIs) identification and assessment results. Once safety climate assessment is completed, it is important to link the questionnaire results with safety related key performance indicators to eliminate subjectivity aspects of the questionnaires and also identify the relationships between safety culture dimensions and key performance indicators.

- Chapter 8 details the result of an observational study on-board two sister ferries operating on the same passage to investigate how the differences on crew members' attitudes and perceptions affect their working practices and the safety performance of their vessels. The observational study is deployed as a complementary study to identify some detailed information which cannot be captured without being on board vessels of a company.

- Chapter 9 proposes improvement methodologies and appropriate action plans based on the requirements of the shipping companies.

- Chapter 10 details the contribution of the research to the state-of-art knowledge and how the aim and objectives were achieved. Encountered difficulties are discussed and the potential recommendations for the future research are given.

- Chapter 11 summaries the main findings of the thesis.

1.4 Research Outputs

The following publications were generated throughout the timespan of the PhD studies related to this thesis.

Project Reports:

1. **Arslan, V**., Kurt, R. E., & Turan, O. (2014). Review of Occurrence Analysis. EU FP7 SEAHORSE Project Report, Deliverable 2.2.
2. **Arslan, V**., Kurt, R. E., & Turan, O. (2015). Database of Identified Shortcuts on Board Ships. EU FP7 SEAHORSE Project Report, Deliverable 4.1.
3. **Arslan, V**., Kurt, R. E., Khalid, H., Comrie, E., & Turan, O. (2015). Risk & Benefit Analysis of Taking Shortcuts. EU FP7 SEAHORSE Project Report, Deliverable 4.2.
4. **Arslan, V**., Comrie, E., Kurt, R. E., & Turan, O. (2015). SEAHORSE Procedure Improvement Methodology. EU FP7 SEAHORSE Project Report, Deliverable 4.3.
5. Comrie, E., Yaldiz, Y., **Arslan, V**., Kurt, R. E., & Turan, O. (2015). User Guide for Implementing the SEAHORSE Procedure Improvement Methodology. EU FP7 SEAHORSE Project Report, Deliverable 4.5.
6. **Arslan, V**., Comrie, E., Kurt, R. E., Oikonomou, F., Varelas, T., De Wolff, L., Wood, B., & Turan, O. (2016). Validation report: SEAHORSE Procedure Improvement Methodology. EU FP7 SEAHORSE Project Report, Deliverable 6.3.
7. **Arslan, V**., Kurt, R. E., Castellano A., Papadakis, G., Demosthenous, S., De Wolff, L., Kececi, T., Arslan, O., & Turan, O. (2016). Guidelines and Best practice. EU FP7 SEAHORSE Project Report, Deliverable 7.1.
8. **Arslan, V**., Kurt, R. E., Castellano A., Papadakis, G., Demosthenous, S., De Wolff, L., Kececi, T., Arslan, O., & Turan, O. (2016). Training modules. EU FP7 SEAHORSE Project Report, Deliverable 7.2.

Conference papers:

1. Kurt, R. E., **Arslan, V**., Turan, O., De Wolff, L., Wood, B., Arslan, O., ... & Papadakis, G. (2015). SEAHORSE project: Dealing with maritime workarounds

and developing smarter procedures. Safety and Reliability of Complex Engineered Systems - Proceedings of the 25th European Safety and Reliability Conference, ESREL 2015, 8, 3811-3818.

2. **Arslan, V**., Kurt, R. E., Turan, O., & De Wolff, L. (2016). Safety culture assessment and implementation framework to enhance maritime safety. Transportation Research Procedia, 14, 3895-3904.
3. Turan, O., Kurt, R. E., **Arslan, V**., Silvagni, S., Ducci, M., Liston, P., ... & Papadakis, G. (2016). Can we learn from aviation: safety enhancements in transport by achieving human orientated resilient shipping environment. Transportation Research Procedia, 14, 1669-1678.
4. **Arslan, V**., Kurt, R. E., Comrie, E. L., Turan, O., & De Wolff, L. (2016). Identification and Implementation of Key Performance Indicators (KPIs) for Achieving Safer and Resilient Passengers Shipping Operations. In: Proceedings of the 25th European Safety and Reliability Conference, 25 – 29 September 2016. Glasgow, UK.
5. Kurt, R. E., **Arslan, V**., Khalid, H., Comrie, E., Boulougouris E., & Turan, O. (2016). SEAHORSE Procedure Improvement Methodology. In: Proceedings of the International SEAHORSE Conference on Maritime Safety and Human Factors, 21 – 23 September 2016. Glasgow, UK.
6. **Arslan, V**., Kurt, R. E., Boulougouris E., & Turan, O. (2016). Gaining Insight into Safety Culture Maturity Levels in Shipping Organizations. In: Proceedings of the International SEAHORSE Conference on Maritime Safety and Human Factors, 21 – 23 September 2016. Glasgow, UK.
7. Kurt, R. E., **Arslan, V**., H. Khalid, E. Comrie, E., & Turan, O. (2016). SEAHORSE Procedure Improvement System. In: Proceedings of the 6th Conference on Design for Safety, 28 – 30 November 2016. Hamburg, Germany.

1.5 Chapter Summary

The chapter overview, general perspectives, structure of the thesis and research outputs have all been presented in this chapter. The next chapter will define the research aim, objectives and also the motivation behind this study.

2 Research Aims and Objectives

2.1 Chapter Overview

This chapter presents the motivations behind this thesis, and details the aims and objectives of the research.

2.2 Motivations behind this Work

The literature review on maritime safety culture and human factors identified that the majority of the accidents are attributed to the human and organizational factors (Rothblum, 2000). The efforts of the regulatory bodies failed to provide the envisaged level of safety culture in the shipping industry. There is also a lack of proper implementation of safety culture and the principles of safety are not understood properly within the industry. Therefore, there is a requirement of a comprehensive methodology to improve current safety culture maturity levels in shipping organizations. Such a comprehensive safety culture assessment and improvement framework does not exist in the maritime domain.

2.3 Aims and Objectives

The main aim of this PhD thesis is to develop a safety culture assessment and improvement framework to enhance safety culture maturity levels in shipping organisations. The specific objectives of the research are given below:

- To review the literature on safety culture and identify the pros and cons of different types of safety culture assessment methodologies in other industries and analyse the appropriate methods and systems which are compatible with maritime industry.
- To develop a comprehensive safety culture assessment and improvement methodology to identify the current levels of safety in shipping companies,

address the weaknesses and develop improvement strategies to enhance the safety culture maturity levels.

- To develop questionnaires and semi-structured interviews for crew members and shore personnel to capture their attitudes and perceptions towards safety and develop a benchmark by distributing these questionnaires to different shipping companies.
- To develop Key Performance Indicator assessment methodology to identify the KPIs which have positive impact on the safety performance and correlate these KPIs with the safety climate results in order to establish the relationship between safety perceptions and safety KPIs.
- To perform overt observations on board vessels as a complementary study to the overall framework for identifying the crucial parameters that affect seafarers' adherence to safety management rules and identify the affects the workload distribution on safety performance.
- To develop improvement methodologies and appropriate action plans to address the existing vulnerabilities in shipping companies and to enhance safety.
- To implement the overall safety culture assessment and improvement framework in maritime context and propose action plans based on the strengths and weaknesses identified.

2.4 Chapter Summary

The aims, objectives and the motivations behind this study are presented in this chapter.

3 Critical Review

3.1 Chapter Overview

A critical review is performed and presented along with the brief theoretical information required in this study.

3.2 Introduction

Shipping is one of the most dangerous type of transportation worldwide and 90% of the world's cargo is carried by ships (UNCTAD, 2012, IMO, 2012). Shipping is also known to be highly complicated due to the involvement of numerous maritime stakeholders. This condition is illustrated by Graddol (1997) after the Sea Empress accident as:

> "Built in Spain; owned by a Norwegian; registered in Cyprus; managed from Glasgow; chartered by the French; crewed by Russians; flying a Liberian flag; carrying an American cargo; and pouring oil on to the Welsh coast."

The shipping transportation increased 240% in the last 30 years and it is expected to increase in the future (Benoit Langard, 2013). Growing shipping transport constitutes new challenges for the maritime industry and triggers the entire maritime community to take preventive measures for a safer maritime industry.

Technological developments and global competition also changed the shipping industry substantially (Knudsen, 2009). The vessel-system integration got more complex, safe manning levels decreased on board and workload of the seafarers peaked accordingly. Crew members became also more multi-national and thus the differences between languages and cultures appeared as challenges within the industry. Existence of these challenges increases risks of the shipping operations and adversely affects safety.

Several catastrophic shipping accidents raised a significant awareness in the maritime industry and the majority of these accidents are attributed to human and organizational factors according to recent studies (Rothblum, 2000, Arslan, 2013, Chauvin et al., 2013). Accident rates amongst crew members are found to be 11 to 26 times higher than those working ashore (Roberts, 2002).

The maritime industry attempted to avoid these accidents with reactive (lagging) measures such as root cause analysis, accident/incident investigation alongside with technical measures in the past era (See Table 3-1). However, the reactive approaches did not provide the desired level of safety. Recently companies from various sectors are focusing on proactive approaches to develop intervention strategies before an accident happens (Tomlinson et al., 2011). Safety culture assessment and improvement methods are therefore proposed to gain insight into the safety related problems and take the appropriate measures beforehand to enhance safety.

Table 3-1 Development of the accident attribution (taken from Håvold (2007))

Stage	Accidents are attributed to	Remedial Action
5	Cultural Faults since the 1980s	Safety Culture Improvement
4	Managerial Faults since the 1970s	ISM Code
3	Human error since the 1910s	Disciplinary measures
2	Technical error since the 1800s	Certification, design amendments
1	Fate since mankind evolved	Nothing can be done about it

3.3 Safety Culture

The "safety culture" term was introduced by the International Atomic Agency following the Chernobyl accident (IAEA, 1986) and Health and Safety Commission (1993) stated the most comprehensive and prevalent definition of safety culture as:

> "the product of individual and group values, attitudes and beliefs, competencies and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organisation's health and safety management."

Even though there is not a consensus about the definition of safety culture amongst some researchers (Antonsen, 2012), numerous definition of safety culture exist in the literature (Cooper, 2000, Glendon and Stanton, 2000, Guldenmund, 2010a, Håvold, 2007, Oltedal, 2011, Smircich, 1983, Sorensen, 2002, Wiegmann et al., 2002).

Different definitions of safety exist in the literature due to the fact that the concept of safety includes several disciplines and theories such as human factors, economics, science, organizational theory, sociology, decision making, law, man-machine interactions, decision theory and engineering (Rasmussen, 1997).

Even though, safety culture and safety climate sometimes are used interchangeably, they have different meanings in the state-of-the-art safety research. The term "climate" is replaced by the term "culture" in safety researches after 1970s (Guldenmund, 2010a). These terms have distinct meanings in safety research where safety culture is seen as a part of overall culture in organizations and it reflects shared belief and values amongst the members of organizations, however safety climate is seen as a snapshot of the employees' attitudes and risk perceptions towards safety (Guldenmund, 2010a). Zohar (2010) who performed the first safety climate study in 80s also describes safety climate as the shared perceptions concerning practices, procedures and behaviours that work for a common strategic focus.

Alternatively and simply, safety culture can be also defined as "how an organization behaves when no one is watching" or "the way we do things around here" (Pronovost and Sexton, 2005). In the safety research, qualitative techniques are predominately utilized for safety culture assessment, quantitative techniques are utilized for the safety climate assessments (Glick, 1985).

Organizational psychologists describe the culture as a changing functional state of a company which can be used to improve safety and efficiency (Wiegmann et al., 2002). It is also considered as there is a conceptual bridge between safety culture, safety behavior and safety management systems. Oltedal (2011) defines the organizational culture as an integrated concept which is driven by organizational management and prevalent risk perception.

Reason (1997) describes safety culture as a highly informed culture where people can report anything without fear of punishment and companies can utilize this information to improve safety. Organizations with an appropriate safety culture should have means for assessing their safety performance and should work together to enhance safety by learning from each other (Ostrom et al., 1993).

Schein (1985) states that values and norms form a culture within an organization and the new members adjust themselves according to the existing culture. He also describes the safety culture as “social glue” amongst employees. A strong safety culture can also be passed on to juniors from senior members by socialization (Håvold, 2007). Nevertheless, a strong safety culture can have both positive and negative aspects. Junior officers can also copy their seniors’ bad practices while performing their duties in order to get accepted by the community (Weick, 1998).

Safety culture is found at each level in an organization and existence of different subcultures of within the organization can be seen as a threat to safety (Brown, 1995). These subcultures appear due to the differences amongst groups such as ages, nationalities, profession. Therefore, the companies should invest on safety culture trainings to bring each group to the same safety culture maturity level.

Learning is also of crucial importance to enhance safety culture within an organization. Pidgeon and O'Leary (2000) define the learning as one of the key component of safety culture and identify the main difficulties that eliminate organizational learning as communication, blame and political pressure which caused the well-known disasters in the history such as the Challenger shuttle disaster and Bhopal chemical disaster. Prior to the launch of the Challenger, a discussion was held between the NASA and the manufacturer regarding the functionality of the O-rings in low temperatures and the additional risks caused by this. However, the consortium proceeded with the launch due to the political pressure by the decision makers and the consortium ignored the increased risk (Vaughan, 1997). It is therefore important for organizations to have an appropriate safety culture in order to withstand the external pressure.

An appropriate safety culture can be achieved through the utilization of procedures and written instructions however it highly depends on the common mindset of the organization. Ship and shore staff should ensure, encourage and inspire the envisaged attitudes and competency levels to achieve the same safety objectives (Berg, 2013).

Some studies tried to gain insight into the main levels of safety culture, Guldenmund (2010a) proposes three main safety culture levels that an organization can have, namely:

- Surface level: safety slogans and meetings are introduced.
- Intermediate level: Safety management system is prepared to meet the requirements of regulations.
- Deepest level: Safety is perceived as the core value.

Taylor et al. (2011) developed the renowned safety culture maturity ladder and described its important levels as shown below:

- **Pathological:** Employees only react to the safety matters not to get caught by the regulatory compliance.
- **Reactive:** Employees do not follow the basic safety instructions. The importance of safety is understood only after a serious accident.
- **Calculative:** There is an effort within the company to collect the safety associated data and arrange regular audits. Employees have more understanding about "how the system works", but the data are not analysed to enhance safety.
- **Proactive:** This stage focus more on "what might go wrong in the future" instead of analysing occurrence data. The interaction between employers and employees increases.
- **Generative:** This is the most advanced stage a company can have. The company uses human errors to improve safety rather than apportion blame. There provides excellent feedback and reporting systems between all workers within the company. The company is therefore always prepared for the unexpected.

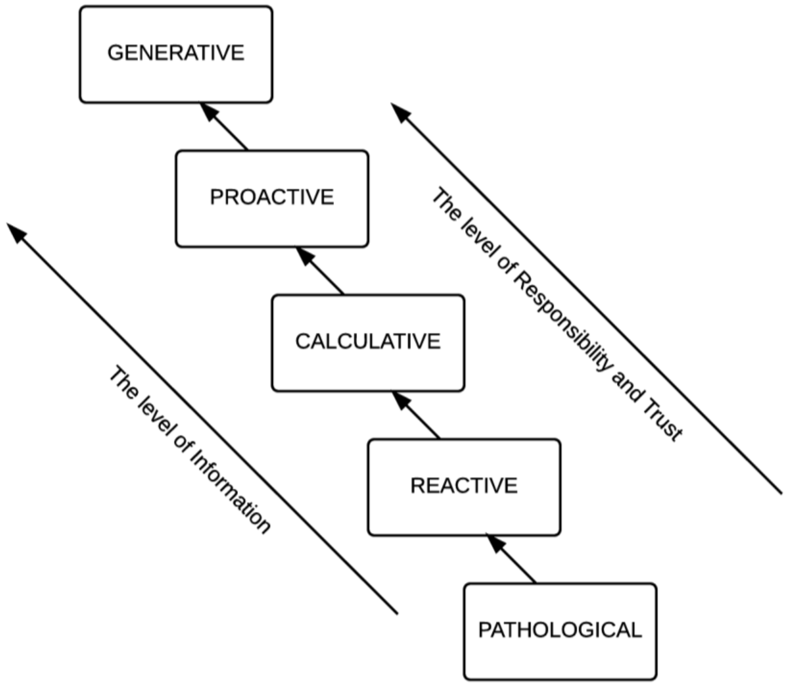

Figure 3-1 Safety Culture Ladder

It is of paramount importance to have a generative safety culture in safety critical organizations. When the organizations climb the safety culture ladder, the level of information, trust and responsibility increase accordingly.

Employees' attitudes towards risk, also define the level of an organization on the safety culture maturity ladder. Another sign of the generative safety culture is the possession of a will to improve safety not because of a mandatory rule or regulation, but due the continuous improvement policy of an organization. Dyer (1986) proposed that top-down approach can change existing safety culture if the senior managers gain credibility of the employees within the organization and then the cultural change may form easy and straightforward.

However, safety culture is also criticised by some researchers and described as a "buzzword" or a chaotic word to hide the confusion (Rosness, 2003, Zhang et al., 2002).

Measuring the fuzzy concepts such as safety is not an easy task and some researchers still believe that the safety concept is not fully understood (Groeneweg et al., 2013). Increasing the level of safety requires continuous consideration since risk is inherent in shipping operations. This is due to some studies identifying that even organizations without an accident can still have a large likelihood of a catastrophic accident (Hovden, 2001). Therefore, shipping companies should encourage the near miss reporting to gain further insight into the existing problems which could lead to a catastrophic event according to the ISM code Section 9.1 (IMO, 2008). A near-miss can be defined as an unexpected event that could have resulted in loss or injury (Popov, 2016).

The effective reporting culture can be achieved by handling blame and punishment appropriately. It is a well-known fact that a blame culture exists in the shipping industry (Veiga, 2002) and different means are provided to tackle this existing problem. The blame culture seeks for an individual/person to be punished for an undesired situation or an accident. The blame culture leads to an unwillingness to take risks or accept responsibility for an erroneous act (Gorini et al., 2012).

In order to eliminate the negative effects of the blame culture, firstly, the no-blame culture was introduced to boost reporting activities, however the approach was criticised since it doesn’t provide punishments for even deliberate actions (Skybrary, 2017). Ek (2003) stated that the “Just Culture” approach is a more balanced approach to enhance reporting since it was understood that the implementation of the no blame culture is not realistic. In Just Culture approach, companies are responsible for defining a distinction between an acceptable and unacceptable behaviour which is known to be a challenging task for the ship managers (IMO, 2008). The “Just Culture” approach is a significant part of an effective safety culture and therefore maritime industry has moved onto the just culture approach. The Just Culture approach therefore tolerates the honest mistakes that can occur during shipping operations but takes into consideration that deliberate violations can result in severe consequences. Since the risk is inherent in shipping operations; learning from mistakes, deficiencies and vulnerabilities are crucial for continuous safety culture improvement. All the aforementioned efforts can build up a generative and informative safety culture within an organization.

Several industries have understood the huge importance of safety culture approaches to avoid accidents. This has resulted in a tremendous amount of investments on safety being made in order to firstly determine current safety culture maturity levels and secondly to learn how they can improve their current maturity levels. The health, aviation and the nuclear sectors led the safety culture research and influenced the many others to utilize proactive measures for preventing accidents. The significant developments and milestones of the safety culture research are given in the sections below.

3.3.1 Safety Culture in the Health Industry

Numerous measurement techniques and tools were introduced in safety culture research to identify which areas are in need of improvement to remedy any existing problems which were found within the health organizations. The first study in this safety culture area is conducted by Zohar (1980). His research proposed the first safety climate dimensions to capture employees' perceptions in 20 industrial organizations in Israel. After the 1980s, the healthcare sector led the developments in safety culture areas since patient safety has been and still is of paramount importance worldwide.

"To err is human: building a safer health system" report which is published by The American Institute of Medicine is considered as a turning point for safety culture amongst health organizations (Bahadori et al., 2016). Since then, healthcare organizations embed continuous improvement to their organizations and safety culture enhancement became one of the pillars of the patient safety (Nieva and Sorra, 2003).The change was accelerated with the implementation of electronic health records, team training and distribution of the safe practices (Leape and Berwick, 2005)

The use of questionnaires is always seen as the easiest and most straight forward means to assess safety culture. A 42 item survey, 'Hospital Survey on Patient Safety Culture' has a broad range of utilization amongst researchers in the healthcare sector (Sorra and Nieva, 2004). The Management Attitudes Questionnaire for the intensive care units is developed based on the flight management attitude questionnaire (FMAQ) which is also prevalently used to identify cross sectional attitude differences between several occupations (Sexton et al., 2000, Thomas et al., 2003).

Sexton et al. (2015) surveyed 203 clinical areas to generate a benchmark amongst health care clinics and they collected 10843 response under 6 safety climate dimensions.

James Reason's Swish Cheese Model was heavily used for accident prevention and error management method in many sectors at the early stage of the safety research. Reason and Wreathall (2000) developed a checklist for assessing institutional resilience (CAIR) to assess safety culture. Even though this tool was used numerous times in different studies, latest safety climate studies utilized an additional number of items in order to collect more information about an organization. Reason's method of collecting responses as yes or no for each item is not sufficient for a detailed analysis, hence recent studies propose that at least 5 level of Likert scale should be used for improved assessment methodologies (Allen and Seaman, 2007).

3.3.2 Safety Culture in the Aviation Industry

Safety Culture is perceived as paramount in aviation. There is an increasing interest about safety culture assessment methods amongst the flight deck crew, air traffic controllers and aviation maintenance teams. Numerous studies have been conducted to measure the existing safety culture levels via different measurement tools. The one of the earliest initiative, the Cockpit Management Attitudes Questionnaires (CMAQ) was, utilised to investigate safety related attitudes of the commercial aeroplane pilots (Helmreich, 1984). The CMAQ was improved and evolved into the renowned Flight Management Attitude Questionnaire (FMAQ). The FMAQ is one of the most used questionnaires in aviation which was created by (Helmreich et al., 1993) to capture attitudes of the people after identifying crew performance related issues as main underlying reasons of the airline accidents. The FMAQ was further updated and converted into the FMAQ 2.0 (international version) and FMAQ 2.1 (USA/Anglo) versions to take cross sectional differences into consideration on flight operations (Merritt, 1996). These questionnaires serve as a base for the safety culture assessment studies in the aviation industry and they were used by several researchers.

Mearns et al. (2013) utilized surveys and feedback workshops to measure safety culture amongst air traffic management services within the Europe. Exploratory and confirmatory factor analysis was utilized to examine in order to establish a consistent model for the Europe.

Another mean for measuring safety in aviation, called the Line Operations Safety Audit (LOSA) was proposed to observe pilots' safety related behaviours to enhance airline safety. The LOSA was introduced in 1994 by a request of Delta airlines to check whether the training provided is transferred into the flight operations or not (Klinect et al., 2003). Each observation aims to collect data on communication, leadership, workload management and cross check performance (Helmreich et al., 1994).

To conclude, the aviation industry invested heavily on positive safety culture approaches due to the inherent safety risk of flight operations. Aviation industry prioritized the proactive safety awareness as the most important trait of safety culture for achieving highest standards of safety (Adjekum et al., 2015). The International Civil Aviation Organization (ICAO) also places importance on safety awareness training for front-line personnel to enhance operational safety.

3.3.3 Safety Culture in the Nuclear Industry

In the nuclear industry, the International Atomic Energy Agency (IAEA) provides the "Safety Standards" for the industry and also publishes guidelines to retain the appropriate level of safety culture in nuclear installations (IAEA, 2017). The IAEA developed the safety culture perceptions questionnaire which includes 132 statements in order to conduct assessments within the nuclear industry and safety culture workshops are also proposed to increase awareness of the senior experts continuously by introducing the safety culture assessment tools (Berg, 2013).

In addition to the nuclear industry regulatory bodies, safety culture was promoted by the local governments. Finland was the first country who made the "good safety culture" compulsory in nuclear installations by a national law (Oedewald et al., 2015). Safety Culture is defined by this law as "*full commitment by the management and personnel to compliance with the management system and continuous improvement of performance throughout the life cycle of the nuclear facility."*

Questionnaires are used as most common safety culture assessment methods in the nuclear industry. Reiman and Oedewald (2009) investigated the nuclear safety culture levels in Swedish and Finnish nuclear installations by conducting interviews under 6 safety culture dimensions. These 6 dimensions are; sense of responsibility, motivation, sense of control, mindfulness, understanding hazards and understanding nuclear safety were found to be significantly influential on nuclear safety culture.

Moreover, safety culture training courses were developed and utilized in numerous studies to enhance the safety culture awareness of the nuclear platform employees and employers, however, Harvey et al. (2001) found the safety culture trainings more effective on managers than employees. Thus these types of trainings should be altered for employees to increase the safety culture maturity levels amongst them.

The recent Fukushima Daiichi nuclear plant accident which happened in 2011 showed that even extremely safe industries such as nuclear industry can have catastrophic accidents and safety culture requires continuous consideration and commitment (Berg, 2013).

The nuclear industry achieved their high safety culture maturity levels and acquired the high reliability industry norms by developing the perception that accident and injury prevention is the mission of everybody in an organization (Lee and Harrison, 2000). This led the industry to develop a common set of expectations which is formed by safe behaviours and norms.

3.4 Maritime Safety Culture

The maritime industry has witnessed catastrophic accidents throughout the years such as Herald of Free Enterprise, Costa Concordia, Exxon Valdez and MV Prestige (Kurt et al., 2015) (See Figure 3-2). Regulatory bodies developed the International Safety Management (ISM) code in order to avoid reoccurrence of these accidents. Unfortunately, the maritime industry traditionally adopted a reactive approach to eliminate these errors therefore none of these measures provide the desired level of safety. Recently, the maritime industry has started to adopt proactive approaches by developing an appropriate safety culture.

“These images have been removed by the author of this thesis for copyright reasons.”

Figure 3-2 the Herald of Free Enterprise (a) and the Costa Concordia (b) Accidents

Some international bodies and associations have determined key specifications of safety culture and developed guidelines to improve it. The IMO (2017b) defined three key features of an effective safety culture as below:

- A company can prevent all types of accidents and incidents which are an accumulation of unsafe acts or deviations from Standard Operating Procedures.
- Safety requires constant consideration by employees including all shipboard and shore personnel.
- Companies should target a zero accident policy and continual improvement.

The International Chamber of Shipping ICS (2013) also listed three key parameters of developing an appropriate safety culture as:

1. Management Commitment
2. Analysis of the existing performance and behaviour
3. Behaviour improvement

In addition to the regulatory bodies, numerous maritime stakeholders published guidelines to improve safety culture within the maritime industry such as

- HSE (2005b)
- EU-OSHA (2011)
- OGP (2010)
- ABS (2011)
- API (2015)

3.4.1 The Effects of the Maritime Regulations on Safety Culture

Shipping is commonly regarded as one of the most dangerous industries in the world and according to the International Maritime Organization (IMO), there is the necessity for a set of international regulations to be followed by shipping organisations, globally, to improve safety (IMO, 2012). It is of crucial importance to gain insight into international rules and regulations in order to develop a realistic approach towards increasing maturity of the maritime safety culture. Importantly, the IMO has taken steps to prevent ship operators cutting expenditure at the cost of shipping safety (IMO, 2012). Therefore, the IMO developed the International Safety Management (ISM) Code to ensure safety at sea, prevent loss of life and avoid possible injuries of seafarers (Maritime and Costguard Agency, 2015) and this code became mandatory in 2002 for all ships above 500 gross tons (IMO, 2014). There were several driving forces led the ISM Code to be implemented. The notorious accidents which are given below, made contribution for the development of the ISM Code (Oltedal, 2011):

- Herald of Free Enterprise, 1987
- Donna Paz, 1987
- Exxon Valdez, 1989
- Scandinavian Star, 1990
- Agip Abruzzo, 1991
- Have, 1991
- Salem Express, 1991
- Aegean Sea, 1991
- Braer, 1993
- Estonia, 1994

The ISM Code is the first regulation which focuses the management styles of the shipping companies. Shipping companies develop their own Safety Management Systems (SMS) to meet the standards of the ISM Code (Lappalainen, 2008). The hierarchical representation of the relationships between the rules is given below:

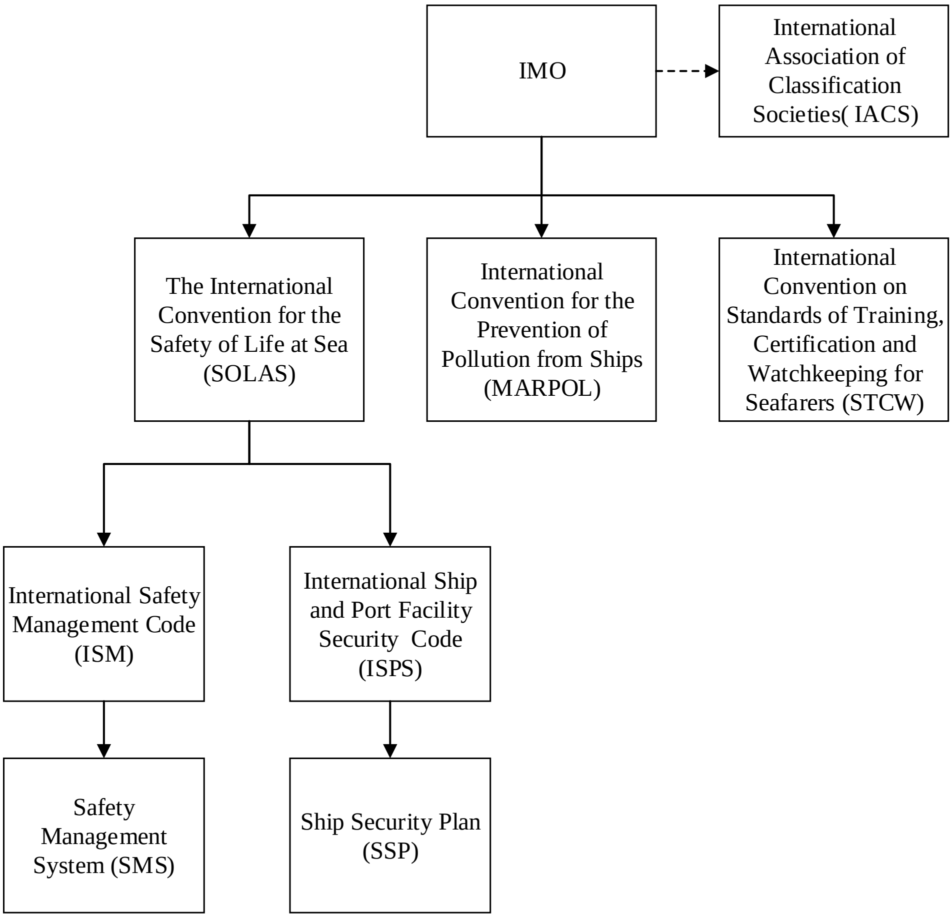

Figure 3-3 Hierarchical Representation of Governing Rules and Regulations

The ISM Code provides guidance for achieving and retaining an appropriate level of safety for the shipping organizations. The implementation of the SMS should also support and encourage the development of an appropriate safety culture in the shipping industry. Commitment, values are and beliefs are the most significant success factors of the safety culture development. (European Maritime Safety Agency, 2014).

There are numerous safety aspects in the ISM Code which shipping companies are required to adhere to. Shipping companies should designate a person ashore (DPA) in order to establish a link between crew members and the company managers. The DPA is responsible that adequate resources are allocated on board to maintain safety (IMO, 1995). In the ISM Code, it is also dictated that masters should act as a representative of the company management and take actions to enhance the level of safety (IMO, 2005).

IMO (2014) stated that “the application of the ISM Code should support and encourage the development of a safety culture in shipping. Success factors for the development of a safety culture are, inter alia, commitment, values and beliefs”.

The objectives of the ISM Code are summarized by Håvold (2010b) as:

- to maintain safer practices in shipping operation and develop a safer working environment
- to establish safeguards against all identified risks
- to enhance competency and safety management skills of employees both on shore and on board continuously
- to develop an appropriate emergency preparedness for the protection of safety and environment
- to develop and enhance a safety culture in shipping

Even though, the ISM Code urges shipping companies to develop and implement an effective safety culture within their organizations, the code does not provide a structured guidance on how to achieve safety culture improvement in the shipping companies. Therefore, organizations look for means to improve their safety culture maturity levels and the safety culture studies are highly fragmented and substandard in the shipping industry. Majority of the safety culture studies exist as a paper exercise in shipping companies.

Mearns et al. (2013) recognise that a SMS without a suitable level of organisational culture will certainly not be enough. Within the air traffic management remit, Mearns et al. (2013) identify that “good communication between management and staff not only enhances safety, but can also improve morale and productivity. Additionally, an SMS should include procedures and support systems to promote and communicate safety culture and safety practice in the organisation”. Bhattacharya (2012) however finds that there is a significant gap between the managers’ and seafarers’ perceived meaning of the ISM code thus leading to a gap between the intended purpose of the code and the way in which it is operationalised in daily seafaring. Seafarers believe that the ISM Code is commonly used for protecting company’s name from sanctions, it does not contribute to the operational safety (Athanasios, 2014). This gap causes clear concern as the operational reality fails to meet the intended purpose of the code, again leading to the need for more improved understanding of practices on-board vessels. Related to this it is noted that, while ISM attempted to improve the safety it also caused a substantial increase in paper-based activities (paper work on-board ship), which has been met by seafarers with scepticism and doubt, claiming that those developing these regulations do not understand seafaring (Knudsen, 2009). This is an example of opposition toward regulations where they are rejected based on the assumption that those designing them are not designing them appropriately.

Mearns et al. (2013) state: "It can be seen that both safety culture and safety management go hand in hand to achieve safe practices in an organisation. If there is only an SMS but no real commitment to safety, then the SMS will not be effective, as decisions will not really prioritise safety, and the SMS will be merely a 'paper exercise'. Similarly, if there is a good safety culture but no SMS, then in a complex organisation the way safety is applied runs the risk of being inconsistent, under or mis-resourced, and not seen as business driven (because it will not be part of the business plan)". Therefore, it is of paramount importance to implement safety culture thoroughly and take all the necessary measures to spread a positive safety culture within the organization. Otherwise, the company only spends their resources without achieving the desired impact.

In 2005, the IMO prepared a guidance for shipping companies to assess the effectiveness of the ISM Codes within their organizations (IMO, 2005). They also suggested easing the implementation by reducing paperwork in shipping operations, however paperwork still stays as a hot topic amongst seafarers.

In addition to the efforts of IMO, the other three main regulatory bodies who work for safer seas in the maritime domain are: flag states, port states and classification societies. The connections between regulatory bodies can be seen in the Figure below.

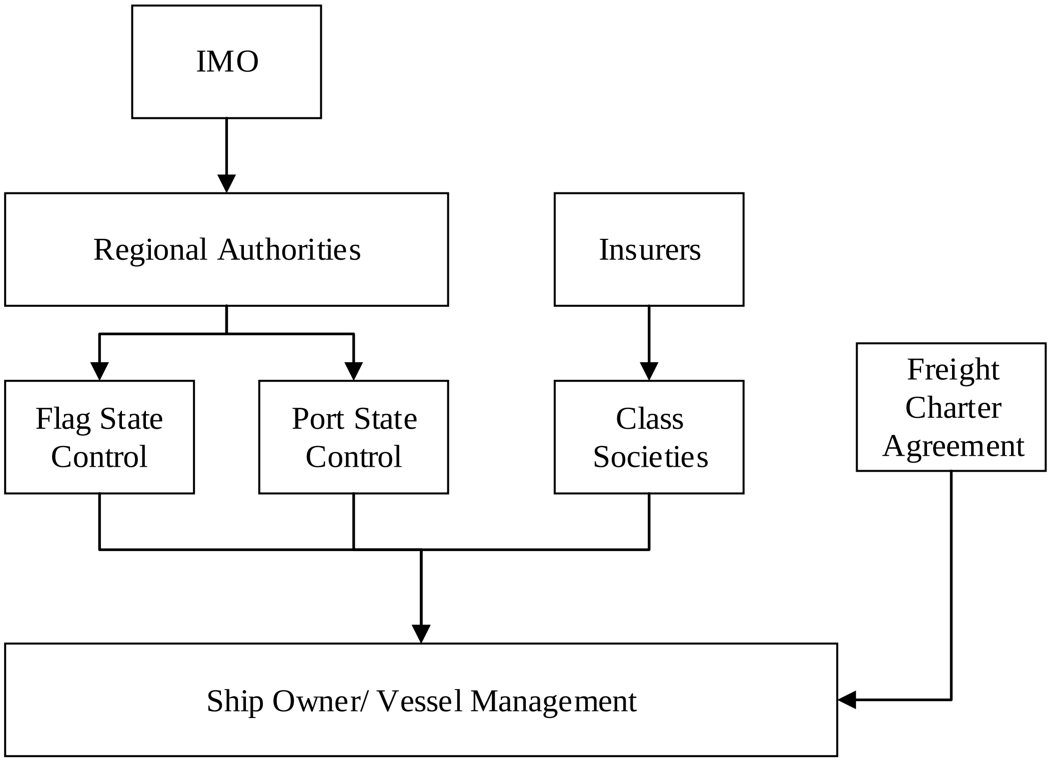

Figure 3-4 Mechanism between maritime stakeholders (Soma, 2004)

The Port State Control inspects the implementation of the regulations in the states regardless the flags that ships are flying with (Stopford, 2009). There are nine regional agreements (Memorandum of Understanding) amongst port state controls to ensure consistency in ship inspections, namely: Paris MoU, Tokyo MoU, Acuerdo de Viña del Mar, Caribbean MoU, Abuja MoU, Black Sea MoU, Mediterranean MoU, Indian Ocean MoU and Riyadh MoU. The United States of America maintain their own inspection regime. (IMO, 2017a) The MoUs keep records of the inspections that held in their territory so shipping companies can compare their inspections, deficiency and detention numbers with the industry benchmark. The Port State Controls mostly inspect the foreign ships with regards to crew manning levels, compliance with the international regulations, competency levels of crew members and condition of ships. If a threat to safety is identified by an Port State Control, the vessel will be detained until the corrective action is taken (Stokke, 2013).

The Classification Societies were established to maintain the quality of the ship design, construction and maintenance in order to enhance maritime safety by utilizing the accumulation of maritime knowledge (IACS, 2011). The Flag state can be simply described as the country who owns the vessel's registration (Oltedal, 2011). Besides their obligations regarding the registration, taxation and ownership of the vessel, the flag states hold responsibility for checking if the ships are properly manned and ensuring the required quality for sailing (Fikri, 2007). The obligations of the flag states differ tremendously, thus some shipping companies looking for the flags which offers the minimum requirements in order to stay in the market (MacDonald, 2006). Achieving and retaining an appropriate level of safety is the common goal for all of these regulatory bodies.

3.4.2 Safety Culture in the Offshore Industry

Together with the effort of the maritime stakeholders, several safety culture improvement efforts were done in the maritime industry. One of the first initiative to improve safety in the offshore area; the Safety Case Regulation, was proposed in 1992 as a response to the Piper Alpha accident for avoiding reoccurrence of catastrophes. (Antonsen, 2012). It is mandatory for every ship owners to prepare a safety case and submit to the HSE for the acceptance (HSE, 2005a). Flin et al. (1996) developed a questionnaire to assess risk perceptions of the offshore crew since quantitative risk assessments are required in safety cases. The study revealed that the safety attitudes constitute great importance in offshore safety culture and employees are aware of the underlying reason of the casualties. These studies provided insight into attitudes and perceptions of the offshore workers. Recently, the maritime industry has also started putting efforts on safety culture assessment and improvement methods within their organizations. Offshore organizations are known with their leading safety records in the maritime domain and there are more safety culture/climate research in the offshore industry compared to shipping. The reason behind this difference could be attributed to the fact that offshore oil industry is young and more profitable, therefore it draws more finance and political interest (Håvold, 2007). The severe consequences of the offshore accidents also led offshore organizations to have a superior safety standards compared to shipping. The society is extremely aware of the environmental consequences of offshore catastrophes such as the Deep Water Horizon accident (Hazen et al., 2010).

The importance of the proactive safety culture studies was understood quickly within the offshore organizations and several researchers performed questionnaires and interviews to prevent loss of life and environmental pollutions in offshore after the catastrophes such as Piper Alpha, Alexander Kielland and Ocean Odyssey (Håvold, 2007).

Questionnaires and interviews were utilized together to gain insight into main problems in offshore supply vessels (Antonsen, 2009). The results indicated that the occupational identity is an important driver for safety as well as people's perception about themselves and their job. Mearns et al. (2003) analysed safety culture surveys results which are derived from 13 oil and gas companies together with the recorded accident numbers in order to benchmark offshore safety. They asserted that regular offshore platform visits influences safety performance positively. Another empirical safety climate assessment study identified that authentic leadership and psychological capital have a direct influence on the perceptions of the offshore employees according the 261 questionnaires collected (Hystad et al., 2014).

"Safety Climate Assessment Toolkit" was developed as a guide for the offshore industry by Cox and Cheyne (2000) and it is one of the most comprehensive guides in the maritime industry that shows how to implement the safety climate assessment together with interviews step by step. Based on the 200 responses collected, supportive environment, communication, and employee involvement were found to be the weakest areas amongst ten safety culture dimensions in the given organization. Even though, the overall methodology has an observation module, it only tries to capture if the certain tasks are completed safely or not such as using chemicals or lifting. In addition to this, the key performance indicators are not used to support questionnaires, the analysis doesn't go beyond the trend analysis.

3.4.3 Safety Culture in the Shipping Industry

Shipping companies are prioritizing every aspect of safety in their daily operations to avoid catastrophic events. Similar safety culture approaches of the other sectors have also been implemented in shipping companies to enhance safety culture maturity levels. Both quantitative (questionnaires) and qualitative (interviews and observations) techniques have been also used in the shipping industry. The safety culture assessment and improvement efforts can be categorized into four main groups in shipping, namely: safety climate assessments (questionnaires and interviews), key performance indicator assessments, observation studies and improvement methods. The studies performed in each area together with the contribution of state of the art shipping are given in the sections below.

3.4.3.1 Safety Climate Research

Shipping organizations firstly tried to gain insight into safety climate of seafarers by utilising questionnaires. The renowned flight management attitude questionnaire was converted to the "ship management attitudes questionnaire" and distributed for capturing attitudes of the seafarers in the maritime domain by Andersen et al. (1999) and Röttger et al. (2013).

Many other questionnaires were also developed and distributed in different shipping operations (Ek and Akselsson, 2005, Havold, 2000, Håvold, 2005, Håvold, 2010b, Langard et al., 2013, Oltedal, 2010, Oltedal and Engen, 2009, Oltedal and Engen, 2010) to capture attitude and perceptions of crew members. Each safety climate assessment questionnaire had a different set of dimensions and numbers of questions based on the research gaps identified.

In the fishing sector, Håvold (2010a) developed a safety culture questionnaire in order to analyse the level of safety amongst fishing vessels by utilizing Principal Component Analysis (PCA). 209 fishermen participated in the survey and the results of the questionnaire demonstrated that the safety attitude of management has a crucial impact on a company's safety policy. Age groups, vessel types and occupation have an influence on the safety attitudes of the fishermen.

In between offshore supply vessels, the relationships between risk perceptions of the crew members and the accident statistics were compared (Bye and Lamvik, 2007). 487 questionnaires were collected and occupational accident data was obtained from Norwegian offshore service industry for this analysis. The results indicate that there is a large discrepancy between how the crew members perceive the risk of their operations and their actions to eliminate the associated risks. Antonsen (2009) investigated the relationship between offshore supply vessel safety and the safety culture. The results revealed that crew members value the importance of "good seamanship" to avoid catastrophes, however, seafarers show reluctance towards being told how a job should be performed. Therefore, procedures and checklists should have the utmost quality to maintain the trust of seafarers.

In the passenger shipping industry, Ek and Akselsson (2005) developed safety culture questionnaires comprised of 97 items and distributed to six Swedish passenger shipping companies to assess the safety culture levels. Authors performed their analysis based on 9 developed safety dimensions, namely: working situation, communication, learning, reporting, justness, flexibility, attitude towards safety, safety related behaviours and risk perception. The highest scores were achieved on "attitude towards safety" and "safety related behaviour" dimensions. Lu and Yang (2011) studied the relationship between safety climate and safety behaviour amongst passenger shipping companies. Self-reporting was found to be highly correlated with the safety training and emergency preparedness of the passenger ship crew members. Authors also identified that the respondents who work in larger passenger companies and also older respondents are more likely to adhere with safety rules and regulations.

In tanker shipping, 1158 questionnaires were collected from Norwegian-owned tankers and analysed by factor analysis (Håvold, 2010b). The study indicated that safety culture is affected by the ship owner, the vessel's flag, seafarer's ranks, vessel's age and country of origin. However, there was no significant difference between types of tankers. The respondents who sail under Norway International flag, the Marshall Islands and Britain had higher safety attitudes and also officers had higher safety attitudes than crew members. Norwegian and Dutch crew members are found to have fewer fatalities than Indonesian and Filipino seafarers. Studies showed that cultural and organizational factors have a significant impact on safety culture. Oltedal (2010) also distributed safety climate questionnaires to investigate the effectiveness of the SMS within the tanker industry. Reporting activities were found to be directly linked to the amount of feedback provided by companies. Results also highlighted that seafarers refuse to use procedures and checklists when the company do not utilize the feedback of the seafarers to amend the existing SOPs.

The aforementioned studies which predominantly deployed subjective measures such as questionnaires, provided quite good insights into safety levels of the shipping companies. Even though, some of the researchers validate the data with interviews and/or observations in order to enhance quality of the research (Ek and Akselsson, 2005, Langard et al., 2013), the relationship between safety attitudes and safety performance is unexplored. Therefore, the safety climate studies should be supported by key performance indicators to establish the links between safety culture dimensions and safety performance.

Interviews were also conducted to capture attitudes and perceptions of the employees in some studies. Alexander et al. (1994) utilized interviews complementary to safety culture questionnaires in the UK offshore industry at the North Sea under the 6 dimension (commitment of the management, safety needs, blame, supportive environment, risk perception and control) and results indicated that offshore workers have higher level of risk perception and safety needs than the shore staff.

Cox and Cheyne (2000) also utilized interviews and focus discussion groups to support the renowned "Safety Climate Toolkit". Ek and Akselsson (2005) interviewed 31 officers and 21 crew members to gain further insight into seafarer's perceptions, Langard et al. (2013) interviewed officers to explore decision making strategy of the officers. Kaplan and Kite-Powell (2000) interviewed 22 crew members from the fishing industry and the results highlighted that regulations do not serve for the purpose, fishermen's input is not considered as valuable for the rule development.

Even though, interviews allow crew members to reveal the exact issues that affect safety of shipping, it cannot capture the full picture since they are highly subjective and participants' views can be biased due to a structure of an interview (Guldenmund, 2010a, King, 2004).

3.4.3.2 Key Performance Indicators Research

Another initiative in safety culture assessment area, Key Performance Indicators (KPIs) has comprehensive utilization areas in the maritime industry including offshore platforms, maintenance, operations and management in order to enhance maritime safety.

One of the leading classification society, Lloyd's Register, developed a set of KPIs for an oil and gas company in order to provide means to improve operational safety. In total, 73 safety related KPIs had been identified for the company which currently establish the data collection system to utilize those KPIs (Brown, 2009). ABS (2012) developed the most detailed leading indicators model in the maritime industry. They proposed 30 subsidiary KPIs and 29 core KPIs to monitor a shipping company's safety culture level and identify the metrics which of them have a positive impact on safety performance. Banda et al. (2016) also identified 53 KPIs to gain insight into safety management system of a shipping company. The innovative ideas like unmanned ships rely on the quality of the key performance indicators for the monitoring purposes. Rødseth and Mo (2016) developed KPIs to arrange a maintenance plan of a vessel. The utilization of the KPI directly affects the success of the high risk operations such as unmanned vessel operations.

Even though there has been noted success in implementation of KPIs in those companies, the envisaged impact on safety has not yet been achieved since there is a data collection requirement on annual basis. However majority of the shipping companies do not value the importance of data collection for safety performance monitoring and the collected data can be incomplete or reports are faulty. The correct results can only be obtained after years of accurate data collection, monitoring and assessment processes.

Numerous organizations propose a set of KPIs to be used for the shipping companies however only the INTERTANKO provides a benchmark amongst tanker organizations in the maritime industry. (BIMCO, 2017). Even though, the BIMCO provides a good representation of the company's safety performance, the shipping industry still doesn't know investing on which KPIs can enhance the safety performance of the vessels and which safety culture traits/dimensions affect the safety performance positively.

3.4.3.3 Observation Research

Observational techniques were also held on board ships to identify the operational practices that affect safety. The observations were conducted on board the two sister ships, over a total of 45 hours in order to capture main activities of the OOWs to gain insight into collision avoidance manoeuvres (Langard et al., 2013). This study brought field observations and questionnaire collection together however; they failed to link the questionnaire results with key performance indicators. The second weakness of the study is that even though the entire crew were surveyed, observation only took place for the OOW and also wasn't compared with the respondent's attitudes collected.

Another observation on passenger ferries was conducted for a three day period in order to identify whether certain tasks like loading and safety drills are performed safely (Ek and Akselsson, 2005).

However no study has employed an overt observation to capture crew members' adherence to safety management rules, by observing the entire tasks of crew members in a typical day and perform workload analysis to identify whether allocated time is given to seafarers for performing their jobs in a safe manner.

3.4.3.4 Improvement Methodologies

Improvement methodologies are of high importance since all the shipping organizations perform assessments in order to determine the way forward for a better and enhanced safety performance. Hale et al. (2010) assessed the effectiveness of the 298 interventions to improve safety culture in between 17 projects in Netherland. They compared the safety performance after and before the implementation of the interventions. Less than 50% of the interventions were found to be successful and low success rate highlights the difficulty of obtaining successful results from the implementation of the interventions even when these interventions are funded by the government. The successful interventions can be categorized under these headings:

- Energy, creativity & support
- Engagement and empowerment of the workforce in a learning/change process.
- Training and motivating managers.
- Planned & systematic approach.

ABS (2011) has provided recommendations to improve each safety dimension in the maritime domain, however these recommendations stay on a superficial level and do not provide a structured guidance for shipping managers to improve certain aspects of the safety culture within a company. Beside this vulnerability, the most comprehensive and advanced safety culture assessment framework was proposed up to date by American Bureau of Shipping (ABS, 2011) for shipping companies. The framework consists of three methodologies, namely, objective leading indicators method, subjective leading indicators method and a questionnaire. The proposed framework allows a comparison between the collected survey data and the safety performance KPIs. However, the questionnaire is not linked with the interviews and observation to capture their real operating practices that affect safety of the operation.

Some doctoral studies have been performed to look into the different aspects of the safety culture studies and contributed the state of the art safety culture research in shipping:

- Soma (2004) looked into the characteristics that lead a shipping company to have a superior safety standard (blue-chip) or a low safety standard (substandard). It has been found that mature safety culture and attitude of the ship owners are the main drivers that make a shipping company a "blue-chip" organization. The most important variables of "blue-chip" shipping companies are found like below:
    - Number of ILO conventions adopted by vessel flag (BCOL)
    - Estimated availability of propulsion system (BCOL)
    - Main flag of the Strategic Level's fleet (ASL)
    - Uses c/o ownership (and/or adapted the companies country of register) (ASL)

    - Strategic Level uses class. societies outside IACS (ASL)
    - Mean age of Strategic Level's fleet (ASL)
    - The vessel's ship type (Admiralty Coefficient) (BCOL)
    - The vessel's flag.

  The author also asserted that there is negative relationship between economic performance of a company and the risk of having an accident and hence when the economic performance decreases, the accident risk increases.

- Shea (2005) tried to gain insight into the relationship between the organizational culture and climate on board a ship and their links with maritime accidents. Three sets of questionnaires were developed, namely: maritime culture questionnaire, assumptions through metaphor questionnaire and maritime climate questionnaire. The results show that there is a link between organisational culture and marine accidents based on the three set of questionnaires distributed. The collegial behaviour was found crucial to enhance a vessel's safety culture. Moreover, the size of a ship, department category and the flag that ship sails under do not affect likelihood of having accident. The study also demonstrated that the level of regulatory compliance also directly affects the workload of the seafarers.
- Ek (2006) investigated and compared safety culture levels amongst airport ground handling, passenger ships and air traffic controls by means of questionnaires, interviews and observations. The results indicate that air traffic control achieved better scores than other groups and the ground handling was found as the least safe group. The managers' and employees' perceptions were recorded different from each other and the poorer scores of the employees' can be attributed to the misperception of the managers about the on board issues. The results also demonstrated that the learning process is more mature in air traffic control setting compared to other two sectors. Air traffic control was also found better at reporting of nonconformities, at having more structured standard operating procedures and at the implementation of improvements.

- Håvold (2007) developed a practical safety culture assessment tool (safety orientation instrument) for measuring the degree of orientation towards safety in shipping. Two set of questionnaires were developed by reviewing all the available measurement surveys and pooling the entire questions within the safety culture research. His research attempted to capture the safety attitudes, safety culture and safety climate of seafarers working in Norwegian-owned vessels. It has been found that safety behaviour is highly influenced by the safety orientation. The safety orientation is found to be useful if it only becomes an essential part of the safety management. He identified that ships with multicultural crew have higher safety orientation than a crew from a single nation.
- De Rossi (2010) examined the relationships between international crew and safety management systems in the offshore oil industry. The research sought for means to avoid occupational casualties by exploring relationships between human action and cultural diversity. Observations and interviews identified that cultural bias directly affect how safety is perceived and maintained. According to the research, crew members interpret a job as safe when there are no any associated risks, however the company believes that every job has its own risks and they should be reduced as low as reasonably practicable (ALARP). Crew members' understanding of safety performance is also different than the management; they see the concept of the safety performance as not getting hurt. The results highlighted the cross-cultural safety consciousness as a crucial element to retain a safer environment in a shipping organization.
- Guldenmund (2010b) made an extensive literature review on safety culture and safety climate and he examined the different definitions, theories and organisational psychological traditions behind the safety culture. His safety culture perspective shed light on the development of safety culture in the maritime domain. Majority of the questionnaires used in safety culture research was found to be linked to management related issues according to his review of the assessment techniques. He therefore asserted that the safety culture in an organization is formed by the decisions and choices made at the

organizational level. This changed the general perception of what really drives safety culture in shipping. Even though questionnaire use was found as the easiest and efficient way to make safety culture comparison between companies, it does not capture the full picture without the collection of facts and norms. He also strongly suggests to identify common issues within a company by talking to the management prior to launching safety culture studies.

- Oltedal (2011) explored the relationship between safety culture, safety performance, safety management and the application of safety management concept in Norwegian shipping industry. A questionnaire was distributed to 83 tanker and bulk carrier vessels which resulted in 1262 responses. The study identified several deficiencies in SMS such as; reporting and collection of safety performance data, data processing and analysis, safety measure development and implementation. The underreporting of data is found to be the biggest deficiency causing poor data processing. In addition to this, the developed safety measures were always limited to the development of procedures and checklists in shipping. The author identified crewing policy, contract conditions and ship management as the driving forces that affect safety culture on board. As also identified by Guldenmund (2010b), the ship management was found as the key player for developing or changing a safety culture (Oltedal, 2011).
- Lappalainen (2016) studied the relationships between the ISM Code and the prevailing safety culture in the Finnish shipping industry by arranging thematic interviews. 94 interviewees were participated and the results indicate that even though the ISM Code is perceived as essential and beneficial, implementation way of the ISM Code was highly criticised. The incident reporting and the documentation of the safety management systems raised concerns amongst seafarers. According to interviewees, the developers of the ISM code should take unstructured and fragmented traits of safety culture into consideration in the next versions of the code. Another critic of the study is that the ISM code should be amended to cover all types of maritime business environment. In conclusion, the results indicated that the

ISM Code is introduced to enhance safety culture on board, nevertheless, envisaged impact has not been seen yet due to different interpretation of the code between on board and on shore personnel.

All these researchers utilised different set of methods to explore certain aspects of the safety culture, however, all assessment methods failed to incorporate subjective assessment techniques with the company safety performance data with a robust methodology as well as comprehensive improvement methodologies. The improvement methodologies and action plans are of paramount importance to define the way forward for the enhanced maritime safety.

3.5 Identified Safety Culture Gaps in the Shipping Industry

Since the first safety culture assessment study was conducted by Zohar (1980), the safety culture research has made a tremendous amount of progress to avoid catastrophic accidents in all safety critical sectors. Researcher utilized different safety culture assessment techniques to identify the improvement areas and made contribution to the state of the art safety research.

In shipping, the introduction of the ISM encourages the development of the safety management and hence improvement of safety culture. All shipping companies therefore have their safety management manuals with the aim of enhancing safety culture (IMO, 2012). However, safety culture concept was found to be poor in the shipping industry (Lappalainen, 2016). The shipping companies either copy and paste other companies' safety manuals or just generate safety culture documentations from scratch but do not take any action for the implementation.

Even though, the ISM Code mandates the development of safety culture, it does not provide a structured guideline on the assessment and improvement process of safety culture. Therefore, some shipping companies have a safety culture approach without understanding the meaning of it and hence the approach does not go beyond being a paper exercise.

Wrong interpretation of the ISM code also lead shipping companies to develop safety management manuals which only seek for regulatory compliance (bureaucratic confirmation) but not boosting safety culture on board vessels (Bhattacharya, 2012). The safety management system is therefore considered as unpractical, complicated and detailed documentation for maintaining safety on board vessels.

In addition to these, questionnaires, interviews and observations are used to a certain extend to identify safety culture maturity levels in the shipping industry, having said that the links between safety culture attitudes and safety performance are unexplored. The shipping companies do not know the effects of different safety culture attitudes and perceptions on accident ratios and the performance records.

There is a big perception difference between the shore and on board personnel about the on board safety culture levels (Lappalainen, 2016). The rules are sometimes developed by the people who do not perform shipping operations day to day and this causes a discrepancy between “work as imagined” and “work as done” in shipping. The reductions on crew manning levels also caused some safety concerns within the maritime community, and it is well-known that today seafarers perform less navigation but more paperwork & administrative work (Knudsen, 2009). Therefore, it is of crucial importance to hold an observation study as a part of the safety culture assessment in order to discover whether current on board dynamics and workload affects the attitudes and perceptions of seafarers on board.

Reporting, data collection and data processing is known to be extremely inadequate in the shipping industry. Maritime regulatory bodies do not publish their data or researchers are having difficulties in accessing them (Wu and Winchester, 2005) Companies can neither monitor the changes of their safety performances nor compare (benchmarking) their performances with their competitors.

Even though the several shipping companies utilized safety culture assessment techniques, they failed to take the necessary action to improve current safety culture maturity levels. There are no available guidelines, tools and training modules to enhance certain elements of safety culture. The majority of the assessment studies are also not repeated to see the impact or the change within a company.

3.6 Chapter Summary and Conclusions

The literature on safety culture assessment and improvement methods was reviewed and gaps were identified. Even though a tremendous amount of research has been conducted in the safety areas, a comprehensive safety culture assessment and improvement framework does not exist in the maritime domain to the best of this author's knowledge.

4 Methodology

4.1 Chapter Overview

This chapter depicts the methodology of this thesis.

4.2 Maritime Safety Culture Assessment and Improvement Framework

Based on the research problem identified, the maritime safety culture assessment and improvement framework is developed and being implemented in shipping organisations. The ultimate aim of the safety culture assessment and improvement framework is to identify safety related problems of any shipping company, address the vulnerabilities and develop improvement strategies to enhance the maritime safety. The proposed methodology (See Figure 4-1) comprises of three assessment and one improvement sub-methods, namely:

- Safety Climate Assessment
- Identification and Assessment of Key Performance Indicators (KPI)s
- Overt Observations
- Improvement Methodologies and Action Plans

The assessment methodologies shed light on the problems in shipping organizations and appropriate action plans are proposed based on the problems identified. Each assessment methods were utilized and tested in shipping companies. Even though different studies tried to assess the safety culture with some methods, such a comprehensive methodology does not exist in the maritime domain. The proposed framework utilizes all of the available information within a company and seeks for improvement areas via the combinations of the methodologies. The developed assessment and improvement methods are designed to work as complementary to each other. The proposed framework assists shipping companies to eliminate the limitations of different methods by creating a cross check and validation mechanisms

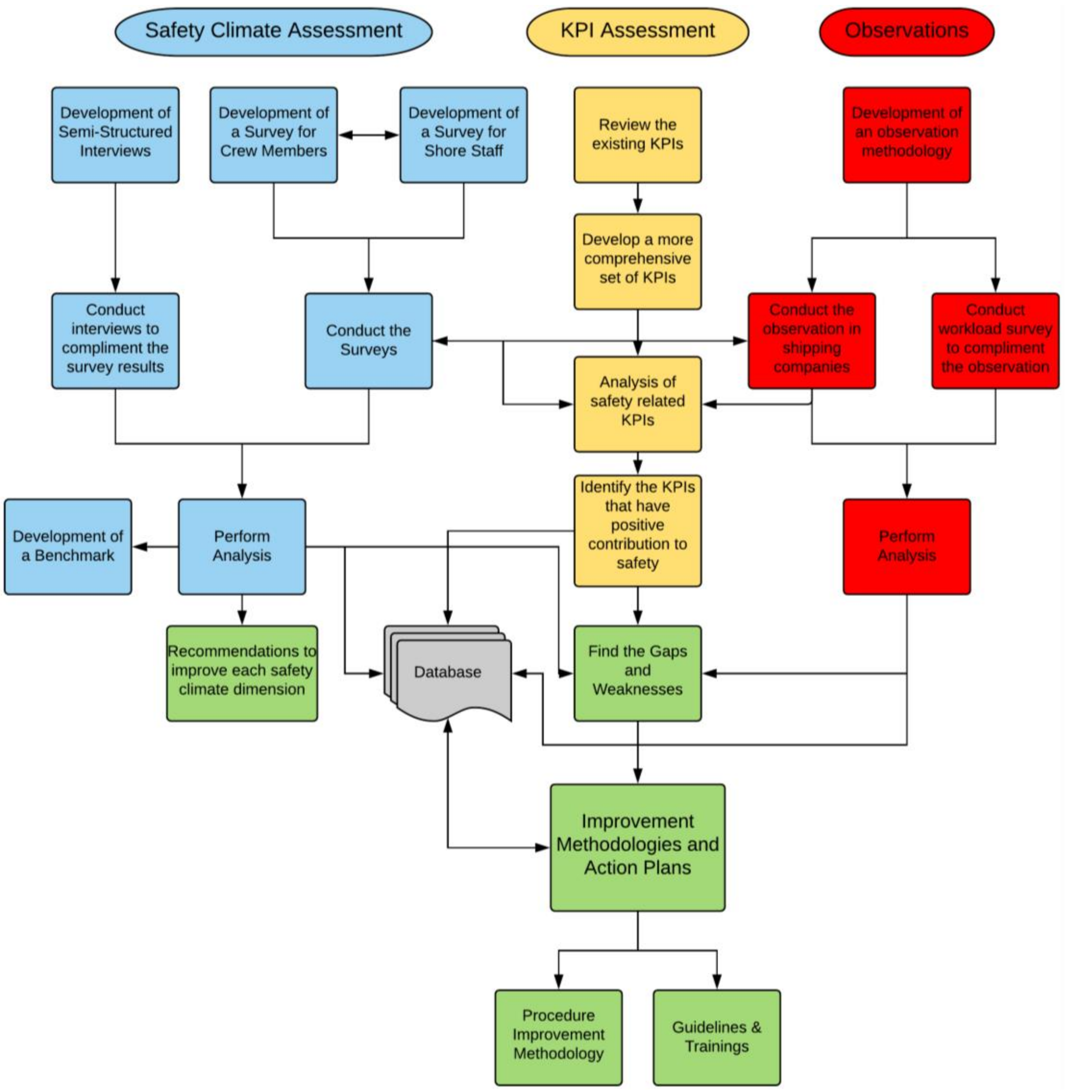

Figure 4-1 the Proposed Safety Culture Assessment and Improvement Methodology (Results of the blue section is given in Chapter 5, Results of the yellow section is given in Chapter 6, Results of the red section is given in Chapter 7 and Results of the green section is given in Chapter 8

to enhance the quality of the study. The overall structure is briefed below.

Firstly, safety culture assessment questionnaires are distributed to the companies and these surveys are supported by semi-structured interviews in order to capture attitude and perceptions of the employees towards safety. A benchmark is generated to see the safety performance of the each shipping company. The gaps are identified and general improvement recommendations are provided for the gaps. Secondly, company key performance indicators are collected and correlated with the survey data for further clarification. KPI data are also used for trend analysis to capture the KPIs which have a positive impact on safety performance of a shipping company.

Gaps and weaknesses are also pooled to the database. Finally, on board observation studies take place to capture the main drivers of the safety performance of a shipping company. When all the assessments are completed and all the gaps are identified through a comprehensive assessment methodology, the problematic procedures (or lack of them) are addressed one by one through the developed procedure improvement tool and the Standard Operation Procedure (SOP) development guideline.

The details of the each sub-assessment and improvement methodologies are given below:

4.2.1 Safety Climate Assessment

The aim of the safety climate assessment is to identify strengths and weaknesses of a company based on several safety culture dimensions and identify the attitude and perception differences of the seafarers and shore staff. It is a well-known fact that attitudes and perceptions of the employees have a direct impact on employees' behaviour towards safety (Coyle et al., 1996). In order to identify attitudes and perceptions of the employees, two different techniques were utilized:

- Safety Culture Questionnaires
- Semi-Structured Interviews

4.2.1.1 The Safety Culture Questionnaires

Two online questionnaires have been developed, one for crew members, one for shore personnel to analyze the attitude of the employees in shipping companies. Different questionnaires were developed for seafarers and shore personnel since not all the shore personnel have the seagoing experience and thus they do not possess the similar types of certificates or relevant training.

Management personnel spend a month to encourage employees to participate in the survey in order to get high response rates within companies. After the introduction of the study and the surveys, the questionnaires are distributed to companies.

The questionnaires are made available in 3 formats for shipping companies, namely, web based online survey, a protected electronic format and paper format. For the web based version, the questionnaires are developed with the Qualtrics Survey Software.

After the distribution and the collection of the surveys in shipping companies, followings assessments take place:

1) The first and the basic part of the safety climate assessment is as shown below:

   a) Calculate the arithmetic mean of the each statement for ship and shore side

Means of the each statement and dimension are interpreted according to the Table 4-1 which was generated during an expert workshop:

The workshop was conducted on the 4th of February, 2014 in Glasgow where a HSEQ manager, a chief mate and a safety researcher and two human factors experts were participated in. A brain storming session was conducted to define a threshold for safety climate scores and different suggestions were noted to a flip chart. The company representatives with seafaring backgrounds were participated to in order to discuss minimum acceptable/desirable scores that the company desires and the safety and human factors researchers commented on the other safety climate score interpretations conducted in the maritime and other industries. After discussions amongst the participants, the Table 4-1 was proposed as the safety climate score interpretation table.

The score 80, represent the "agree" statement for the chosen Likert scale and the results over 80 highlights the fact that respondents are agreed on items to a greater extent (agree or strongly agree) such as "the company has excellent maintenance standards" and therefore the scores which are lower than 80 were considered as undesirable within organizations. In addition to this, the company should lean into issues by starting from the lowest scores. Especially, scores lower than 60 requires urgent corrective actions.

Table 4-1 Mean Score Interpretation

Mean Scores	Results
$100 > X \geq 90$	Very Good
$90 > X \geq 80$	Good

$80 > X \geq 70$	Average
$70 > X \geq 60$	Poor
$60 > X$	Very Poor

b) Calculate the arithmetic mean of each statement for each vessel

c) Calculate the arithmetic mean of each safety culture factor.

2) The second part of the safety climate assessment consist of the followings:

a) Identify statistical differences between groups like ship-shore, ranks, nationality, age, gender etc.

Statistical analysis is performed by utilizing SPSS to shed light into the differences between groups via the ANOVA test. This test is utilised to identify statistical differences between different groups such as age, department, nationalities etc. By using this method, the results are validated by removing the chance factor from the analysis. Due to difference in sample size and non-homogenous variances, Hochberg's GT2 and Games-Howell post hoc tests were conducted on the statistically significant variables only. The statistically significant (*p-value* < 0.05) interactions are defined for each question amongst different groups.

b) Identify the correlations between different safety climate dimensions

Spearman's Rho correlation test was utilised to determine the statistical correlations between different safety factors since the data does not come from a normal distribution.

4.2.1.2 Semi-Structured Interviews

Interviews are crucial to validate survey results and receive reliable feedback from the participants of the surveys. Interviews arranged as semi-structured in order to give opportunity to people to express their own opinions but not to divert them from the topics at the same time. The semi-structured interviews involve a general question from each safety culture dimension firstly to gain further insight into the problems specific to each dimension, secondly to compare the interview results with the survey results.

Necessary travel arrangements are organized to the company headquarters and on board vessels in order to conduct semi-structured interviews with the employees. 5% of the employees participated in surveys are chosen as interviewees and 20 minutes is allocated for each person.

Questionnaires and interviews are structured in line with each other in order to compare the results between them and provide more accurate safety climate results for shipping organizations.

4.2.2 Identification and Assessment of Key Performance Indicators (KPIs)

Safety culture survey and interviews are subjective measures as it is based on the personal opinions provided by the participants. There is a requirement to perform an analysis to establish statistical relationships between the safety culture survey outcomes, KPIs, safety related activities (number of meetings, trainings, safety bulletins, feedback to enquiries) and near miss data to correlate and confirm the subjective results of the safety culture survey. The study also;

- Confirms whether survey results are in line with the KPIs and reported near miss data.
- Identifies and eliminates any distortion.
- Priorities the improvement actions.
- Helps to establish baseline and monitor the efficacy of any actions taken to make improvement and improvements achieved

The KPI identification and assessment methodology aims to generate four main outcomes for each company, namely:

1. Trend Analysis
2. KPI vs KPI Correlation
3. Safety Culture Questions vs KPI Correlation
4. Safety Culture Dimensions vs KPI Correlation

4.2.2.1 Trend Analysis

The KPI data is utilized for the trend analysis to gain a basic understanding into the safety performance changes throughout the years. The trends provide the information on where to focus on during the statistical analysis. The trend analysis is done by utilizing the chart builder functionality of the SPSS software.

4.2.2.2 KPI vs KPI Correlation

The comparison of different set of key performance indicators by statistical correlation analysis allows shipping companies to identify the KPIs which have positive impact on safety performances of their fleet. Each KPI is correlated with the rest of the databank by utilizing the SPSS software and Spearman's rho correlation test is chosen appropriate for this assessment since the KPI data is a non-parametric data and also it does not come from normal distribution. This helps company to invest on right parameters to enhance safety and prevent dangerous accidents by making scientific assumptions on the impact of a parameter on other KPIs. There is a need for at least 5 years of historic data to perform a reliable analysis.

4.2.2.3 Safety Culture Questions vs KPI Correlation

Third analysis aims to identify the correlations between the safety culture questions and KPIs. The relationship between these two parameters determines which safety performance indicators make positive or negative impact on seafarers' attitudes and perceptions. Seafarers' understanding can be further enhanced by prioritizing the right KPIs. The KPIs are correlated with the questionnaires by utilizing the SPSS software and Spearman's rho correlation test is chosen appropriate for this assessment since the KPI data is a non-parametric data and also it does not come from normal distribution. This section only includes the KPIs from the year when the questionnaires were also distributed and collected.

4.2.2.4 Safety Culture Dimensions vs KPI Correlation

The final analysis seeks any correlation between safety culture dimensions and the safety performance of the company. There is a requirement to enhance the results of the entire safety culture dimensions in order to minimize risks in shipping operations and achieve envisaged level of safety. The company can choose the appropriate KPIs accordingly to generate an impact on any of the dimensions. The Spearman's rho correlation test is chosen as the appropriate test for this correlation study since the KPI data is a non-parametric data and also it does not come from normal distribution.

4.2.3 Observations

The observation study aims to capture seafarers' attitudes and perceptions, identify their compliance with safety management rules, monitoring the unsafe acts/behaviours together with measuring the impact of workload on their safety performance. It is of paramount importance to be on board vessels in order to capture the real dynamics that lead a shipping crew to have higher standards of safety culture than another one. Therefore, the observational studies are held in sister ships to also measure the effects of different operational practices of the crew on vessel safety.

The observation study is conducted in sister vessels operating on the same passage and the same ranks are observed in same ships. The scope of the observations was restricted to Officers only (deck and engine departments). The officers of the sister vessels comprise of the Captain, Chief Mate, Third Mate, Chief Engineer and Second Engineer. Crew members are observed for one day, with the researcher shadowing them for their entire shift. Each crew member's daily activities such as type of tasks being performed and the duration of the task are recorded in detail from the beginning of their tasks until the end of their daily tasks. The researcher will spend 6 days in the each sister ship for the observation study. The weaknesses and gaps identified by the safety climate assessment and KPI assessment are meticulously observed to understand the underlying reasons of the problems.

Prior to the observation study, the accident statistics and safety climate results of the vessel(s) is/are investigated to gain deeper understanding into the vessels' performance and identify possible problems arise from the these studies. Then, a through observation takes these assessment results into consideration. If the observation study is to be conducted on sister vessels, accident numbers and safety perceptions of the each vessel should be compared with each other. During the observation study, safety perceptions and attitudes are observed and any problems identified are logged under predefined 10 safety climate dimensions i.e. how they communicate, how they prioritise safety on board operations. It is of paramount importance to identify whether any safety perceptions under 10 safety climate score effect on board safety performance or not.

Overt observation data is also supplemented by a workload assessment questionnaire which the participants filled out at the end of their shifts. The questionnaire is distributed to collect seafarers' opinions about the general issues they faced during the operation. The workload assessment questionnaire is also distributed to compare the real time observation data on workload and crew member's perception about their workload as well as its associated effects on safety.

Existing links of the Assessment Methods:

The complementary links between the assessment methods are given below:

- The interviews were developed in the same structure as the questionnaires for the safety climate assessment, firstly to validate the results obtained via the questionnaires, secondly to further explore the underlying reasons that lead to lower scores on some of the safety culture dimensions.
- The overt observation methodology was developed to investigate how the differences on crew members' attitudes and perceptions affect their working practices and the safety of their vessels since it is an onerous task to capture the full picture of a company's safety culture level without being on board vessels of the company.
- It is also of high importance to link the questionnaire results with safety related key performance indicators of the company to eliminate subjectivity aspects of the questionnaires.

4.2.4 Improvement Methodologies and Action Plans

The most important part of the whole framework is the improvement methodologies and action plans section since all the identified gaps and weaknesses will adversely affect the safety of the shipping operations if the appropriate action plans are not implemented thoroughly.

All the gaps and improvement areas are determined by utilizing the proposed framework within shipping companies. Even though, some of the problems are identified by different methods, some unique problems can only be captured by a certain part of the framework.

As all shipping operations are run by procedures, it is of paramount importance to improve the quality of the procedures that leading accidents and incidents in the shipping industry. In order to remedy the identified problems via the assessment methods, the improvement methodologies are developed and categorized into two headings:

- Procedure Improvement Tool
- Best Practice Guideline for SOP Development

If there is a procedure does not work well as intended and cause problems to a shipping company, the quality of the procedure can be improved by the procedure improvement tool. Additionally, if there is a lack of a procedure for a shipping operation that causes a human error or a technical fault, the SOP development guide can be utilized in order to develop safer and more resilient set of SOPs. The set of improvement methodologies were developed to enhance safety by addressing different issues in different shipping companies.

4.3 Chapter Summary

The general methodology followed has been presented in this chapter.

5 Development of the Proposed Framework

5.1 Chapter Overview

This chapter explains the development stages of the each sub-method of the overall framework and how the each method works in detail.

5.2 Development of Safety Climate Assessment Method

Two online questionnaires and a semi structured interview have been developed to analyze the attitude of the employees in shipping companies within this part of the framework.

The ultimate aim of this section is to provide generate safety climate benchmark amongst case studies so that they can compare their safety performances according to several significant safety culture dimensions. Safety culture dimensions can be described as the important drivers of the safety culture such as training, feedback and just culture etc. Improving the conditions of the each safety culture dimension will lead a company to have a superior level of safety in their organization. There is not a standardized way to choose the most appropriate safety culture dimensions since researchers came up with different dimensions based on their research problems and objectives (Tomlinson et al., 2011). The amount of the dimensions utilized varies between 2 and 28 in the safety culture research (Håvold, 2007). In this study, firstly, the most common safety culture dimensions which are used in the literature were examined (Cox and Cheyne, 2000, Ek and Akselsson, 2005, Havold, 2000, Langard et al., 2013, Lee and Harrison, 2000, Mearns et al., 2000, Oltedal, 2011, Zohar, 1980). The most significant safety culture dimensions for the shipping context were identified and shortlisted at the expert workshops by the health and safety managers and safety researchers which was held on the 5th of December 2014. The most significant traits of safety culture were taken into account in these workshops to cover all the fundamental aspects of safety culture for a comprehensive assessment. 10 safety culture dimensions were chosen for this study. The chosen dimensions are: communication, procedures and safety rules, feedback, involvement, just culture, problem identification, priority of safety, responsiveness, safety awareness and training & competence. Questionnaires and semi-structured interviews were arranged according to this dimensional distribution. The proposed dimensions and their definitions are given in Table 5-1.

Table 5-1 Safety Culture Dimensions

Safety Culture Dimensions	Definitions
1) Communication (COM)	The way that health, safety, operational values, objectives are communicated within the company. Crew member's communication styles and language barriers are also examined in this dimension. Improved communication is of crucial importance during risky shipping operations, therefore there is a requirement of good and clear communication channel between seafarers and shore staff as well as between ship and shore.
2) Procedures and Safety Rules (PRS)	The quality and efficacy of the procedures are extremely important in order to comply with the international standards and maintain safety on board. Crew members' adherence to safety rules is also taken into consideration.
3) Feedback (FDB)	The way that feedback is provided (duration and style) and managed within the company. It is questioned whether seafarers receive timely feedback about their operational practices. An efficient feedback channel is of paramount importance to perform timely actions to avoid catastrophes.
4) Involvement (INV)	This dimension examines what extent the seafarers

	feel involved about the possible changes that may affect their operational practices. Increasing involvement of the crew members is highly important for them to pay more attention to the safety of their duties.
5) Just Culture (JC)	The Just Culture dimension tries to measure the trust between crew members and managers. In the just culture approach, undeliberate violations are not punished and are treated as learning opportunities. Establishment of a just culture allows seafarers to raise their concerns without the fear of a blame or sanction.
6) Problem Identification (PI)	This dimension measures that what extend crew members can recognize unsafe acts & conditions and take corrective actions accordingly. Since the risk is inherent in shipping operations, the problem identification attitude can assist seafarers to identify dangerous deviations on board.
7) Priority of Safety (PoS)	This dimension tries to identify the importance of health and safety over cost within the company and whether the company takes any possible safety improvement into consideration to improve the safety performance. Especially ship management's choices have a significant impact on safety. The utmost importance of safety should be practiced within the company and communicated to on board personnel.
8) Responsiveness (RES)	This dimension aims to investigate seafarers' efficacy of performing their duties and how well they respond when they are in undesired conditions. The ability to respond to an emergency is extremely important to maintain safety on board
9) Safety Awareness	This dimension captures safety awareness of the

(SA)	employees and how they perceive different safety initiatives. Enhanced safety awareness is a key element for seafarers to anticipate and project the risks of shipping operations and take the necessary actions to avoid any types of accidents and incidents.
10) Training and Competence (TaC)	Training and competency levels are questioned as well as the training arrangements of the company under this dimension. Training and competence level of the seafarers also plays a crucial role for achieving zero accident targets on board vessels.

Even though these dimensions were utilised within the safety climate assessment, the new dimensions can be found at the factor analysis results which are given in Appendix B.

Safety Climate Measurement Framework comprise of two sections:

- Questionnaires
- Semi-Structured Interviews

5.2.1 The Safety Culture Questionnaires

It is of paramount importance to choose the appropriate questions to capture the right information throughout the questionnaire distribution (Soma, 2003). Therefore, in this study, a detailed literature review was performed not only in the maritime industry but also in other industries to identify the requirements of an appropriate safety culture questionnaires and assessment methods.

5.2.1.1 The Questionnaire Design

After the review of numerous safety culture assessment questionnaires, all the safety culture questions are pooled in to a database under the 10 safety culture dimensions. A workshop with the company representatives (safety manager, seafarer, and psychologists) and human factors researchers was held on the 17th of January, 2014 to elicit expert's opinions on questions to be utilized in the study. The author invited different experts to the workshop in order to ensure that all the safety climate questions in the literature are investigated by the researchers, the applicability of the questions to the real maritime operations are checked by seafarers and lastly human limitations and psychological aspects are taken into account at the questionnaire design by psychologists. All the participants reviewed the questions one by one via the questionnaire booklet provided and expressed their ideas on each single statement. Some of them were rephrased and some were not found applicable for the study due to various reasons. The author decided to use all the questions are chosen at the final expert workshop since the companies wanted all shortlisted questions to be asked. In order to compare the results of the dimensions and questions with shipping companies, the same set of questions and dimensions were utilized in all case studies. However a factor analysis was performed to enhance the quality of the questionnaires instrument for future studies. The factor analysis section is given in Appendix B. An exploratory factor analysis (EFA) is used to understand the structure of a set of (latent) variables and reduce a dataset to a more manageable size while retaining most of the original information (Field, 2013).

Two online questionnaires, one for crew members and one for shore staff, have been developed with an interdisciplinary group to ensure that they capture the right information for conducting a comprehensive analysis. In total, 75 questions were chosen by utilizing the knowledge of safety managers in various companies and reviewing the safety culture literature. Once the questionnaires were finalized, they were distributed to a small group of researchers who have seagoing experience for further improvement. The questionnaire was also checked for the internal consistency by utilizing the Cronbach's coefficient alpha test and the Alpha value was found as 0.896. It can be commented that a questionnaire has a high internal consistency and good reliability if the alpha value exceeds 0.7 (Hair et al., 1998). The Cronbach's alpha test is known to be the most accepted way for measuring the internal consistency (Hinkin, 1995, Shevlin et al., 1997).

Anonymity is treated as a crucial aspect within the design of the questionnaires in order to overcome the existing blame culture problem in the maritime industry. The Likert scale has been applied and answers were organized as ***strongly disagree***,

disagree*, *neutral, ***agree***, ***strongly agree*** and ***do not know*** in the questionnaire. In the calculation processes, each statement has a score varies between 1 and 5 where 1 represents the minimum score and 5 represents the highest score. The negatively worded questions were included in survey in order to capture consistency of the responses provided by each participant. The results of these statements are reversed during the analysis to ensure consistency. The required time to complete the questionnaire was also considered as a vital factor in order to get more results from a shipping company.

In order to calculate average scores, all the Likert Scale statements (responses) were converted into numbers for the entire data as given below:

Table 2 Likert Scale Conversion

Likert Scale	Score
Strongly Agree	5
Agree	4
Neutral	3
Disagree	2
Strongly Disagree	1
Do not know	Treated as a missing value

After the conversion of the all verbal statements to the mathematical numbers, the average score of the each statement is calculated as shown below:

$$\frac{Participant\ Score\ (1) + \ Participant\ Score\ (2) + \cdots\ Participant\ Score\ (n)}{\mathrm{n}} \times \frac{100}{5}$$

The constant 100/5 was added to the equation in order to represent the results out of 100 as a percentage.

5.2.1.2 The Questionnaire Structure

The questionnaire was split into four main parts, namely:

- Information Section
- Demographic Section
- Safety Culture Dimensions Section

- Open Ended Questions Section

The first part of the questionnaires aims to encourage respondent to participate in the survey and also briefly explain some of the important issues. The information sheet can be found in Appendix A.

The second part of the questionnaire aims to collect demographic information about seafarers/workers in order to identify the effects of different backgrounds on their attitudes and perceptions. The set of demographic questions can be seen below:

Table 5-3 Demographic Questions

Demography
a. What is your age?
b. What is your gender?
c. Which department do you work for?
d. What is your rank / role? (Optional)
e. What is your nationality?

The third part of the questionnaire is the main part which tries to capture the attitudes and the perceptions of the seafarers and shore personnel. In total, 75 questions can be found under the ten safety culture dimensions.

Table 5-4 provides an example on some questions that are distributed to different groups.

Table 5-4 Difference between crew members' and shore staff' questionnaires

13	Crew Members	I am always informed about the outcome of shipboard safety meetings.
	Shore Staff	Our crew are always informed about the outcome of shipboard safety meetings.

All the safety culture dimension questions of the seafarers are given below:

Table 5-5 Safety Culture Questions

No	**Safety Culture Statements**

	1) Communication
1	Language/dialect related issues amongst crew members are not a threat to safety.
2	There is good communication about safety.
3	There is good cooperation between the ship and shore.
4	Operational values, objectives and targets are effectively communicated.
5	I always ask questions if I do not understand or unsure about the safety instructions given to me.
6	The company operates an effective system for reporting safety matters.

	2) Procedures and Safety Rules
7	Crew members are closely monitored to ensure company procedures are always followed.
8	There is an effective system in place to modify the procedures that are unworkable or impractical for crew use.
9	I never breach operating procedures, even if the breach is in the company's best interests.
10	Operating procedures provided by the company are helpful to the conduct of daily operations.
11	Safety rules and procedures are strictly followed.
12	The crew members are never encouraged to break rules to complete a task or maintain the timetable.

	3) Feedback
13	I am always informed about the outcome of shipboard safety meetings.
14	I am satisfied with the follow-up measures taken after accidents, incidents and near misses.
15	The crew is always given feedback on accidents, incidents, and near misses that occur on board.
16	I receive feedback about my compliance to safety procedures.

	4) Involvement
17	Crew members are encouraged to improve safety.
18	Suggestions to improve health and safety are welcomed.
19	I am consulted about the changes that affect safe work practices.
20	I have sufficient control of my work to ensure it is always completed safely.
21	Staff members from all departments and levels attend safety meetings.

	5) Just Culture
22	Mistakes are corrected without punishment and treated as a learning opportunity.
23	The company always tries to resolve any safety concerns and problems identified.
24	Crew members should not question a senior officer's decision even if safety is

	affected.
25	I am able to discuss any concerns I have with my line manager.

	6) Problem Identification
26	Other crew members encourage me to report unsafe events.
27	I am confident that I can operate the equipment within my area of responsibility safely.
28	Asking for assistance can make me look incompetent.
29	Whenever I see unsafe behaviour, I always report it.
30	I am encouraged to conduct, or refer to a risk assessment before performing any hazardous work.
31	I am encouraged to report all near misses.
32	Crew members sometimes carry out non-work activities while on duty.
33	I don't mind when other crew members ignore safety procedures.
34	The possibility of being involved in an accident is quite high in this company.

	7) Priority of Safety
35	When ship management is informed about accidents, incidents, or near misses, corrective action is taken promptly.
36	Shore side managers never put timetable or costs above safety.
37	Members of the management team are personally and routinely involved in safety.
38	The company places a high priority on safety training.
39	Manning levels are appropriate for our workload.
40	The company is giving much more attention to safety now, than it did one year ago.
41	The company has excellent maintenance standards.
42	The company only takes action(s) in actions when an accident occurs.
43	The company makes too much noise (excessive promotion) about safety.

	8) Responsiveness
44	I feel confident that I will be able to operate effectively in an emergency situation.
45	I am confident that I can operate all equipment in my work area effectively.
46	My attention to safety suffers when I am stressed or fatigued.
47	I am provided adequate resources (time, staffing, budget, and equipment) to perform my job.
48	There is a system in place for observing my rest hours.
49	The crew is expected to comply with work-rest hour regulation.
50	I have adequate rest on the work schedule cycle that I work.
51	Crew members monitor each other for signs of stress or fatigue.
52	Our crew has adequate training in emergency procedures.
53	The crew has access to all necessary personal protective equipment (PPE).

	9) Safety Awareness
54	Watch hand-overs are comprehensive and not hurried.
55	My ship works to ensure the safety in hazardous areas and during hazardous activities.
56	My ship holds an adequate number of safety meetings.
57	Checklists are essential for safety.
58	The company provides sufficient time for the hand-overs when joining the ship.
59	Learning from mistakes is a good way to improve overall safety.
60	I always give proper instructions when I initiate any work.
61	Drug abuse is a safety issue in my company.
62	Alcohol use is a safety issue in my company.
63	Safety briefings and training are professional and effective.
64	Safety is the top priority for crew on board this ship.
65	When I joined this ship, I received a proper induction, including familiarization with new tasks.
66	Sometimes, the rules are not followed in order to comply with sailing timetable.
67	Safety is a visible part of the selection and recruitment process in this company.
68	This company cares about my health and safety.
69	I fully understand my responsibilities for health and safety.

	10) Training and Competence
70	The training provided by our company is of a high quality and standard.
71	My company continuously tries to improve the quality of the trainings.
72	I have adequate knowledge of the company (Safety) Management System.
73	I am properly trained to deal with unfamiliar situations where safety might be at stake.
74	I am trained to cope with fatigue.
75	Adequate time is allowed for safety drills.

The final part of the questionnaire aims to collect information that has not been captured by the structured questions and further explore the problems the employees may have. Open ended questions can be found below:

Table 5-6 Open-Ended Questions

Open Ended Questions
a. What could the company do to improve health and safety?
b. What could the company do to improve ship safety?
c. What could the company do to improve harbour operations safety (e.g. ports, harbours, link-spans, PAS)?

d. What could the company do to improve office safety?
e. What questions should have been asked as part of this survey, but were not included?

5.2.1.3 The Questionnaire Distribution

When the questionnaire development is accomplished, the discussions were made to define the best way of survey distribution to increase response rates within organizations.

The surveys are made available in 3 different formats depending on the accessibility, for a duration of a month for each shipping company.

1. Web based online survey: This is the most preferred option, ship based and shore based staff will follow the link and complete and submit the questionnaire online. The submitted questionnaire will be stored in the database automatically. For this option access to internet is essential.
2. A protected electronic format: The questionnaire will be submitted in Microsoft word format and the participants can fill, save and submit their questionnaires directly to Strathclyde University or relevant people onboard can send the files to Strathclyde University in bulk.
3. Paper format: A PDF or word version of the questionnaire will be provided to companies and every ship can print the paper version and distribute to crew. The filled papers can be collected in an anonymous manner and posted to Strathclyde University.

5.2.1.4 Questionnaire Analysis

5.2.1.4.1 Demographic analysis

The questionnaire analysis starts with a demographic analysis in order to gain insight into characteristics of a sample. It provides information on the characteristics and features of a sample so that the further analysis can take important information into account such as age or nationality of the group which can affect the interpretation of the results since different demographics may have different safety culture levels.

5.2.1.4.2 Safety Culture Dimension analysis

The main aim of this section is to calculate average safety climate scores achieved for each question amongst crew members and shore personnel. This assessment identifies the statements that respondents are not agree and therefore highlights the problematic safety culture attitudes and perceptions of seafarers. This section provides straightforward and easy problem identification for the company and these average scores can also be compared with safety culture scores of the other shipping organizations.

5.2.1.4.3 Statistical Analysis

As stated before, existence of different subcultures of within the organization can be seen as a threat to safety (Brown, 1995), therefore it is of crucial importance to identify statistically significant subcultural differences between groups. The company can therefore investigate what kind of safety culture differences exist amongst sub-groups and define strategies to bring all the groups to the desired level of safety.

5.2.2 Semi-Structured Interviews

Interviews are crucial to validate survey results and receive reliable feedback from the participants of the surveys. Especially, crew members are more willing to share their opinions about safety matters during face to face interviews instead of filling surveys.

The interview data collection sheets include one or two general question on each safety culture dimension to capture the understanding of the respondents. Then these results are compared with survey results. The applicants were also given extra time to provide further insight into the aspects that they find is of high importance. The semi-structured interview data collection questions can be found below:

1. How is the overall communication within the company? Are you happy with the communication levels? How does the company communicate with you? (such as communicating operational values, objectives, targets and other safety matters)
2. Are the SOPs effective within the company? How does the company manage the feedback provided by crew members with regards to SOPs?
3. How is the overall feedback management within the organization? Do you receive feedback on what you report to the company? If you receive, how quickly?
4. What do you think about the involvement of the employees/seafarers with the organization? Do they ask your opinion about the changes that may affect your working practices?
5. How are the mistakes handled within the company? (Just culture or blame culture)
6. Do you think crew members and employees report unsafe acts or near misses that they observe immediately? Are they encouraged for this? Do you report them?
7. Do you think company puts timetable or cost above safety? Do you think safety performance of the company is improving?
8. Do you think you are able to cope with emergency situations? Do you always feel that you are ready for it? Are there any conditions that your performance may be decreasing?
9. Are you happy with safety environment within the company? (Are the checklists and watch-handovers comprehensive and have they the required qualities?)
10. Do you think seafarers/employees have adequate training? If they request further training from the company, do you think that the company will provide these training in a short duration?

Even though, interviews can provide crucial information which is not possible to capture with other techniques, it has some weaknesses. There is a possibility that researcher's understanding can be biased and therefore, the views which can be worthwhile noting could be different amongst people or interviewees provide their opinions in line with the expectations of the researchers. (Guldenmund, 2010a, King, 2004). In order to overcome this problem, interviewees are encouraged to speak freely and they are informed about their rights which are defined by the University Ethical Framework. In addition to this, the overall framework developed to cover weaknesses of the each sub-method by utilizing different means in an integrated manner.

5.3 Identification and Assessment of Key Performance Indicators (KPIs)

Majority of the shipping companies have been already utilizing the KPIs such as number of accidents, number of near misses, lost time incident frequencies, recordable case frequencies, number of deficiencies and number of detentions. However, the maritime industry does not have a standard way of KPI collection and assessment technique. In order to develop a comprehensive set of KPIs, firstly, a through literature review was conducted regarding the how the companies measure their safety performances and compare with their competitors. After a detailed review of the key performance indicators in shipping and other industries, all the available safety critical KPIs were added to a databank. The KPIs which were already in use by three shipping companies were also requested and additional ones were added to the KPI databank. One of the shipping companies did not have a data collection system and therefore could not contribute the KPI list at all. After the generation of a big KPI databank, a workshop was organized to generate a manageable and thorough list of KPIs for shipping organizations. The workshop was organized in Glasgow with tanker shipping representatives and safety researchers on the 14th of October 2015 to elicit expert's opinion on most critical key performance indicators in order to monitor safety performances in shipping organizations. The number of KPIs were decreased to 52 at the expert workshop and these KPI sets were provided to three shipping companies for long term data collection. However due to the limitation of the study, the correlations were only performed amongst available data. The comprehensive and shortlisted set of KPIs were proposed as shown below:

Table 5-7 Key Performance Indicators List

No	Key Performance Indicators

1	Number of fatalities (FAT)	Number of death(s) resulting from an accident or disaster
2	Number of permanent total disabilities (PTD)	The number cases where a seafarer has work injury which incapacitates the individual permanently resulting in termination of employment on medical grounds (e.g. loss of limb(s) permanent brain damage, loss of sight).
3	Number of lost work day cases (LWC)	Any work related injury that renders the injured person temporarily unable to perform their normal work or restricted work on any day after the day on which the injury occurred.
4	Number of restricted work cases (RWC)	Any work-related injury (other than a fatality or lost time incident) that results in a person being unfit to perform all of his/her regular job after the accident.
5	Number of medical treatment cases (MTC)	Work related injuries that are not severe enough to be reported as fatalities, LTI, or RWC but are more severe than requiring simple first aid treatment; however the injured person is able to carry out all his duties after treatment
6	Lost time incident (LTI)=FAT+PTD+LWC	Any work-related injury other than a fatal injury that results in a person being unfit for work for a period of 24 continuous hours immediately after the occurrence of the incident.
7	Lost time incident frequency (LTIF)	The total lost time incidents multiplied by 1 million, divided by the number of exposure (working) hours in the last year.
8	Total recordable cases (TRC)=	The sum of all work-related fatalities,

	LTI+RWC+MTC	lost time incidents, restricted work accidents and medical treatment cases. TRCs = LTIs + RWCs + MTCs.
9	Total recordable case frequency (TRCF)	The total recordable cases multiplied by 1 million, divided by the number of exposure (working) hours in the last year.
10	Number of first aid cases (FAC)	Minor work-related injuries only requiring simple first aid treatment.
11	Number of navigational accidents	Events that include steering failures, propulsion failures, navigational equipment failures, collisions, groundings, or other navigational or equipment failures.
12	Number of near-miss reports	An event, or a chain of events, that under slightly different circumstances could have resulted in an accident, injury, damage, or loss of personnel, equipment, or the vessel.
13	Number of unsafe acts	Unsafe act is a subcategory of a near miss reporting which includes unsafe acts or behaviors
14	Number of unsafe conditions	Unsafe condition is a subcategory of a near miss reporting which includes unsafe condition or environment
15	Number of internal audits per ship	Number of internal audits arranged for a vessel within the company
16	Number of superintendent visits per vessel	Number of superintendent visit arranged for a vessel within the company
17	Number of PSC inspections	A visit on board a ship to check both the validity of relevant certificates and other documents, and the overall condition of the ship, its equipment, and its crew by

		Port state control.
18	Number of inspections with deficiencies	Number of Port State Control inspections which include any identified deficiencies
19	Number of PSC deficiencies	The number of a non-compliance, discrepancy or deviation from the requirements of the relevant instruments/conventions on a vessel identified by Port State Control.
20	Type of deficiency	The category of the deficiencies identified by PSC
21	Number of PSC detentions	Detention: Intervention action taken by the port State in case of detainable deficiencies or substantial non-compliance to ensure that the ship does not sail until detainable deficiencies have been rectified.
22	Number of internal audit (ISM) non-conformities	Number of nonconformities identified by an internal audit which is arranged by the company.
23	Number of external audit non-conformities	Number of nonconformities identified by an external audit which is arranged by the company.
24	Number of superintendent visit findings	Number of problems identified by superintendent.
25	Number of safety meetings	Number of safety meeting held on board.
26	Frequency of toolbox talk	A toolbox talk is an informal safety meeting that is part of an organization's overall safety program.
27	Percentage of safety reports which feedback was provided	What is the percentage of the safety reports which the company provided feedback on?
28	Percent of employees who have	Percent of employees who have their

	their performance appraised annually	performance appraised annually
29	Percentage of safety suggestions on which feedback was provided	Percentage of safety suggestions on which feedback was provided.
30	Number of safety inspections per annum	Number of safety inspections per annum.
31	Number of days without an accident	Number of days without an incident or accident.
32	Number of corrective action reports (CARs) originating from audits	Corrective action means that action/actions adopted to eliminate the problem from occurring again.
33	Percentage of new hires put through a formal induction process	Percentage of new hires put through a formal induction process.
34	Average working hours on the ship and in the office	Average working hours on the ship and in the office
35	Number of safety performance indicators utilized	Key performance indicator is a quantifiable measure used to evaluate the success of an organization. All given rows are KPIs in this table.
36	Number of familiarization training provided to crew	Number of familiarization training provided to crew.
37	Number of reports related with impractical procedures	The number of the standard operating procedures which found impractical by the crew members.
38	Total number of annual safety related trainings for each crew	Total number of annual safety related trainings for each crew.
39	Frequency of assessing the quality of training	Frequency of assessing the quality of training
40	Total duration of training (hours)	Total duration of training (hours)
41	Number of safety audit recommendations closed out in time	Number of safety audit recommendations closed out in time

42	Number of procedure violations detected	Number of procedure violations detected
43	Percentage of maintenance items completed on time	Percentage of maintenance items completed on time
44	Percentage of follow up of actions from risk assessment	Percentage of follow up of actions from risk assessment
45	Number of cases where drugs or alcohol is abused	The number of cases where any person being part of the ship's complement (e.g. officers, ratings and cadets) violates company's drugs and alcohol abuse prevention policy.
46	Percentage of work-rest hour violations (%)	The number of cases with violation of STCW or MLC conventions regarding rest or work hours.
47	Crew retention %	Crew retention refers to the ability of an organization to retain its employees for the upcoming year.
48	Average corrective maintenance per ship	Corrective maintenance is a maintenance task performed to identify, isolate, and rectify a fault so that the failed equipment, machine, or system
49	Ballast water discharge violations	The number of times where prevailing regulations regarding ballast water management have been violated and recorded by an external party (maritime authorities).
50	% of new cadets assigned to vessel	The number of cadets under training with the ship owner or ship manager during last year
51	Management visit frequency	The frequency of ship management's visit to on board ship
52	Number of oil spills	The total number of oil spills to the

	environment (overboard), excluding contained spills.

The overview of KPI identification and Assessment method is given in Figure 5-1.

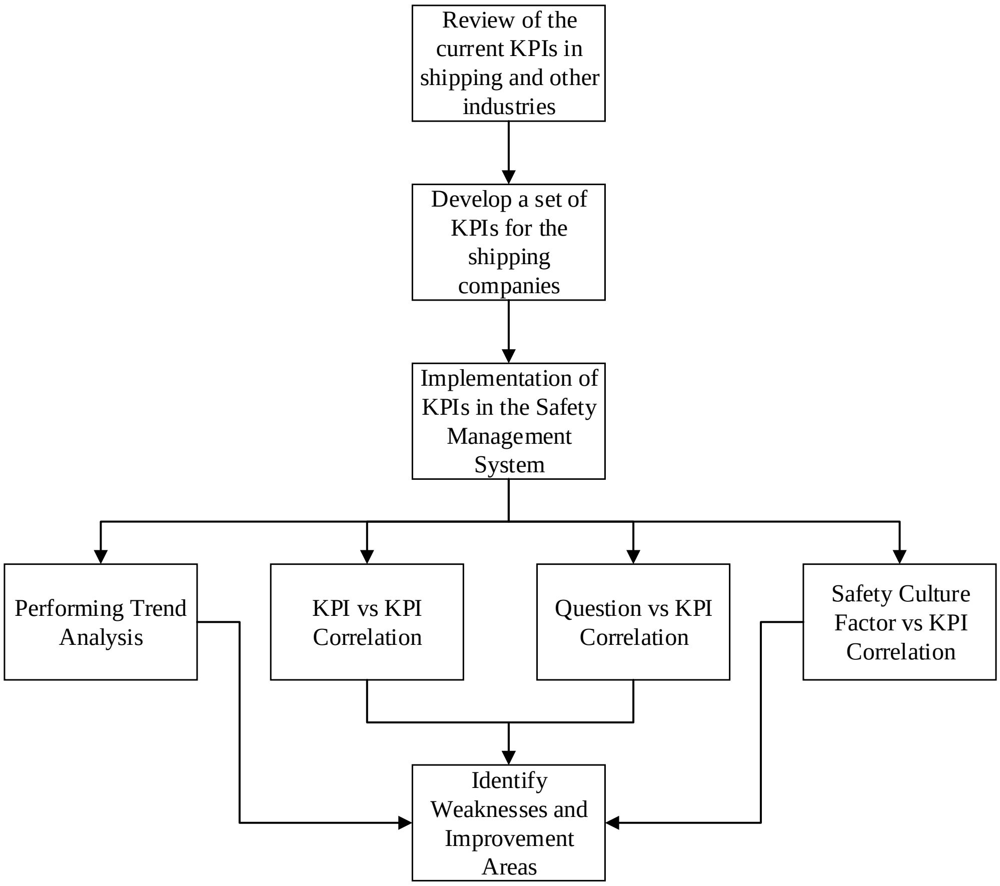

Figure 5-1 KPI Identification and Assessment Method in Detail

5.4 Observations

The observation module is developed complementary to the whole framework in order to justify some of the elements which could not be identified during questionnaires, interviews and KPI study. Representative sample groups are chosen from the bridge and engine department to be observed since the overt observation study requires substantial amount of time to be spent on board. The sample group consists of a master, a chief mate, an officer of watch (OOW), a chief engineer and a second engineer. The weaknesses and gaps identified by the safety climate assessment and KPI assessment are meticulously observed to understand the underlying reasons of the problems. Such a comprehensive observation hasn't been performed in any shipping company yet.

The observation study is conducted in sister vessels operating on the same passage and the same ranks are observed in same ships. Overt observation data is also supplemented by a questionnaire which the participants filled out. The workload assessment questionnaire (See Appendix D) is distributed to collect seafarers' opinions about the general issues they faced during the operation. The workload assessment questionnaire is also distributed to compare the real time observation data on workload and crew member's perception about their workload as well as its associated effects on safety.

The aspects to be recorded during the observations were decided prior to the study and appropriate data recording sheets were made to help the recording. The data collection sheet can be found in Appendix C. The decision was taken to focus on the tasks performed by each crew member and the time spent of these tasks. All activities were timed and associated information was also noted to allow insight into the tasks over one day. Each task was recorded by the observer; the task name was therefore decided by the observer. In order to achieve consistency in the task naming, the research group worked through their data to develop a set of rules of what the tasks could be categorised as. For the bridge team, the following high level task categorisations were established. For the engineering team, using the same process, the following high level task categorisations were established.

Each of these is shown in Table 5-8 along with a description.

Table 5-8 Task Categorisations for Bridge Crew & Description

Task Categorisation	Description
1)Berthing/Unberthing	The activity related to berthing or unberthing the vessel. This person uses the manual side controls and main controls. They are always supported by another member of the bridge team during this. This requires communication with the DPs and Bridge team.

2)Berthing/Unberthing Support	For safety, regulations stated that two persons must be on the bridge during all berthings and unberthings. The role of berthing/unberthing support related to every task performed once the berthing/unberthing commences. This includes checklists.
3)Break & Rest Periods	This task categorisation includes all official breaks (breakfast, lunch and dinner) taken in the mess room and rest periods where they went to their cabin for extended rest of around 3 hours.
3)Communication with Colleagues	Conversations between crew members about work related aspects. Captured for vessel 1, were only conversations that were work related. For vessel 2, all conversations were recorded.
4)Open Sailing & Watch-Keeping	All activities performed while responsible for the sailing of the vessel between red zones. It includes watch keeping, adjusting course.
5)Paperwork (Bridge)	All paperwork completed on bridge, including checklists, reading documents, signing documents, updating maps, and so on.
6)Paperwork (Office)	All computer and paper based work.
7)External Communications	Communication with persons not on the vessel or not part of the crew. This includes communication via phone, discussions with passengers, communication with other vessels.
8)Pre-Departure Checks	All checks made in preparation for departing port, including checks of car deck.
9)Start-up/Shut-down Activities	Start and end of day tasks when vessel is not in operation.
10)Staff Organisation	Any sort of management or organisation of staff.
11)Technical Issues	This is a broad category and encapsulates all activities that the bridge crew were required to do that were not strictly paper based. This included, checking of safety equipment, inductions, and general checks of the vessel.

Based on the observations, the tasks of the engineering crew were separated into seven distinct categories, each category along with an associated short description is shown in Table 5-9.

Table 5-9 Task Categorisations and Descriptions for Engineers

Task Categorisation	Description
1)Break & Rest Periods	This task categorisation includes all official breaks (breakfast, lunch and dinner) taken in the mess room and rest periods where they went to their cabin for extended rest of around 3 hours.
2)Communication with Colleagues	Communication with colleagues on the vessel related to work.
3)External Communications	Communication with persons not on the vessel or not part of the crew.
4)Paperwork (All)	All paper work completed on-board.
5)Staff Organisation	Any management or organisation of crew.
6)Start-up/Shut-down Activities	Tasks associated with the start-up and shut-down of the vessel.
7)Technical Issues	This is a diverse category including engine maintenance, ship maintenance, i.e. when working with technology on the vessel.

Finally, ethical considerations were made to the study which was ethically approved by the University of Strathclyde's ethics process. All participants need to sign a consent form agreeing to being observed.

5.5 Improvement Methodologies and Action Plans

The most important part of the whole framework is the improvement methodologies and action plans section since all the identified gaps and weaknesses will adversely affect the safety of the shipping operations if the appropriate action plans are not implemented thoroughly.

All the gaps and improvement areas are determined by utilizing the proposed framework within shipping companies. Even though, some of the problems are identified by different methods, some unique problems can only be captured by a certain part of the framework.

The improvement methodologies and action plans can be categorized under two headings:

- Procedure Improvement Tool
- SOP Development Guideline

The set of improvement methodologies were developed to enhance safety by addressing different issues in different shipping companies.

5.5.1 Procedure Improvement Tool

The Procedure Improvement Tool was developed to improve the quality of the SOPs with an ultimate aim of enhancing safety culture in shipping companies (SEAHORSE, 2013). The Procedure Improvement Tool was developed within the EU FP7 SEAHORSE Project and the author made a significant contribution to the development of the tool.

The shipping standard operating procedures are the accumulation of the best practices and they are developed to ensure safety of shipping operations. Therefore, it is of crucial importance to maintain high quality of SOPs by taking new best practice suggestions into consideration for the continuous safety culture improvement. Continuous improvement is known to be one of the key parameters of a positive safety culture and hence associated initiatives should be utilized by the shipping organizations (IMO, 2017b). The tool allows seafarers to submit an opportunity for improvement through their computers or mobile phones. The suggestion is submitted to the system anonymously and experts compare the suggested standard operating procedure with the existing one to identify whether the suggested alternative practical way enhances safety of a specific shipping operation more or not. The methodology behind the tool and details are explained in Chapter 9. The utilization of this tool improves each safety culture dimension as given below:

1. <u>Communication:</u> The tool works as a communication channel and improves the communication between ship and shore by allowing direct submission of any nonconformity identified by a crew member.

2. Safety Rules and Procedures: The ultimate aim of the tool is to improve the quality of SOPs and thus improving adherence to safety rules.
3. Feedback: The tool generates and improved feedback loop within a shipping organization. The feedback can be provided by experts from even their mobile phones and all the feedback for different procedures suggestions are stored for crew members' use.
4. Involvement: The tool provides opportunity for crew members to be involved at the development stage of SOPs. All employees can access to the system and can be involved by giving their suggestions on any case.
5. Just Culture: All the procedure improvement suggestions appear on the tool anonymously, therefore by diminishing blame culture, reporting activities can increase.
6. Problem Identification: The tool also eases the problem identification process since reporting can be done without any paperwork by even taking the video of the problem and uploading it to the system via the tool.
7. Priority of Safety: The utilization of the tool indicates that company prioritize safety in all aspects and invest on initiatives to improve their maritime operations.
8. Responsiveness: The tool also provide access to all the company standard operating procedures, therefore crew members can always stay up to date and response to unexpected situations on board.
9. Safety Awareness: The tool provides enhanced situational awareness by identifying and amending poorly written SOPs. Crew members can therefore expect "the unexpected" and can be vigilant at all conditions.
10. Training and Competence: Better SOPs can support competency of seafarer and the tool can also work as a self-learning platform for crew members to expand their knowledge.

5.5.2 SOP Development Guideline and Training Module

The majority of shipping SOPs are known to be highly fragmented and substandard throughout the industry and even they sometimes differ from ship to ship in a same organization. However, a structured guideline for developing an SOP does not exist in the shipping industry. Therefore, best practices of developing standard operating procedures guide was developed as part of the overall safety culture improvement framework.

The SOP development guideline provide step by step instructions for either the development of an SOP from scratch or improving the quality of an SOP in structured and comprehensive manner. The SOP development guide can work stand alone or together with the procedure improvement tool with an ultimate aim of safety improvement.

The guideline has also converted into a training module to ease the usage of it by the ship management personnel. This guideline can be utilized to improve the quality of procedures under any safety culture dimension such as communication, feedback, involvement, etc.

5.6 Chapter Summary

The details of the proposed framework are summarized in this chapter.

6 Safety Climate Assessment Results

6.1 Chapter Overview

The Safety Climate Assessment Method aims to identify strengths and weaknesses of the companies by distributing questionnaires and performing semi structured interviews. The safety culture questionnaires were distributed to 3 shipping companies, however due to time consuming nature of the face to face interviews, semi structured interviews were only held in one shipping company. Only the results of the tanker shipping company are given in this chapter and other two case studies are given in Appendix E and F. The results generated in this chapter firstly provide generic information about the company and then identify the attitude and perception differences of the employees. The safety climate study aims to generate benchmark amongst shipping companies where organizations can compare their safety culture maturity levels.

6.2 Introduction

Risk is inherent in shipping operations and there is requirement to gain insight into the issues that seafarers face during their day to day operations. It is a well-known fact that majority of the maritime accidents are attributed to human and organizational factors, it is therefore important to identify the attitude and perception differences amongst seafarers leading to different safety performances. Questionnaires and interviews have been utilized tremendously in safety culture area due to their straightforward and easy assessment nature. Even though, these assessment techniques provide substantial information about the general safety perspectives of a company, the results should be compared with the other companies in order to define a safety culture benchmark of a company amongst other organizations in the maritime industry.

Therefore, the safety climate assessment method was developed and utilized in three shipping companies with an ultimate aim of generating benchmark of safety culture within the maritime industry. The assessment was performed in shipping companies which operate in different locations and perform different operation types (tanker shipping, bulk carrier and container shipping) in order to involve wider range of demographics within the study.

6.3 Case Study - Safety Climate Assessment in a Tanker Shipping Company

This section detailed the safety climate assessment of a tanker shipping company. Firstly, the demographic characteristic of the employees are explored in the shipping company. Then, the safety culture factors and the open-ended questions are analysed. Finally, the report provides detailed statistical findings for gaining full insight into the current safety climate level of the company. The Safety Climate results are then compared and supported with semi-structured interview results.

6.3.1 Safety Culture Questionnaire Data Collection

The questionnaires were distributed to 2220 people in a tanker shipping company. A 71% response rate is gained from the administration of the survey in the company. The detailed return rates from different groups described below:

- **Crew on board:** 1076 responses out of 1202 people (90%)
- **Crew on shore:** 379 responses out of 828 people (45%)
- **Shore staff:** 190 responses out of 190 people (100%)

6.3.2 Missing data

The data were screened to look for missing and unusual data. The questionnaires asked 87 questions in total and there were 1645 responses. The majority of the demographic questions such as age, gender have negligible amount of missing questions which accounts for 50 - 80 responses.

The final five questions required the participants to write free texts. There are a lot of missing cases within these five answers, as can be expected from open-ended questions. All “Do Not Knows” of the questionnaire were also recorded as missing data for the analysis.

6.3.3 Demographics

The following presents the results of the demographics section of the questionnaire. This section provides background information about the participants.

A total of 1645 questionnaires were filled and returned. Of these, 1455 (88%) were completed by seafarers and the remaining 190 (12%) were completed by shore personnel.

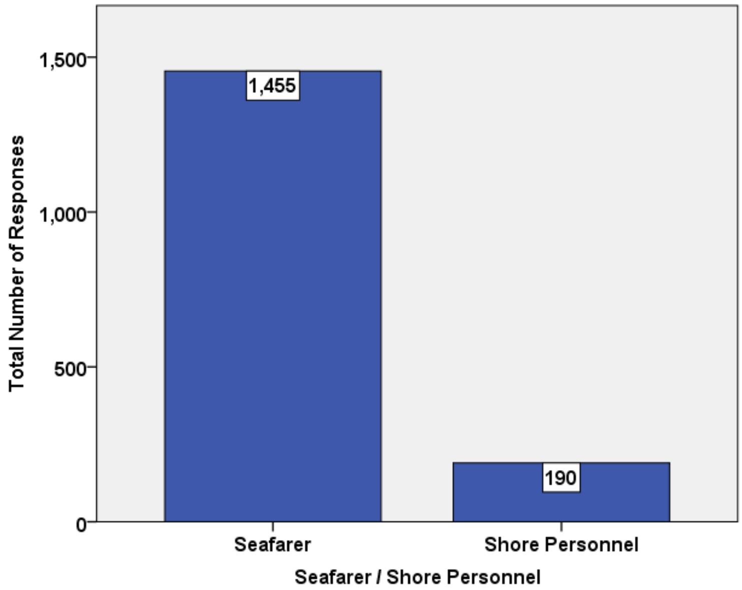

Figure 6-1 number of responses

6.3.3.1 Age

The age distribution of seafarers and shore personnel is given in Figure 6-2. Crew members are mostly younger than shore staff in the shipping company. The majority of the seafarers are between 25 and 34 years of age on board ships and account for 42.1%. The larger part of the shore staff are between 35 and 44 years of age and account for 5 % of the all respondents. This reflects the well-known practice in the maritime industry that when crew members get older they want to transfer to shore-based positions for the sake of a more regular life.

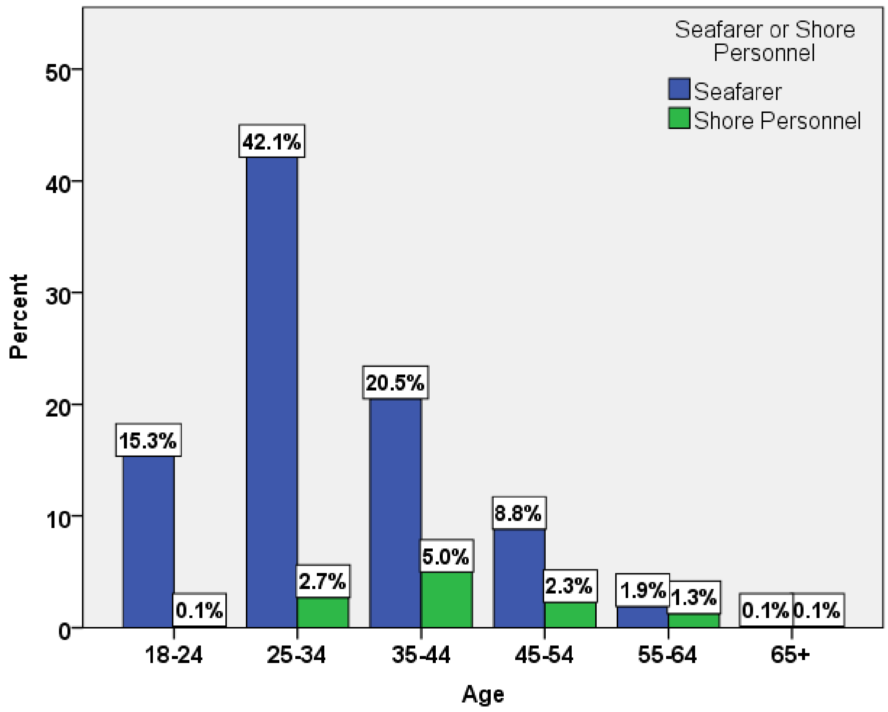

Figure 6-2 the age distribution of the respondents

6.3.3.2 Gender

Further investigation reveals that 87.1% of the respondents are male seafarers. The number of female responses is higher than male responses on shore.

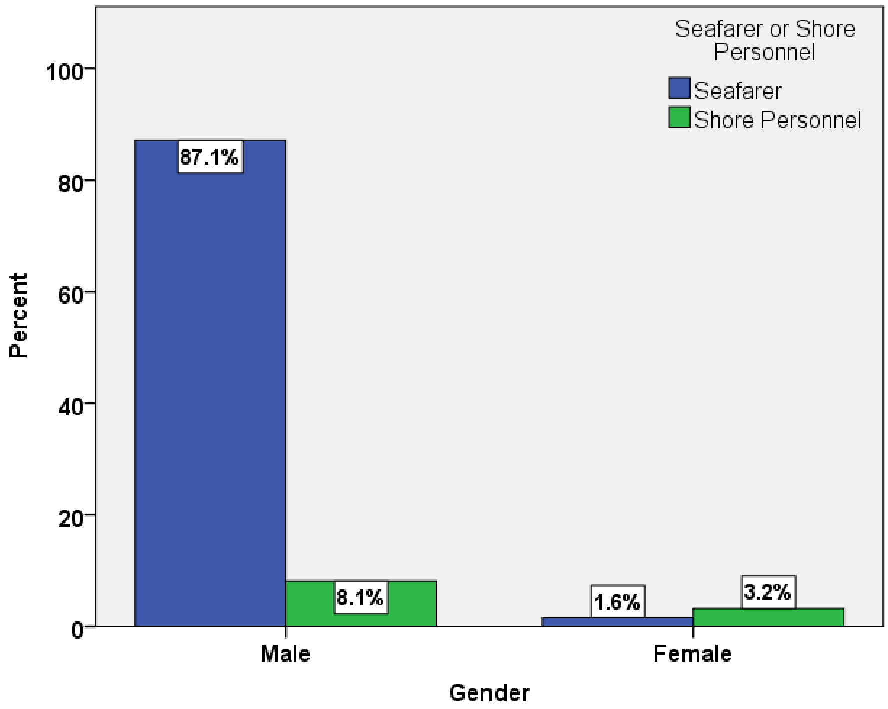

Figure 6-3 the gender distribution of the respondents

6.3.3.3 Departments

The highest percentage of respondents work in the Deck Department and Engineering Department with 38.8% and 34.9%, respectively. Ratings and Port Officers are with 14.8% and 8.6%, respectively. Only 2.5% are from the ship management department.

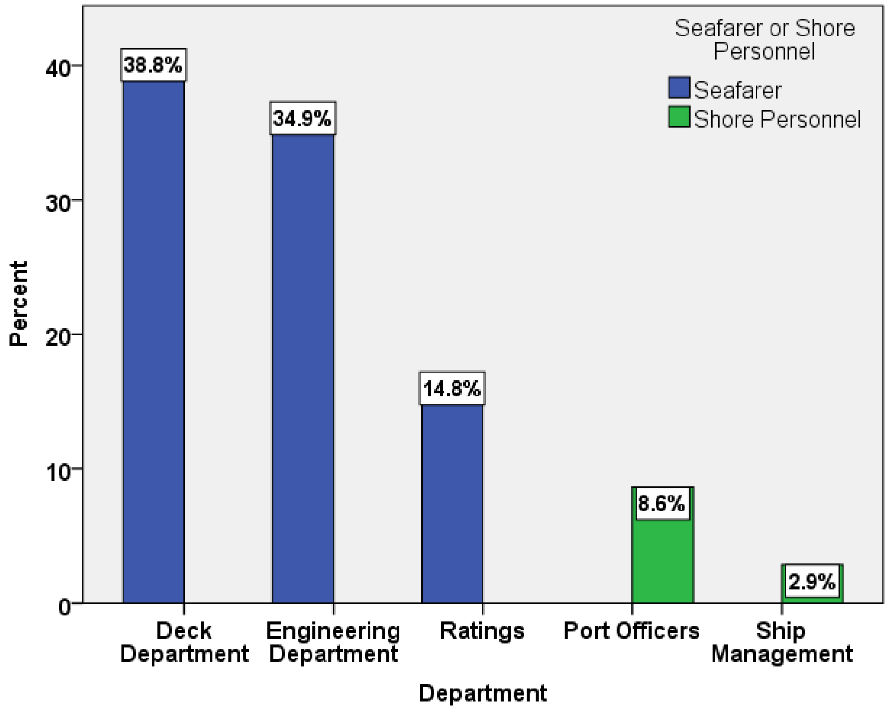

Figure 6-4 Distribution of employees amongst departments

6.3.3.4 Seafarers' Ranks

The distribution of ranks is given below in Figure 6-5. 47 out of 1455 crew members left their rank blank. While the majority of the crew members answered the question about their ranks, a small number did not reveal their ranks due to the existing blame culture, as they do not feel comfortable to share anything which can identify them. The largest group participated in the survey are 3rd engineers.

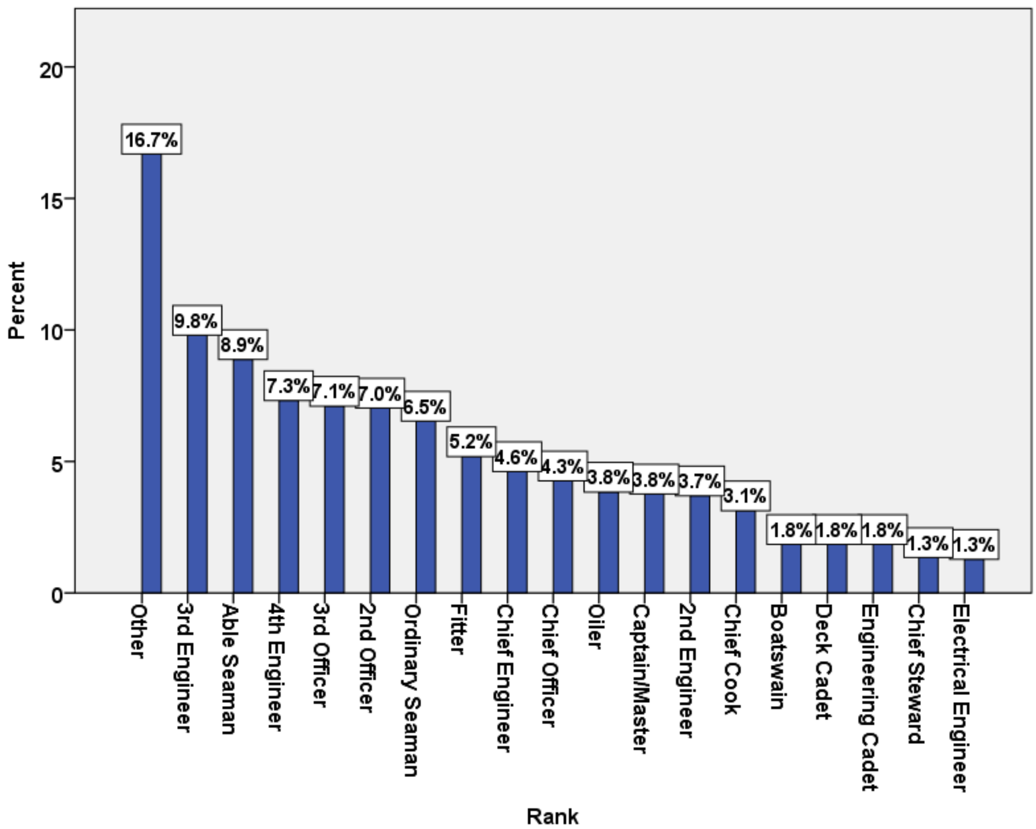

Figure 6-5 Distribution of ranks amongst crew members

6.3.3.5 Nationalities

The majority of the participants are Malaysian (73.2%). Malaysian are followed by Filipinos (17.5%), Indians (4.0%), Bangledishies (1.5%) and Yemenis (1.2%). The rest of the nationalites constitutes the minority within the company. Therefore, the dominant Malaysian group will influnece the results and gaps of this case study.

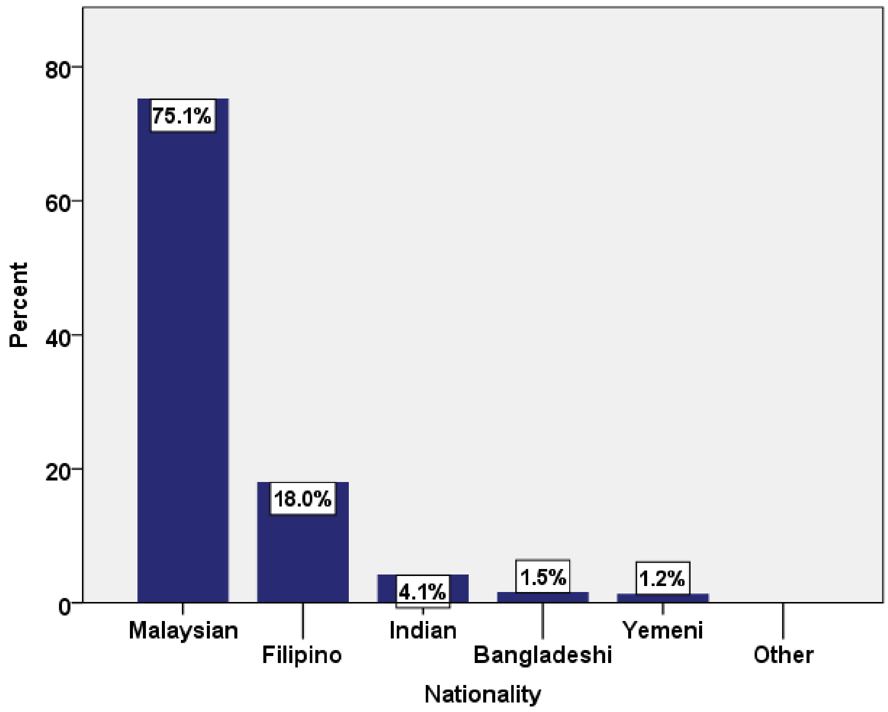

Figure 6-6 Distribution of nationalities

6.3.4 Safety Culture Dimension Results

This section presents the attitude and perception results of the employees within the company. In total, 1455 seafarers and 190 shore personnel completed the survey and all of these responses included in the following analysis. There was less than 7% of missing data for each question.

The average scores of the each safety climate dimension in the questionnaire were calculated. The results revealed that the highest score was obtained in the **Involvement** section and the lowest score was received in **Priority of Safety** amongst respondents. It can be seen from the table below that crew members had better safety attitudes and perceptions on several safety related factors than shore staff. It can be seen in the Table 6-1 that the biggest difference between crew members and shore staff was recorded on the involvement factor with 4.75 percent. This clearly identifies that shore staff do not feel as involved as crew members in order to make a contribution to enhance safety within the company.

The scores which are lower than 80, are not desirable within organizations. Relevant efforts should be invested to strengthen the identified vulnerabilities. In the calculation process, each statement has a score varies between 0 and 100, where 0 shows the min score and 100 represents the highest score.

Table 6-1 Safety Climate Scores – Tanker Shipping Company

Safety Climate Dimensions	Scores for Crew Members (%)	Standard Deviation (%)	Scores for Shore Staff (%)	Standard Deviation (%)
1) Communication	82.60	9.84	79.77	11.09
2) Procedures and Safety Rules	82.31	9.38	79.29	11.39
3) Feedback	84.05	10.57	80.30	13.06
4) Involvement	88.13	9.99	83.38	11.67
5) Just Culture	79.73	10.61	77.10	11.19
6) Problem Identification	81.93	9.34	77.95	9.91
7) Priority of Safety	75.12	8.82	76.48	10.20
8) Responsiveness	79.69	8.69	76.66	9.78
9) Safety Awareness	84.59	8.46	81.07	9.69
10) Training and Competence	81.98	10.01	78.95	11.93
Av. Score=	**81.85**		**79.04**	

6.3.4.1 Communication Statements

The communication factor consists of six statements. The average scores of the each statement for crew members and shore personnel are given in Table 6-2 and all the colours which are not green require an immediate improvement. The statement with the lowest score for crew members and shore personnel is: "*Language dialect related issues amongst crew members are not a threat to safety*".

The maritime English level is seen as a threat to safety by the seafarers and shore staff within the company as it creates a communication barrier between different crew members on board ship. The shipping industry is known as one of the most international occupations worldwide and several nationalities are present on board a vessel. These nationalities also have different education and competency levels due to diverse levels of education provided in their countries including language skills. Since all the maritime communication is held in English, the company should bring all the seafarers to a sufficient level of English in order to address language barriers amongst different nationalities. Within this company, almost 75 percent of the respondents are Malay and they may tend to speak in their local language, however this can lead to dangerous situations for crew since non-Malay seafarers should have knowledge on the type of communication is taking place regarding the vessel of safety. The company should take stringent measures to avoid communication in any other languages beside English.

Communication is of key importance especially in emergency situations, hence all crew members should have the English proficiency to communicate effectively and run the ship safely. Advanced maritime English courses can be utilised to tackle with the language related issues. Different dialect groups should have been represented in simulator environments during safety critical shipping operations which require intense communication and seafarers therefore will improve understanding of different dialects. Communication barriers can be identified and addressed with tailored English courses. It is of crucial importance to ensure the presence of clear communication in a simulator environment to avoid any miscommunication during shipping operations. Beside the maritime English, the overall communication was found satisfactory within the company.

Table 6-2 Communication Dimension

Communication		
Statements	**Average Score**	
	Crew Members	**Shore Personnel**
1. Language/dialect related issues amongst crew members are not a threat to safety.	66.27	60.24
2. There is good communication about safety.	86.47	83.56
3. There is good cooperation between the ship and shore.	82.82	81.05
4. Operational values, objectives and targets are effectively communicated.	83.96	82.09
5. I always ask questions if I do not understand or unsure about the safety instructions given to me.	90.10	87.05
6. The company operates an effective system for reporting safety matters.	85.79	83.91

6.3.4.2 Procedures and Safety Rules Statements

The procedures and safety rules factor consists of six statements. The average scores of the each statement for crew members and shore personnel are given in Table 6-3 and all the colours which are not green require an immediate improvement. The statement with the lowest score for crew members and shore personnel is: "*I never breach operating procedures, even if the breach is in the company's best interests*".

Crew members should strictly follow the SOPs in all conditions. The importance and benefits of following SOPs need to be communicated between ship and shore clearly to enhance operational safety on board. Sometimes, seafarers breach operating procedures and compromise safety in order to deliver the cargo on time. They also conduct these risky deviations to show their commitment to the company by taking additional risks. However, the shipping industry has experienced numerous accidents due to deviations from the company SOPs since it is a well-known fact within the shipping industry that SOPs do not always match with operational realities. These deviations to overcome a problem are defined as shortcuts or workarounds in shipping. Therefore, there is a need for continuous SOP improvement in order to address these impractical or unworkable procedures which cause seafarers to perform deviations on board vessels. Standard Operating Procedures need to be reviewed regularly to enhance operational safety. There is not an effective system to modify unpractical procedures within this company. The Procedure Improvement Tool which was developed as a safety culture improvement methodology can be utilized to modify impractical SOPs in a structured and consistent manner.

Even though crew members strongly believe that they are closely monitored to ensure company procedures are strictly followed, the shore personnel do not share the same perception. The reason behind the different perceptions between ship and shore should be discussed within the company to bring the shore members' perception to a sufficient level. Recording and monitoring tools can be utilised to generate an evidence to ensure crew members' adherence to safety rules.

Table 6-3 Procedures and Safety Rules Dimension

Procedures and Safety Rules

Statements	Average Score	
	Crew Members	Shore Personnel
7. Crew members are closely monitored to ensure company procedures are always followed.	84.56	79.75
8. There is an effective system in place to modify the procedures that are unworkable or impractical for crew use.	79.23	76.07
9. I never breach operating procedures, even if the breach is in the company's best interests.	78.63	72.31
10. Operating procedures provided by the company are helpful to the conduct of daily operations.	82.39	81.37
11. Safety rules and procedures are strictly followed.	86.22	81.46
12. The crew members are never encouraged to break rules to complete a task or maintain the timetable.	83.03	83.71

6.3.4.3 Feedback Statements

The feedback factor consists of four statements. The average scores of the each statement for crew members and shore personnel are given in Table 6-4 and all the colours which are not green require an immediate improvement. The statement with the lowest score for crew members and shore personnel is: "*I receive feedback about my compliance to safety procedures*".

The adherence to standard operating procedures is of paramount importance in the shipping industry to retain and achieve appropriate level of safety. The compliance can be described as adherence to safety rules, laws, procedures and guidelines. The shore personnel think that seafarers do not receive a sufficient amount of feedback regarding to their compliance to safety procedures. There should be a system in place to provide feedback for the crew members on how each ship is performing regarding to compliance to standard operating procedures. Crew members who genuinely adhere to procedures and provide suggestions for improvement should be acknowledged by the company and feedback should be provided to the fleet about the most compliant vessel since deviations from SOPs can result in accidents and incidents.

Table 6-4 Feedback Dimension

Feedback		
Statements	Average Score	
	Crew Members	Shore Personnel
13. I am always informed about the outcome of shipboard safety meetings.	85.42	81.27
14. I am satisfied with the follow-up measures taken after accidents, incidents and near misses.	82.99	84.97
15. The crew is always given feedback on accidents, incidents, and near misses that occur on-board.	85.50	82.36
16. I receive feedback about my compliance to safety procedures.	82.22	74.05

6.3.4.4 Involvement Statements

The involvement factor consists of five statements. The average scores of the each statement for crew members and shore personnel are given in Table 6-5 and all the colours which are not green require an immediate improvement. In general, the average scores are high in the involvement factor. Crew members' answers are recorded as good or very good. The statement with the lowest score for shore members: "*Staff from all departments and levels attends safety meetings*".

Shore personnel believe that participant numbers for the safety meeting should be increased and the outcomes of the safety meetings should be communicated to the employees more clearly. Furthermore, shore personnel should be involved more about the changes that affect their working practices.

Table 6-5 Involvement Dimension

Involvement		
Statements	Average Score	
	Crew Members	Shore Personnel
17. Crew members are encouraged to improve safety.	90.02	88.42
18. Suggestions to improve health and safety are welcomed.	89.43	87.76

19. I am consulted about, and invited to get involved in changes that affect safe work practices.	84.87	79.64
20. I have sufficient control of my work to ensure it is always completed safely.	86.73	82.69
21. Staff from all departments and levels attends safety meetings.	89.70	78.41

6.3.4.5 Just Culture Statements

The just culture factor consists of six statements. The average scores of the each statement for crew members and shore personnel are given in Table 6-6 and all the colours which are not green require an immediate improvement. The statement with the lowest score for crew members and shore personnel is: "*Mistakes are corrected without punishment and treated as a learning opportunity"*.

The lowest score of the statement identifies the well-known factor in the maritime industry called "blame culture". Especially, shore personnel's perception on just culture level of the company can be considered as extremely insufficient. There is a certain problem within this company regarding how the errors or mistakes are handled. Probably numerous events go silent due to the existing blame culture within the company and the fear of punishment forces them not to report all the near misses happening on board. Same problems may lead to a catastrophe in future if the corrective actions are not taken. Therefore, blame culture should be eliminated to enhance safety culture maturity level within the organization. People should be treated as a resource for safety improvement rather than someone to blame for the failure. Implementation of the "just culture approach" can assist shipping companies to treat mistakes in a consistent and anonymous manner to increase the trust between each group. A well-established "just culture" will also increase the number of safety related reporting within an organization. Cultural norms of the respondents on managing errors should be carefully investigated in order to come up with a fit for purpose improvement action.

Moreover, the importance of being a team is of substantial importance for preventing accidents and incidents. A resilient crew team can cover up each other's deficiencies by cooperating, communicating and enhancing situational awareness. Therefore, if a junior crew member identifies a problem which is overlooked by a senior, they should be able to talk to their seniors without any hesitation. Seniors members' attitudes should also be encouraging for juniors to speak up freely regarding the safety matters.

Table 6-6 Just Culture Dimension

Just Culture		
Statements	**Average Score**	
	Crew Members	**Shore Personnel**
22. Mistakes are corrected without punishment and treated as a learning opportunity.	75.96	67.90
23. The company always tries to resolve any safety concerns and problems identified.	82.47	82.59
24. Crew members should question a senior officer's decision if safety is affected.	79.63	71.93
25. I am able to discuss any concerns I have with my line manager.	80.99	84.25

6.3.4.6 Problem Identification Statements

The problem identification factor consists of nine questions. The average scores of the each statement for crew members and shore personnel are given in Table 6-7 and all the colours which are not green require an immediate improvement. The statement with the lowest score for crew members and shore staff is: "*Crew members do not carry out non-work activities while on duty*".

Results of the Q32 indicated that according to the shore personnel, crew members quite often carry out non work activities while on duty. Due to the dangerous nature of the shipping, crew members should always be extremely alert to maintain safety on board. The industry faced with numerous catastrophes because crew members were distracted by other elements. It is of therefore important to have interviews with the crew to identify the nature of the non-work activities and develop measures to eliminate those since it is quite obvious from the low results that this practice is known to the majority of the seafarers. It is also important to investigate how this subculture has been developed, why this practice has been tolerated for a long duration of a time and became widespread within the company. Shore personnel also share the same perception which identifies that the problem is known to the management as well. A thorough investigation should take place to gain more insight into the issues that cause to this perception.

Employees also believe that it is quite likely to be involved in an accident within the organization. Organization needs to invest on accident preventive measures and these efforts should be clearly communicated to seafarers in order to change this perception.

Question 28 identifies a significant problem within the company. Employees do not ask for assistance due to the fear of being seen as incompetent when it is required. The company should establish campaigns to inform and encourage employees in order to ask for help when they are in need regardless of their ranks, age, gender and experience levels.

Table 6-7 Problem Identification Dimension

Problem Identification		
Statements	**Average Score**	
	Crew Members	**Shore Personnel**
26. Other crew members encourage me to report unsafe events.	83.02	79.88
27. I am confident that I can operate the equipment within my area of responsibility safely.	87.13	79.87
28. Asking for assistance cannot make me look incompetent.	77.06	71.67
29. Whenever I see unsafe behaviour, I always report it.	84.08	81.07
30. I am encouraged to conduct, or refer to a risk assessment before performing any hazardous work.	88.08	87.26
31. I am encouraged to report all near misses.	88.05	88.48
32. Crew members do not carry out non-work activities while on duty.	69.52	58.87
33. I mind when other crew members ignore safety procedures.	87.43	82.99
34. The possibility of being involved in an accident is not high in this company.	72.69	69.27

6.3.4.7 Priority of Safety Statements

The priority of safety factor consists of nine statements. The average scores of the each statement for crew members and shore personnel are given in Table 6-8 and all the colours which are not green require an immediate improvement. The statement with the lowest score for crew members and shore personnel is: "*The Company makes too much noise (excessive promotion) about safety".*

A company which treats safety as a core value should always make too much noise about safety. However, employees do not have the perception that the company does enough with regards to this aspect. Based on the information provided, the company mostly takes action something goes wrong. The company should utilize more improvement methods to change this perception amongst employees, possibly through better and more effective communication. Additionally, this questionnaire study is a safety initiative and the implementation of it should have considered as a safety promotion since employees received several reminder emails prior to and during the safety culture questionnaire. However, when the low results were further investigated during interview, it has been identified that the question was not fully understood and received in a negative way. Due to lack of an advanced safety culture understanding, the respondents interpreted "excessive promotion" in a negative way. This question was eliminated due to insufficient loading via the factor analysis for future studies in order to avoid any misinterpretation.

According to the results of Q 36, the respondents also found the management policy of the company on safety vs timetable insufficient. If the company neither allocate enough resources to navigate the ship safely nor suspend the shipping operations due to valid safety reasons, the "safety first" slogan does not go beyond being a wall decoration. Timetable pressure from the company can also lead crew members to take risky actions which can result in catastrophic events. In order the change crew members' perception on timetable vs safety, the company should be consistent with their actions and keep prioritizing safety.

Manning levels should be investigated carefully since crew members believe manning levels are not appropriate for their workload. Insufficient manning levels lead crew members to accumulate fatigue which is known as the main underlying reason for many shipping accidents. Workload observation study can be conducted to identify whether sufficient number of crew is allocated to run the ship safely. The details of this study can be found in Chapter 5.

Furthermore, employees do not think that company is giving more attention to safety now than a year ago. The number of safety improvement initiatives should be steadily increased to change this perception and these initiatives should be communicated effectively.

Table 6-8 Priority of Safety Dimension

Priority of Safety		
Statements	**Average Score**	
	Crew Members	**Shore Personnel**
35. When ship management is informed about accidents, incidents, or near misses, corrective action is taken promptly.	84.65	84.75
36. Shore side managers never put timetable or costs above safety.	68.00	72.86
37. Members of the management team are personally and routinely involved in safety.	83.65	82.84
38. The company places a high priority on safety training.	87.30	85.24
39. Manning levels are appropriate for our workload.	74.33	77.99
40. The company is giving much more attention to safety now, than it did one year ago.	79.88	76.26
41. The company has excellent maintenance standards.	80.23	80.49
42. The company takes action(s) not only when an accident occurs.	64.08	70.25
43. The company makes too much noise (excessive promotion) about safety.	53.67	57.16

6.3.4.8 Responsiveness Statements

The responsiveness factor consists of ten statements. The average scores of the each statement for crew members and shore personnel are given in Table 6-9 and all the colours which are not green require an immediate improvement. The statement with the lowest score for crew members and shore personnel is: "*My attention to safety does not suffer when I have been stressed or fatigued"*.

The contribution of the fatigue to the maritime accidents is undeniable and it is mentioned in the literature numerous times. Both seafarers and shore personnel stated that they lose their attention to safety when they are stressed or fatigued. The main cause of the fatigue and stress is known as the workload, therefore, observation studies should be arranged to gain further insight into workload of the employees. Fatigue management courses should be delivered to all crew members in order to increase resilience of the seafarers. The shift patterns of the seafarers can also contribute to fatigue hence it is a well-known fact that seafarers accumulate fatigue when they work 6 on – 6 off on board vessels.

The employees disagree with the fact that they are provided with adequate resources to perform their jobs safely. As it can also be seen from the lowest scores achieved regarding the work and rest period issue, the company should probably look into their manning levels to capture underlying reasons of the current problems. An overt observation study can also identify which crew members' workload distribution should be addressed.

Results for the question 45 highlight that shore personnel believe that crew members could operate the equipment more effectively. The reason behind this perception should be investigated between ship management and ship officers and more comprehensive familiarization and training should be provided to crew members. Bridge or engine room equipment may change from a ship to a ship since even sister ships can have different set of equipment and layout. Inductions are of therefore importance to familiarize crew members with the on board equipment and hence enhance operational safety.

Lastly, crew members should be more aware regarding fatigues of others and ship management should invest in fatigue management courses for crew members. The causes of fatigue should also be investigated to define whether inappropriate shift patterns or the insufficient manning is the biggest contributor for fatigue.

Table 6-9 Responsiveness Dimension

Responsiveness		
Statements	**Average Score**	
	Crew Members	**Shore Personnel**
44. I feel confident that I will be able to operate effectively in an emergency situation.	84.04	81.34
45. I am confident that I can operate all equipment in my work area effectively.	85.70	76.69
46. My attention to safety does not suffer when I am stressed or fatigued.	50.33	54.70
47. I am provided adequate resources (time, staffing, budget, and equipment) to perform my job.	74.94	72.93
48. There is a system in place for observing my rest hours.	84.29	84.46
49. The crew is expected to comply with work-rest hour regulation.	84.79	86.36
50. I have adequate rest on the work schedule cycle that I work.	79.42	79.17
51. Crew members monitor each other for signs of stress or fatigue.	81.25	75.48
52. Our crew has adequate training in emergency procedures.	85.75	81.27
53. The crew has access to all necessary personal protective equipment (PPE).	86.55	79.88

6.3.4.9 Safety Awareness Statements

The safety awareness factor consists of 16 statements. The average scores of the each statement for crew members and shore personnel are given in Table 6-10 and all the colours which are not green require an immediate improvement. The statement with the lowest score for crew members and shore personnel is: "*Expected time of arrival can be postponed in order to follow safety rules strictly on board*".

The question 66 highlights a safety critical issue within the company. Shipping companies are exposed to time pressure from numerous stakeholders to deliver cargo on time due to the contractual requirements. Sometimes shipping companies take additional risks to avoid penalties due to delay and continue their operations. Even though, sailing or time schedule are of paramount importance for the shipping organizations, an operation should immediately stop if safety is at stake. The company needs to communicate clearly that ETA can be postponed if necessary, in order to change the lack of awareness within the organization as the industry is familiar with the severe consequences of deviations.

Watch handovers are of crucial importance to enhance safety awareness amongst crew since a thorough handover note increases the knowledge/ familiarisation of the crew members regarding the strengths and weakness of a vessel. However, the respondents stated that sometimes hand overs are not comprehensive and sufficient time is not allocated for proper handover. Without familiarization, crew members can find themselves in extremely compromising conditions.

Shore staff highlights the need for the increased number of safety meetings. It is also of significant importance to involve as many business units as possible for taking different perceptions into account and having fruitful safety related discussions.

As identified in question 62, alcohol use is extremely dangerous and cannot be tolerated in any circumstances due to the associated risks of its use. Therefore, respondents' perceptions should be taken into account to identify the people who breach the procedure related to alcohol use.

Lastly, safety attitudes and perceptions should be treated as the most critical traits during the recruitment processes. The company will therefore maintain higher standards of safety culture of its crew in the future.

Table 6-10 Safety Awareness Dimension

Safety Awareness		
Statements	**Average Score**	
	Crew Members	**Shore Personnel**

54. Watch hand-overs are comprehensive and not hurried.	84.07	75.54
55. My ship works to ensure the safety in hazardous areas and during hazardous activities.	85.38	83.21
56. My ship holds an adequate number of safety meetings.	86.10	77.82
57. Checklists are essential for safety.	87.18	83.54
58. The company provides sufficient time for the hand-overs when joining the ship.	77.16	77.69
59. Learning from mistakes is a good way to improve overall safety.	82.75	81.83
60. I always give proper instructions when I initiate any work.	85.71	82.07
61. Drug abuse is not a safety issue in my company.	88.21	82.10
62. Alcohol use is not a safety issue in my company.	85.42	78.65
63. Safety briefings and training are professional and effective.	86.18	82.70
64. Safety is the top priority for crew on board this ship.	91.09	87.65
65. When I joined this ship, I received a proper induction, including familiarization with new tasks.	85.95	84.03
66. Expected time of arrival can be postponed in order to follow safety rules strictly on board.	66.95	66.26
67. Safety is a visible part of the selection and recruitment process in this company.	84.93	79.75
68. This company cares about my health and safety.	86.81	83.18
69. I fully understand my responsibilities for health and safety.	89.66	86.47

6.3.4.10 Training and Competence Statements

The training and competence factor consists of six statements. The average scores of the each statement for crew members and shore personnel are given in Table 6-11 and all the colours which are not green require an immediate improvement. The statement with the lowest score for crew members and shore personnel is*: "I am trained to cope with fatigue".*

There should be fatigue management training for employees to observe the sign of fatigue in order to avoid fatigue related accidents. Accumulation of fatigue causes sleepiness and thus shipping accidents. The competency of seafarers becomes extremely crucial during emergencies rather than day to day routine shipping operations. Therefore shore members' perceptions should be taken into account and more emergency trainings should be delivered to crew members. Ship management personnel should also have an adequate level off knowledge regarding to the SMS since they monitor the performance of the crew according to their adherence to the SMS.

Table 6-11 Training and Competence Dimension

Training and Competence		
Statements	**Average Score**	
	Crew Members	**Shore Personnel**
70. The training provided by our company is of a high quality and standard.	83.01	80.49
71. My company continuously try to improve the quality of the trainings.	84.46	82.80
72. I have adequate knowledge of the company (Safety) Management System.	82.85	77.56
73. I am properly trained to deal with unfamiliar situations where safety might be at stake.	83.41	78.19
74. I am trained to cope with fatigue.	74.91	73.85
75. Adequate time is allowed for safety drills.	83.35	81.38

6.3.5 Statistical Results

Differences between group means were examined and tested for statistical significance using ANOVA test. This test is utilised to identify statistical differences between different groups such as age, department etc. If the generated result (p value) is lower than 0.05 for a question, it means that there is a significant statistical differences (scientifically proven) between different groups responded to that particular question. The average scores of the each age group were represented by utilising the same colour codes which were also used while assessing the results of the overall scores of the safety culture dimensions. The meanings of the each colour are given in Chapter 4.

6.3.5.1 Effect of Age

The questions which are highlighted in red represents that there is a significant statistical difference between the different age groups and their answers given to the questionnaires.

Table 6-12 ANOVA on Age (significant interactions, p-value < 0.05, are shown in red)

Var	p-value	Var	p-value	Var	p-value	Var	p-value	Var	p-value
Q1	0.032	Q16	0.001	Q31	0.108	Q46	0.134	Q61	0.148
Q2	0.265	Q17	0.753	Q32	0.001	Q47	0.004	Q62	0.036
Q3	0.026	Q18	0.227	Q33	0.165	Q48	0.142	Q63	0.834
Q4	0.226	Q19	0.009	Q34	0.843	Q49	0.001	Q64	0.667
Q5	0.023	Q20	0.206	Q35	0.064	Q50	0.010	Q65	0.842
Q6	0.871	Q21	0.007	Q36	0.181	Q51	0.010	Q66	0.049
Q7	0.619	Q22	0.000	Q37	0.079	Q52	0.577	Q67	0.555
Q8	0.059	Q23	0.051	Q38	0.149	Q53	0.977	Q68	0.151
Q9	0.304	Q24	0.367	Q39	0.000	Q54	0.073	Q69	0.941
Q10	0.344	Q25	0.067	Q40	0.302	Q55	0.384	Q70	0.056
Q11	0.937	Q26	0.003	Q41	0.029	Q56	0.724	Q71	0.369
Q12	0.052	Q27	0.031	Q42	0.000	Q57	0.713	Q72	0.326
Q13	0.906	Q28	0.217	Q43	0.201	Q58	0.000	Q73	0.560
Q14	0.038	Q29	0.940	Q44	0.329	Q59	0.377	Q74	0.198
Q15	0.029	Q30	0.704	Q45	0.649	Q60	0.130	Q75	0.417

Due to difference in sample size and non-homogenous variances, Hochberg's GT2 and Games-Howell post hoc tests were conducted on the statistically significant variables only (the red cells given above).

Table 6-13 Summary of the findings of post hoc tests for interaction of Age

Q#	QUESTION	18-24	25-34	35-44	45-54	55+
Q3	There is good cooperation between the ship and shore.	85.2	81.6	83.0	82.4	83.2

Q#	QUESTION	18-24	25-34	35-44	45-54	55+
Q5	I always ask questions if I do not understand or unsure about the safety instructions given to me.	91.7	89.8	89.3	89.1	86.2
Q14	I am satisfied with the follow-up measures taken after accidents, incidents and near misses.	85.3	82.2	83.4	83.5	85.1
Q15	The crew is always given feedback on accidents, incidents, and near misses that occur on-board.	86.4	85.6	84.5	82.7	87.6
Q16	I receive feedback about my compliance to safety procedures.	84.3	81.3	80.6	80.1	76.9
Q19	I am consulted about, and invited to get involved in changes that affect safe work practices.	86.1	84.1	84.9	83.1	79.2
Q21	Staff from all departments and levels attends safety meetings.	90.7	88.8	88.0	86.2	85.6
Q22	Mistakes are corrected without punishment and treated as a learning opportunity.	79.3	75.7	71.5	74.9	74.9
Q26	Other crew members encourage me to report unsafe events.	83.9	83.7	81.0	80.5	83.5
Q32	Crew members do not carry out non-work activities while on duty.	73.6	68.2	66.7	67.9	64.6
Q39	Manning levels are appropriate to our workload.	78.0	72.3	74.7	78.2	80.4
Q42	The company don't only get involved in actions when an accident occurs.	62.1	63.5	66.4	66.6	75.9
Q47	I am provided adequate resources (time, staffing, budget, and equipment) to accomplish my job.	75.8	73.0	75.9	76.1	79.6
Q49	The crew is expected to comply with rest hour regulation.	84.3	83.7	86.3	86.7	89.0
Q50	I get adequate rest on the work schedule cycle that I work.	77.0	78.8	80.7	81.9	80.4
Q51	Crew members monitor each other for signs of stress or fatigue.	81.8	81.6	78.7	80.5	77.1
Q58	There is sufficient time allocated for the hand-overs when joining the ship.	79.3	75.0	77.8	81.1	80.4
Q62	Alcohol use is not a safety issue in my company.	85.9	84.3	84.6	86.7	77.1

Q#	QUESTION	18-24	25-34	35-44	45-54	55+
Q66	The rules are always adhered prior a sailing goes ahead.	66.2	66.3	68.6	64.6	73.5

The table above demonstrates the differences between age groups based on the ANOVA analysis. It can be seen form the above table that younger (18-24) seafarers have significantly higher average scores on most of the safety features analysed in this study and they agree with the given statements more than the other age groups. This may be attributable to the general attitude of high energies and excitement displayed by this group.

The younger age groups complain more about their workload distribution and the time allocated for watch handovers. Work-rest hour distribution should be carefully balanced for the all age groups since younger crew members are tend to be less experienced and they may require additional time for the watch handovers.

The 55+ age group believe that alcohol use is a bigger problem than the other age groups within the company. Older seafarers are may have less tolerance to alcohol abuse due to their previous undesired experiences. The 18-24 age group have the highest significantly higher scores regarding to the level of communication and adherence to procedures. Higher scores of the younger group on the communication can be attributed to the advanced communication skills of the younger generations. The 25-34 age group has the second highest safety culture scores on most of the questions.

6.3.5.2 Effect of Gender

The questions which are highlighted in red represents that there is a significant statistical difference between the genders and their answers given to the questionnaires.

Table 6-14 ANOVA on Gender (significant interactions, *p-value* < 0.05, are shown in red)

Var	p-value	Var	p-value	Var	p-value	Var	p-value	Var	p-value
Q1	0.705	Q16	0.004	Q31	0.448	Q46	0.020	Q61	0.009
Q2	0.083	Q17	0.360	Q32	0.106	Q47	0.085	Q62	0.002

Q3	0.793	Q18	0.322	Q33	0.619	Q48	0.000	Q63	0.085
Q4	0.053	Q19	0.296	Q34	0.177	Q49	0.046	Q64	0.270
Q5	0.061	Q20	0.561	Q35	0.619	Q50	0.023	Q65	0.411
Q6	0.038	Q21	0.000	Q36	0.620	Q51	0.000	Q66	0.430
Q7	0.008	Q22	0.882	Q37	0.723	Q52	0.000	Q67	0.288
Q8	0.039	Q23	0.103	Q38	0.579	Q53	0.000	Q68	0.005
Q9	0.009	Q24	0.012	Q39	0.622	Q54	0.003	Q69	0.027
Q10	0.696	Q25	0.759	Q40	0.480	Q55	0.267	Q70	0.001
Q11	0.072	Q26	0.007	Q41	0.886	Q56	0.000	Q71	0.054
Q12	0.315	Q27	0.019	Q42	0.677	Q57	0.139	Q72	0.000
Q13	0.027	Q28	0.617	Q43	0.387	Q58	0.530	Q73	0.021
Q14	0.856	Q29	0.009	Q44	0.018	Q59	0.960	Q74	0.340
Q15	0.044	Q30	0.127	Q45	0.000	Q60	0.004	Q75	0.255

Due to difference in sample size and non-homogenous variances, Hochberg's GT2 and Games-Howell post hoc tests were conducted on the statistically significant variables only. A summary of the post hoc tests is outlined in the table below. The group scoring significantly higher average is highlighted using green colour.

Table 6-15 Summary of the findings of post hoc tests for interaction of Gender

No	QUESTION	M	F
Q6	The company operates an effective system for reporting safety matters.	85.7	82.2
Q7	Crew members are closely monitored to ensure proper procedures are always followed.	84.3	79.7
Q8	There is an effective system in place to fix procedures that are unworkable or impractical for crew use.	79.1	75.3
Q9	I never breach operating procedures, even if the breach is in the company's best interests.	78.2	72.9
Q13	I am always informed about the outcome of shipboard safety meetings.	85.2	81.6
Q16	I receive feedback about my compliance to safety procedures.	81.6	76.5
Q21	Staff from all departments and levels attends safety meetings.	88.7	82.5
Q24	Crew members should question senior officers' decisions when safety is affected.	79.2	71.4
Q26	Other crew members encourage me to report unsafe events.	82.9	78.2
Q27	I am confident that I can operate the equipment within my area of responsibility safely.	86.5	82.6
Q29	Whenever I see unsafe behaviour, I always report it.	83.9	79.7

No	QUESTION	M	F
Q44	I feel confident that I will be able to operate effectively in an emergency situation.	83.9	80.0
Q45	I am confident that I can operate all equipment in my work area effectively.	85.1	78.6
Q46	My attention to safety does not suffer when I am stressed or fatigued.	50.5	56.9
Q48	There is a system in place for observing my rest hours.	84.6	76.6
Q50	I get adequate rest on the work schedule cycle that I work.	79.6	74.6
Q51	Crew members monitor each other for signs of stress or fatigue.	80.9	73.4
Q52	Our crew has adequate training in emergency procedures.	85.5	79.7
Q53	The crew has access to all necessary personal protective equipment (PPE).	86.2	77.8
Q54	Watch hand-overs are thorough and not hurried.	83.4	78.3
Q56	My ship holds an adequate number of safety meetings.	85.5	77.5
Q60	I always give proper instructions when I initiate any work.	85.5	80.9
Q61	Drug abuse is not a safety issue in my company.	87.8	82.3
Q62	Alcohol use is not a safety issue in my company.	85.0	77.5
Q68	This company cares about my health and safety.	86.6	81.8
Q69	I fully understand my responsibilities for health and safety.	89.5	86.3
Q70	The training provided by our company is of a high quality and standard.	83.0	77.1
Q72	I have adequate knowledge of the company (Safety) Management System.	82.5	75.9
Q73	I am properly trained to deal with unfamiliar situations where safety might be at stake.	83.0	79.3

It is obvious from above that males generally scored higher than females. This may be attributable to the higher level of safety training received by the male seafarers within the company. Even though, both groups have extremely insufficient scores for the fatigue and stress management statement, females have significantly higher scores than the male respondents in this question. This statement shows that when female respondents are stressed or fatigued, their attention to safety is affected less than the male respondents participated in the study.

6.3.5.3 Effect of Department

The questions which are highlighted in red represents that there is a significant statistical difference between the departments and their answers given to the questionnaires.

Table 6-16 ANOVA on Department (significant interactions, *p-value* < 0.05, are shown in red)

Var	p-value	Var	p-value	Var	p-value	Var	p-value	Var	p-value
Q1	0.009	Q16	0.000	Q31	0.034	Q46	0.074	Q61	0.000
Q2	0.067	Q17	0.168	Q32	0.000	Q47	0.056	Q62	0.000
Q3	0.075	Q18	0.382	Q33	0.000	Q48	0.002	Q63	0.002
Q4	0.022	Q19	0.000	Q34	0.034	Q49	0.087	Q64	0.023
Q5	0.003	Q20	0.001	Q35	0.073	Q50	0.084	Q65	0.152
Q6	0.126	Q21	0.000	Q36	0.007	Q51	0.000	Q66	0.365
Q7	0.000	Q22	0.000	Q37	0.023	Q52	0.000	Q67	0.000
Q8	0.063	Q23	0.012	Q38	0.020	Q53	0.000	Q68	0.003
Q9	0.000	Q24	0.000	Q39	0.002	Q54	0.000	Q69	0.000
Q10	0.276	Q25	0.024	Q40	0.013	Q55	0.002	Q70	0.038
Q11	0.000	Q26	0.016	Q41	0.799	Q56	0.000	Q71	0.031
Q12	0.223	Q27	0.000	Q42	0.000	Q57	0.007	Q72	0.000
Q13	0.000	Q28	0.002	Q43	0.046	Q58	0.731	Q73	0.000
Q14	0.062	Q29	0.065	Q44	0.000	Q59	0.005	Q74	0.896
Q15	0.038	Q30	0.006	Q45	0.000	Q60	0.000	Q75	0.067

Due to difference in sample size and non-homogenous variances, Hochberg's GT2 and Games-Howell post hoc tests were conducted on the statistically significant variables only. A summary of the post hoc tests is outlined in the table below. Dark green colours represent the highest safety culture scores and the dark red colours represent the poorest safety culture scores.

Table 6-17 Summary of the findings of post hoc tests for interaction of Department [

* D: Deck department; E: Engineering department; R: Ratings department; PO: Port Officer department; SM: Ship management department

No	QUESTION	Departments*

		D	E	R	PO	SM
Q1	Language/dialect related issues amongst crew members are not a threat to safety.	65.3	65.1	69.3	60.5	59.5
Q4	Operational values, objectives and targets are effectively communicated.	84.9	83.5	82.5	82.7	80.0
Q7	Crew members are closely monitored to ensure proper procedures are always followed.	85.3	84.1	83.6	79.3	81.0
Q9	I never breach operating procedures, even if the breach is in the company's best interests.	80.2	77.5	77.1	72.7	70.9
Q11	Safety rules and procedures are strictly adhered-to.	86.4	86.2	85.1	81.3	82.2
Q13	I am always informed about the outcome of shipboard safety meetings.	85.1	86.6	83.6	82.0	78.9
Q16	I receive feedback about my compliance to safety procedures.	81.4	82.6	83.3	75.4	70.0
Q19	I am consulted about, and invited to get involved in changes that affect safe work practices.	84.3	85.6	85.0	80.8	76.1
Q21	Staff from all departments and levels attends safety meetings.	90.0	90.1	87.7	79.8	74.1
Q22	Mistakes are corrected without punishment and treated as a learning opportunity.	76.7	74.3	77.4	67.0	70.8
Q23	The company always tries to resolve any safety concerns and problems identified.	82.9	80.9	84.7	83.1	81.0
Q24	Crew members should question senior officers' decisions when safety is affected.	81.8	79.4	75.8	74.1	64.4
Q27	I am confident that I can operate the equipment within my area of responsibility safely.	86.9	88.4	84.9	78.7	84.0
Q30	I am encouraged to conduct, or refer to a risk assessment before performing any hazardous work.	88.0	89.2	85.4	87.5	86.5
Q31	I am encouraged to report all near misses.	88.1	89.0	85.9	88.8	87.3
Q32	Crew members do not carry out non-work activities while on duty.	68.8	70.2	69.8	60.0	54.5
Q33	I mind when other crew members ignore safety procedures.	88.9	87.9	83.3	84.7	77.4

No	**QUESTION**	**Departments***				
		D	**E**	**R**	**PO**	**SM**
Q36	Shore side managers never put timetable or costs above safety.	68.3	67.6	67.3	74.8	64.7
Q37	Members of the management team are personally and routinely involved in safety.	84.0	84.4	81.1	83.4	80.6
Q39	Manning levels are appropriate to our workload.	74.2	73.1	77.5	79.3	73.1
Q42	The company doesn't only get involved in actions when an accident occurs.	65.7	62.9	62.4	71.6	65.6
Q43	The company does not make too much noise about safety.	54.6	53.0	53.3	55.3	64.0
Q44	I feel confident that I will be able to operate effectively in an emergency situation.	83.7	85.9	81.3	82.7	76.8
Q45	I am confident that I can operate all equipment in my work area effectively.	85.4	87.1	83.5	76.6	76.9
Q48	There is a system in place for observing my rest hours.	84.5	84.7	83.1	86.8	76.0
Q51	Crew members monitor each other for signs of stress or fatigue.	81.2	81.5	80.9	76.4	72.1
Q52	Our crew has adequate training in emergency procedures.	86.2	85.5	84.8	82.3	77.7
Q53	The crew has access to all necessary personal protective equipment (PPE).	86.6	86.8	85.4	81.1	75.4
Q54	Watch hand-overs are thorough and not hurried.	85.1	84.1	81.6	76.0	74.1
Q55	My ship works to ensure the safety in hazardous areas and during hazardous activities.	85.9	85.8	83.4	84.2	80.0
Q56	My ship holds an adequate number of safety meetings.	86.1	86.5	85.3	79.5	71.9
Q59	Learning from mistakes is a good way to improve overall safety.	83.9	80.5	84.2	82.8	78.4
Q60	I always give proper instructions when I initiate any work.	85.4	86.8	83.9	83.1	78.4
Q61	Drug abuse is not a safety issue in my company.	89.0	88.5	84.9	84.1	74.9
Q62	Alcohol use is not a safety issue in my company.	84.7	87.1	82.2	80.0	73.9

No	QUESTION	Departments*				
		D	E	R	PO	SM
Q67	Safety is a visible part of the selection and recruitment process in this company.	85.0	84.9	84.5	80.5	77.4
Q68	This company cares about my health and safety.	87.0	86.4	87.5	84.3	79.5
Q69	I fully understand my responsibilities for health and safety.	89.7	89.5	89.8	88.1	81.5
Q70	The training provided by our company is of a high quality and standard.	83.2	82.5	83.3	81.7	76.2
Q72	I have adequate knowledge of the company (Safety) Management System.	82.6	83.7	81.3	79.7	70.5
Q73	I am properly trained to deal with unfamiliar situations where safety might be at stake.	83.8	83.5	81.9	79.2	74.5

The results of the ANOVA analysis between the departments demonstrated that ‘Deck’ and ‘Engineering’ departments are more tuned up to align themselves for the safety aspects analysed in this study. Deck and Engineering Department members (officers) receive a substantial amount of training to maintain safety of the fleet and thus their safety culture attitudes and perceptions are high. Officers have lower scores than other groups only on matters regarding the workload and company’s involvement after accidents. Senior shipping crew therefore find their workload more problematic and they think the company gets involved mostly when something goes wrong on board. With regards to the workload, it is a well-known fact that crew members’ ranks and the time they spend on paperwork increase are aligned with each other. After the officers, next higher attitude and perception scores are achieved by ratings and they were followed by port officers and ship management. Interestingly, ship management feels that ‘not enough’ safety consideration is evident amongst crew members. There is a definite discrepancy between what crew members and shore management think regarding on board safety culture. Even though some of the shore personnel may have the seafaring background, the operating procedures and best practices change continuously on board due to the advancement of the technology. Therefore, ship management personnel and port officers conduct more ship visits to gain insight into the prevailing safety culture perceptions of the crew members. Either ship management do not have the full picture about the current shipping operations or not the all existing problems within the fleet are known to crew members of the each vessel. Ship management have significantly lower scores than others at the majority of the questions.

6.3.5.4 Effect of Seafarers' Ranks

The questions which are highlighted in red represents that there is a significant statistical difference between the seafarer's ranks and their answers given to the questionnaires.

Table 6-18 ANOVA on Rank (significant interactions, *p-value* < 0.05, are shown in red)

Var	p-value	Var	p-value	Var	p-value	Var	p-value	Var	p-value
Q1	0.000	Q16	0.000	Q31	0.000	Q46	0.103	Q61	0.000
Q2	0.027	Q17	0.005	Q32	0.000	Q47	0.001	Q62	0.005
Q3	0.022	Q18	0.008	Q33	0.000	Q48	0.000	Q63	0.008
Q4	0.056	Q19	0.000	Q34	0.000	Q49	0.000	Q64	0.016
Q5	0.001	Q20	0.000	Q35	0.002	Q50	0.002	Q65	0.003
Q6	0.288	Q21	0.000	Q36	0.000	Q51	0.019	Q66	0.000
Q7	0.000	Q22	0.000	Q37	0.001	Q52	0.000	Q67	0.007
Q8	0.189	Q23	0.012	Q38	0.024	Q53	0.000	Q68	0.001
Q9	0.000	Q24	0.000	Q39	0.000	Q54	0.000	Q69	0.000
Q10	0.159	Q25	0.001	Q40	0.056	Q55	0.000	Q70	0.140
Q11	0.002	Q26	0.024	Q41	0.458	Q56	0.000	Q71	0.240
Q12	0.157	Q27	0.000	Q42	0.000	Q57	0.008	Q72	0.000
Q13	0.000	Q28	0.000	Q43	0.408	Q58	0.002	Q73	0.000
Q14	0.022	Q29	0.000	Q44	0.000	Q59	0.000	Q74	0.072
Q15	0.093	Q30	0.000	Q45	0.000	Q60	0.000	Q75	0.012

Due to difference in sample size and non-homogenous variances, Hochberg's GT2 and Games-Howell post hoc tests were conducted on the statistically significant variables only. Due to the existence of numerous seafarer ranks (groups) the average safety culture scores are not given. Only the statistically significant differences are identified within this section and the interpretation of each significant statistical difference is given next to the questions by utilising “<” and “>” signs. The table below represents the identified significant differences on each statement.

For Example, on Q7, Captains have higher safety culture scores than 3rd Engineers, 4th Engineers and employees. Captains believe that crew members are more closely monitored than the other groups think.

Table 6-19 Summary of the findings of post hoc tests for interaction of Department

* Capt: Captain; CO: Chief Officer; 2nd O: 2nd Officer; 3rd O: 3rd Officer; DC: Deck Cadet; Bw: Boatswain; AS: Able Seaman; OS: Ordinary Seaman; CE: Chief Engineer; 2nd E: 2nd Engineer; 3rd E: 3rd Engineer; EC: Engineering Cadet; EE: Electrical Engineer; Oil: Oiler; Fit: Fitter; CS: Chief Steward; CC: Chief Cook; 4th E: 4th Engineer; Emply: Employee; Mgr: Manager

No	QUESTION	Remarks*
Q2	There is good communication about safety.	DC > Oil, CC, Empl
Q3	There is good cooperation between the ship and shore.	Capt > 3rd E, Empl DC > 3rd E, Empl
Q5	I always ask questions if I do not understand or unsure about the safety instructions given to me.	Empl < Capt, CO, 2nd O, 2nd E, 4th E
Q7	Crew members are closely monitored to ensure proper procedures are always followed.	Capt > 3rd E, 4th E, Empl
Q9	I never breach operating procedures, even if the breach is in the company’s best interests.	Emply < Capt, CO, 2nd O, 3rd O, AS, CS, CC
Q11	Safety rules and procedures are strictly followed.	Emply < Capt, 2nd O
Q13	I am always informed about the outcome of shipboard safety meetings.	Empl < Capt, CE, 2nd E, 3rd E, EC
Q14	I am satisfied with the follow-up measures taken after accidents, incidents and near misses.	CS > 2nd O, CE, 3rd E
Q16	I receive feedback about my compliance to safety procedures.	Empl < DC, AS, OS, 2nd E, 3rd E, Oil, Other, 4th E.
Q17	Crew members are encouraged to improve safety.	Capt > 2nd O, 3rd O, Empl
Q18	Suggestions to improve health and safety are welcomed.	Capt > 3rd O, AS, Oil, Empl
Q19	I am consulted about, and invited to get involved in changes that affect safe work practices.	Capt > 3rd O, Empl, Mgr Empl < Capt, 2nd E, EC

No	**QUESTION**	**Remarks***
Q20	I have sufficient control of my work to ensure it is always completed safely.	Capt > 3rd E, Empl Empl < Capt, CE, CS
Q21	Staff from all departments and levels attends safety meetings.	Capt > 2nd O, AS, OS, 3rd E, Oil, Fit, CC, Empl, Mgr Empl < Capt, CO, 2nd O, 3rd O, DC, Bw, AS, OS, CE, 2nd E, 3rd E, EC, Oil, CS, 4th E Mgr < Capt, CE, 2nd O, 3rd O, CE, 2nd E, 3rd E, CS, 4th E
Q22	Mistakes are corrected without punishment and treated as a learning opportunity.	DC > Capt, CO, 3rd O, CE, 2nd E, 3rd E, 4th E, Empl, Mgr Empl < DC, AS, OS, CC Mgr < DC, AS, OS, Fit
Q23	The company always tries to resolve any safety concerns and problems identified.	4th E < Capt, DC
Q24	Crew members should question senior officers' decisions when safety is affected.	Empl < Capt, CO, 2nd O, 3rd O, CE, 2nd E, 3rd E, 4th E
Q25	I am able to discuss any concerns I have with my line manager.	Capt > 2nd O, 3rd O, AS, 3rd E, Oil, Fit, 4th E Mgr > 3rd O
Q27	I am confident that I can operate the equipment within my area of responsibility safely.	Empl < Capt, 2nd O, AS, CE, 2nd E, 3rd E, Fit, 4th E Mgr < Capt
Q28	Asking for assistance cannot make me look incompetent.	AS < Capt, CO, 2nd O, 3rd O, CE, 2nd E, 3rd E, 4th E OS < Capt, CO, 2nd O, 3rd O, CE, 2nd E, 3rd E Fit < Capt, CO, 2nd O, 3rd O, CE, 3rd E CC < Capt, CO, 2nd O, 3rd O Empl < Capt, CO, 2nd O, 3rd O, CE, 2nd E, 3rd E
Q29	Whenever I see unsafe behavior, I always report it.	Capt > 2nd O, DC, 3rd E, Other, 4th E, Empl Empl < Capt, CE, CS
Q30	I am encouraged to conduct, or refer to a risk assessment before performing any hazardous work.	Epml < Capt, 2nd E
Q32	Crew members do not carry out non-work activities while on duty.	Empl < Capt, CO, 3rd O, CE, 2nd E, 3rd E, EC, 4th E Mgr < EC

No	**QUESTION**	**Remarks***
Q33	I mind when other crew members ignore safety procedures.	OS < Capt, CO, 2^{nd} O, 3^{rd} O, CE Oil < Capt, CO, CE Fit < Capt, CO, 2^{nd} O, 3^{rd} O, CE Emply < Capt, CO, 2^{nd} O, 3^{rd} O, CE, 3^{rd} E, 4^{th} E
Q34	The possibility of being involved in an accident is not high in this company.	Capt > AS, OS, Oil, Fit, CC, Emply OS < Capt, CO, 2^{nd} O Oil < Capt, 2^{nd} O
Q35	When ship management is told about accidents, incidents, or near misses corrective action is taken promptly.	Capt > 3^{rd} O, AS, OS, 3^{rd} E, Oil, Fit, 4^{th} E, Emply
Q36	Shore side managers never put timetable or costs above safety.	Capt > 2^{nd} O, OS, 3^{rd} E Mgr > 2^{nd} O, 3^{rd} O, Bw, AS, OS, 3^{rd} E, Oil, Fit, 4^{th} E, Emply
Q37	Members of the management team are personally and routinely involved in safety.	Capt > Fit, Emply
Q38	The company places a high priority on safety training.	Capt > Emply
Q39	Manning levels are appropriate to our workload.	3^{rd} O < OS, EC, Oil, CC, Mgr 3^{rd} E < Capt, DC, AS, OS, EC, Oil, Fit, CC, 4^{th} E, Emply, Mgr
Q42	The company doesn’t only take actions when an accident occurs.	Capt > 3^{rd} O, AS, OS, 2^{nd} E, 3^{rd} E, Oil, Fit, CC Mgr > AS, OS, 2^{nd} E, 3^{rd} E, Oil, Fit, CC
Q44	I feel confident that I will be able to operate effectively in an emergency situation.	Capt > Fit, CC, Emply OS < Capt, CO, 2^{nd} O, CE, 2^{nd} E, 3^{rd} E, 4^{th} E Emply < Capt, CO, 2^{nd} O, CE, 2^{nd} E, 3^{rd} E, 4^{th} E
Q45	I am confident that I can operate all equipment in my work area effectively.	Capt > AS, OS, Emply, Mgr Emply < Capt, CO, 2^{nd} O, 3^{rd} O, AS, CE, 2^{nd} E, 3^{rd} E, Fit, 4^{th} E
Q47	I am provided adequate resources (time, staffing, budget, and equipment) to accomplish my job.	Capt > 3^{rd} O, 2^{nd} E, 3^{rd} E, Emply
Q48	There is a system in place for observing my rest hours.	Capt > Bw, AS, OS, 3^{rd} E, Oil, Fit, Emply OS < Capt, CO, 2^{nd} O, CE, 2^{nd} E, CS, 4^{th} E, Mgr Mgr > AS, OS, Oil, Fit, Emply
Q49	The crew is expected to comply with rest hour regulation.	Mgr > 2^{nd} O, 3^{rd} O, AS, OS, 3^{rd} E, Oil, Fit, CC, 4^{th} E, Emply

No	**QUESTION**	**Remarks***
Q50	I get adequate rest on the work schedule cycle that I work.	Capt > Emply
Q51	Crew members monitor each other for signs of stress or fatigue.	Emply < 2^{nd} E, EC, 4^{th} E
Q52	Our crew has adequate training in emergency procedures.	Emply < Capt, 3^{rd} O, AS, 3^{rd} E, CS
Q53	The crew has access to all necessary personal protective equipment (PPE).	Capt > AS, OS, Emply Emply < Capt, CO, 2^{nd} O, 3^{rd} O, AS, OS, CE, 2^{nd} E, 3^{rd} E, EC, EE, Oil, CS, CC, 4^{th} E
Q54	Watch hand-overs are thorough and not hurried.	Emply < Capt, CO, 2^{nd} O, 3^{rd} O, DC, Bw, AS, OS, CE, 2^{nd} E, 3^{rd} E, EC, Oil, Fit, 4^{th} E
Q55	My ship works to ensure the safety in hazardous areas and during hazardous activities.	Capt > AS, OS, 4^{th} E, Emply
Q56	My ship holds an adequate number of safety meetings.	Capt > AS, Emply, Mgr Emply < Capt, CO, 2^{nd} O, 3^{rd} O, DC, OS, CE, 2^{nd} E, 3^{rd} E, EC, EE, Oil, CS, CC, 4^{th} E
Q57	Checklists are essential for safety.	Emply < Capt, 2^{nd} O, 3^{rd} E
Q58	There is sufficient time allocated for the hand-overs when joining the ship.	Capt > 3^{rd} O, 3^{rd} E
Q59	Learning from mistakes is a good way to improve overall safety.	AS > CE, 2^{nd} E, 3^{rd} E, 4^{th} E, Emply
Q60	I always give proper instructions when I initiate any work.	Capt > DC, AS, OS, Emply Emply < Capt, 2^{nd} O, 3^{rd} O, CE, 2^{nd} E, 3^{rd} E
Q61	Drug abuse is not a safety issue in my company.	Emply < 3^{rd} E, AS, 2^{nd} E, 3^{rd} E, CS
Q63	Safety briefings and training are professional and effective.	Emply < Capt, 2^{nd} O
Q64	Safety is the top priority for crew on board this ship.	Capt > Emply
Q65	When I joined this ship, I received a proper induction, including familiarization with new tasks.	Capt > 4^{th} E, Emply
Q66	The rules are always adhered prior a sailing goes ahead.	Capt > 2^{nd} O, OS, Oil, Emply CE > OS, Oil, Emply
Q67	Safety is a visible part of the selection and recruitment process in this company.	Empl < AS
Q68	This company cares about my health and safety.	Capt > 3^{rd} O, 3^{rd} E, 4^{th} E, Empl CS > 3^{rd} O, 4^{th} E, Empl Empl < Capt, CO, CS

No	QUESTION	Remarks*
Q69	I fully understand my responsibilities for health and safety.	Capt > 2^{nd} O, 3^{rd} O, AS, OS, 3^{rd} E, Fit, CC, 4^{th} E, Empl Empl < Capt, CO, 2^{nd} O, CE, 2^{nd} E, 3^{rd} E, CS, Mgr
Q72	I have adequate knowledge of the company (Safety) Management System.	Capt > 3^{rd} O, Bw, AS, OS, 3^{rd} E, Fit, Emply Emply < Capt, CO, 2^{nd} O, 3^{rd} O, CE, 2^{nd} E, 3^{rd} E, Oil, 4^{th} E
Q73	I am properly trained to deal with unfamiliar situations where safety might be at stake.	Capt > AS, Emply Emply < Capt, CO, 3^{rd} O, 4^{th} E
Q75	Adequate time is allowed for safety drills.	Capt > AS, Emply

In general, the Captains have significantly higher averages on safety features than all other ranks. Captains are the most expert and competent seafarers and they have been practicing the risky operations for numerous years. Therefore, their adherence to safety is extremely sufficient. Since captains have direct communication with the ship management, they have more knowledge about the new safety initiatives and upcoming safety campaigns which also resulted in higher safety culture perceptions. Deck officers find the overall communication better than the engineering personnel. This may be due to the BRM and the HELM courses, which include communication modules, assist bridge officers to have more superior communication skills compared to other groups.

On the other hand, lower cadre in general and shore employees have displayed significantly lower averages than other categories.

There is a difference between junior bridge officers' and captains' views regarding the involvement. Junior bridge officers neither think that they are consulted about the changes affect their way of working as much as the captains are consulted nor their suggestions for improving safety are welcomed to the same extent. The junior bridge and engine officer also are not confident as Captains to discuss any safety concerns they have with the company.

Surprisingly management do not think that all staff attends to safety meetings and the results of the safety meetings are not communicated to shore employees. Ship management also do not believe that mistakes are treated as a learning opportunity as the other ranks do. These results highlight the lack of awareness of the management with regards to existing safety culture issues.

Ratings care less when other crew members violate the procedures which is found to be a crucial problem within this company. The company should communicate the severe consequences of such breaches and importance of working as a team. Lower cadre/ratings should receive Bridge Resource Management (BRM) Courses to create a shared awareness and understanding as it is done in the aviation industry. The Bridge Resource Management (BRM) is only provided to officers currently in shipping. Ratings also have the lowest scores regarding to asking assistance due to the fear of looking incompetent. Scenarios should be introduced where it is necessary for ratings to ask assistance in order to perform their duties. Increasing the safety culture maturity level of the lower ranks should be the first priority within this company since their lack of safety culture maturity may put all crew into a dangerous situation. More training should be conducted with lower ranks to increase their safety levels to the company standards. Ratings also have significantly lower scores than Captains regarding to the PPE access. The captains should have a meeting to identify what type of problems ratings have with regards to the PPE use.

Lastly, the lowest scores on workload and manning level issues were obtained by 3rd Officers and 3rd Engineers. Therefore, their workload distribution should be carefully examined since they may need to deal with lots of unfavourable jobs as junior officers.

6.3.5.5 Effect of Nationalities

The questions which are highlighted in red represents that there is a significant statistical difference between the nationalities and their answers given to the questionnaires.

Table 6-20 ANOVA on Nationality (significant interactions, *p-value* < 0.05, are shown in red)

Var	p-value	Var	p-value	Var	p-value	Var	p-value	Var	p-value
Q1	0.028	Q16	0.192	Q31	0.158	Q46	0.021	Q61	0.280
Q2	0.147	Q17	0.430	Q32	0.543	Q47	0.000	Q62	0.157

Q3	0.070	Q18	0.163	Q33	0.013	Q48	0.001	Q63	0.034
Q4	0.196	Q19	0.027	Q34	0.051	Q49	0.021	Q64	0.211
Q5	0.000	Q20	0.000	Q35	0.033	Q50	0.001	Q65	0.001
Q6	0.004	Q21	0.000	Q36	0.000	Q51	0.008	Q66	0.055
Q7	0.010	Q22	0.354	Q37	0.090	Q52	0.008	Q67	0.171
Q8	0.430	Q23	0.047	Q38	0.599	Q53	0.179	Q68	0.031
Q9	0.272	Q24	0.001	Q39	0.000	Q54	0.035	Q69	0.000
Q10	0.220	Q25	0.000	Q40	0.037	Q55	0.121	Q70	0.247
Q11	0.003	Q26	0.013	Q41	0.332	Q56	0.543	Q71	0.133
Q12	0.030	Q27	0.010	Q42	0.000	Q57	0.370	Q72	0.072
Q13	0.000	Q28	0.019	Q43	0.000	Q58	0.004	Q73	0.000
Q14	0.209	Q29	0.268	Q44	0.003	Q59	0.100	Q74	0.007
Q15	0.009	Q30	0.000	Q45	0.000	Q60	0.297	Q75	0.004

Due to relatively small sample sizes in a number of nationalities (1 or 2), the post hoc tests could not be conducted. The results of the ANOVA analysis between different nationalities demonstrated that nationalities have significant bearings on the feedback provided by the seafarers.

6.3.5.6 Effect of Ships

The questions which are highlighted in red represents that there is a significant statistical difference between the ships seafarers are serving on and their answers given to the questionnaires.

Table 6-21 ANOVA on Ships (significant interactions, *p-value* < 0.05, are shown in red)

Var	p-value	Var	p-value	Var	p-value	Var	p-value	Var	p-value
Q1	0.000	Q16	0.000	Q31	0.000	Q46	0.000	Q61	0.000
Q2	0.000	Q17	0.000	Q32	0.000	Q47	0.000	Q62	0.000
Q3	0.000	Q18	0.000	Q33	0.000	Q48	0.000	Q63	0.000
Q4	0.000	Q19	0.000	Q34	0.000	Q49	0.000	Q64	0.000
Q5	0.000	Q20	0.000	Q35	0.000	Q50	0.000	Q65	0.000
Q6	0.000	Q21	0.000	Q36	0.000	Q51	0.000	Q66	0.000
Q7	0.000	Q22	0.000	Q37	0.000	Q52	0.000	Q67	0.000
Q8	0.000	Q23	0.000	Q38	0.000	Q53	0.000	Q68	0.000
Q9	0.000	Q24	0.000	Q39	0.000	Q54	0.000	Q69	0.000
Q10	0.000	Q25	0.000	Q40	0.000	Q55	0.000	Q70	0.000
Q11	0.000	Q26	0.000	Q41	0.000	Q56	0.000	Q71	0.000

Q12	0.000	Q27	0.000	Q42	0.000	Q57	0.000	Q72	0.000
Q13	0.000	Q28	0.000	Q43	0.000	Q58	0.000	Q73	0.000
Q14	0.000	Q29	0.000	Q44	0.000	Q59	0.000	Q74	0.000
Q15	0.000	Q30	0.000	Q45	0.000	Q60	0.000	Q75	0.000

It can be seen from above table that virtually all feedbacks from seafarers seem to be influenced by the ship they are serving on. This is in line with the general effects of working environment on human beings. However, just comparing the names of ships in post hoc tests doesn't seem to be very promising as there could be confounding variables hidden behind the names such as the type of vessel, route of vessel, duration at sea, size of the vessel, accommodation capacity of the vessel etc. Hence, it would be more appropriate to pool the ships in accordance with one or more of the aforesaid categories for a more useful comparison during the detailed analyses.

6.3.5.7 Effect of Workplace (sea or shore)

The questions which are highlighted in red represents that there is a significant statistical difference between the workplace that respondents are in and their answers given to the questionnaires.

Table 6-22 ANOVA on Workplace (sea or shore) (significant interactions, *p-value* < 0.05, are shown in red)

Var	p-value	Var	p-value	Var	p-value	Var	p-value	Var	p-value
Q1	0.002	Q16	0.000	Q31	0.681	Q46	0.012	Q61	0.000
Q2	0.005	Q17	0.103	Q32	0.000	Q47	0.150	Q62	0.000
Q3	0.141	Q18	0.106	Q33	0.002	Q48	0.892	Q63	0.001
Q4	0.072	Q19	0.000	Q34	0.058	Q49	0.171	Q64	0.001
Q5	0.002	Q20	0.000	Q35	0.925	Q50	0.858	Q65	0.077
Q6	0.103	Q21	0.000	Q36	0.006	Q51	0.000	Q66	0.713
Q7	0.000	Q22	0.000	Q37	0.476	Q52	0.000	Q67	0.000
Q8	0.010	Q23	0.922	Q38	0.043	Q53	0.000	Q68	0.001
Q9	0.000	Q24	0.000	Q39	0.021	Q54	0.000	Q69	0.001
Q10	0.341	Q25	0.005	Q40	0.009	Q55	0.032	Q70	0.027
Q11	0.000	Q26	0.006	Q41	0.828	Q56	0.000	Q71	0.116
Q12	0.603	Q27	0.000	Q42	0.001	Q57	0.001	Q72	0.000
Q13	0.000	Q28	0.005	Q43	0.051	Q58	0.739	Q73	0.000
Q14	0.087	Q29	0.004	Q44	0.011	Q59	0.518	Q74	0.492
Q15	0.006	Q30	0.444	Q45	0.000	Q60	0.000	Q75	0.064

Due to difference in sample size and non-homogenous variances, Hochberg's GT2 and Games-Howell post hoc tests were conducted on the statistically significant variables only. A summary of the post hoc tests is outlined in the table below. The group scoring significantly higher average is highlighted using green colour.

Table 6-23 Summary of the findings of post hoc tests for interaction of Workplace (sea or shore)

No	QUESTION	Sea	Shore
Q1	Language/dialect related issues amongst crew members are not a threat to safety.	66.3	60.2
Q2	There is good communication about safety.	86.5	83.6
Q5	I always ask questions if I do not understand or unsure about the safety instructions given to me.	90.1	87.1
Q7	Crew members are closely monitored to ensure proper procedures are always followed.	84.6	79.8
Q8	There is an effective system in place to fix procedures that are unworkable or impractical for crew use.	79.2	76.1
Q9	I never breach operating procedures, even if the breach is in the company's best interests.	78.6	72.3
Q11	Safety rules and procedures are strictly adhered-to.	86.2	81.5
Q13	I am always informed about the outcome of shipboard safety meetings.	85.4	81.3
Q15	The crew is always given feedback on accidents, incidents, and near misses that occur on-board.	85.5	82.4
Q16	I receive feedback about my compliance to safety procedures.	82.2	74.0
Q19	I am consulted about, and invited to get involved in changes that affect safe work practices.	84.9	79.6
Q20	I have sufficient control of my work to ensure it is always completed safely.	86.7	82.7
Q21	Staff from all departments and levels attends safety meetings.	89.7	78.4
Q22	Mistakes are corrected without punishment and treated as a learning opportunity.	76.0	67.9
Q24	Crew members should question senior officers' decisions when safety is affected.	79.6	71.9
Q25	I am able to discuss any concerns I have with my line manager.	81.0	84.3
Q26	Other crew members encourage me to report unsafe events.	83.0	79.9
Q27	I am confident that I can operate the equipment within my area of responsibility safely.	87.1	79.9
Q28	Asking for assistance cannot make me look incompetent.	77.1	71.7

No	QUESTION	Sea	Shore
Q29	Whenever I see unsafe behavior, I always report it.	84.1	81.1
Q32	Crew members do not carry out non-work activities while on duty.	69.5	58.9
Q33	I mind when other crew members ignore safety procedures.	87.4	83.0
Q36	Shore side managers never put timetable or costs above safety.	68.0	72.9
Q39	Manning levels are appropriate to our workload.	74.3	78.0
Q40	The company is giving much more attention to safety now, than it did one year ago.	79.9	76.3
Q42	The company doesn't only get involved in actions when an accident occurs.	64.1	70.2
Q44	I feel confident that I will be able to operate effectively in an emergency situation.	84.0	81.3
Q45	I am confident that I can operate all equipment in my work area effectively.	85.7	76.7
Q46	My attention to safety hasn't suffered when I have been stressed or fatigued.	50.3	54.7
Q51	Crew members monitor each other for signs of stress or fatigue.	81.2	75.5
Q52	Our crew has adequate training in emergency procedures.	85.8	81.3
Q53	The crew has access to all necessary personal protective equipment (PPE).	86.5	79.9
Q54	Watch hand-overs are thorough and not hurried.	84.1	75.5
Q56	My ship holds an adequate number of safety meetings.	86.1	77.8
Q57	Checklists are essential for safety.	87.2	83.5
Q60	I always give proper instructions when I initiate any work.	85.7	82.1
Q61	Drug abuse is not a safety issue in my company.	88.2	82.1
Q62	Alcohol use is not a safety issue in my company.	85.4	78.7
Q63	Safety briefings and training are professional and effective.	86.2	82.7
Q64	Safety is the top priority for crew on board this ship.	91.1	87.7
Q67	Safety is a visible part of the selection and recruitment process in this company.	84.9	79.8
Q68	This company cares about my health and safety.	86.8	83.2
Q69	I fully understand my responsibilities for health and safety.	89.7	86.5
Q72	I have adequate knowledge of the company (Safety) Management System.	82.8	77.6
Q73	I am properly trained to deal with unfamiliar situations where safety might be at stake.	83.4	78.2

The seafarers have higher level of safety culture attitudes and perceptions than the employees at shore. The questionnaire has a number of questions where the shore based personnel are asked to rate the safety conditions of their ship borne counterparts. It appears from above comparison table that shore based management considers the safety aspects of ships to be somewhat inadequate. Shore staff should come together with the crew members more frequently to identify the underlying reasons of the different perceptions between ship and shore. Even though shore personnel believe that they never put safety above cost and timeline, there is a significant statistical difference between seafarers' and shore personnel's opinions regarding to this issue. In addition to this, shore staff do not consider manning levels as a problem as much as crew members do. An observation study may assist shore personnel to gain insight into the workload of each crew member. In addition to this, shore staff should spend more time on board ships to observe challenging working conditions of crew members and problems they face. These observations can improve the ship managements' understanding regarding the on board issues and can also create a resilient team culture for addressing problems in an efficient manner.

Moreover, crew members' different perception about the fact that company only gets involved when accidents happen should be investigated to capture the reason behind this perception.

6.3.6 Open Ended Questions

In total, five open ended questions were asked to the respondents. The questions are:

1. What could the company do to improve health and safety
2. What could the company do to improve ship safety?
3. What could the company do to improve harbour operations safety (e.g. port)
4. What could the company do to improve office safety?
5. What questions should be included in the survey?

The responses of the open ended questions are into categorized and these categories are given for the each question below.

6.3.6.1 Response Rate

There was a much higher percentage of missing data ranging between 14% and 27% amongst open ended questions. There are more missing data within this section because the open ended questions take more time to be answered and seafarers who do not understand the importance of the safety culture, mostly leave this section blank. Moreover, they are reluctant to share any further information due to the existing blame culture and fear of sanctions. Last but not least, language barriers may also prevent majority of the respondents to leave this section blank due to insufficient levels of English.

6.3.6.2 What could the company do to improve health and safety?

In this section, the biggest problem was identified as the stress level amongst crew members. Stress management methods can improve health and safety of the whole crew. The most common suggestions to improve health and safety are given below:

- More comprehensive and sufficient training (292 responses)
- More safety training (143 responses)
- Good quality of PPEs (100 responses)
- More balanced work rest cycle (65 responses)
- Fitness equipment (variety of the equipment) (48 responses)
- A campaign to manage stress at work (more entertainment to deal with stress)
- Bonus for the zero accident
- Producing more safety bulletins
- HSE campaigns

The training is seen as the most significant mean for improving health and safety by the participants. Amongst these suggestions, improving the quality of the PPEs is considered as the easiest and the most straightforward safety enhancement. As identified at Likert Scale questions sections, workload is also raised as an issue at the open ended questions section.

6.3.6.3 What could the company do to improve ship safety?

The majority of the feedback was related to the PPE use and safety training. The most common suggestions to improve ship safety are given below:

- Many of the respondents stated that there should be more safety training, drills on-board the vessels. (282 responses)
- Request for high quality and branded PPEs (215 responses)
- Arrangements of more safety briefings, videos, seminars (153 responses)
- Improve safety culture (113 responses)
- Better standard operating procedures (81 responses)
- Encourage near miss reporting
- Address the existing blame culture

There is a big concern regarding the quality of the PPEs within the company, the problems should be identified during face to face interview and appropriate action plans should be proposed to address this issue. PPE related issues are widespread in the shipping industry, mostly offshore industry has the superior quality of PPEs than shipping and therefore, shipping companies should aim bringing the quality of PPEs to the offshore industry standards. The quality of the standard operating procedures are found as sufficient, however, as identified via surveys, there is a lack of a system to fix unworkable procedures and this issue needs to be addressed in order to obtained better shipping standard operating procedures on board.

6.3.6.4 What could the company do to improve harbour operations safety (e.g. port)

The majority of the respondents mentioned about the importance of an effective communication between different parties. The most common suggestions to improve harbour operation safety are given below:

- Arranging more safety meetings (179 responses)
- Maintaining open communication and good cooperation about safety between ship and shore (146 responses)
- Providing more training (130 responses)
- Increase manning for port operations to reduce hours of rotation for crew shifts (84 responses)
- Enhancing safety awareness (78 responses)
- Providing a safety officer on board

- Effective pre port meetings and clear instructions during port operations
- Several respondents stated there should be no extra work placed upon crew.

Crew members are exposed to extensive pressure during port operations since the officers need to be present during port operations even if they are off duty. Furthermore, crew members should also ensure the ship is in a good condition due to the possibility of port state inspection. All these factors results in extra working time for officers during port operations. Manning levels therefore becomes a crucial factor for running the port operations safely.

6.3.6.5 What could the company do to improve office safety?

Safety trainings and drills were the most prevalent type of suggestions raised by the respondents. The most common suggestions to improve office safety are given below:

- Arranging safety meetings (238 responses)
- Implementing safety culture (131 responses)
- More robust health and safety campaigns to the office staff (76 responses)
- Providing more resilient standard operating procedures on safety in the office (71 responses)
- Installation of CCTVs, safety drills and trainings (52 responses)
- Establish better communication with other parties
- Access cards to enter into offices
- Applying two way audit between ships and shore
- Continual monitoring of safety matters in the company circulars and also to ensure the company circulars are always informative.
- To ensure communication of all necessary safety information.

Safety culture of the office personnel is of significant importance since majority of the personnel carry out regular visits to fleet for audits, surveys and meetings. Therefore, safety culture commitment of the shore personnel and their own safety will lead to an advanced safety culture attitudes and perceptions on board.

6.3.6.6 What questions should be included in the survey?

Majority of the participants mentioned about the efficacy and user friendliness of the SMS manual. Some of other questions raised by respondents are given below:

- Are there any appreciations for people who work hard to implement or create safety culture amongst employees? (182 responses)
- PPE quality and adequacy of the other resources (95 responses)
- Happiness and welfare of the shore and ship personnel (physical, mental, social) (80 responses)
- Is the company SMS effective? (8 responses)
- Working overtime should be included
- How to increase the motivation of the seafarers?
- Are the crew members are aware of the accidents happened on other ships?

The respondents would like to be acknowledged when they invest efforts into implementing and enhancing safety culture amongst employees. Advertising successful efforts or initiatives of crew members can encourage others to work towards similar safety culture enhancement campaigns within the company.

6.3.7 Interview Results

Performing a face to face study requires a substantial amount of time and necessary travels are required to be arranged to headquarters and to the fleet. Therefore, semi structured interviews were only conducted in this case study due to the availability of the vessels.

The semi-structured interviews were conducted at the head quarter office of the company and on board two ships. The ultimate aims of the interviews are to validate survey results and gain more insight into the problems by face to face discussions. In total, 33 seafarer and 2 shore personnel form the fleet management services were interviewed. The initial plan was to interview more employees but due to the nature of the shipping, some ship arrival times were delayed resulted in unavailability of the ships and crew for interviews.

The interviews provided excellent insight about the company to clarify some important aspects after the survey results. The most prevalent and interesting issues identified can be found below:

- The quality of the PPEs
- Blame culture
- Maritime English
- Feedback management
- Training arrangements

The information elicited from interviews on each safety climate dimension is given below.

6.3.7.1 Communication

In general, communication levels are found to be good on board vessels and crew members were happy about the communication levels with shore personnel. The only issue highlighted by crew members (more than 50% them) was the level of English. They commented that, despite English being the official communication language, communications in English was the major problem on board vessel and it is needed to be addressed properly. It was found to be quite difficult to communicate in English with the ratings as well. It was also commented that, crew members communicate in local language from time to time and this creates a shared awareness problem for members who are international crew.

6.3.7.2 Procedures and Safety Rules

Majority of the seafarers were happy to a certain extent about the quality of the SOPs in use and they perceived that following the standard operating procedures is the best way of running ship safely. Nevertheless, they also commented that in some cases there is a big difference between the work as imagined (the procedures) and the work as done (real operations) on board ships. Therefore, they said there is a requirement of a structured way to increase the quality of procedures. It has been also said that "the SOP development process is not straight forward; it takes tremendous amount of time to follow all the procedural changes and increase the awareness and knowledge about the changes." All these procedural changes are required to be approved by the company in order to maintain higher standards of safety. Therefore, there is a requirement of an electronic system to update and keep all the final versions of the SOPs in order to improve accessibility of the changes and SOPs.

6.3.7.3 Feedback

The biggest problem identified under this dimension was the variation of the time it takes for the company to provide response to the individual crew according to interviews. Even though, solving some problems can take more time than the others, majority of the respondents said that the response duration highly depends on the people they communicate with. This indicates that there is not a system to manage the feedback in a consistent manner, the duration to receive a feedback highly relies on the department/person they communicate to. It is recommended that company establishes a feedback procedure to standardise the feedback process as it will improve the communication and mutual trust between company and the employee. Other criticism was that although crew need to ensure sailing goes on safely, sometimes they do not receive an important feedback quick enough to ensure the safe sailing. It was also considered on board ship that some information is not transmitted to on-board crew as the shore personnel think that information to be provided is not important enough. Crew on board sometimes need to follow up and remind the shore staff in order to obtain the information as the missing information is needed in time to complete their task(s).

6.3.7.4 Involvement

Even though, crew member think that the communication is not always straightforward and receiving a feedback may take some time, they strongly believe that they are involved in the processes that affect their operation. Seafarer’s suggestions are taken into account and important aspects are being briefed clearly within the company.

6.3.7.5 Just Culture

The one of the most problematic dimension was the just culture within the organization according to seafarers’ views. Crew members were not happy with what company says about the blame culture and how they react in real occasions. Majority of the seafarers agreed that any investigation carried out by the company is not necessarily to understand the facts leading to specific error. They believe that investigation is only there to blame people (someone needs to pay the price).

6.3.7.6 Problem Identification

The majority of the participants were happy about the amount of near miss and undesired event reporting. They stated that they are highly encouraged to report near misses, the company even puts minimum targets regarding near miss reports on board. They commented that sometimes the reporting can be postponed for a short period of time to ensure the safety of an operation but reports will be sent after ensuring safety and security promptly. Some respondents claimed that they created random near miss reports since the company expect every ship to report minimum number of near misses. The general perception on shore is that seafarers report “unsafe conditions” more rather than “unsafe acts” and only 60 % of near misses are reported.

6.3.7.7 Priority of Safety

The majority of the respondents stated that even though commercial pressure affect their operation significantly, if safety is concerned, company shows appreciation and crew members do not have to rush the things which may constitutes risks to people, vessel or environment. However, they also stated that if the risk is not substantial, operation will continue. In some cases, they need to continue working in order not to delay estimated time of arrival (ETA) by breaching work-rest regulations. In general, almost everybody agreed that safety is improving within the organization and this company is doing better than their competitors.

6.3.7.8 Responsiveness

Emergency preparedness was found to be sufficient. The general opinion was that there is even more than required drills and training for the emergencies. They mentioned about company’s effort to enhance emergency awareness by different drill scenarios, and seafarers were all confident about handling the unexpected events and emergency situations. They were only slightly worried about the level of English and the possible effects of it in an emergency situation. Majority of them agreed that company needs to provide more training and drills for new joiners.

6.3.7.9 Safety Awareness

The overall safety awareness was found to be sufficient by the participants. All the initiatives to enhance safety and awareness such as procedures, checklists, internal communication and hand over notes are of always paramount importance amongst crew. They said that the friendly environment on board also improve safety awareness since people can warn others about the mistakes without any hesitation.

6.3.7.10 Training and Competence

All the crew members were happy about the quality of the training and amount of training delivered by the company. Only problem was found to be the timing and duration of the training arrangements. Regarding the on board training, everybody stated that it can be arranged very quickly but training centre needs minimum number of people to run a course and this causes delays to attend the training in a timely manner. Vice versa, some crew members criticised that some courses can be already full. Especially, due to this organisation's style of the courses, sometimes crew members cannot relax during their holiday-leave properly as they may be called for training. Crew members also stated that having possibility of attending other training centres' courses would be very beneficial to expand their knowledge by blending different working practices.

Personnel Protective Equipment (PPE)

Even though, there is not a safety climate dimension with regards to the PPEs, the quality of the PPEs was questioned by too many seafarers during both interviews and surveys. The most common PPE problems raised during the interviews were related to safety gloves, safety shoes, goggles and helmets.

Some seafarers said that their PPEs are not as good as the offshore industry. Safety boots should provide more comprehensive protection including the protection of their ankles. They also raised an issue that when you wear safety boots for long duration, their feet become extremely sore. Safety shoes are also found to be slippery when a surface is wet and some seafarers commented that safety boots are worn very quickly.

The gloves were a big issue according to large number of seafarers. It was mentioned that the cotton gloves do not serve for the purpose as they sometimes get stuck due to its texture and generates some risks. It has been also raised as an issue that some items are available on one ship but not on another ship. Many people said that gloves shouldn't be in one size and they should be leather.

Helmets were found to be problematic by some seafarers. They said the helmets can fall off in windy days because they do not have an extra stripe from the back side of the ears and also do not have an additional chin support. In addition, it was commented that the front part of the helmet can block vision if you need to look up constantly due to the nature of certain jobs.

It was also observed that some of the crew members bought their own goggles because the ones supplied by the company do not provide enough protection from dust. The reason behind this problem is that the company provides one size of goggles and they are not adjustable for different face types and sizes.

Due to the aforementioned reasons, the company needs to make sure that PPEs are available in different sizes and fit for the purpose.

6.3.8 Overall Results

The first part of the safety culture assessment framework has been successfully conducted in the tanker shipping company via the collection of the questionnaires and the arrangement of the semi-structured interviews. Due to the demographic background of the sample size (73% Malaysian), the results and the general suggestions are only applicable to this sample size. The safety climate assessment identified several areas which require further improvements to enhance safety. The major problems identified within the shipping company are given below:

- **Maritime English/dialects:** The level of English is perceived as a threat to safety by the majority of the respondents. This problem was also validated during the semi-structured interviews. This is an industry-wide problem as similar concerns were recorded during different safety culture surveys. The company is based in South Asia and majority of the seafarers are Malaysian. During the interviews, other nationalities commented that "they speak Malay if they are not communicating with you so you cannot share the same situational awareness". This practise is considered as extremely dangerous and resilient crew is key for avoiding accidents and incidents on board. The company needs to provide extra English training courses in addition to the existing tests to enhance the level of English within the company.
- **Procedures and Safety Rules:** The lack of a system to fix procedures in a more robust and consistent manner is raised by both crew members and shore personnel. The Procedure Improvement Methodology developed within FP7 SEAHORSE project (Kurt et al., 2015) provides an opportunity for any company to address this issue. The training for the system was delivered to a small group of crew members and shore personnel in the company. Extremely valuable feedback was collected during training sessions.
- **Feedback management:** One of the most significant problems was seen as the lack of a feedback management system within the company. This was highlighted by the survey results that the length of time to hear back from a person or from a department depends on the personalities of the managers. This can be achieved by a new initiative of a feedback management system where all the problems are needed to be addressed within a fixed time frame throughout the company. There should be a procedure to describe maximum time frame that company needs to come back to people with a feedback. This is an effective communication issue that directly affects the safety culture. Such feedback system can easily be integrated to any tools that are available.
- **Blame culture:** Similar to the most of maritime industry, the existing blame culture is seen as a major problem within the company, majority of crew members stated through the surveys and interviews that the blame culture affects almost every single aspect of the operation. Adopting a "just culture"

approach requires a massive commitment from top to bottom within a company.

- **Fatigue and stress:** Fatigue and stress management is raised as an issue by the seafarers and majority of them do not think that they are capable to cope with fatigue. Similar types of fatigue and stress management training which are delivered in BRM and HELM could be provided to ratings to enhance their stress and fatigue resilience. However, it needs to be understood that fatigue cannot be managed by individuals as it is strongly linked to company's operational practices. Therefore, in addition to the trainings, company may need to look at the root causes of fatigue and take action on root causes that may be caused by operational practices.
- **Training:** The Company is praised for providing the opportunity for trainings. However, the duration of the training arrangements are highlighted by some seafarers as it may be coinciding with their off period away from the ship. Because majority of the seafarers would like to attend to their training as soon as possible and then have more effective rest time during their off period.
- **Personnel Protective Equipment:** The quality of the PPEs is seen as a threat to the well-being and safety of the seafarers as seafarers believe that PPEs don't serve for the purpose as intended (e.g. gloves, safety boots, and goggles). Although company provides the PPEs in plenty, company should pay attention to the needs of individual the seafarers (such as size) and the location where the PPE will be used. This is necessary while ordering PPEs in order to make sure the effectiveness of PPEs to achieve maximum safety.

6.4 Comparison of Shipping Companies – A Benchmark

The questionnaires were distributed to three different shipping companies in order to cover different operation types and create a benchmark for each safety climate dimension. The return rates were given below:

Shipping Companies	Company Size	Return Rate
Container Shipping Company	475 Employees	70 Employees **(14%)**
Bulk Carrier Company	87 Employees	87 Employees **(100%)**
Tanker Shipping Company	2220 Employees	1645 Employees **(74%)**
Total	**2782 Employees**	**1802 Employees (64.7%)**

The container shipping company was the first company that the questionnaires were distributed. More initiatives were introduced to increase the return rates afterwards.

In total, 1802 employees answered to the safety climate questionnaires. The confidential assessment reports were provided to each company together with the recommendations and action plans.

The companies gained insight into safety culture maturity levels on ten dimensions. The average results of the each company are given below:

Table 6-24 Comparisons of three shipping company

Comparison of the Companies			
Companies	**Scores for Crew Members (%)**	**Scores for Shore Staff (%)**	**Overall Score**
1) Tanker Shipping Company	81.85	79.04	80.44
2) Bulk Carrier Shipping Company	78.32	87.13	82.72
3) Container Shipping Company	76.17	78.84	77.50
Benchmark	**78.78**	**81.67**	**80.22**

It is extremely important to generate a benchmark amongst companies hence they can compare their performances with each other. Individual scores of the each shipping company on different dimensions are given below:

Table 6-25 Comparison of safety climate scores

Comparison of the Companies			
Safety Culture Factors	**Tanker Shipping Company**	**Bulk Carrier Shipping Company**	**Container Shipping Company**
1) Communication	82.29	81.95	80.66
2) Procedures and Safety Rules	81.97	81.34	79.32
3) Feedback	83.63	82.93	81.55
4) Involvement	87.62	86.54	81.17
5) Just Culture	79.44	79.94	75.71
6) Problem Identification	81.50	77.21	76.09
7) Priority of Safety	75.27	76.77	75.66
8) Responsiveness	79.37	79.46	76.34
9) Safety Awareness	84.21	77.19	75.75
10) Training and Competence	81.66	82.29	81.29
Average	**81.54**	**79.54**	**77.66**

The safety culture levels of the employees for the each shipping company are compared and the results are given below.

6.4.1 Common Problems of the Three Shipping Organizations

Safety Culture Assessment Results demonstrated that majority of the problems are not only specific to a single shipping company but they exist at the industry level. These problems can be listed but not limited to:

- *Insufficient Maritime English Proficiency*
- *Blame Culture*
- *Manning related fatigue and stress*
- *PPEs are not fit for purpose*

The maritime English has been identified as one of the major problem within three shipping companies. Even though the IMO STCW Convention (1995) defines the minimum English requirement for the industry (Pritchard, 2003), language barriers are recognized as crucial obstructions for an effective communication which is known to be a key safety culture dimension. Communication related accidents highlight the requirement of a more developed and comprehensive maritime English course for the shipping personnel (both sea and shore). All of these shipping companies should deploy advanced and comprehensive maritime English courses for their employees.

Blame culture and its negative effects have been discussed within this thesis numerous times. Unfortunately, the shipping industry has not yet reached the envisaged level of just culture and thus seafarers always criticize their companies' just culture policies via the surveys, interviews and observations conducted within three shipping companies. Ship management personnel of shipping companies should define a consistent and transparent just culture policy and should treat all the cases according to the policy without an exception. Continuous implementation of such a policy can boost the reporting activities and the provided insights can be utilized to prevent future catastrophes.

The IMO's "principle of safe manning" resolution is utilized as a guidance to determine required amount of crew for a commercial vessel in the shipping industry. However it is a well-known fact that decreasing crew sizes due to the automation and technological improvements led to an increase on crew members' workload. In addition to this, as being an excessively overregulated domain, the amount of paperwork had also peaked in shipping in recent years. All these aforementioned factors should be taken into account at manning calculations thoroughly since safety culture assessment methods identified that crew member do not have enough rest periods and sometimes they deviate the work and rest hour regulations to complete their tasks. Moreover, the high workload also leads to the accumulation of fatigue and stress which have also identified that there a big potential for improvement regarding workload issues in these three shipping companies. The overt observation method is therefore crucial to demonstrate whether the current manning levels are sufficient for performing on board operations safely and how much each crew member spends time on different type of tasks in a daily shift.

In addition to these major problems, some shipping companies have specific safety culture attitude and perception issues amongst their employees. The lack of a system for fixing impractical procedures is identified as a major issue at the tanker and container shipping companies. Even though SOPs are designed to demonstrate the best way of working, either a crew member can identify a smarter way of performing a certain task or the quality of an SOP may not be sufficient due to the changing circumstances of shipping operations. Therefore, it is a necessity of having such system to identify these deficiencies and continuously improve the quality of the SOPs. The Procedure Improvement Tool is developed in order to address this issue in the shipping industry. The tool has already implemented in two shipping organizations and the results were found extremely satisfactory. The details of the tool can be found in Chapter 9.

Furthermore, drug and alcohol use are found as a major issue in both bulk carrier and container shipping organizations. Even though almost entire shipping organizations have zero alcohol policy and have strict drug policies, 2 of the case studies determined that this is still an ongoing issue in some of the organizations. The crew members' awareness should be increased with regards to the outcomes of these dangerous habits not only at the organization level but also at the individual level.

In addition to the similar safety culture related problems of the shipping companies, the individual safety culture performance of the each organization and their performance comparison with the benchmark is given below.

6.4.2 Benchmarking

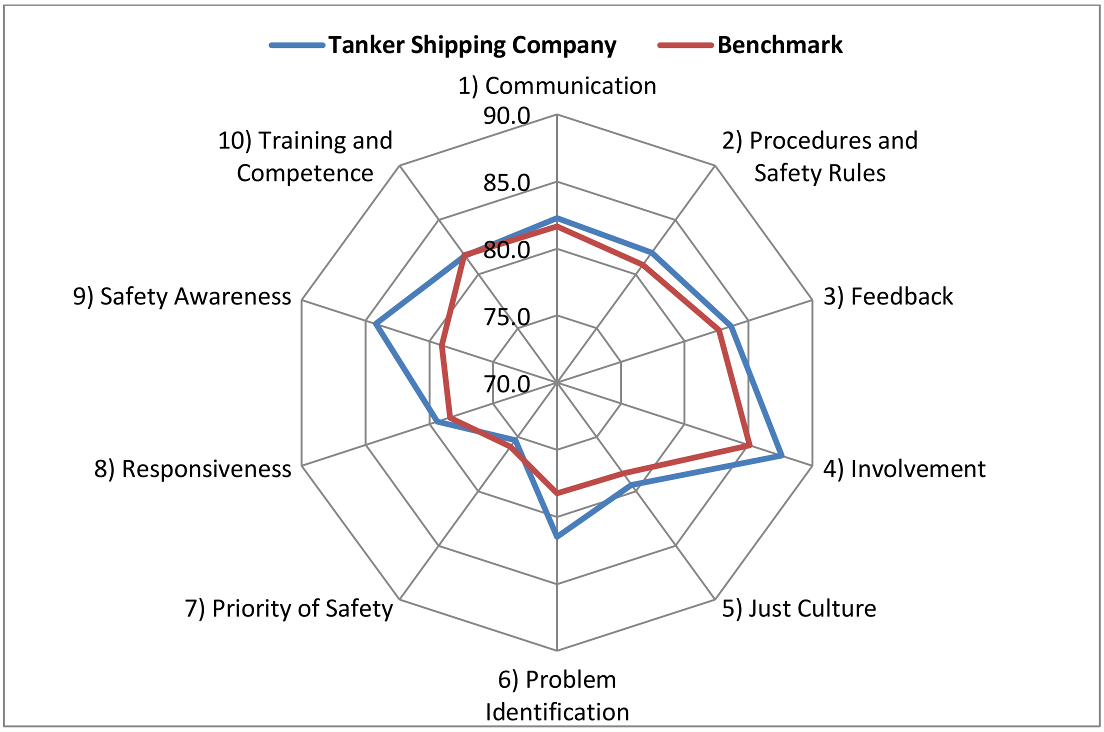

Figure 6-7 Tanker Shipping Company

The comparison of the tanker shipping company employees and the benchmark is given in Figure 6-7. The safety culture attitude and perceptions of the respondents are higher than the benchmark on every dimension except the priority of safety. Even though the company has a satisfactory level of safety culture, the efforts should be invested to change the perception of the priority of safety within the company.

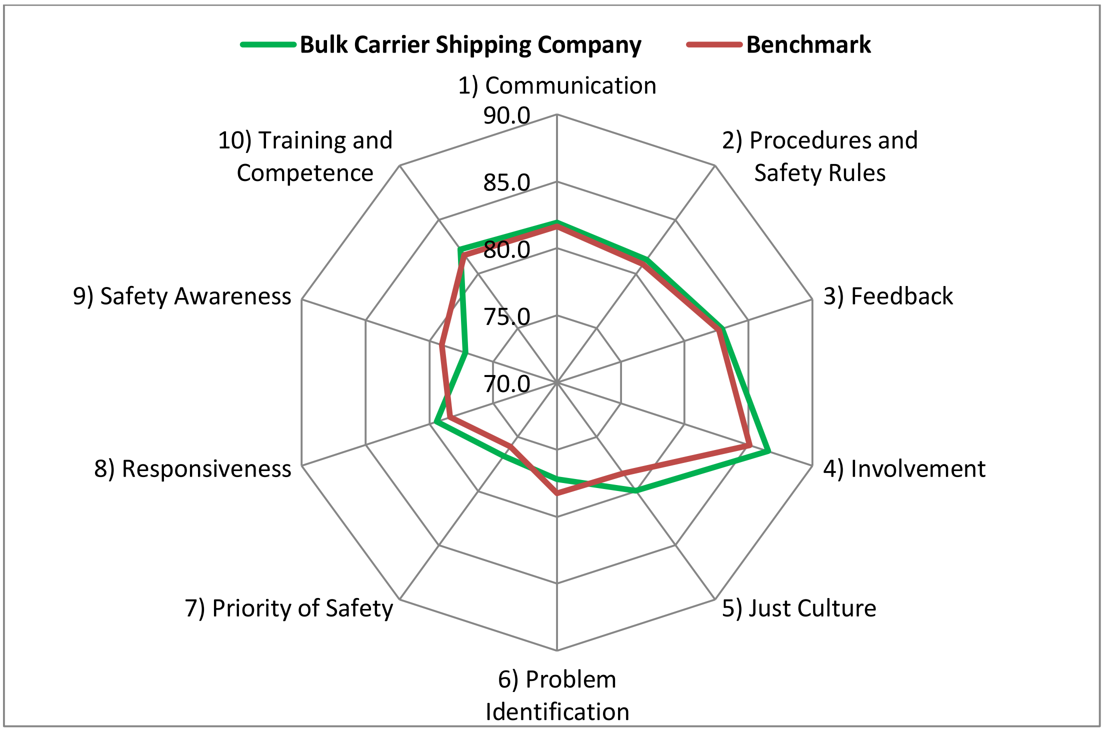

Figure 6-8 Bulk Carrier Shipping Company

The comparison of the bulk carrier shipping company employees and the benchmark is given in Figure 6-8. The employees of the company have slightly better scores than the benchmark on most of the dimensions. However, the company failed on Problem Identification and Safety Awareness dimensions which require further efforts to be invested in order reach the industry average.

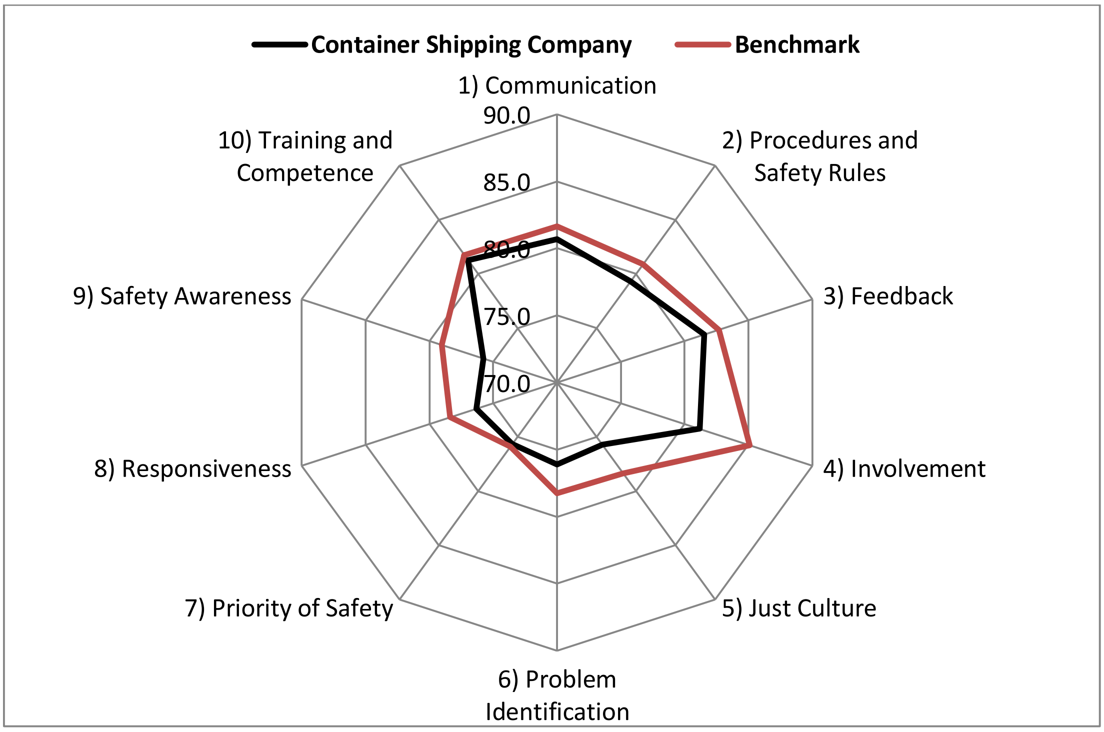

Figure 6-9 Container Shipping Company

The comparison of the container shipping company employees and the benchmark is given in Figure 6-9. The container shipping company failed to meet the benchmark on the entire safety culture dimensions. The company needs to develop a new safety management strategy to remedy the problematic dimensions imminently.

6.5 Chapter Summary and Conclusions

Three case studies were conducted within this chapter. Results of the safety climate assessments were generated for the each shipping company and then individual results were compared to the benchmark. Results of the two shipping companies can be found in Appendix E and F. The studies provided a significant insight into the attitude and perceptions of the employees of the organisations. The tanker shipping company is found to be superior to other shipping companies. The container shipping company's safety culture maturity level was found extremely unsatisfactory in comparison with the others. The safety climate result will be compared with key performance indicators and observation study in the next chapter to eliminate subjectivity aspects of the questionnaires and hence enhance the maritime safety.

7 Key Performance Indicators (KPIs) Assessment Results

7.1 Chapter Overview

Key performance indicators (KPIs) are utilized in several domains in order to develop intervention strategies for the organizational problems and make shipping operations more resilient. The proposed Key Performance Indicators (KPIs) Assessment method was employed in a tanker shipping company and results are detailed in this chapter.

The ultimate aim of this chapter is to explore relationships between the safety culture attitudes and the company key performance indicators as well as the near miss data.

The results of the statistical correlations identify that which KPIs the company should focus on for enhancing the level of safety culture attitudes and perceptions of crew members. The results of the relationships therefore assist the shipping company to prioritize their improvement actions and monitor the efficacy of the actions taken.

7.2 Introduction

The International Safety Management (ISM) Code has been introduced by the IMO to achieve the envisaged level of safety in maritime organizations. Shipping companies are expected to adhere to these rules to ensure onboard safety during shipping operations. Therefore, shipping companies are looking for means to measure their safety culture maturity levels and develop appropriate strategies to address vulnerabilities within their organizations. Majority of the catastrophic accidents could have been prevented, if some of the significant indicators were taken into account. Thus, Key Performance Indicators (KPIs) which are also known as leading indicators are introduced as proactive measures to gain insight into safety levels in several industries to avoid future accidents (Grabowski et al., 2007). KPIs ease the process of measuring norms such as safety, health and environment.

Two important challenge has been identified regarding the utilization of the KPIs (Groeneweg et al., 2013):

1. It is not certain yet which KPIs are in use by different organizations.
2. Which KPIs are useful and contribute towards safety in organizations.

A case study was performed in this Chapter with an aim of answering these questions in a structured manner. The results of the case study were structured as given below:

1. Trend Analysis
2. KPI vs KPI Correlation
3. Safety Culture Questions vs KPI Correlation
4. Safety Culture Dimensions vs KPI Correlation

7.3 Case Study – Results of KPIs Assessment in a Tanker Shipping Company

Safety related Key Performance Indicators were collected at two levels within the company:

- Vessel level
- Organization level

The KPI data were collected at vessel level in the same year when the safety climate assessment also took place within the shipping company. The KPIs were collected at the organizational level for a period of 9 years. Fictitious year numbers are utilized to hide any information that can identify the name of the company as sensible company data are given within this Chapter. After the data cleansing, the proposed methodology was utilized to generate the four main results given below.

7.3.1 Trend Analysis

The trend analysis aims to represent how the safety performance of the company changes throughout the years and gain insight into the positive and negative trends within the company. The trend analysis is structured as below:

- Number of fatalities
- Lost time Incident Frequency (LTIF)
- Total Recordable Case Frequency (TRCF)
- Number of first aid cases (FAC)
- Number of navigational accidents
- Number of near-miss reports
- Number of unsafe acts
- Number of unsafe conditions
- Number of internal audit per ship
- Number of superintendent visit per vessel
- Number of PSC inspections
- Number of inspections with deficiencies
- Number of PSC deficiencies
- Number of PSC detentions
- Number of superintendent visit findings
- Number of days without an accident
- Number of procedure violations detected
- Number of cases where drugs or alcohol is abused
- Crew Retention (%)
- Number of corrective maintenance
- Management visit frequency
- Number of oil spills

The company only had fatalities in year 5 due to an undesirable accident. The company works continuously in order to avoid reoccurrence of this kind of an accident in their maritime operations. The company managed to prevent any life loss in the last 4 years of operation by learning from accidents and takings the appropriate measures on board. The lesson learnt from fatalities and catastrophes should be made part of the seafarers' training in order to avoid reoccurrence of such events. The shipping companies should share these types of information within the industry to enhance the safety awareness at the industry level.

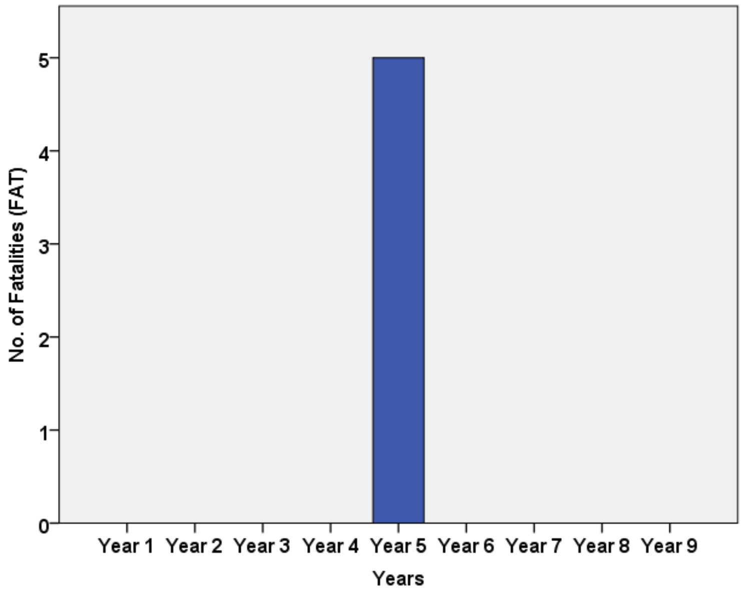

Figure 7-1 Number of fatalities

It can be seen from the figure below that company improves its safety performance by decreasing the lost time incident frequency. Even in the last three years, the company achieved the zero score twice on the lost time incident frequency. This shows that the investments on safety made an impact on lost time incident numbers. The figure also depicts that the company's last 4 years' performances are significantly better than the previous years. Nevertheless, the company should maintain its safety culture improvement investments since safety does require continuous improvement.

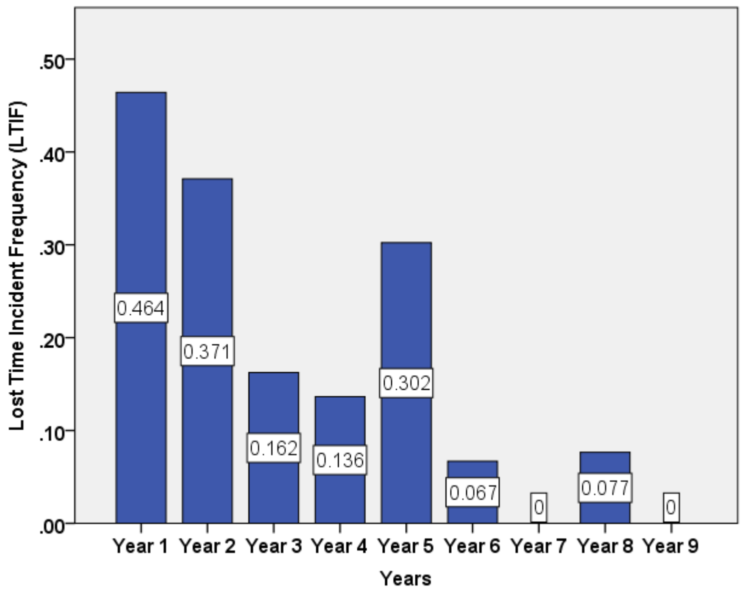

Figure 7-2 Lost Time Incident Frequency (LTIF)

The below figure represents that total recordable case frequencies decrease throughout the years. The value achieved in the year 9 is almost ten times lower than the value obtained in the year 1. Since the year 6, the company maintains an acceptable level of total recordable case frequency with a will to decrease the number to zero. Even though there is an overall decreasing trend within the company, especially, safety achievement obtained after the year 5 is noteworthy.

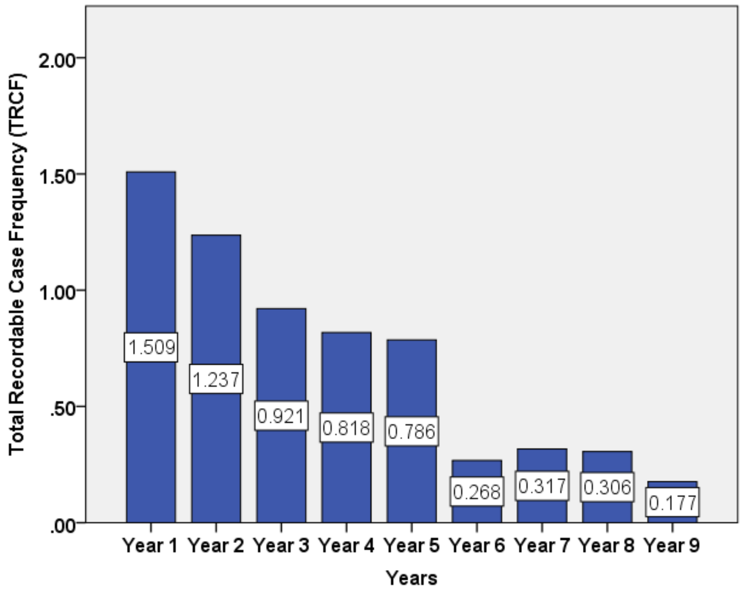

Figure 7-3 Total Recordable Case Frequency (TRCF)

There is a declining trend regarding the number of first aid cases within the company (See Figure 7-4). The improving safety standards of the company also led to a lower level of minor injuries achieved in the last years. In the year 9, the company only had 8 first aid cases which show the commitment of the company to avoid any type of injuries at work place. The company should keep implementing its successful measures such as ergonomic and human factor engineering design principles to decrease the TRCFs further.

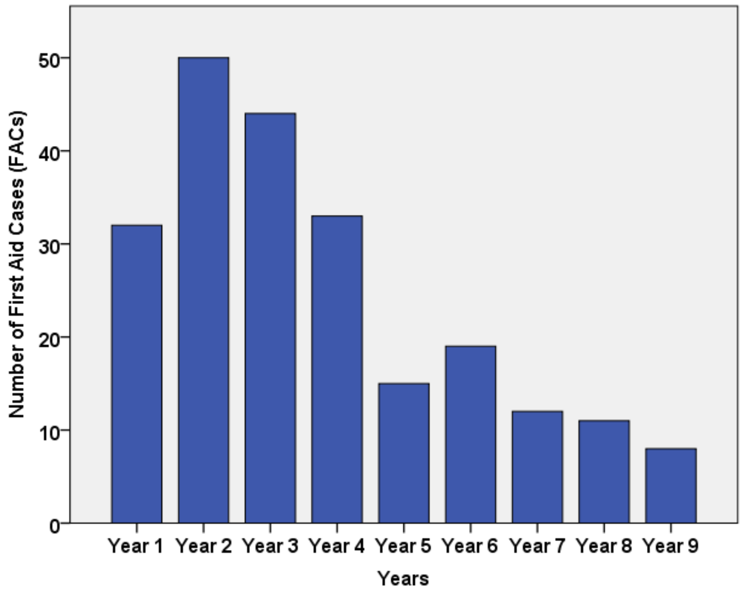

Figure 7-4 Number of First Aid Cases (FAC)

The results of the navigational accidents are well-known to the shipping organizations. The company maintained low number of navigational accidents during the last 5 years. In the year 9, the company's investments paid off and the company had zero navigational accidents. The company now has a more challenging task which is maintaining the zero number of navigational accidents for the upcoming years. This requires even better and comprehensive watch keeping procedures together with enhanced competency levels of bridge officers.

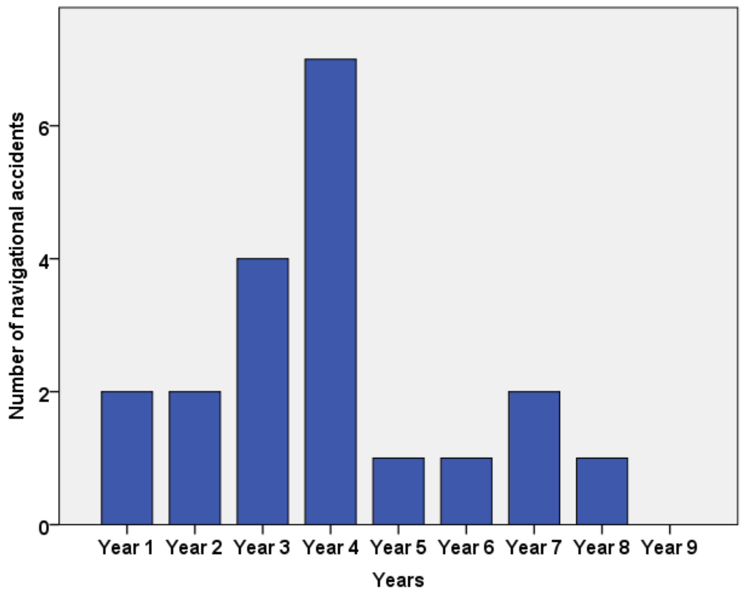

Figure 7-5 Number of navigational accidents

The figure below indicates that the number of near miss reports has increased steadily since the year 2. This shows that the company successfully encourages crew members to report more and gains more insight into the prevalent problems on board ships as well as within the organisation. However, when the near miss reporting numbers reach to the to a certain level, the number of near miss reports are expected to decrease steadily in the future provided the organisation takes the necessary measures to address the root causes.

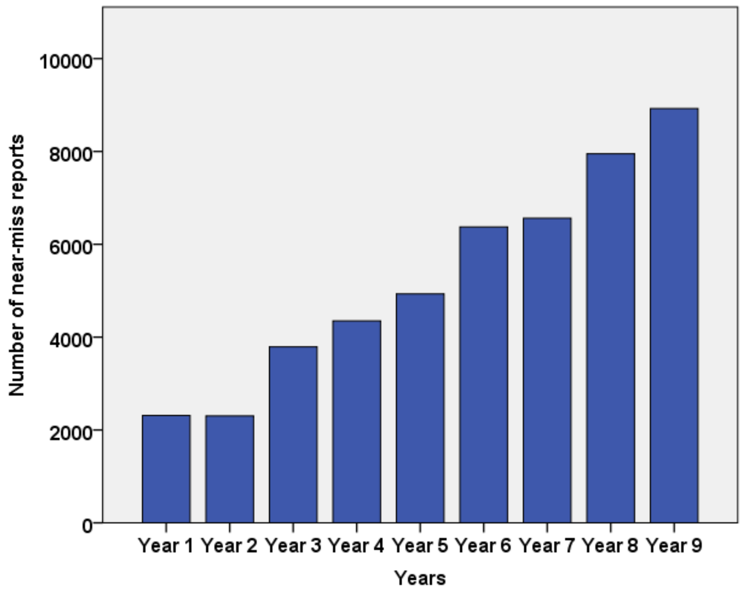

Figure 7-6 Number near-miss reports

Near misses reports can be categorized under two groups, namely unsafe acts and unsafe conditions. Unsafe acts can be defined as erroneous acts and behaviours of crew members; unsafe conditions refer to a high risk environments as well as faulty equipment. It can be seen from the figure below that the number of reported unsafe acts increased gradually since the year 7. This increase indicates that the just culture is improving in the company and hence crew members are willing to report more unsafe acts to avoid any type of accidents.

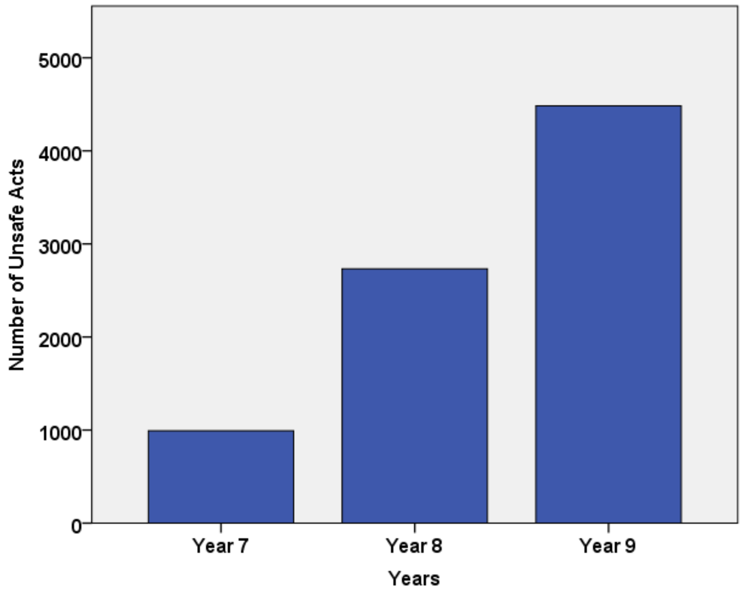

Figure 7-7 Number of unsafe acts

The number of unsafe conditions didn't changed significantly, however the number of unsafe condition reporting is found to be vital for ship managers to identify the prevalent types of problems on board.

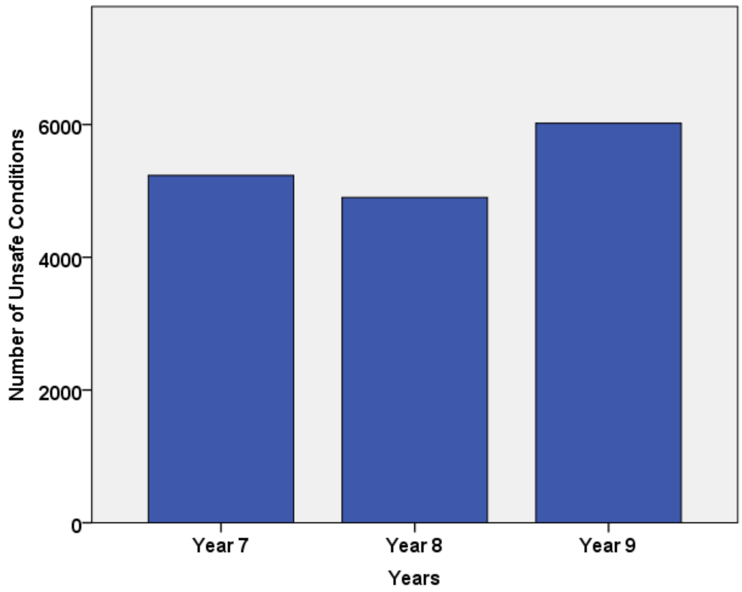

Figure 7-8 Number of unsafe conditions

The figure below indicates that every ship almost had an internal audit in the year 8 and 9 however, there were more internal audits observed in the year 7 within the company. Internal audits and near miss reports are of paramount importance for identifying issues before turning into accidents. Especially, internal audits can spot the latent and risky factors which are either not reported as near misses or overlooked by on board personnel. The company should aim to conduct 4 audits per year since the major shipping companies set quarterly audits as their targets. When the problems are identified and fixed internally, the likelihood of having a deficiency or detention from a port state control will decrease and so the safety reputation of the company will increase accordingly.

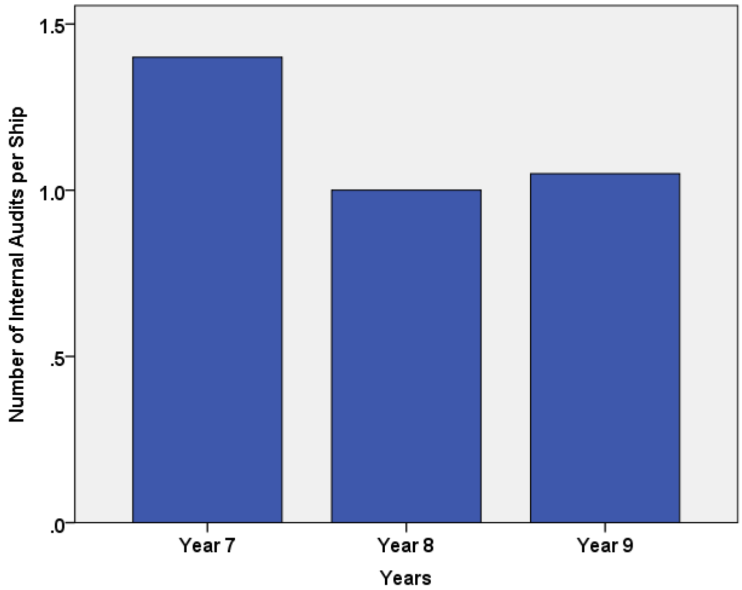

Figure 7-9 Number of internal audits per ship

A superintendent visit to a ship is another mean for internal safety assessment. It can be seen from the figure below that company prioritize the superintendent ship visits to gain insight into the problems and fix them before an accident happens. Even though number of superintendent visits per vessel decreased in the year 8, three superintendent visits per vessel was achieved within the company in the year 9.

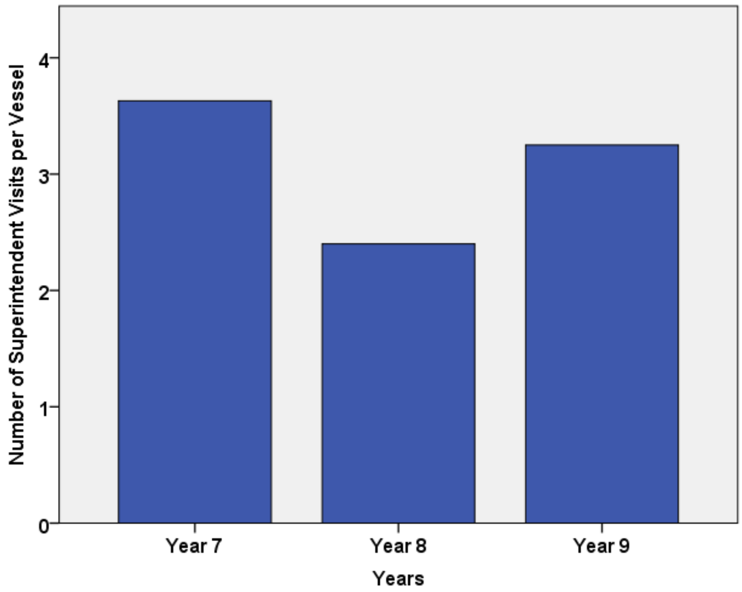

Figure 7-10 Number of superintendent visit per vessel

The number of Port State Control (PSC) inspections didn't change significantly between the year 1 and 6, but there is a decreasing trend in the last three years. The possible reasons to have less PSC inspection can be linked to the better safety reputation of the company and increasing safety standards on board. When PSCs identifies less deficiencies for a company, they also tend to perform less inspections on their vessels in the future.

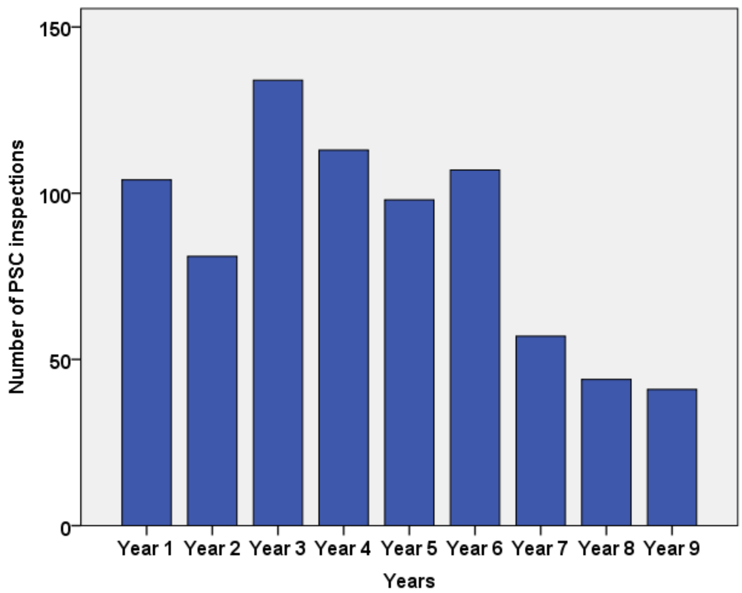

Figure 7-11 Number of PSC inspections

The figure below also supports the aforementioned hypothesis about the increasing safety performance of the company. Since the year 7, the company had smaller amount of inspection with deficiencies. Mainly after the year 6, the company achieved a remarkable success.

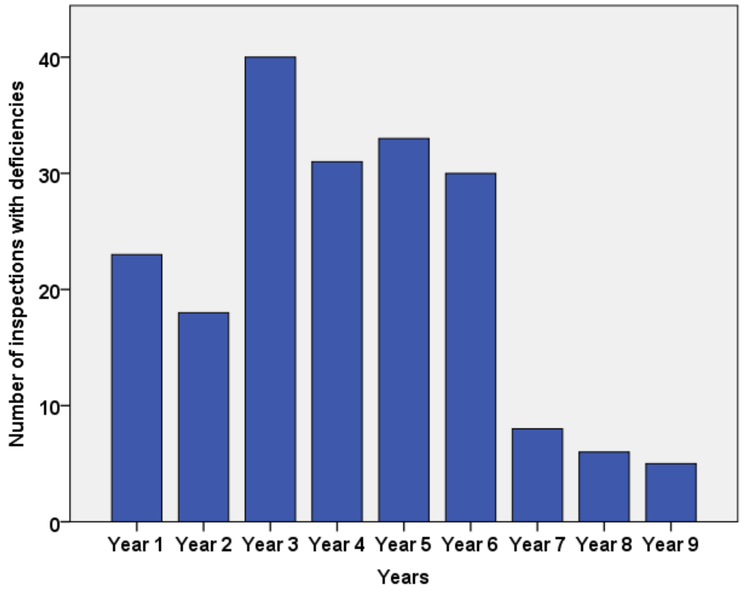

Figure 7-12 Number of inspections with deficiencies

Figure 7-13 is directly correlated with the figure shown above. The number of PSC deficiencies decreased significantly in the last three years.

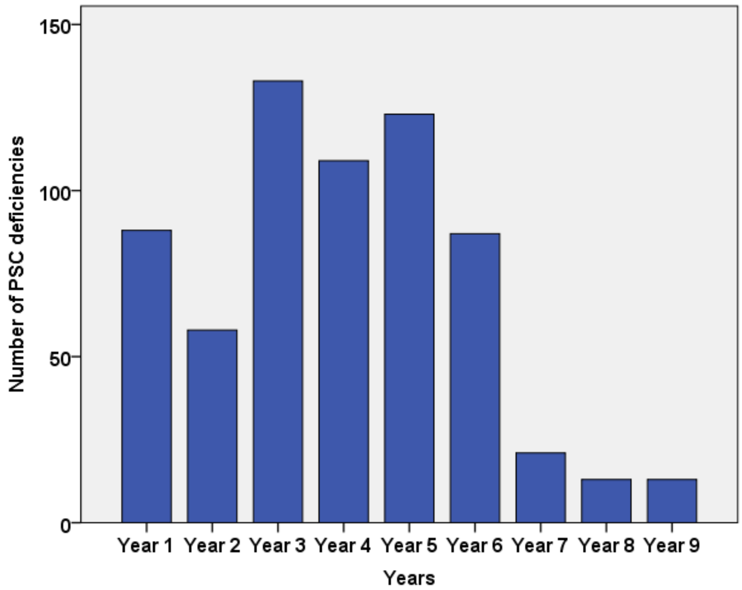

Figure 7-13 Number of PSC deficiencies

The figure below also supports the opinion that company's safety standards are increasing is since the company didn't have any detention in the last three years. The names of detained vessels are published at the port state controls' website. Therefore, zero detention number assists the shipping company to maintain their safety reputation and profitability in the market. The company with a good safety reputation becomes a favourable organization and their market value and revenues increase in return. This condition demonstrates that investment on safety should be considered as actually an investment on the company assets.

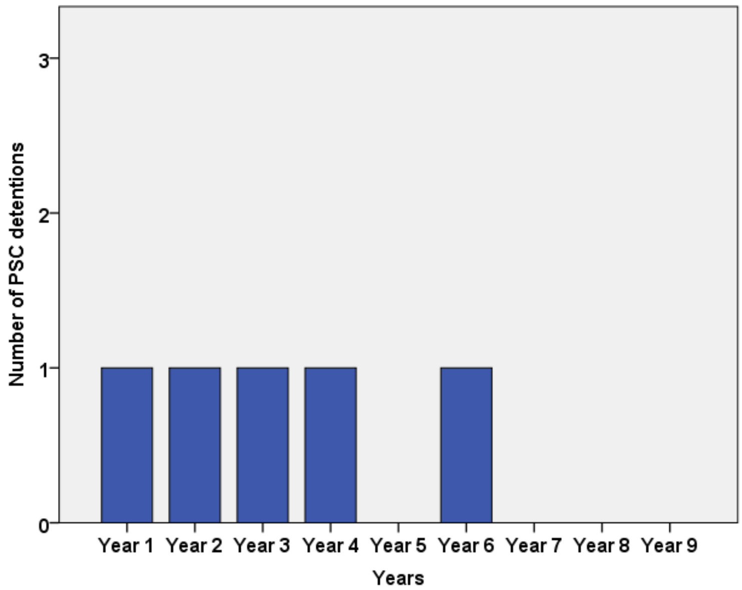

Figure 7-14 Number of PSC detentions

It can be seen from the figure below that the number of superintendent findings increase throughout the years. This directly affects the number of PSC deficiencies and detentions adversely, as the company identifies and fixes more problems internally, resulting in a better safety reputation amongst Port States.

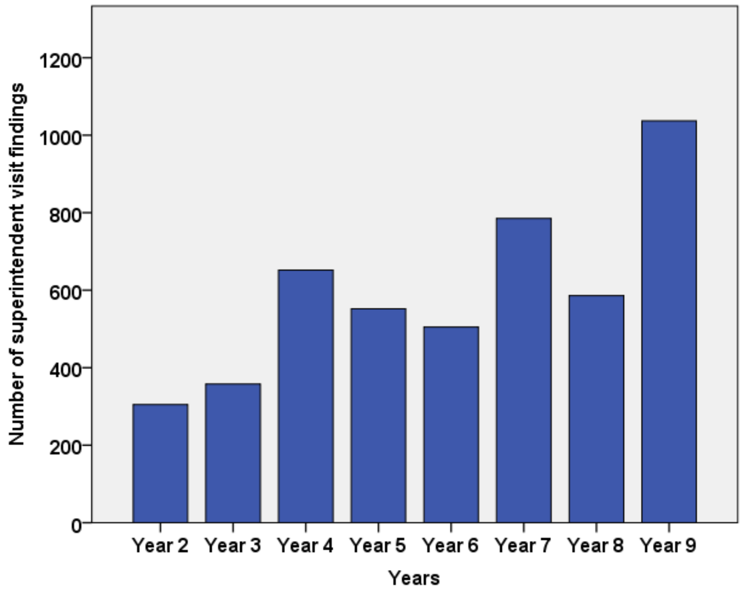

Figure 7-15 Number of superintendent visit findings

There is a gradual increase in the number of days without an accident. This identifies that the company's safety policy pays off since the year 3. The company can further increase this number by taking more proactive safety measures to further avoid any type of accident/incident on board ships.

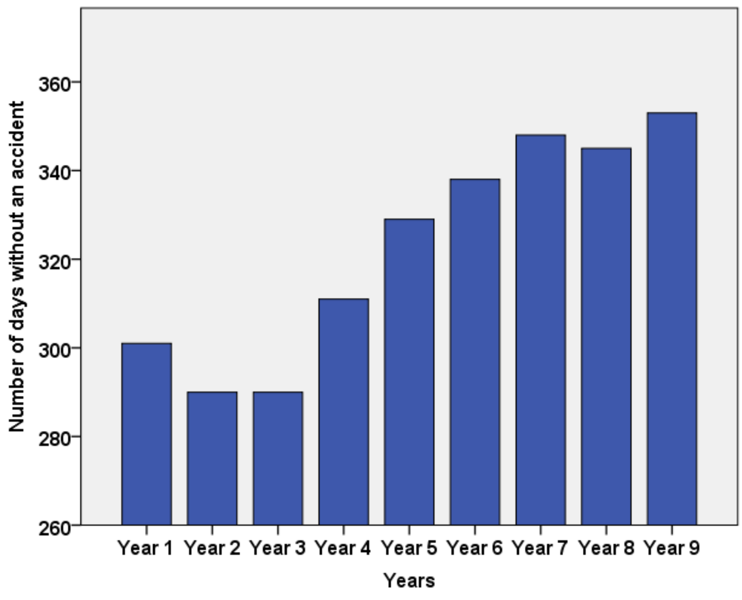

Figure 7-16 Number of days without an accident

The figure below indicates that number of procedure violations detected by superintendents was high until the year 6, however seafarers follow the company standard operating procedures more strictly in the last three years. This can be attributed to the higher standard of the training provided to crew members or the improved quality of the SOPs within the company.

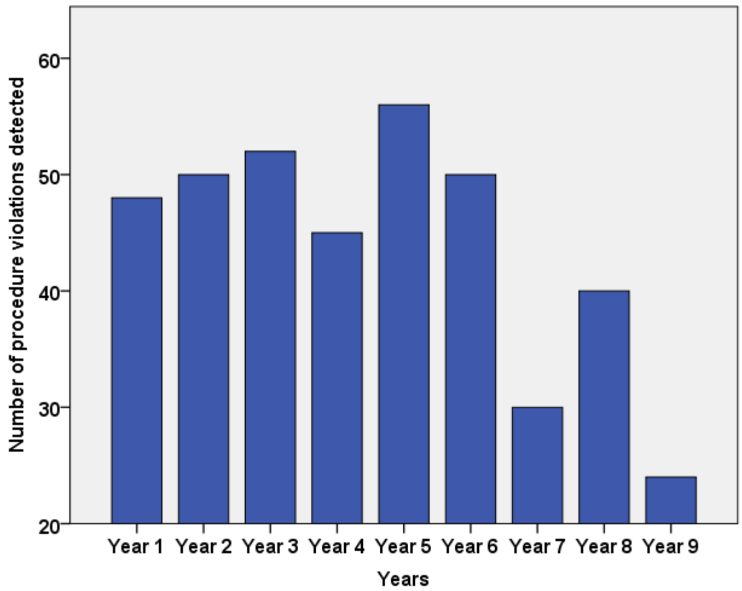

Figure 7-17 Number of procedure violations detected

Figure 7-18 shows that the number of drug or alcohol abuse has been decreasing within the company. Drug and alcohol abuse is one of the most dangerous problems for shipping organizations since the shipping operations continuously require a vigilant and competent crew. The adverse effects of the drug and alcohol use had caused numerous accidents in the maritime industry. Decrease in these numbers directly improves the safety of the entire fleet. The company should take all the necessary measures to drop these numbers to zero.

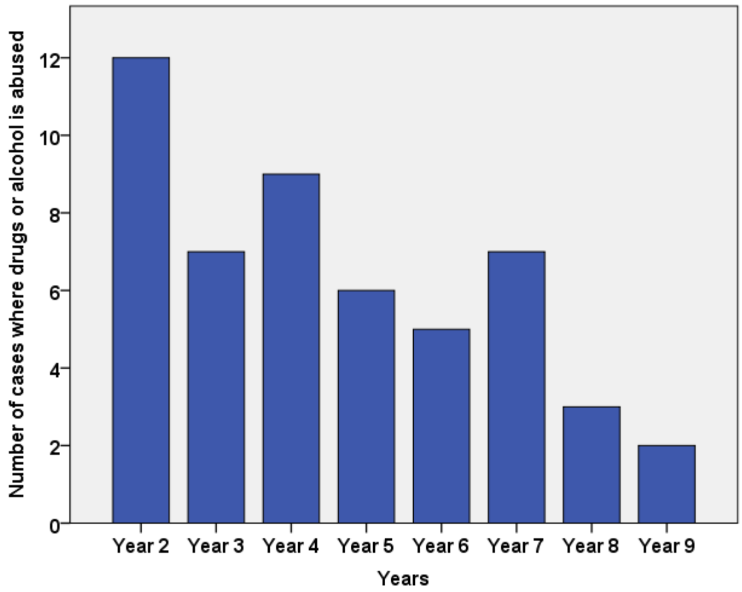

Figure 7-18 Number of cases where drugs or alcohol is abused between 2008 and 2016

Crew retention rates almost stayed same within the company between 2008 and 2016. On average, 94% of the seafarers continue working for the shipping company in the upcoming years. The high rate of retention shows that the company has a good culture and trying to maintain the same work force who knows each other for a long period of time.

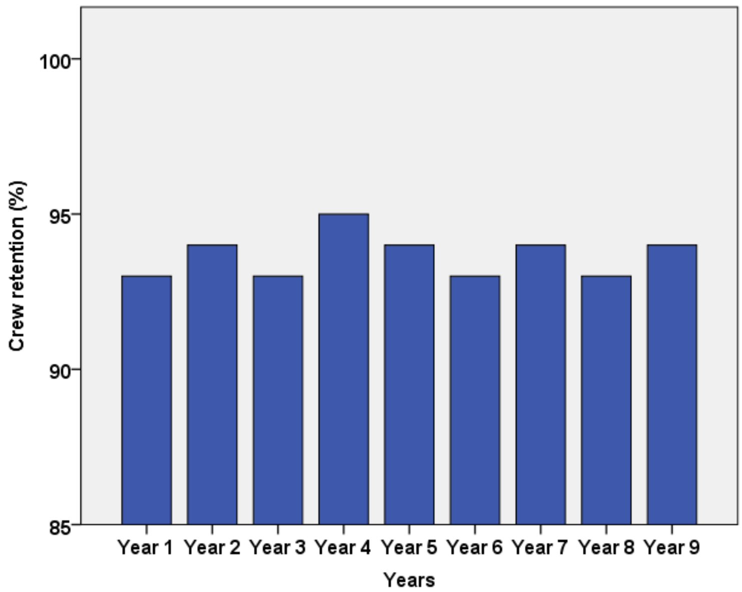

Figure 7-19 crew retention (%)

The number of corrective maintenance performed on board declined gradually throughout the years (See Figure 7-20). This indicates that the company started performing more proactive type of maintenance and try to fix the safety critical items before they break down. Utilizing condition monitoring tools help shipping companies to identify the equipment which are expected to be broken. When these types of equipment are replaced before they breakdown via proactive maintenance, crew members do not need to suspend the operation for maintenance work and therefore efficiency of shipping operations are improved.

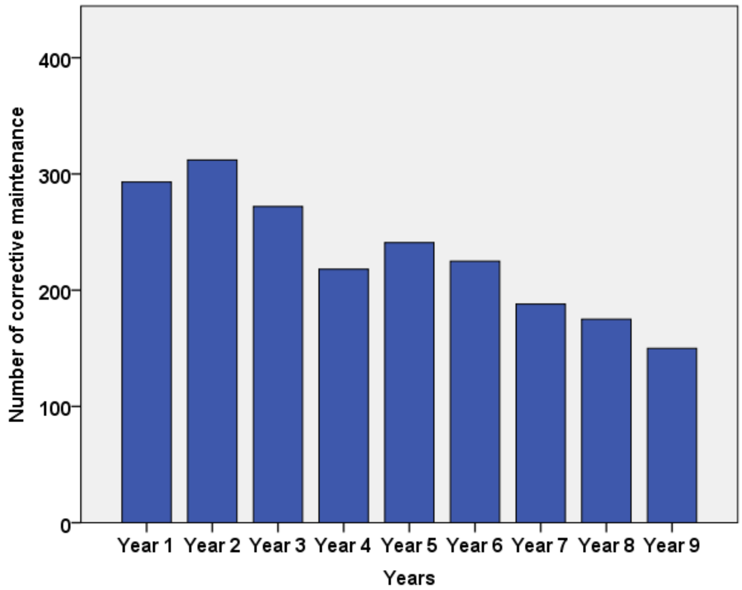

Figure 7-20 Number of corrective maintenance

Three year of data are available regarding the frequency of the management visits and it can be seen from the figure below that the management visit slightly decreased only in the year 9. Even though, the historic data is not enough to make a more accurate assumption, the numbers of management visit frequencies are found to be insufficient within the company by considering the total number of the ships. The management visit frequency is found to be low within this company by considering number of ships they operate (over 40). The management is expected to visit each ship at least once per year. This will lead crew members to feel more committed to the company and also ship management will broaden their knowledge about the fleet.

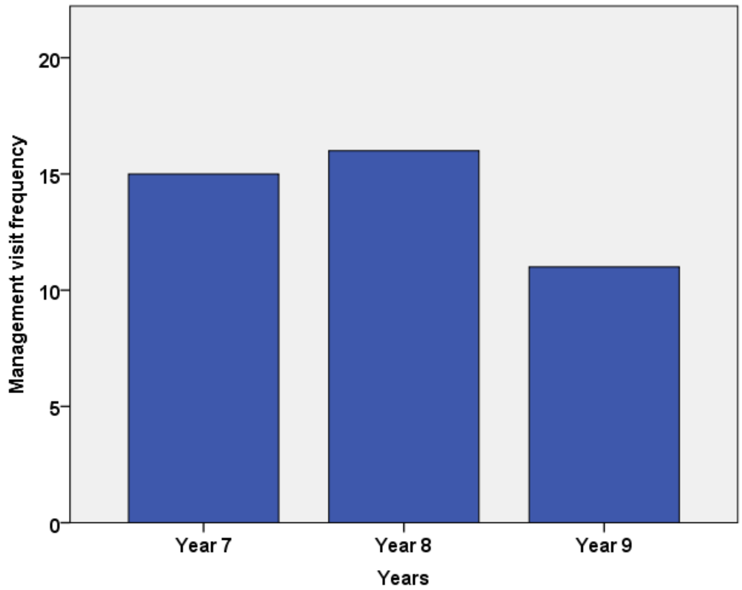

Figure 7-21 Management visit frequency

The company only had oil spill in the year 3 in 9 years period. It is noted that not having any oil spill in the last 5 years shows that the company prioritizing the environmental safety and protection in their operations. Oil spills do not only cause to excessive amount of fines but also affect the reputation of an organization amongst charterers adversely. The BP was fined for 20.8 Billion Dollar after the notorious Deepwater Horizon oil spill (Barrett, 2015). It is therefore important to take extremely stringent measures to avoid oil spills with the ultimate aim of keeping the oceans clean.

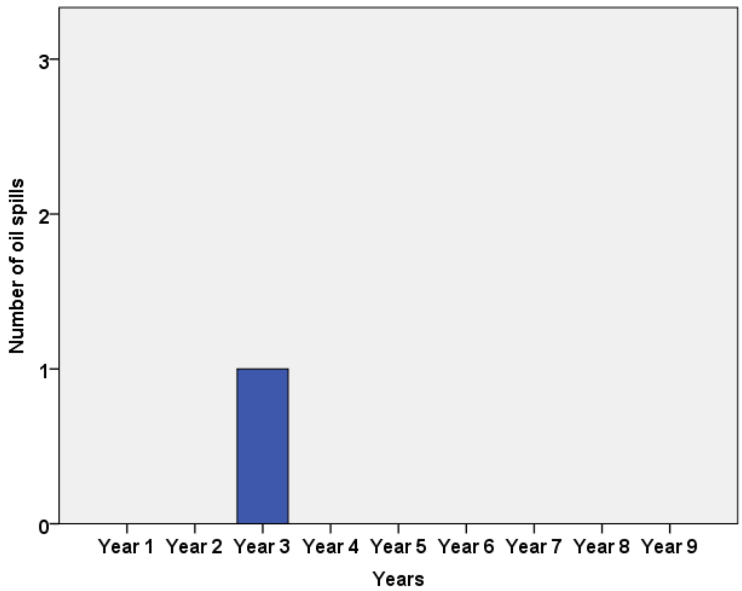

Figure 7-22 Number of oil spills between

All the figures given above depict that there is a positive safety trend within the company. Especially, in the last three years, the company made a tremendous amount of progress to protect the wellbeing of their seafarers and the fleet. All these efforts will not only help the company to have better reputation but also will help to protect all their assets.

First of all, near miss reporting, superintendent visits and internal audits are of paramount importance for enhanced safety performance of a fleet. Shipping companies need to collect more internal information to gain insight into on board dynamics. When the problems are identified and fixed internally, the likelihood of accidents and PSC findings of the company will decrease gradually. The increasing number of near miss reports and superintendent visit findings show the improving safety culture maturity levels of the company. However, number of internal audit per ship should be further increased to achieve the envisaged level of safety.

Particularly, near miss reports are known as the most easiest and straightforward mean for collecting information with regards to prevailing on board safety issues. Automated and anonymized near miss reporting system should be implemented to increase the number of reports and hence the on board safety culture. It is therefore crucial to treat all the reported honest errors within the just culture framework for not effecting reporting activities adversely. Seafarers then even may report unsafe acts more than unsafe conditions.

There is a decreasing trend regarding the TRCF, LTF and first aid cases. The company managed to lower all important safety performance KPIs within the organization and these trends also prove that the safety performance of the company is improving. The LTF and TRCF are used by tanker operators to compare their performances with each other.

The only parameter that the company can perform better is the number of management visits. The company should aim at least a visit per ship annually in order to pass the company values and objectives more clearly to the employees.

Even though, the company improved its safety culture significantly throughout the years, risk is inherent in the maritime operations. Therefore, the company should continuously implement proactive measures to enhance the level of safety on board vessels.

7.3.2 KPI vs KPI Correlations

The main aim of this section is to identify positive or negative correlations between KPIs so the company can focus on the right indicators to decrease number of accidents, injuries and undesired events.

The comparison of different set of key performance indicators by statistical correlation analysis allows shipping companies to identify the KPIs which have positive impact on safety performances of their fleet.

Each KPI was correlated with the rest of the databank by utilizing the SPSS software. Spearman's rho correlation test was chosen appropriate for this assessment since the KPI data is a non-parametric data and also it does not come from normal distribution. This method allows us to make scientific assumptions on the impact of a parameter on other KPIs. Powers of correlations were found amongst all the KPIs. The power of correlation varies between "1" and "-1" where "1" shows the strongest positive correlation and "-1" show the strongest negative correlations.

7.3.2.1 KPI: Lost time incident frequency (LTIF)

The table below shows that the lost time incident frequency is correlated with 5 other KPIs. The lost time incident frequency has positive correlations with the number of first aid cases and average corrective maintenance per ship. It also has negative correlations with the number of near miss reports, number of superintendent findings and number of days without an accident.

The lost time incident frequencies are recorded when crew members are unfit for performing their duties due to any work related injury. Therefore, it is of high importance to decrease LTIFs at work place. The near miss reports and superintendent visits provide substantial information regarding on board problems. As long as these on board problems are addressed, the seafarers may expose to less risks of having incidents on board and therefore may have a decreased frequency of lost time incidents. Additionally, the events which require corrective maintenance may be occurred due to the hazardous conditions such as explosions or fire. Therefore, a hypothesis can be constructed that increase on near miss reports and superintendent visits as well as performing less corrective maintenance may lead to the decreased number of LTIFs within the company.

Table 7-1 the correlation for lost time incident frequency (LTIF)

KPI 1	KPI 2	Correlation	Power of the correlation
Lost time incident frequency (LTIF)	Number of first aid cases (FAC)	Positive	.686*
	Number of near-miss reports	Negative	-.870**
	Number of superintendent visit findings	Negative	-.778*
	Number of days without an accident	Negative	-.849**
	Average corrective maintenance per ship	Positive	.870**

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

7.3.2.2 KPI: Total recordable case frequency (TRCF)

The table below shows that the total recordable case frequency (TRCF) is correlated with 5 other KPIs. The total recordable case frequency (TRCF) has positive correlations with the number of first aid cases, number of navigational accidents and average corrective maintenance per ship. It also has negative correlations with the number of near miss reports and number of days without an incident or accident.

The strongest correlation is found between the near miss numbers and TRCFs. Decreasing TRCFs is considered as a substantial safety improvement amongst tanker shipping organizations. It can be seen from the table below that together with the TRCFs, all other navigational accidents and first aid cases tend to decrease with a reasonable likelihood. As the TRCF is the sum of the LTIFs and other medical treatment cases, the increasing near miss reports may influence the TRCF in a similar way to LTIFs. Therefore, a hypothesis can be constructed that increase on near miss reports may lead to the decreased number of TRCFs within the company.

Table 7-2 the Correlation for total recordable case frequency (TRCF)

KPI 1	KPI 2	Correlation	Power of the correlation
Total recordable case frequency (TRCF)	Number of first aid cases (FAC)	Positive	.800**
	Number of navigational accidents	Positive	.725*
	Number of near-miss reports	Negative	-.933**
	Number of days without an accident	Negative	-.879**
	Average corrective maintenance per ship	Positive	.850**

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

7.3.2.3 KPI: Number of first aid cases (FAC)

The table below shows that the number of first aid cases (FAC) is correlated with 8 other KPIs. Number of first aid cases (FAC) has positive correlations with lost time incident frequency, total recordable case frequency, the number of navigational accidents, number of PSC inspections and average corrective maintenance per ship. It also has negative correlations with the number of near miss reports, number of superintendent visit findings and number of days without an accident.

Number of first aid cases can be decreased by identifying and addressing hazardous areas which could lead to undesired events such as trips, falls and slips. When the unsafe conditions are reported within the near miss reports, the company may gain insight into the hazardous conditions and preventive measures can therefore be taken prior to the accidents. Similarly, superintendent visits are highly useful on highlighting safety critical issues. Therefore, a hypothesis can be constructed that increase on near miss reports and superintendent visits may lead to the decreased number of FACs within the company. When all these accident numbers decrease in correlation with each other, the company may be exposed to less PSC inspections due to the increasing safety reputation. As identified by the statistical analysis, decreasing number of corrective maintenance may also have influence on first aid case reductions since the faulty parts that cause the malfunction may also lead to a personal injury which requires first aid cases.

Table 7-3 the Correlation for number of first aid cases (FAC)

KPI 1	KPI 2	Correlation	Power of the correlation
Number of first aid cases (FAC)	Lost time incident frequency (LTIF)	Positive	.686*
	Total recordable case frequency (TRCF)	Positive	.800**
	Number of Navigational Accident	Positive	.759*
	Number of near-miss reports	Negative	-.933**
	Number of PSC	Positive	.733*

inspections		
Number of superintendent visit findings	Negative	-.810*
Number of days without an accident	Negative	-.946**
Average corrective maintenance per ship	Positive	.850**

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

7.3.2.4 KPI: Number of navigational accidents

The table below shows that the number of navigational accidents is correlated with 5 other KPIs. Number of navigational accidents has positive correlations with the total recordable case frequency, number of first aid cases, number of PSC inspections and average corrective maintenance per ship. It also has negative correlations with the number of near miss reports and number of days without an accident.

Since all the accident numbers tend to increases or decrease together, a hypothesis can be constructed that all accident figures are related to each other and successful safety measures may lead to a decrease for all of them. Once again, number of near misses is found negatively correlated with another accident figure such as the number of navigational accidents.

The PSCs perform more inspections on vessels which are substandard and unreliable that's why number of inspections may decrease when the company has less accidents in its history.

Table 7-4 the Correlation for number of navigational accidents

KPI 1	KPI 2	Correlation	Power of the correlation
Number of navigational accidents	Total recordable case frequency (TRCF)	Positive	.725*
	Number of first aid cases (FAC)	Positive	.759*
	Number of near-miss reports	Negative	-.673*
	Number of PSC inspections	Positive	.690*
	Number of days without an accident	Negative	-.676*

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

7.3.2.5 KPI: Number of near-miss reports

The table below shows that the number of near-miss reports is correlated with 8 other KPIs. Number of near-miss reports has positive correlations with the number of superintendent visit and number of days without an accident. It also has negative correlations with the lost time incident frequency, total recordable case frequency, number of first aid cases, number of navigational accidents, number of PSC detentions and average corrective maintenance per ship.

Increasing number of near miss reports within companies demonstrates companies' and its employees' commitment to safety. The importance of the near miss reports has been discussed many times within this thesis. Near miss reporting is found significantly and negatively correlated with all accident numbers and therefore a hypothesis can be constructed that increasing number of near miss reports may influence safety performance positively. Furthermore, number of near miss reports has a negative correlation with the PSC detentions. The PSC detentions are one of the worst case scenarios a shipping company can have and therefore number of detentions should be kept as zero. Increasing number of near miss reports may also decrease number of corrective maintenance since lesson learnt from an error which led to a corrective action, can be disseminated through the fleet and therefore similar type of maintenance issues can be prevented.

Table 7-5 the Correlation for number of near-miss reports

KPI 1	KPI 2	Correlation	Power of the correlation
Number of near-miss reports	Lost time incident frequency (LTIF)	Negative	-.870**
	Total recordable case frequency (TRCF)	Negative	-.933**
	Number of first aid cases (FAC)	Negative	-.933**
	Number of navigational accidents	Negative	-.673*
	Number of PSC detentions	Negative	-.779*
	Number of superintendent visit findings	Positive	.786*
	Number of days without an accident	Positive	.954**
	Average corrective maintenance per ship	Negative	-.950**

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

7.3.2.6 KPI: Number of PSC deficiencies

The table below shows that the number of PSC deficiencies is correlated with 5 other KPIs. Number of PSC deficiencies has positive correlations with the number of restricted work cases (RWC), number of PSC inspections, number of inspections with deficiencies, number of navigational accidents, numbers of inspections with deficiencies, number of PSC deficiencies and number of procedure violations detected.

As expected, number of inspections and deficiencies are correlated. When the PSCs perform more inspections due to bad reputation of a company or a random selection, the likelihood of having a deficiency increases within a company as well. In addition to this, there is a positive statistical correlation between procedural violations detected and number of deficiencies. A hypothesis can be constructed that violations from procedures may be recognized and recorded as deficiencies by PSCs. The ship management should conduct meeting with the crew to explore whether violations are performed due to impractical procedures or seafarers' lack of competency.

Table 7-6 the Correlation for number of PSC Deficiencies

KPI 1	KPI 2	Correlation	Power of the correlation
Number of PSC Deficiencies	Number of restricted work cases (RWC)	Positive	.682*
	Number of PSC inspections	Positive	.879**
	Number of inspections with deficiencies	Positive	.979**
	Number of days without an accident	Negative	-.697*
	Number of procedure	Positive	.798**

	violations detected		

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

7.3.2.7 KPI: Number of PSC detentions

The table below shows that the number of PSC detentions is correlated with 6 other KPIs. Number of PSC detentions has positive correlations with the number of lost work day cases (LWC), number of first aid cases (FAC), number of PSC inspections and average corrective maintenance per ship. It also has negative correlations with the number of near-miss reports and number of days without an accident.

The increasing number of near miss reports and its relationships with the safety performance came to sight again in this correlation. Detained ships are not allowed to sail until corrective actions are implemented thoroughly and increasing number of near miss report may increase the information of the ship management regarding the fleet and therefore may lead to a decreased number of detentions within the company. Correlations were also found between number of detentions and LWCs & FACs. When the accident numbers decrease, the company may have exposure to less inspections and therefore to detentions due to improving safety reputation.

Table 7-7 the Correlation for number of PSC detentions

KPI 1	KPI 2	Correlation	Power of the correlation
Number of PSC detentions	Number of lost work day cases (LWC)	Positive	.840**
	Number of first aid cases (FAC)	Positive	.866**
	Number of near-miss reports	Negative	-.779*
	Number of PSC	Positive	.779*

	inspections		
	Number of days without an accident	Negative	-.783*
	Average corrective maintenance per ship	Positive	.693*

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

7.3.2.8 KPI: Number of days without an accident

The table below shows that the number of days without an accident is correlated with 11 other KPIs. Number of days without an accident has positive correlations with the number of near-miss reports and number of superintendent visit findings. It also has negative correlations with the lost time incident frequency (LTIF), total recordable case frequency (TRCF), number of first aid cases, number of navigational accidents, number of PSC inspections, number of PSC deficiencies, number of PSC detentions, number of procedure violations detected and average corrective maintenance per ship.

The strongest statistical significant correlation was found between number of days without an accidents and number of near misses within the organization. A hypothesis can be constructed that increasing number of near miss reports may identify the events that can go wrong beforehand and therefore may increase the number of days without an accident. Another strong negative correlation exists between number of days without an accidents and corrective maintenance.

Table 7-8 the correlation for number of days without an accident

KPI 1	KPI 2	Correlation	Power of the correlation
Number of days without an accident	Lost time incident frequency (LTIF)	Negative	-.849**

	Total recordable case frequency (TRCF)	Negative	-.879**
	Number of first aid cases (FAC)	Negative	-.946**
	Number of navigational accidents	Negative	-.676*
	Number of near-miss reports	Positive	.954**
	Number of PSC inspections	Negative	-.695*
	Number of PSC deficiencies	Negative	-.697*
	Number of PSC detentions	Negative	-.783*
	Number of superintendent visit findings	Positive	.826*
	Number of procedure violations detected	Negative	-.710*
	Average corrective maintenance per ship	Negative	-.904**

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

7.3.2.9 KPI: Average corrective maintenance per ship

The table below shows that the average corrective maintenance per ship is correlated with 8 other KPIs. Average corrective maintenance per ship has positive correlations with the lost time incident frequency (LTIF), total recordable case frequency (TRCF), number of first aid cases (FAC), number of PSC detentions and number of procedure violations detected. It also has negative correlations with the number of near-miss reports, number of superintendent visit findings and number of days without an accident.

The results reveal that number of corrective maintenance is positively correlated with almost all accident numbers. Therefore, a hypothesis can be constructed that any decrease on corrective maintenance may cause all accident figures to decrease and hence to increase safety performance within the company. . Near miss reports can provide significant amount of information to identify the problems which can be proactively handled without corrective maintenance. Superintendent visits also do the same effect as the near miss numbers by providing insight into issues and hence may cause a decreased number of corrective maintenance on board.

Table 7-9 the correlation for average corrective maintenance per ship

KPI 1	KPI 2	Correlation	Power of the correlation
Average corrective maintenance per ship	Lost time incident frequency (LTIF)	Positive	.870**
	Total recordable case frequency (TRCF)	Positive	.850**
	Number of first aid cases (FAC)	Positive	.850**
	Number of near-miss reports	Negative	-.950**
	Number of PSC detentions	Positive	.693*
	Number of superintendent visit findings	Negative	-.905**

	Number of days without an accident	Negative	-.904**
	Number of procedure violations detected	Positive	.753*

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

7.3.2.10 Key Findings

It is a well-known fact with in the statistics that correlations do not imply causation standalone. They are required to be supported by evidence and theories to prove the existing relationships amongst variables. However, three correlations are found to be extremely strong and the real causal relationships can be established that lead to an enhanced level of safety culture and safety performance. Most importantly, these three correlations do not only have very strong significance values and appeared in numerous analyses but also they are found to be rational by considering the nature of the shipping operations. These relationships and their supporting theories are summarized below:

- Number of near miss reports
- Number of superintendent visit findings
- Number of corrective maintenance performed

The results and trends are underpinning the fact that the safety culture maturity level is increasing within the company. However, the company can further improve the standards by leaning to the right indicators since safety requires continuous improvement. This section therefore provides the most crucial KPIs to be altered in order to change the safety performance of the shipping company.

First of all, the near miss data come into sight when we investigate the correlations between the collected KPIs and its positive contribution for safety cannot be neglected. Increasing near miss reports are significantly correlated with decreasing accident and case frequencies.

The near miss reports provide insight into the events which could lead to undesirable consequences if the appropriate measures are not taken within the company. Managing this potential can therefore make positive contributions to safety. Near miss reports can be also considered as a leading indicator as the investigation of them focuses on "what might go wrong" rather than reactive "what had happened" approach. A thorough investigation of near miss reports will ease the identification of the root causes of the problems and help shipping companies' to prevent future reoccurrences of the same issues. However, if the near miss reports are collected but not properly investigated, the same problems will continue compromising safety. It can be seen from the results that the increasing near miss reports are highly correlated with the decreasing accident ratios. Therefore, a hypothesis can be constructed that the shipping company takes the near miss investigation seriously and implementing the corrective actions to avoid similar problems on board.

Dissemination of the lesson learnt from the near miss reports through the industry may also lead other shipping companies to avoid similar accidents & incidents and therefore will improve level of safety within the maritime industry. Since the introduction of the ISM Code also encouraged the near miss reporting (IMO, 2008), shipping organizations boosted their reporting activities with different initiatives to proactively enhance level of safety.

Even though the company is increasing amount of near miss reports collected through the years, the results demonstrate that there is a room for further safety improvement which can be achieved by increasing the number of near miss reports. In order to achieve the envisaged level of reporting, there are certain areas the company should focus on. The existing blame culture frequently prevents crew members from reporting unsafe acts and conditions. Seafarers therefore tend to report the minor issues but not the major ones due to the fear of punishment or sanctions. The company should implement an effective "just culture" and all the cases should be treated with a consistent and transparent manner. The crew members then can report some of the critical violations that they observe during shipping operations. Furthermore, crew members are excessively wrapped up with their own duties and easing the process of reporting will therefore be crucial for increasing the number of reports. Electronic and automated systems such as video or voice recording can ease the process of reporting within the organization as well. The company should also acknowledge the crew members' reporting efforts by providing feedback on the most important near miss reported through company newsletters and thus can further encourage and promote near miss reporting.

The second important KPI is found as the number of superintendent visit findings. The increasing numbers of superintendent visits are also correlated with the decreasing accident figures such as lost time incident frequencies and first aid cases. Similar to the near miss reports, superintendent visits provide insight into the issues that could lead to undesirable events on board. It is therefore important to conduct more frequent superintendent visits amongst the fleet and implement the corrective actions identified for an enhanced safety. Superintendent visits are also proactive measures organized by the company for identifying and addressing any issue that may affect the safety of a vessel adversely. Superintendents do not only identify the existing problems but also proactively recognize the conditions that may turn into an accident and incident. Utilization of such proactive measures will therefore improve safety culture maturity levels of the companies positively. The company's increasing number of super intendent visits and near miss reports can be interpreted as the company is trying to be more proactive and the safety culture is changing positively.

Superintendents can also identify nonconformities that crew members are reluctant to report due to numerous reasons such as existing blame culture. When the issues are identified and fixed internally, not only safety statistics may improve but also the risk of having deficiencies and detentions by PSCs may decrease. The low number of PSC deficiencies may also affect the safety reputation of the company amongst charterers and may lead the company to be more favorable and profitable in the industry.

The last but not least, decrease on corrective maintenance also has positive effect on safety according to the strong statistical correlations established in several cases. Firstly, corrective maintenance is a reactive measure and reactive approaches are not desirable within the advanced safety culture concept. Especially, corrective maintenance is required when something goes wrong or when there is an equipment failure (maybe a broken unit) on board a vessel. These problems may cause accidents and incidents standalone and hence can affect wellbeing of the seafarers adversely. The shipping operations are also required to be suspended when there is a need for a corrective maintenance and this may result in additional workload for crew who are tied with several other tasks.

In addition to these, corrective maintenance may be required to be done immediately due to a type of a specific shipping operation, therefore a sufficient time may not be available for a through risk assessment. On the other hand, proactive approaches may allow crew members to plan the required work in a safe and a structured manner beforehand. When the number of corrective maintenance decrease within the company, risk of having unexpected or maybe even dangerous events may decrease as well.

Lastly, condition monitoring techniques can be utilized to decrease number of corrective maintenance so that breakdown of an equipment and its hazardous effects can be prevented with an ultimate aim of enhancing safety on board.

7.3.3 The Safety Culture Questionnaires vs KPIs Correlation

The main aim of this section is to explore if any of the KPIs are connected to the seafarers' attitudes and perceptions that captured by questionnaires. The analysis provides an opportunity to identify the KPIs which may make a contribution to the attitudes and perceptions of the seafarers. Spearman Rho's test was utilized in order to identify statistically significant positive and negative relationships between safety culture questions and KPIs.

As aforementioned, correlations do not imply causation in each case unless the relationships are supported with evidences and theories. The relationships are explored between each safety culture questions and key performance indicators within this section, however the detailed study failed to demonstrate strong correlations and the rational links between datasets. The safety culture questions are designed to capture attitudes and perceptions of the seafarers in a detailed manner and it has been found that only one question cannot be representative of the general prevailing trends of a shipping company. Due to this limitation, seeking correlations at dimensional level has been found more reasonable for increasing the accuracy of the relationships.

The obtained results therefore highlight the necessity of performing a correlation study between attitude and perception levels achieved under the each safety culture dimension and safety related key performance indicators. The results of these correlations can be found at the Appendix G.

7.3.4 Safety Culture Dimensions vs KPIs

As aforementioned before, the safety culture questionnaires consist of ten main dimensions. The section aims to seek any correlation between these dimensions and the safety performance of the company, thus, the company can focus on the right KPIs in order to improve safety culture dimensions. The average scores of the each safety culture dimension were calculated for every single vessel for the correlation study. Six safety culture dimensions were found to be correlated with the safety performance data of the company:

- Communication
- Feedback
- Involvement
- Just Culture
- Problem Identification
- Training and Competence

7.3.4.1 Communication

The table below shows that there is a statistically significant correlation between number of the corrective maintenance and the communication dimension. Generally, decreasing number of corrective maintenance is considered as an improvement on safety performance. The correlation between these two variables can only be attributed to increased level of communication when there is a problem on board. However if this hypothesis is correct, seafarers probably have a wrong safety culture perception about the communication dimension. Communication should be preventive and proactive during shipping operations.

Table 7-10 Communication factor vs KPI

Safety Factor	KPI	Relationship	Power of the correlation
Communication	Average corrective maintenance per ship	Positive	.405*

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

7.3.4.2 Feedback

The table below shows that there are statistically significant correlations between the feedback dimension and number of the corrective maintenance per ship & number of days without an accident. Similar to the communication dimension, a hypothesis is constructed that when there is corrective maintenance or a problem on board a vessel, the amount of feedback shared between ship and shore may increase. The employees may also provide more feedback in order to address the corrective maintenance in a timely manner. However, these types of reactive approaches are not desirable within the safety culture concept. The crew members should be informed about how the desired and proactive feedback mechanism should be working.

Table 7-11 Feedback factor vs KPI

Safety Factor	KPI	Relationship	Power of the correlation
Feedback	Number of days without an accident	Positive	.344*
	Average corrective maintenance per ship	Positive	.411*

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

7.3.4.3 Involvement

It can be seen from the table below that there are statistically significant correlations between the number of the average corrective maintenance per ship, the percentage of work-rest hour violations and the involvement dimension. When the crew members feel more involved about the changes that affect their work practices, they may be more committed to the company and perform less work and rest hours violations. Same as the other safety factors, involvement dimension is also correlated with the number of corrective maintenance. The correlation between the dimension and maintenance can be attributed to higher level of involvement of the parties when there is a requirement of a corrective maintenance on board. However, if this hypothesis is correct, the management should consider its management style since the corrective maintenance exposes higher risks to the company than the proactive one due to the nature of challenging shipping environment.

Table 7-12 Involvement factor vs KPI

Safety Factor	KPI	Relationship	Power of the correlation
Involvement	Percentage of work-rest hour violations (%)	Negative	-.321*
	Average corrective maintenance per ship	Positive	.461**

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

7.3.4.4 Just Culture

It can be seen from the table below that there are statistically significant correlations between the number of internal audits, percentage of work-rest hour violations (%) and the just culture dimension. If errors are corrected without punishment and treated as a learning opportunity within the company, seafarers may freely inform ship management and discuss the issues regarding the work-rest hours and therefore may adhere to work rest hour regulations more strictly. The number of internal audits may also make contribution to the enhanced just culture approach within the company.

Table 7-13 Just Culture factor vs KPI

Safety Factor	KPI	Relationship	Power of the correlation
Just Culture	Number of internal audit	Positive	.388*
	Percentage of work-rest hour violations (%)	Negative	-.355*

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

7.3.4.5 Problem Identification

The table below shows that there are statistically significant correlations between the number of first aid cases (FACs), percentage of work-rest hour violations (%), average corrective maintenance per ship and the problem identification dimension. Corrective maintenance was found statistically correlated with almost all safety culture dimensions positively. This can be attributed to the fact that the importance of the proactive approaches may have not been totally understood by the employees since the increased amount of activities due to corrective maintenance may have been misinterpreted by seafarers. Crew members' problem identification capabilities may also improve if the company invest on measures to decrease injuries that require first aid.

Table 7-14 Problem Identification factor vs KPI

Safety Factor	KPI	Relationship	Power of the correlation
Problem Identification	Number of First Aid Cases (FAC)	Negative	-.336*
	Percentage of work-rest hour violations (%)	Negative	-.323*
	Average corrective maintenance per ship	Positive	.333*

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

7.3.4.6 Training and Competence

It can be seen from the table below that there is a statistically significant correlation between the management visit frequency and the training and competence dimension. Management's visit may be considered as an initiative to monitor the competency of the seafarers. When the company employs more management visits on board to check the competence levels of crew members, the perceptions and attitudes of the seafarers may improve regarding this safety culture dimension.

Table 7-15 Training and competence factor vs KPI

Safety Factor	KPI	Relationship	Power of the correlation
Training and Competence	Management visit frequency	Positive	.387*

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

7.4 Chapter Summary and Conclusions

The key performance indicators analysis provided an insight into the safety performance of the company as well as the key parameters to be utilized to improve overall safety culture within the company. It is also of crucial importance to establish the links between safety culture dimensions and safety performance of the shipping company. First of all, the safety performance of the company improved continuously throughout the years, especially in the last three years the company made a substantial progress with regards to safety. The accident numbers such as the total recordable cases frequencies, lost time incidents frequencies and first aid cases are decreasing within the company. The decreases on these numbers are also indicators of company's improving performance since these KPIs are broadly used by tanker shipping operators. Having low number of accident case frequencies will therefore affect the reputation of the company positively within the market.

It can be also seen from the established trends that the company collect more near miss reports and number of superintendent visit findings are increasing too. This situation demonstrates that the company is heavily investing on measures for identifying and fixing the problem internally before undesirable events occur.

Another evidence of the improving safety is considered as the decreasing Port State Control deficiency and detention numbers. Deploying more efforts within the organization for raising issues and addressing them has also resulted in decreased nonconformities.

In addition to the general improving trends, the KPI correlations provide substantial amount of information for the company with regards to the prioritization of the improvement plans. Number of near miss reports, number of superintendent visits findings and number of corrective maintenance were found to be the most significantly critical KPIs for enhancing safety culture within the company. Increasing number of near miss reporting and number of superintendent visit findings increase the amount of problems that are known to the ship management and it is of paramount importance understanding existing problems in order to develop appropriate intervention strategies. Initiatives to enhance near miss reporting such as just culture approach and electronic reporting mechanisms should be employed within the company.

Another important parameter is found as the decreasing number of corrective maintenance amongst the fleet. When the faulty items are identified and maintained proactively, less risk is exposed to crew members and wellbeing of the seafarers is maintained. Furthermore, some of the corrective maintenance is required to be conducted immediately for not stopping safety critical operations and this can lead to additional workload for seafarers. Condition monitoring techniques should be utilized to increase number of proactive maintenance in order to improve safety of the fleet.

The results have demonstrated that the links between safety culture surveys and key performance indicators cannot be explored at individual question level. The safety culture attitudes and perceptions of the seafarers should be correlated under structured safety dimensions in order to enhance the accuracy of the results.

It has been also found that 6 safety culture dimensions are correlated with the key performance indicator changes. These safety culture dimensions are:

1 Communication
2 Feedback
3 Involvement
4 Just Culture
5 Problem Identification
6 Training and Competence

According to the statistical results, corrective maintenance is found correlated with four of the safety culture dimensions, namely: communication, feedback, involvement and problem identification. However, it has been proved that corrective maintenance is not a desired condition for the shipping company and it affects the safety performance adversely. Therefore, it has been considered that this result may have obtained due to the wrong safety culture perceptions of the seafarers on these dimensions as they may have interpreted the requirement of the urgent corrective action as an improved communication and involvement etc. on board.

Even though overall level of safety is found to be satisfactory, the safety culture enhancement journey requires continuous commitment both from ship management and seafarers. Therefore, the company should treat continuous improvement as a core value with an ultimate aim of increasing safety culture maturity level of the company.

The study provided substantial amount of information regarding how the safety general trends are within the company, which safety critical KPIs should be utilized to enhance safety performance of the company and lastly what kind of relationships exist between safety culture dimensions and safety performance. The relationships between safety culture attitudes and key performance indicators have not been established in the maritime sector before. Therefore, this study also provides an objective assessment and shed light into the issues that could not be captured by subjective assessments within the maritime industry.

8 Observation Results

8.1 Chapter Overview

The overt observation methodology works complementary with the safety climate assessment and also has two main aims:

- To explore crew member's attitudes and perceptions under ten main safety culture factors and investigate how the differences on crew members' attitudes and perceptions affect their working practices.
- To understand what the workload comprises for each crew members and how the workload affect the existing safety culture on board.

The workload of seafarers is of the utmost importance with respect to safety of shipping. The workload of seafarers is mandated by the IMO's established safe manning requirements for shipping companies in order to maintain safety and security on board, and prevent accidents or loss of life (IMO, 2011). It is crucial to gain insight into the workload of each crew member, how much time they spend on different tasks and whether the workload distribution allows them to perform their jobs safely. However it is a well-known fact that some seafarers deviate from the work rest regulations due to the lack of sufficient manning on board (Bowring, 2006). Therefore, a detailed observation study method was developed and conducted in a shipping company to capture workload data and how the workload triggers seafarers to perform their duties including safety critical tasks. The study addresses this gap by carrying out overt observations on-board two sister ships operating on the same passage, to identify what the workload comprises of for the crew and attitude differences amongst crew members. The observation method aims to record the activity type, duration of the task, sailing zone, physical situation and interruption levels.

8.2 Introduction

Seafaring is known to be a very challenging and demanding occupation (IMO, 2012). Insufficient manning levels and excessive workload are found to be the contributing factors of main reasons for several catastrophic accidents (Bowring, 2006).

The studies indicate that manning levels, fatigue and hours of work are highly interconnected with each other and administrative burdens (paperwork) was found to be the main contributor of the fatigue on board (MacDonald, 2006). The reductions on crew manning levels caused some safety concerns within the maritime community, and it is well-known that today seafarers perform less navigation but more paperwork & administrative work (Knudsen, 2009). This highly affects the safety attitudes of the seafarers and also safe navigation of a ship when automation fails (e.g. the Royal Majesty accident which happened due to over reliance on radar/navigation aids (Lützhöft and Dekker, 2002).

Another important aspect of driving safety in shipping is that manning costs constitute 33%-50% of the shipping operations (Theotokas and Progoulaki, 2007) and thus, shipping organizations are looking for means to decrease these costs. There is a continuous decrease in manning levels amongst commercial vessels due to the technological improvements on navigational equipment (Board, 1991). Manning levels have decreased from 30-40 in the 60s to 9-14 in the 90s, where nevertheless vessel sizes increased simultaneously (Grabowski and Hendrick, 1993).

Several regulatory bodies published rules and regulations to guide shipping companies on manning levels (ILO, 1976, ILO, 1996, European Community Shipowners' Association, 1999, IMO, 2011). The IMO's "Principle of Safe Manning" resolution is not mandatory, rather it is used as guidance by member state/flag administrations and it is interpreted differently from Administration to Administration (MacDonald, 2006). Therefore, a ship can have a different number of crew under different flags and some shipping companies choose the flag states who propose the minimum manning levels. The MCA examines the manning proposals within the UK, with a Captain and Chief Engineer examining the proposal without a ship visit and having proper knowledge about a vessel (Lloyd, 2008).

Traditionally, workload calculations are made based on the engine size or gross tonnage, size and type of ship, number, size and type of main propulsion units and auxiliaries, level of ship automation etc. (IMO, 2011). However, the total amount of time a crew member spends on each task during his/ her shift has not been recorded and detailed before.

To date, numerous studies have been conducted investigating the effects of workload on crew members (Grabowski and Hendrick, 1993, MacDonald, 2006, Press, 1990) , however to the knowledge of the authors no study has employed an observational method to capture workload data and crew members' adherence to safety management rules, by observing the entire tasks of crew members in a typical day.

Today, there is a need for more comprehensive manning level determination to enhance safety on board by considering the impact of administrative workload, which was initiated by regulatory bodies to maintain higher level of safety.

8.3 Methodology

Whilst many studies have employed methods that capture physiological aspects, there is a distinct lack of studies that employ an observational method to capture workload data and crew members' adherence to safety management rules. A case study approach is adopted, wherein the case was bounded to ferries operating on the same short passage between the mainland and a populated island. The ferries carry out a high number of piers in a day as compared to other ferries in the fleet and were identified as a unique case to investigate.

This observation methodology was developed under the Maritime Safety Culture Assessment and Improvement Framework. It is one of the third assessment methodology which is supported by the action plans and improvement methodologies to enhance maritime safety. The overall framework can be briefly descried as below:

Safety Culture Assessment and Improvement Framework

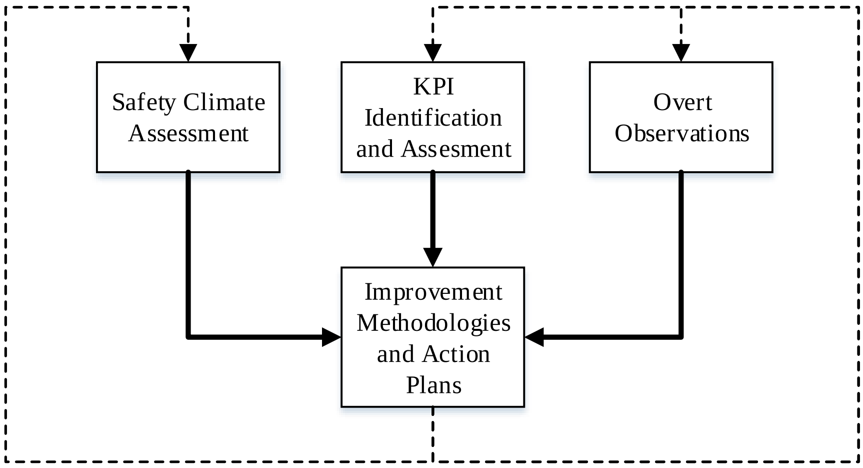

Figure 8-1 safety culture assessment and improvement framework

It was known to the shipping company that two sister vessels have different safety performances even though they sail in the same route with the same state of the art vessel. Safety culture surveys and safety related key performance indicators investigations didn't provide sufficient information to understand the main reasons leading to these differences. Therefore, it is a necessity for safety culture studies to have an on-board observation section where companies can gain insight into real operational practices, attitude and perception differences leading to these gaps records amongst sister ships. This gap makes the arrangement of an observation study necessary to capture the full safety culture picture.

The primary form of data collection was overt observations. Two researchers conducted observations during the same time period of six days with one on each of the ferries. The scope of the observations was restricted to Officers only (deck and engine departments). The officers of the sister vessels comprise of the Captain, Chief Mate, Third Mate, Chief Engineer and Second Engineer. Each crew member was observed for one day, with the researcher shadowing them for their entire shift. Additionally, a questionnaire was developed to support the observation study. Whilst a crew member's tasks were documented for only one day, the researchers stayed on-board the vessel for six days and were also able to generally observe the other five days. These observations were captured by both researchers in the form of a report and this report was provided to the shipping company.

Two researchers spent six days on-board sister ferries conducting observations. Both the researchers were assigned to one vessel each for the entire time period. The breakdowns of these observations are shown in Table 8-1. To summarise, 12 persons were observed over six days amounting to more than 150 hours of observations.

The researchers shadowed the person being observed for an entire shift. However, there were times when the researcher did not follow the person, including when carrying out office work, breaks, rest periods and so on. The researchers also followed the guidance given to them by the crew on-board the vessel. The two main aspects were: (1) the wearing of company required safety equipment and clothing when on the car deck and in the engine room and (2) not to disturb or interrupt the bridge crew during red zone sailing. Due to the long shifts, there was a long rest period in the middle of the day for those who lived on-board the vessel, both researchers also took this rest period. Thus, the researchers gained insight into the actual shift patterns in terms of shift durations.

Table 8-1 Breakdown of Observations & Role

Role	Vessel 1	Vessel 2	Total
Captain	2	1	3
Chief Mate	1	2	3
Third Mate	1	1	2
Chief Engineer	1	1	2
Second Engineer	1	1	2

8.4 Information about the Vessels

The ferries operate on a short sailing, taking approximately 35 minutes. During peak time, the ferries have only 10 minutes between sailings and during non-peak times of the day there is between 20 and 30 minutes. The ferry route crosses a main shipping channel, meaning that there are many large vessels that have priority over the ferries. Also, due to the location the area is also popular for yachts with several nearby marinas.

The majority of crew on the vessel worked a two week on two week off rotation. The staff would typically board the ferry at the mainland at mid-day. Handovers between the back-to-back staff were done in 10 to 15 mins. For the Captains and Chief Engineer all information was required to be collated into a document and given as detailed notes for their back-to-back to read. The crew lived on-board the ships, in the ship's accommodation except third mates. The vessel was not in operation through the night but the effects of the weather could impact on the sleep quality of the crew.

The crew on-board the vessel included: bridge crew (Captain, Chief Mate, Third mate); engineering crew (Chief Engineer, Second Engineer); Bosun; Able bodies; Night Watchman; Chef; Stewards and Cleaners.

8.5 Overt Observations

Firstly, the findings of the observation study from the two vessels are presented separately in order to gain insight into workload distributions of crew members. Comparisons and differences were also identified amongst crew members of the sister ships. For each crew member, a detailed analysis off their days and key points are provided to summarise the key aspects of the data. Finally, the general observations not captured in the data sheets of the researchers are also presented. It should be noted that each crew member should have a 3 hours of rest in order to comply with work-rest hour regulation.

8.5.1 Overt Observation Results – Vessel 1

8.5.1.1 Captains

Two Captains were observed during the observation period on Vessel 1 (See Figure 8-2). The Captains are not directly comparable as they were observed on different days (i.e. different sailing schedules due to an unexpected problem at the port).

Figure 8-2 Observation of a captain – watch keeping

The Figure 8-3below shows a detailed overview of the 1st Captain's day. It can be seen that Captain 1 spent a significant portion of his day completing paperwork. This paperwork was primarily done in their office meaning they are away from the bridge for a significant part of the day. The total time spent on paperwork is 4h25m; this is 34% of captain's day. This was also critiqued by the Captain, who stated "I am the most experienced person on navigation but I spend most of my time on paperwork".

The Captain was confident to leave the bridge and leave the berthing/unberthing to the Chief Mate and the Third Mate; this allowed the Captain to spend more time in their office completing paperwork. The Captain spent very little time doing paperwork on the bridge, just 4 minutes.

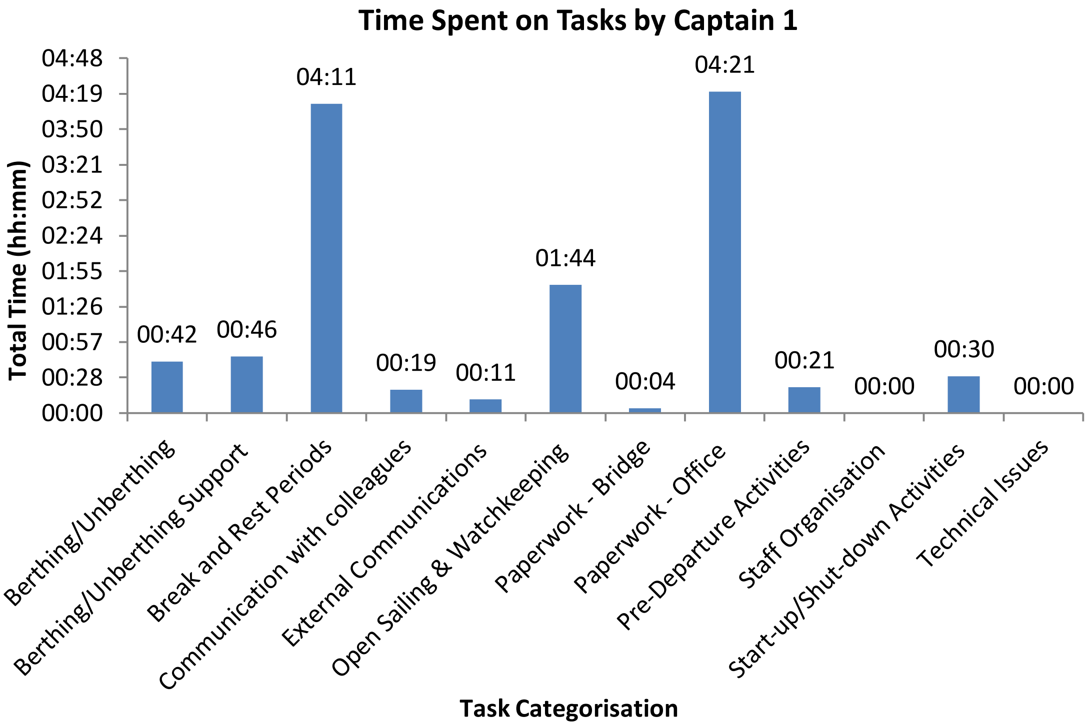

Figure 8-3 Distribution of the time spent on tasks by Captain 1

The distribution of the time spent on the high-level task categorisations for Captain 2 is shown in Figure 2. It can be seen that the Captain spends 2h38m hours on Paperwork (Office), accounting for the highest portion of his day based on the task categorisations except the break and rest periods. The second biggest time spent on a category is for Open Sailing and Watchkeeping with 2h11m hours being spent on this. The captain spends 2h11m and 1h51m hours on Berthing/Unberthing whilst all other tasks had less than one hour spent on them.

These figures indicate that both captains on Vessel 1 spend the majority of their time on paperwork. This can be interpreted as a waste of resource since the most experienced person is utilised in the office for administrative work due to the excessive amount of regulations. Numerous people in the maritime industry now believe that administrative tasks should be addressed by an administrative officer, thus masters can participate more in navigational activities to enhance safety or the majority of the available electronic data can be automatically recorded.

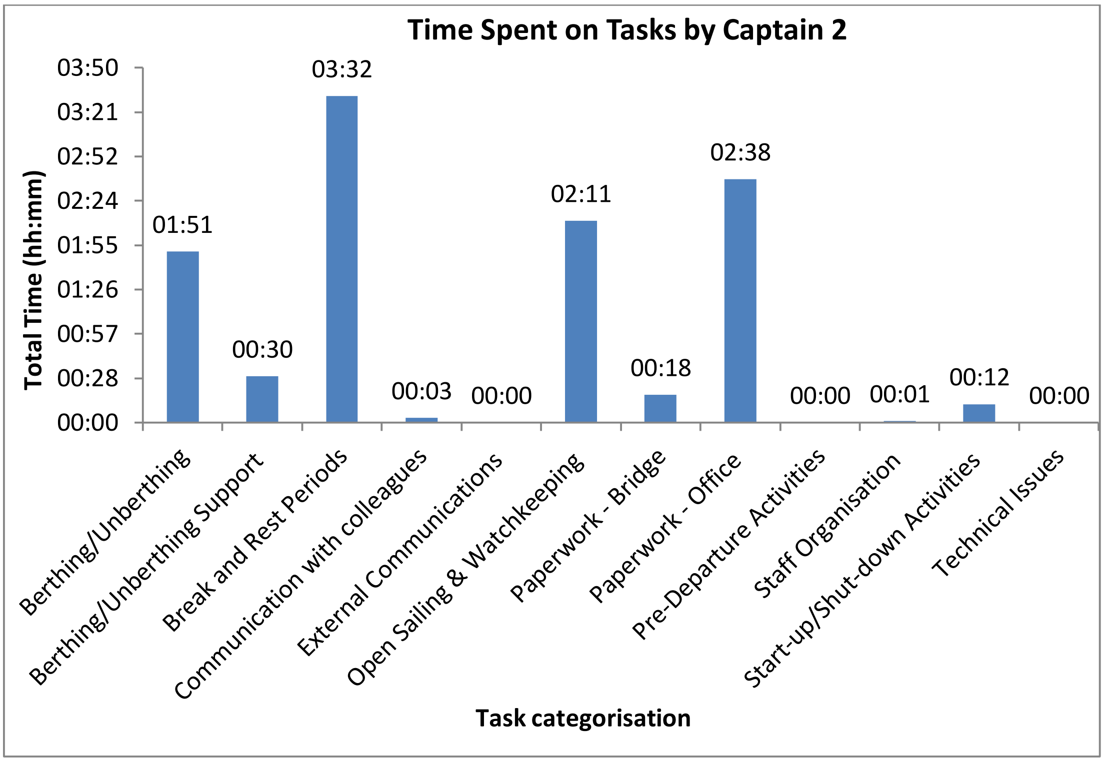

Figure 8-4 Distribution of the time spent on tasks by Captain 2

8.5.1.2 Chief Mate

Only one Chief Mate was observed in Vessel 1 (See Figure 8-6). The Chief Mate spent most of his time on open sailing and watchkeeping, accounting for 2h39m hours excluding the break and rest periods.

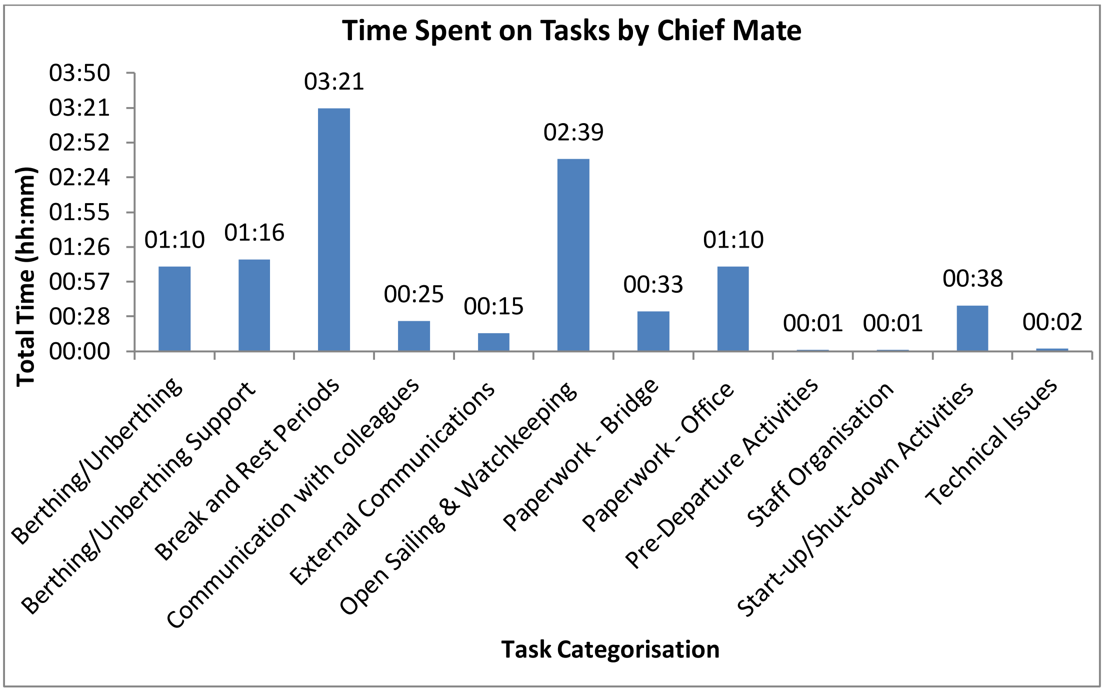

Figure 8-5 Distribution of the time spent on tasks by Chief Mate

Berthing/Unberthing, Berthing/Unberthing Support and Paperwork (Office) have similar times spent on each, around 1h10 to 1h16m. The remaining tasks account for less than one hour of the Chief Mate's observed day.

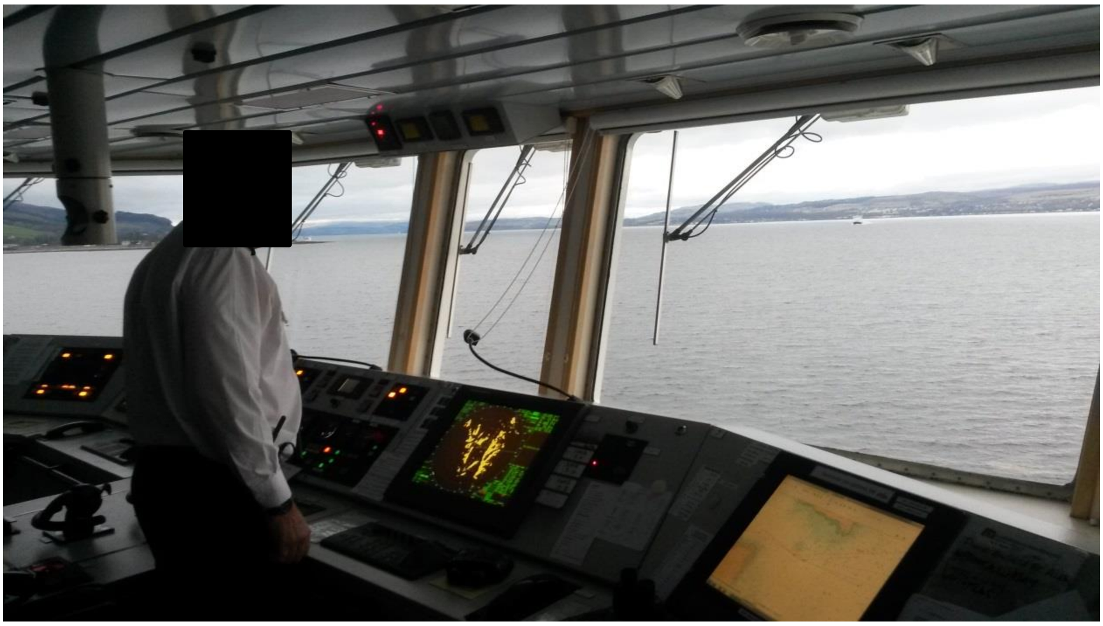

Figure 8-6 Observation of a chief mate - navigation

This was an unusual day as the vessel was redirected to another port. The Chief Mate engaged in a lot of discussion with the captain and is also in contact with on-shore personnel via phone. The Chief Mate also took the responsibility to manage relations with the passengers by doing announcements to inform passengers of the unforeseen conditions. This increased some of his workload.

The Chief Mate spent 1h 43m hours on paperwork (bridge and office) in total. The amount of paperwork the Chief Mate deals with is mostly navigation and maintenance related.

8.5.1.3 Third Mate

The Third Mate observed on-board the vessel (See Figure 8-8) and the distribution of their tasks is shown in Figure 4. As can be seen the time spent watchkeeping is the highest of all tasks, followed by paperwork, berthing/unberthing and berthing/unberthing support. As the Third Mate joins after the first round trip and leaves before the last roundtrip, they do not spend any time on start-up/shut-down activities. Another striking result is that the Third Mate performs more berthing than giving support to the other officers on board this vessel. Challenging task such as berthing/unberthing gives opportunity to the Third Mate to build up his/her knowledge.

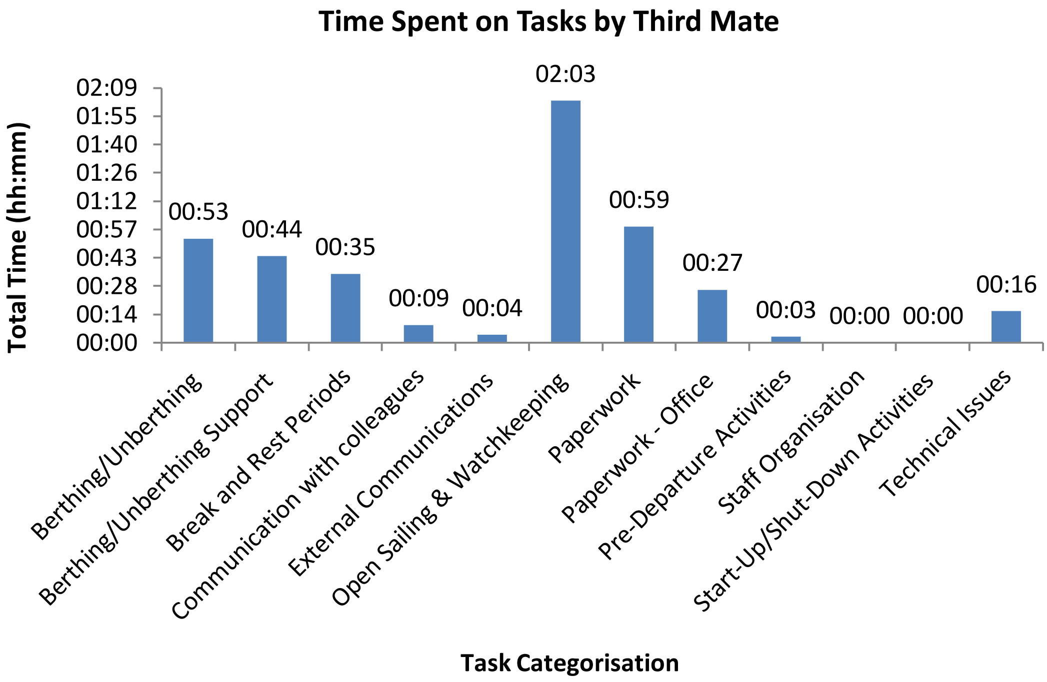

Figure 8-7 Distribution of the time spent on tasks by Third Mate

Figure 8-8 Observation of a third mate and an engineer – general vessel check

The Third Mate is allowed to berth and unberth the Vessel 1. Whilst the Chief Mate and Captain are on their breaks, which almost entirely overlap with the Third Mate's shift, he is always on the bridge. The Third Mate also takes a lot of the watchkeeping duties while he is on-board and this allows the Captain and Chief Mate to do paperwork.

8.5.1.4 Chief Engineer

It can be seen that on the observation day, the Chief Engineer spent most of the time on Paperwork (All) accounting for 4h26m. The Chief Engineer spent a significant amount of the day completing handover notes as he was due to leave the vessel the following day. The Chief Engineer was primarily based at his computer and only went to check the engines and other parts of the vessel occasionally. The daily maintenance of the vessel was left to the lower ranked engineer.

The second significant job was 1h17m for technical issues. Similar times were spent on Communication with Colleagues and Technical Issues. These were the main tasks the Chief Engineer performed during the observation day. The other tasks take less than one hour of the Chief Engineer's time. The Chief Engineer was a key point for reference in discussions. The day revealed that many persons spoke to the Chief Engineer to engage in some sort of work related discussion. The lower ranked engineer reported issues to the Chief, while the bridge team asked amongst other aspects, technical issues related to the engine.

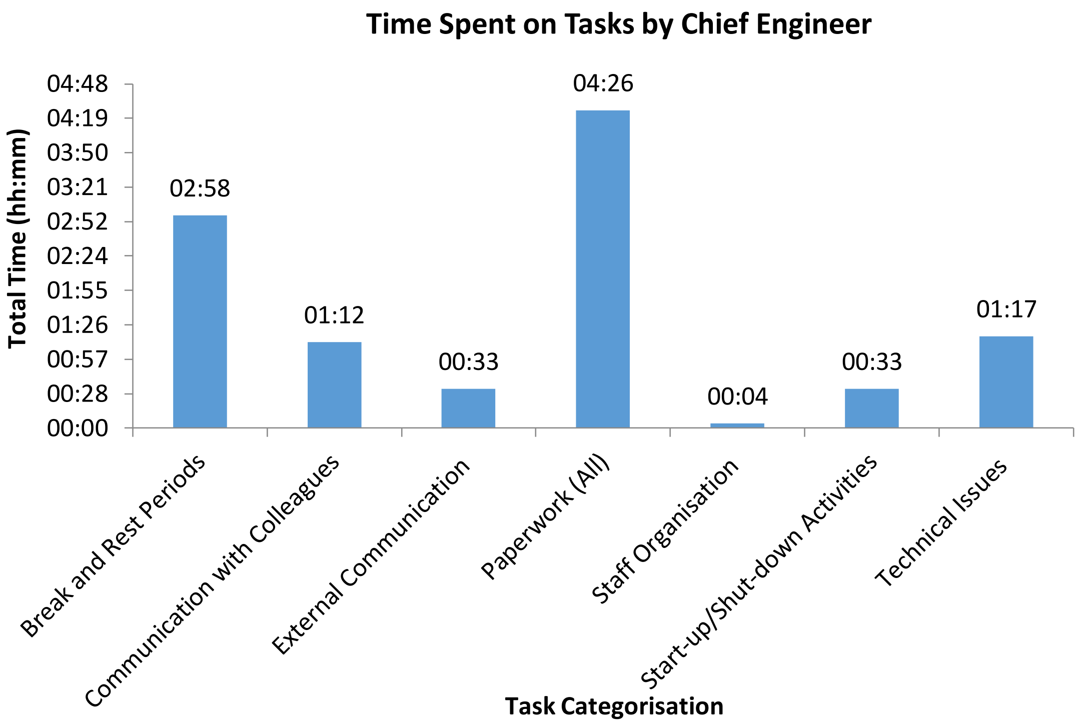

Figure 8-9 Distribution of the time spent on tasks by Chief Engineer

8.5.1.5 Second Engineer

The following highlights the activities of the Second Engineer. Early in the day, the engineers were aware that there was major repair work needed to be carried out once the vessel had stopped its operation. Due to this, there was a need for the engineer to make preparations for the evening and spent 9h27m for the maintenance and other technical issues. The engineer also tried to take more rest during the day, to balance the extra time required in the evening.

Figure 8-10 Observation of a second engineer – engine check

The second engineer spent most of their day out of the bridge (See Figure 8-10). The engineer only returned to the bridge to talk with the Chief Engineer and also to be present on the bridge at the request of the Captain.

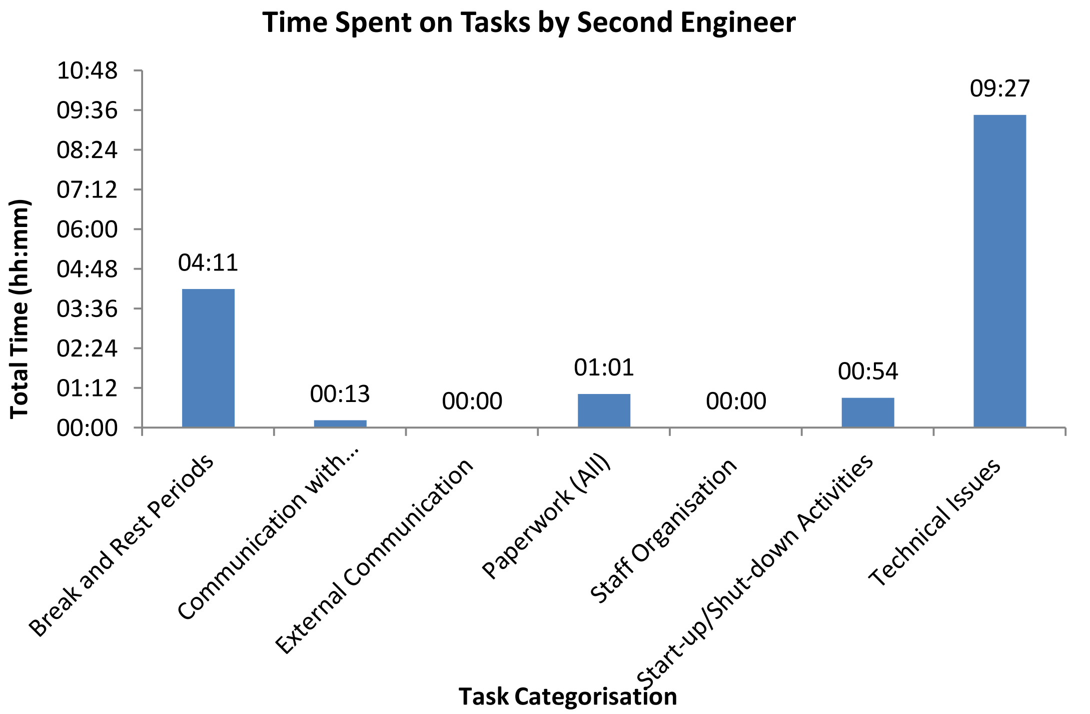

Figure 8-11 Distribution of the time spent on tasks by Second Engineer

8.5.2 Overt Observation Results – Vessel 2

8.5.2.1 Captain

Only one Captain was observed on Vessel 2. The Captain spent the majority of his time on watchkeeping and route keeping which accounts for 3h22m in a one day shift. He wanted to be present in bridge as long as the situation allowed. It has been observed that the Captain wants to be aware of everything on the bridge and does not feel relaxed when Captain is at ship's office.

The Captain was also heavily involved at the completion of the required paperwork (2h24m both in, office and bridge). The Captain berthed and unberthed the vessel for the duration of 1h43m since Third Mate is not allowed to do so. Differences on the Third Mates' navigational duties were attributed to the Captains discretion. Due to the two men rule in red zone, this choice directly affects the workload of the Captain and the Chief Mate. The berthing rotated between the Captain and the Chief Mates at all time. The Captain on vessel 2 had the lowest amount of rest amongst other crew members, this is also related to the choice of Third Mate not allowed to berth the ship.

The Captain spent a reasonable amount of time on communication but those communications were related to managing several issues within the vessel.

The Captain often had meals on the bridge due to the time limitations. The Captain's workload slightly increases towards to the end of their shift due to the handover notes. They need to inform the other Captain of the same vessel regarding the existing problems on board the vessel.

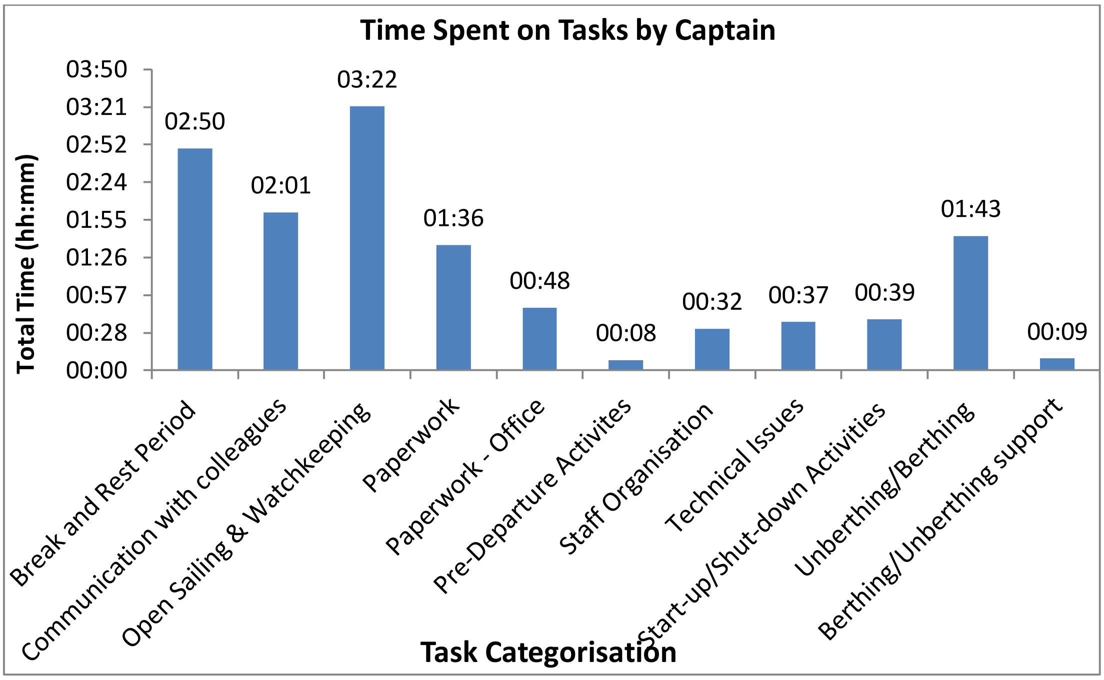

Figure 8-12 Distribution of the time spent on tasks of Captain

8.5.2.2 Chief Mates

Two Chief Mates were observed during the observation period on Vessel 2. The Chief Mates are not directly comparable as 1) they were observed on different days (i.e. different sailing schedules)

It can be seen that Chief Mate 1 spent most of his time on watch-keeping and route keeping activities accounting for 3h37m.

He did quite a lot of berthing/unberthing and berthing/unberthing support. It was also observed that 1h45m of time was spent on paperwork either on the bridge or in the ship's office.

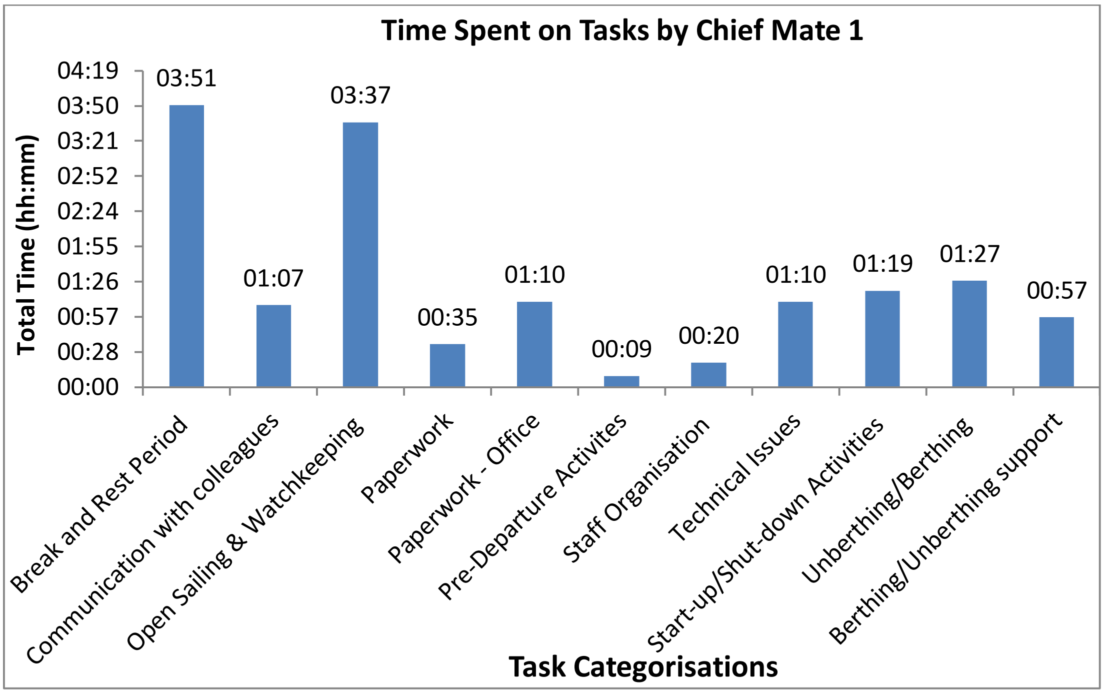

Figure 8-13 Distribution of the time spent on tasks by Chief Mate 1

The following presents the results of Chief Mate 2's observation. It can be seen that the Chief Mate 2 spent almost same amount of time as the Chief Mate 1 (3h20m) for the watch-keeping and route keeping. The Chief Mate 2 spent 2h42m for communication with colleagues since several issues were required to be discussed regarding the safety of the vessel.

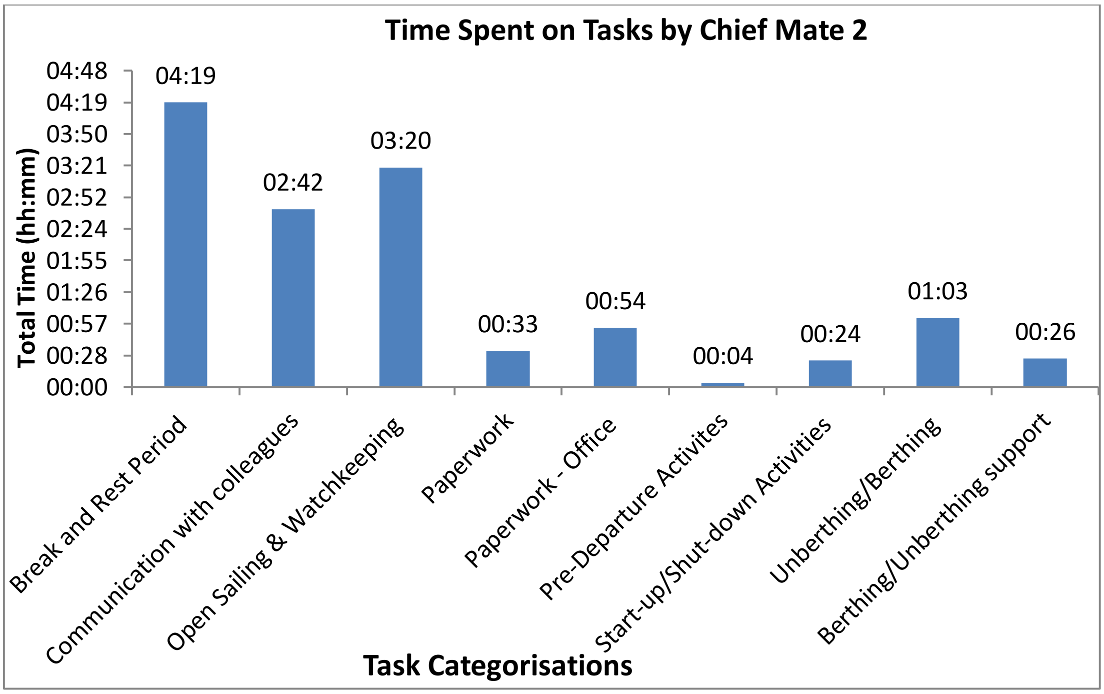

Figure 8-14 Distribution of the time spent on tasks by Chief Mate 2

Second Chief Mate spent slightly more time than the first Chief Mate on the company maintenance system by reporting the accomplished tasks.

8.5.2.3 Third Mate

One Third Mate was observed on-board the Vessel 2. The distribution of his tasks is shown in Figure 8-15. As can be seen the time spent watchkeeping is the highest of all tasks (2h42m), followed by paperwork (2h20m) and communication with colleagues (2h20m). As the third officer is not allowed to berth the ship, he spent 1h39m on berthing/unberthing support. It was also observed different from other officers that, the Third Mate spent the majority of his time on general vessel safety checks such as firefighting equipment check, life-vest check and some enclosed space checks.

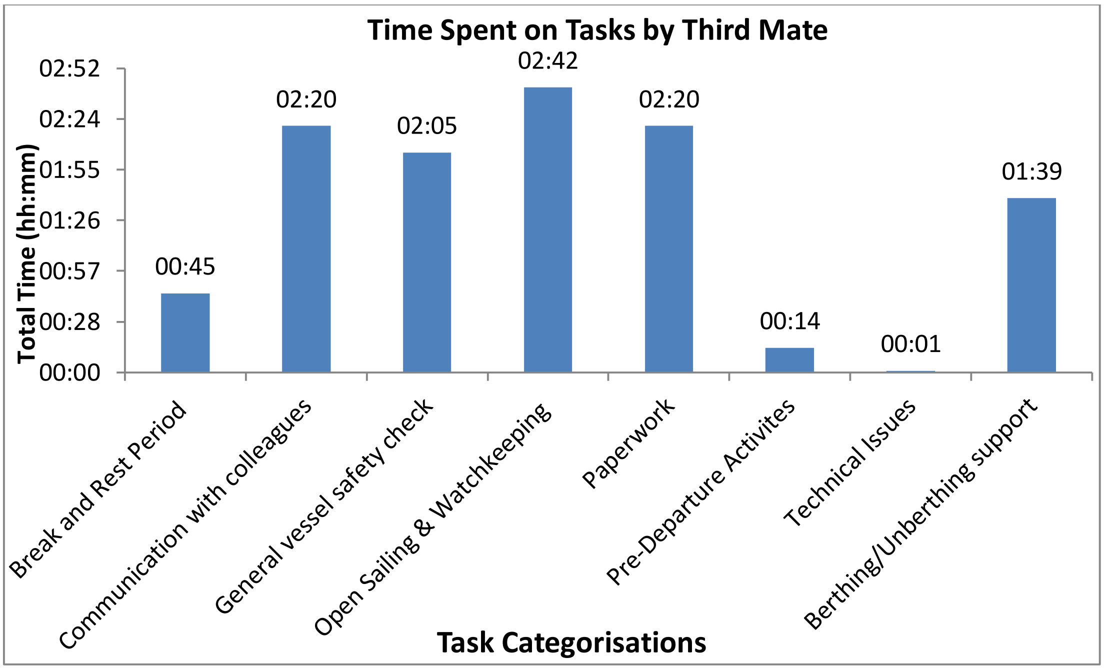

Figure 8-15 Distribution of the time spent on tasks by Third Mate

The Third Mate joins the ship after the vessel's first run and leaves the vessel before the last run. Therefore, he only had breaks during his meals.

Third Mate's main duty was observed as covering Chief Mate's and Captain's break periods on board the Vessel 2. The reason behind this perception is that the Third

Mate was not allowed to berth/unberth the vessel as the Captain on Vessel 2 believes that dangerous operations such as berthing/unberthing should be handled by the most expert seafarers. This decision can also be attributed to the lack of trust in Third Mate's navigational skills. , Therefore, the Third Mate spent a lot of time on paperwork to support berthing activities and also perform the vessel checks which have been addressed by the weekly and monthly maintenance system. He was also heavily involved on watch-keeping activities.

8.5.2.4 Chief Engineer

The following graph shows the results of the observation study based on time spent on tasks. Even though, Chief Engineer had a total break of 11h31m, he performed all the maintenance and paperwork at night. Therefore, he had a long rest during the day in order to accomplish all his work while the ship is not in operation. The observation day was the last shift of the Chief Engineer, therefore, he spent 5h28m for reporting all the accomplished work and writing handover notes. He also spent 1h37m for the maintenance work when the ship stopped sailing (See Figure 8-17). The Chief Engineer, spent the majority of his time on doing maintenance work and then entering data to the company maintenance system. His workload peaked when other crew members finished their duties and engines are stopped. It is recorded that the Chief Engineer's and Captain's workload peaks at the end of their shifts due to the handover notes. This problem requires further consideration in order to achieve safe manning levels on board vessels.

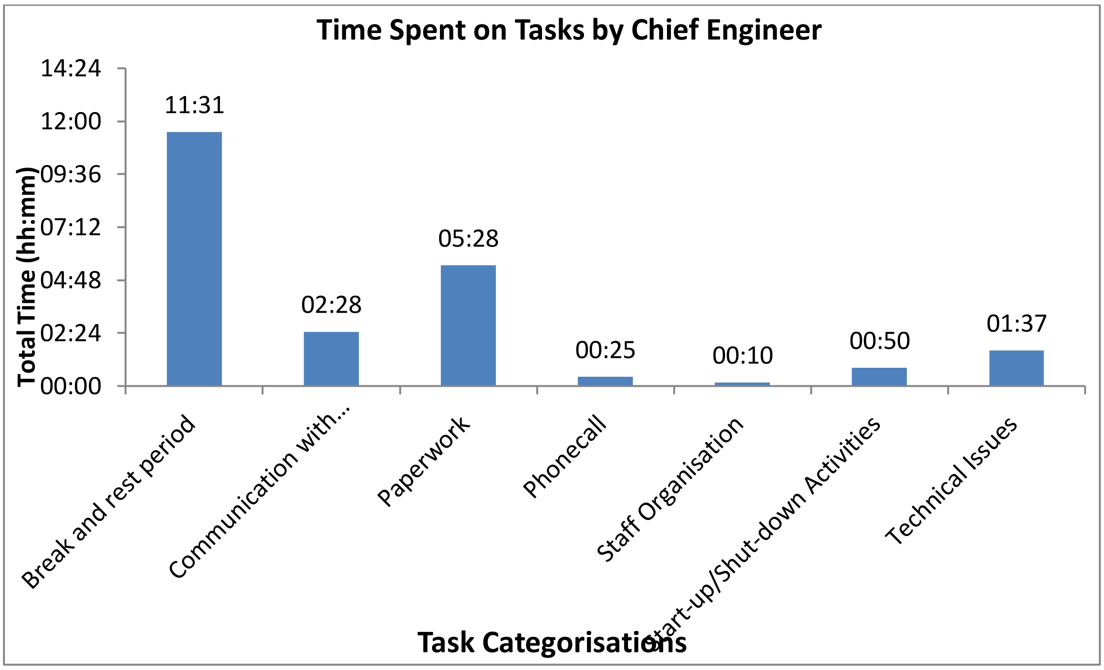

Figure 8-16 Distribution of the time spent on tasks by Chief Engineer

Figure 8-17 Observation of a chief engineer and second engineer - maintenance

The engine control room is located in the ship's bridge and the Chief Engineer continuously watches the situation in there. If there is a problem in the engine room, he sends the Second Engineer to check the problem. He was not actively involved in small maintenance activities on board vessel.

The Captain will often talk to the Chief Engineer for various aspects. Both the Captain and Second Engineer would consult the Chief Engineer on matters related to the engine, seeking advice when necessary, for example after a repair.

8.5.2.5 Second Engineer

The Second Engineer was the second highest ranked engineer on-board. The following highlights the activities of the Second Engineer. He spent almost six hours on performing maintenance and also reporting them to the company maintenance system during his shift.

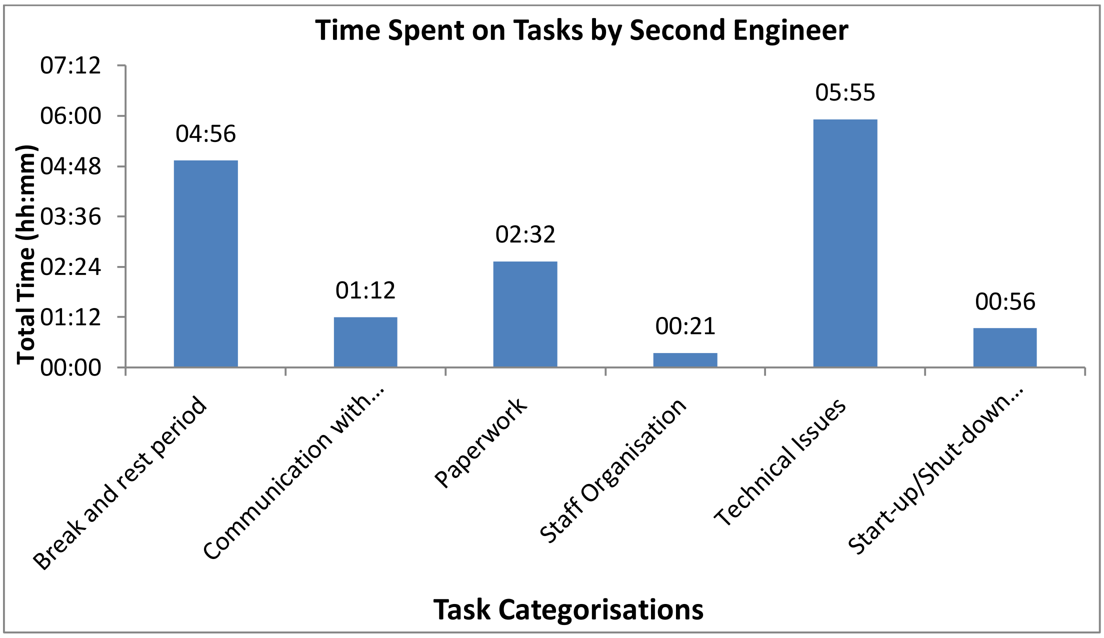

Figure 8-18 Distribution of the time spent on tasks by Second Engineer

The Second Engineer was not as busy during the operation hours since they need to perform the majority of the required maintenance when ship is at port and not operating. He performed 2 hours of the technical work such as greasing the shafts and analysing some oil samples were done when the ship is at the night location.

Second Engineers also work more when the ship is not in operation. His task requires physical endurance since he travels continuously between bridge and the engine room.

The Second Engineer needs to check all the void spaces in the engine room everyday which include more physical activity than the Chief Engineers.

8.6 Comparative Analysis of Two Sister Ships

This section aims to identify differences amongst the crew members' workloads, attitudes and perceptions of the sister vessels.

8.6.1 Comparison of Captains

The time spent on tasks by the Captains is shown in Figure 8-19. By investigating these categorisations and the total time taken in more depth, it can be seen that Captain 3 (V2) spends more time than the other two Captains with respect to berthing/unberthing, berthing/unberthing support. This was expected since Third Mate was not allowed to navigate in Captain 3's vessel.

Captains' decisions about the berthing roles of the Third Mates differed according to Captains' safety perceptions and expertise on the subject. One of the differences between the two vessels is shown between time spent berthing and unberthing and berthing support and unberthing support. This higher time spent by Captain 3 in vessel 2 was partly due to the role of Third Mate on the vessel 2. It is captain's decision whether to allow the Third mate to operate the vessel. The Captains on Vessel 1 allowed the Third Mate to berth and unberth the vessel. However, on the vessel 2 the Captain did not allow the Third Mate to do so, this was because the Captain 3 on Vessel 2 asserted that berthing and unberthing are the most safety critical operations and the Captain 3 believes that these operations should always be handled by expert seafarers.

Prior to the observation study, it was known to the managers that the Vessel 1 (the one that third mate is allowed to navigate the vessel) has a better safety performance than the Vessel 2. Observation study demonstrated that the Captain of Vessel 2 came to bridge more frequently to berth the ships and therefore could not finish the required paperwork. The captain tried to accomplish the aforementioned paperwork at rest periods and hence decreased the amount of rest that allocated for the Captain. It can ben commented that the Captain on vessel 2 accumulated more fatigue than the Captain 1 due to his/her perception of safety. The consequences of fatigue can be fatal on shipping operations.

Captain 1 (V1) spent the most time in their office doing paperwork, totalling more than four hours. Captain 1 was not present for as many berthings/unberthings but it was evident that they had to take breaks from office work to come to the bridge to support the rest of the bridge crew. Captain 3 took the least break and rest times, with a total of only 2 hours and 40 minutes. Considering Captains are required to take 3 hours simply for rest (not including meals) half way through the shift, this means this Captain 3 is significantly reducing his rest period. The attitude differences of Captains therefore caused the Captain 3 to accumulate more workload and to breach the work rest hour regulations.

In addition to this, all Captains noted that they would sometimes do paperwork in their rest periods, indicating that the paperwork was too high. Or, alternatively, they were unable to sleep, so decided to be productive and carry on with paperwork. In some cases, knowing they had paperwork outstanding made them uncomfortable and complete the paperwork during their rest periods. There appears to be a number of factors driving the rest periods for the Captains. The decision to be present for every berthing or to allow the bridge crew to do the task without the presence of the Captain was a personal choice. There was clearly a high responsibility given to the Captains for sailing the ships safely, thus if things went wrong it would be their responsibility as opposed to other members of the crew.

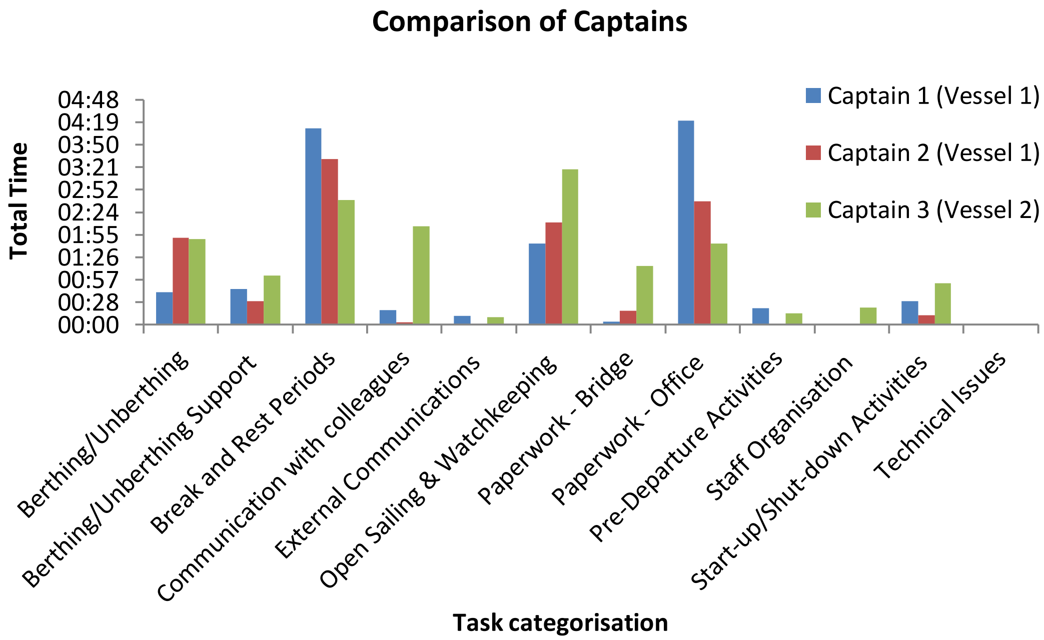

Figure 8-19 Comparisons of Captains

Both Captains have valid points and they make different decisions by considering the safety of the vessels. The Captains who allowed the Third mate to berth/unberth were able to spend extended lengths of time in their office completing paperwork. They would at intermittent points visit the bridge to check everything was in order, but would not necessarily stay for berthing/unberthing. Rotating the berthing/unberthing responsibilities between the three crew members allowed the Third Mate to develop his skills, it provided relief to the Captain and Chief Mate and it allowed all three more time to do work outside the bridge. On the other vessel the Third Mate was not allowed to do berthing/unberthing and instead provided support work only. This meant berthing/unberthing duties rotated between the Captain and Chief Mate only. It also meant for a highly repetitive day for the Third Mate as his main role was to provide many of the supporting activities. Rotation of the work between the Captain and the Chief Mate in Vessel 2 may hamper the team culture since the Third Mate cannot utilise the skills he gained during his trainings and contribute to the operation of the vessel as much as desired.

Another safety culture perception difference of the Captains was observed by the researchers. Recent changes to the structure of one pier allowed the vessel to be berthed either way: stern or bow first. Prior to the changes the vessel could only be berthed one way. The Captains of the Vessel 1 were berthing the stern first as they identified it was a safer way to berth as it allows, if needed, an escape route. The Captains of the Vessel 1 believed that the ship should always be ready to sail in case of a weather related emergency. However, the Captain of the Vessel 2 berthed the bow first since the Captain had years of experience in berthing this position. The only available berthing style was bow first prior to the structural change at port. There were some concerns raised as to whether it was safe to berth the two vessels in two different ways. They noted it caused confusion for those on the shore.

8.6.2 Comparison of Chief Mates

Three Chief Mates were observed on-board the vessels. There were no obvious differences between the workload distributions of the Chief Mates.

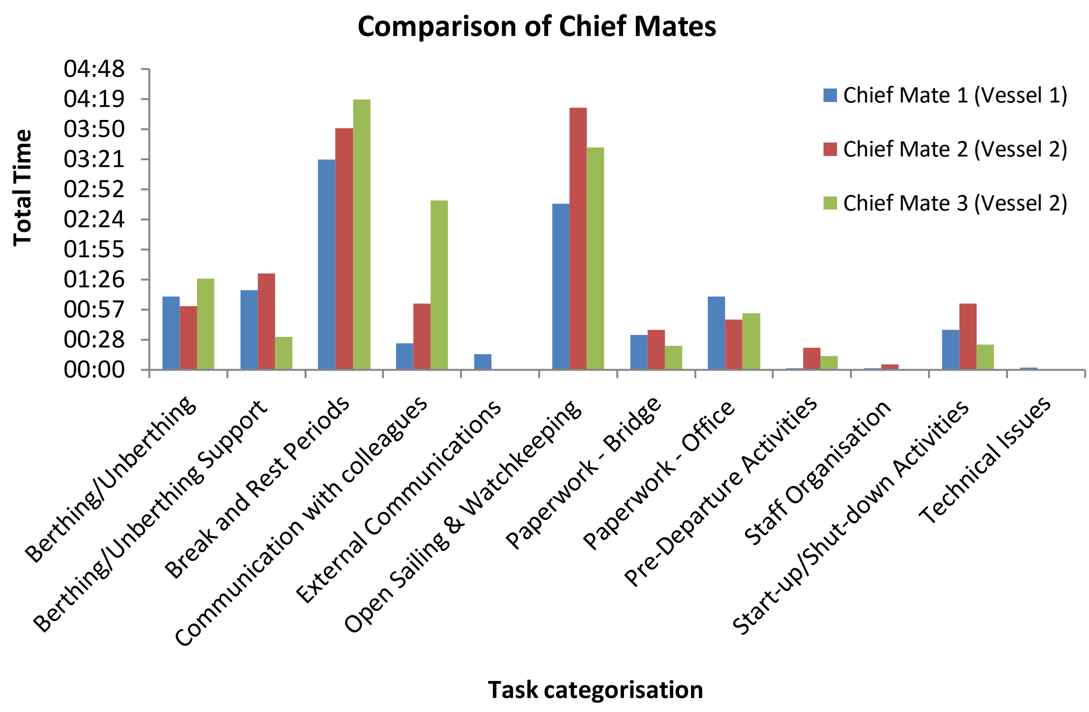

Figure 8-20 Comparisons of Chief Mates

8.6.3 Comparison of Third Mates

The comparison of the two Third Mates show that the activities appear similar in the time spent with the exception of time spent for berthing and unberthing. On the Vessel 1, the Third Mate berthed and unberthed the vessel but on the Vessel 2 the Third Mate spent no time on berthing/unberthing. This is due to the decision of the Captains of the ferries. Differences are also seen between the time spent on bridge paperwork, berthing support and technical issues. With respect to the dissimilarities in technical issues, the large differences for this observation arise from the replacement of the specific tasks of the Third Mate that day. These include some firefighting extinguishers and overall safety checks on board ship. Both Third Mates took less than one hour on breaks and rest periods.

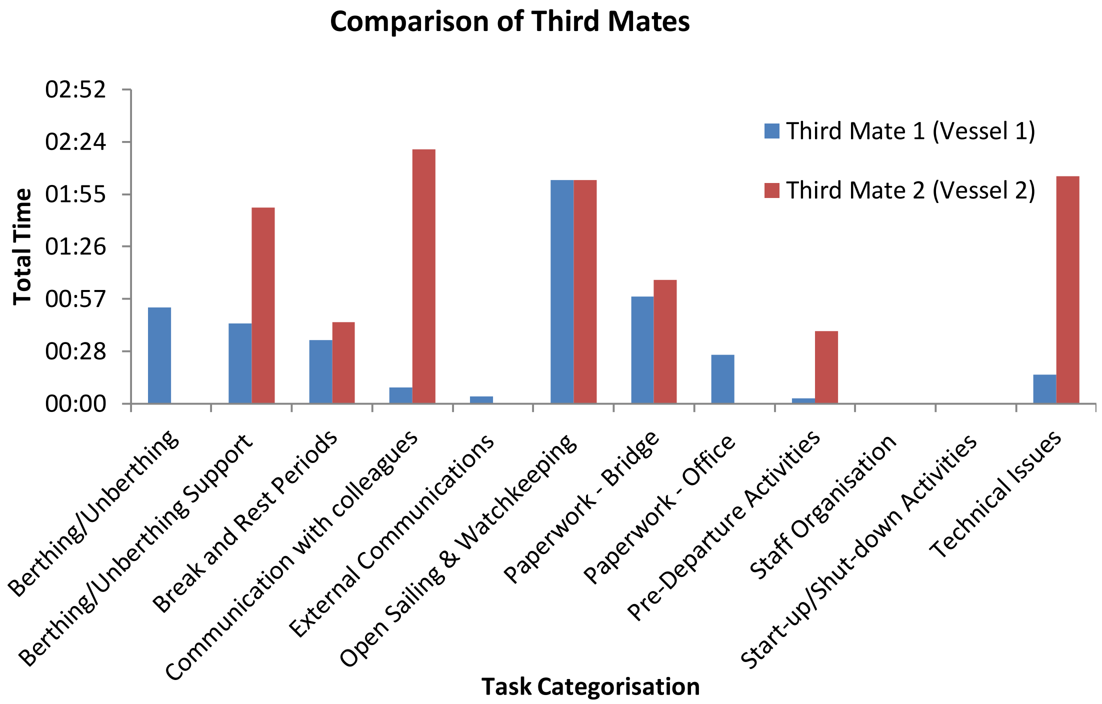

Figure 8-21 Comparisons of Third Mates

8.6.4 Comparison of Chief Engineers

As can be seen the two observed Chief Engineers spent similar lengths of time on the tasks, with the exception of rest periods. It is noted that the Chief Engineer 2 had to perform out of hours repair work, leading to extra rest periods during the day, explaining the difference. One Chief Engineer on each vessel was observed. On Vessel 1, the Chief Engineer was a point of contact for questions, both from the less senior members of the engineering crew and also the bridge crew. Alternatively on the other vessel, less questions were directed at the Chief Engineer. Both Chief Engineers were primarily doing computer based work throughout the day.

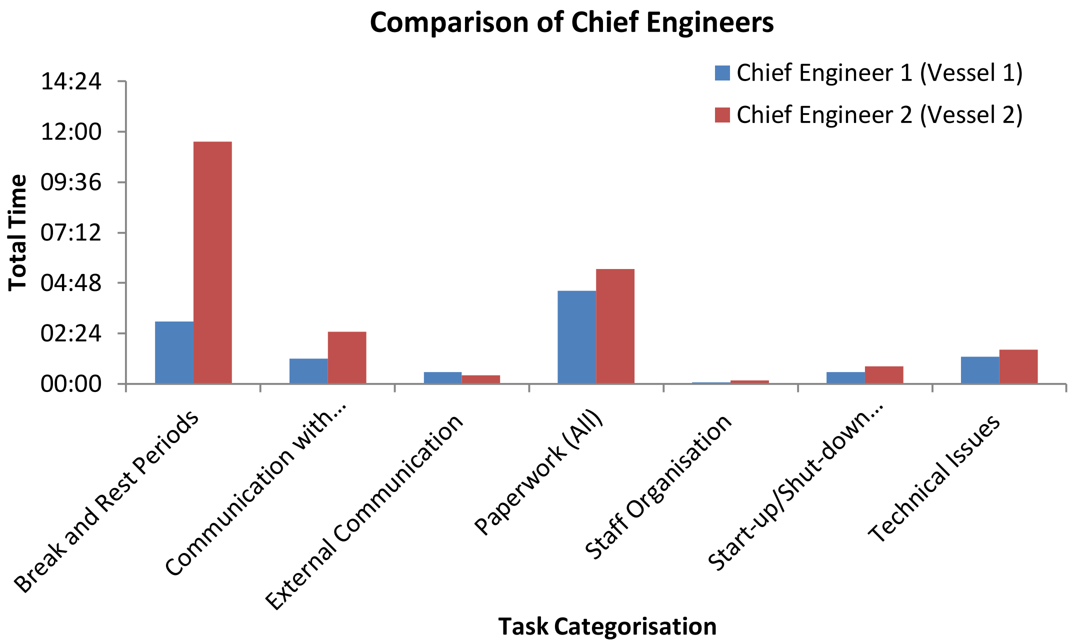

Figure 8-22 Comparisons of Chief Engineers

8.6.5 Comparisons of Second Engineers

Two Second Engineers were observed on each vessel. Both of the Engineers were observed on days where additional work maintenance work was carried out after the vessel was not in operation for the day. Both engineers knew that they would be staying late in the evening to complete the additional maintenance work. During the day the Engineers were tied to no particular schedule.

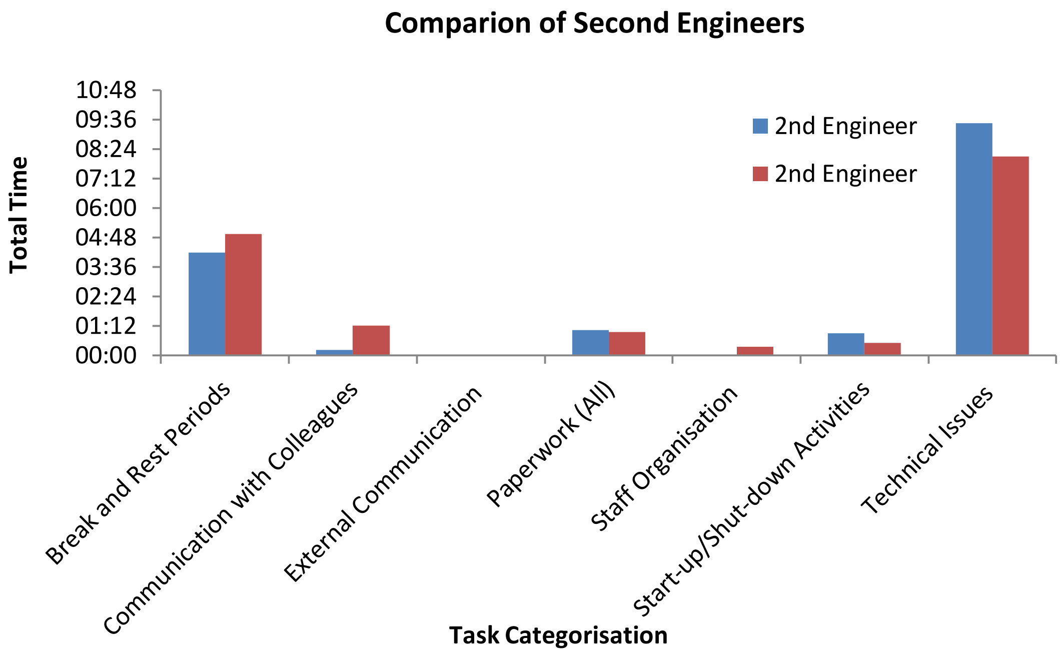

Figure 8-23 Comparisons of Second Engineers

It can be seen that both the Chief Engineers spent a significant portion of their time on paperwork, whereas the Second Engineers do not spent as much time on paperwork. Differences are shown between the times spent on technical issues. It can be established that the Second Engineers spend a significant portion of their time on technical issues whereas the Chief Engineers do not spend as much.

In conclusion, the allowance of third mate to berth the vessel has a significant positive impact on safety of a vessel. The comparison of observation results and safety performance data identified that the vessel with an active third mate has better safety records. Therefore, observation study was found quite useful for revealing the safety culture traits that lead to different safety performances.

8.7 Workload Questionnaires

A questionnaire was developed to support observation data on board. The questionnaire was distributed to each crew member of the observation study, in which the results of these are shown below. The results are compared between the two vessels.

Participants were asked whether there was enough time allowed to follow the Standard Operating Procedures (SOP) to complete a task. The results are shown in Table 8-2. Of the six participants on Vessel 1, four stated that there was enough time to follow the SOP. Alternatively, on Vessel 2, none of six state that there was enough time to perform a procedure following the SOP.

Table 8-2 Time to complete task according to SOP

	Vessel 1	Vessel 2
Yes	4	0
No	2	6

The participants were asked how often they were interrupted when carrying out tasks. The two vessels were the same in their responses. It can be seen for both vessels that half responded that they were interrupted very often and the other half sometimes.

Table 8-3: Frequency of Interruption of Tasks

	Vessel 1	Vessel 2
Always	0	0
Very Often	3	3
Sometimes	3	3
Rarely	0	0
Never	0	0

The participants were also asked about the manning levels on-board vessels. The results of the questionnaire indicate mixed perspectives on the manning levels between the two vessels. On the Vessel 2 all six crew members identified the manning levels as below than needed. Alternatively on the other vessel there were mixed perspectives with two of six stating manning levels were below than needed, three of six stating manning levels were reasonable and one of six stating the manning levels as above than necessary.

Table 8-4: Results of Manning Levels.

	Vessel 1	Vessel 2
Manning levels are below than necessary	2	6
Manning levels are adequate	3	0
Manning levels are above than necessary	1	0

There was a wide variation of the number of hours spent on paperwork each day. It varied between roles, which can be expected due to different roles on the vessel. However, even comparison of those with the same role showed a variation. The observed time spent on paperwork is shown in Table 8-5.

The questionnaire allowed the participants to note the time spent doing paperwork each day. The results show that nine of the 12 gave an estimate that was over the observed paperwork for the day. The biggest difference was for one of the Third Mates who estimated paperwork as 8 hours and 30 minutes but was observed completing paperwork for only 1 hour and 8 minutes. This result is linked to the Third Mate not being allowed to berth the vessel and thus, the belief that he spends almost all of his time on paperwork. This perception can be also attributed to monotonous nature of the paperwork and the Third Mate's definition of paperwork may be different than other crew members. The full results are shown in Table 8-5. Although a small sample size has been used, there may be evidence that people overestimate the time spent on paperwork.

Table 8-5 Observed Paperwork vs Reported Paperwork

	Observed (hh:mm)	Reported (hh:mm)	Difference (Reported-Observed) (hh:mm)
Captain 1 (V1)	04:25	06:00	+01:35
Captain 2 (V1)	02:56	02:00	-00:56
Captain 3 (V2)	02:59	01:12	-01:47
Chief Mate 1(V1)	01:43	02:00	+00:17
Chief Mate 2 (V2)	01:26	02:30	+01:04
Chief Mate 3 (V2)	01:17	02:30	+01:13
Third Mate 1 (V1)	01:26	02:00	+00:34

Third Mate 2 (V2)	01:08	08:30	+07:22
Chief Engineer 1 (V1)	04:26	03:30	-00:56
Chief Engineer 2 (V2)	05:28	05:30	+00:02
2nd Engineer 1 (V1)	01:01	02:00	+00:59
2nd Engineer 2 (V2)	00:57	02:00	+01:03

8.8 Discussions and Conclusions

In conclusion, an observation study was conducted on-board two sister ferries. There were several key findings. First, the time spent on paperwork slightly varied between vessels but in total paperwork accounts for a large percentage of the crews' time. On Vessel 1, 15 hours and 57 minutes were spent on paperwork amongst six crew members for the week. On Vessel 2, 13 hours and 15 minutes were spent on paperwork amongst crew. These results highlight that shipping companies lose one man a day on each vessel due to paperwork. Relevant strategies such as automation, paperless checklists can be utilized to decrease the total number of hours spent on paperwork. The 13 hours of paperwork performed daily is not utilized in manning level calculations, and crew members are expected to perform these tasks mainly in their rest period as stated by them. An administrative officer can be used to decrease the amount of paperwork or automated reporting systems can be utilised to record available electronic data in shipping operations.

A second key finding is that the role of the Third Mate differed on each vessel. On Vessel 1, the Third Mate was berthing and unberthing the vessel, with this responsibility rotating between the Captain, Chief Mate and Third Mate. Alternatively, on Vessel 2, the Third Mate was not allowed to carry out berthing or unberthing. On an average day the vessel is berthed 18 times, for the latter vessel it meant the high number of berthing and unberthings was shared between the Captain and Chief Mate only. When the Captain and Chief Mate of Vessel 2 took their rest periods in the middle of the day, it left the remaining one to do all berthings/unberthings for three consecutive hours. Differences in the choice of role of the Third Mates were attributed to the Captains, as they made the decisions on these matters. Consideration on this matter indicates that the Third Mate on Vessel 1 appeared competent in terms of berthing and the Captain on duty allowed the Third Mate to perform this manoeuvre. It was noted by the bridge crew that this also helped the Third Mates gain experience and build their knowledge of congested waters navigation. In addition to this, berthing was viewed as a cognitively tiring task, sharing the berthings amongst three persons may help share this high mental workload. For these high frequency passages, there appears to be an opportunity to develop the Third Mates' skills. Additionally, developing these skills diversifies the daily tasks of the Third Mate, allowing a difficult cognitive task to rotate between three persons, potentially less disruptions to paperwork and lastly having three competent and capable persons build redundancy in the system. However, berthing and unberthing are complex manoeuvres and with the Captain being the decision maker and the person held accountable should anything happen, then allowing the Third Mate to berth/unberth may be perceived as a risky decision. From the safety perspective, it is also important to utilize the expertise of the Captain on the most risky operation. The safety culture attitude of the Captains generates two different scenarios for their ships. Without being on board, it is not possible to capture these types of information that result in different safety performances.

A third key finding of the observation study relates to the berthing of the vessel. At both ports the vessel could be berthed in either direction, either bow or stern first. However, the two vessels chose to berth in different ways: Vessel 1 (stern first at the mainland) and Vessel 2 (bow first at the mainland). This was the preference and decision of the Captains. There seemed an indication that this caused confusion for those working on-shore. It is recommended that this issue is carefully considered in the organisation, some members of the crew, especially those who moved between vessels, indicated there were safety concerns due to the different berthing preferences and the belief that the vessel was going to berth in the other way when it did not. A review should take place to ensure that there are no safety issues with the boats berthing in different ways. With the ability to berth either way, a review to identify whether one way provides more resilience than the other appears necessary. Safety critical operations should be standardized to enhance competency levels of crew members and hence the safety performance.

A fourth key finding is that the roles in the engineering team (Chief Engineer and Second Engineer) differed greatly. While the Chief Engineers spent most of their time on paperwork (computer based) the Second Engineers spent most of their time carrying out maintenance (planned and unplanned) and checks. The Chief Engineer on Vessel 1 was a point of contact for the Second Engineers and they reported to the Chief Engineer throughout the day. The Chief Engineer on Vessel 1 also seemed to be consulted by the Captain on a regular basis to ask advice when there were technical issues on one vessel, but this was not done as much on the other vessel. The Chief Engineer was not observed to be consulted as much on Vessel 2. For the Second Engineers on both vessels, they mostly faced with unexpected workload due to the required maintenance work as unplanned maintenance are needed to addressed immediately for not suspending shipping operations. Another issue regarding the unplanned maintenance is noted as they are needed to be carried out when the ship was not in operation which resulted in long work hours, meaning that additional rest was required the following day. For unplanned maintenance that could be only conducted after the vessel had stopped operating, the Chief Engineers were observed to assist in these major tasks. Therefore, focus should be given to the shift pattern of engineers to address the times where their workload peaks.

A fifth key finding is that the bridge team was tied mainly to the sailing schedule of the vessel. With a two-man bridge team, two of the three always had to be present on the bridge for berthings and unberthings (during red zones). In terms of paperwork, a small amount was done on the bridge, but this was mainly checklists and log books. Other paperwork was carried out in their offices or the ship’s office. The time spent on paperwork varied between crew members, with some higher than four hours per day. The Captains seemed to spend more time doing paperwork in the office than the Chief Mate. The Third Mate was predominantly on the bridge and only went to the office for a small amount of computer based work. What the paperwork consisted of is unknown and this may be an opportunity for future research. The high levels of paperwork means that the Captains were absent from the bridge a lot.

In general, the time spent completing paperwork was viewed as very high by the crew members. However, comparing questionnaire results to actual observations identified that nine of the twelve crew gave a higher than observed time for the time spent on paperwork each day. One key crew member to identify here is the Third Mate (Vessel 2) who reported time spent on paperwork as 8.5 hours a day, whereas they were recorded doing only approximately 1 hour of paperwork. There is clearly a large difference between the reported and actual time spent on paperwork. The 8.5 hours may be a reflection of how they perceived their day or on the definition of the paperwork may differ according to the Third Mate. The Third Mate on Vessel 2 did not berth or unberth the vessel therefore predominantly supported the Captain and Chief Mate.

The limitation of the research is that the difficulty of the each task is not taken into consideration. Observations of the tasks for bridge crew to complete were highly repetitive. Their job required constant alertness and multi-tasking, as well as communication with a range of persons. Whereas the engineers carried out work alone and had little communication with other members of their team for work purposes or external communication. The bridge crew are tied to the sailing schedule for routine jobs but the engineering crew are not tied to the sailing schedule as much, unless maintenance requires that they carry out work after the vessel is not in operation. Paperwork was identified as a time consuming task. In comparison, the engineering team were less obviously tied to the location in the voyage of the vessel, they may only need to take a break on their maintenance work in the engine room since watertight doors must be shut during berthing/unberthing or at ports. The engineering team had to carry out routine tasks, however the unexpected tasks could result in highly demanding days and also requiring overtime. All crew members indicated that there was a high volume of paperwork to be completed and this appeared to consume a lot of time. For the bridge crew, the time spent on paperwork was fragmented as there were interruptions and need to return to the bridge for berthing/unberthing of the vessel. For the bridge crew, the mental demand of the job was clear, there were many things to carry out and there was a constant need for tasks such as watch-keeping. Berthing and unberthing appeared cognitively demanding and the crew member berthing had to do a lot of multi-tasking.

A further limitation of the study is that only observable tasks were noted. The researchers were only able to record tasks as they saw them being performed. The time spent mentally preparing or doing mental/visual checks was not taken into consideration. Information processing was largely unknown. While the person being observed may look like they were doing little, the person might be processing information mentally. Furthermore, the observation highlighted that crew members often had to be there for safety reasons, for example in berthing/unberthing. The time between berthing and unberthing appears to be a slack time. It was unclear for the Captains what type of paperwork they do. Future research should examine the specific types of paperwork undertaken by the Captains and which paperwork can be automated.

Conducting an observation study was highly useful and allowed insight into firstly what the crew members did on an average day and how their different perceptions affected the safety performances of the vessels. The results of this type of study can be used to provide guidance on manning levels, identify safety issues, training needs and so on. However, in terms of limitations of this study, it is necessary to clarify that the study was conducted during just one week. Therefore, it is difficult to determine the average time spent on tasks such as paperwork. Further studies with more participants are needed to gain more reliable estimates of the time spent on paperwork as well as the variability between different persons.

The observation study will be performed in another route to take other parameters into account. These two observation studies will then be compared in order to reach more accurate results for safe manning calculations. All these results will be provided to the regulatory bodies for reconsideration of safe manning levels to ensure safety on board vessels.

8.9 Chapter Summary

This chapters summarizes the overt observation study performed in sister ships operating in the same route. The scope of the observations was restricted to Officers only (deck and engine departments). The officers of the sister vessels comprise of the Captain, Chief Mate, Third Mate, Chief Engineer and Second Engineer. Each crew member was observed for one day for their entire shift. The overt observation results are produced for the each sister ship and then supported with comparative analysis.

9 Improvement Methodologies

9.1 Chapter Overview

The improvement methodologies are developed and proposed based on the weaknesses identified by the comprehensive assessment framework. The identified weaknesses of the different assessment methods are given in Chapter 6, 7 and 8. It is of paramount importance to implement and prioritize the appropriate action plans to remedy vulnerabilities and enhance safety culture maturity levels in shipping companies.

In the maritime industry, the classic approach for overcoming problems and improving standard of safety is known as the utilization of the rules and procedures. Standard Operating Procedures (SOPs) are designed and introduced to standardize the way of working and spreading best practices within organizations. It is a well-known fact that rules and procedures assist crew members to develop the desired culture for performing shipping operations safely. However, the assessment results indicated that the safety culture maturity levels have not reached to the envisaged standards. There is a requirement for more robust and safe SOPs to enhance crew members' adherence to procedures and hence their safety culture maturity levels. A procedure improvement tool was developed to continuously improve the quality of shipping procedures and hereby to achieve and retain an appropriate level of safety culture on board vessels. A structured SOP development guide was also developed to demonstrate the best practices for standard operating procedure development. The guideline provides step by step instructions to develop safer and more comprehensive SOPs for the shipping operations.

In conclusion, two complementary improvement methods are proposed to enhance safety culture maturity levels, namely:

- Procedure Improvement Tool
- Standard Operating Procedure (SOP) Development Guide

9.2 Procedure Improvement Tool

As aforementioned in Chapter 5, The Procedure Improvement Tool assists shipping companies to identify the different way of working on board vessels, risk assess them in order to define the most effective and safe way of working with an ultimate aim of enhancing safety culture maturity levels. The tool provides continues safety culture improvement in shipping companies.

9.2.1 Introduction

The deviation from SOPs is a phenomenon that affects the entire shipping industry and represents a threat to the safety of shipping. Due to a wide range of reasons, seafarers often deviate from SOPs in order to accomplish their tasks and complete their duties. This phenomenon is defined as “workaround”.

These workarounds may represent a smarter way of working for seafarers but it might increase the risk of shipping. Within the maritime industry, the safety of shipping is paramount and the implementation of SOPs is viewed as a means to work towards increasing safety. There is, to date, no existing methodology that systematically collects and assesses these unstandardized practices. Thus, it is vital that a methodology is developed that supports the collection and assessment of workarounds. This tool proposes a comprehensive methodology to collect and assess deviations from SOPs that can be used with maritime companies. The development of such a methodology is one of the unique contributions of this thesis.

9.2.2 Procedure Improvement Methodology

Procedure Improvement Methodology was developed with the ambitious aim of providing the maritime industry with a robust method for the collection and assessment of workarounds practised on-board vessels. Procedure Improvement Methodology and the tool were developed within the EU FP7 SEAHORSE Project. (SEAHORSE, 2013).

Procedure Improvement Methodology aims to capture workarounds performed by seafarers within a company, assess them and compare them to SOPs in order to find the most effective and safe way of working. A small group of expert reviewers is assigned by the company to compare the workarounds and SOP. All assessments are aggregated into a result that captures how much better (or worse) a specific workaround is than the SOP. These results are then distributed within the company.

A general overview of Procedure Improvement Methodology is shown in Figure 9-1. It consists of three main stages:

1. gathering of workaround data and development of attributes,
2. ranking and selection of alternatives using Fuzzy Multiple Attributive Group Decision Making (FMAGDM) method and The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS)
3. Final decision-making by administrator and feedback provided to seafarer and reviewers.

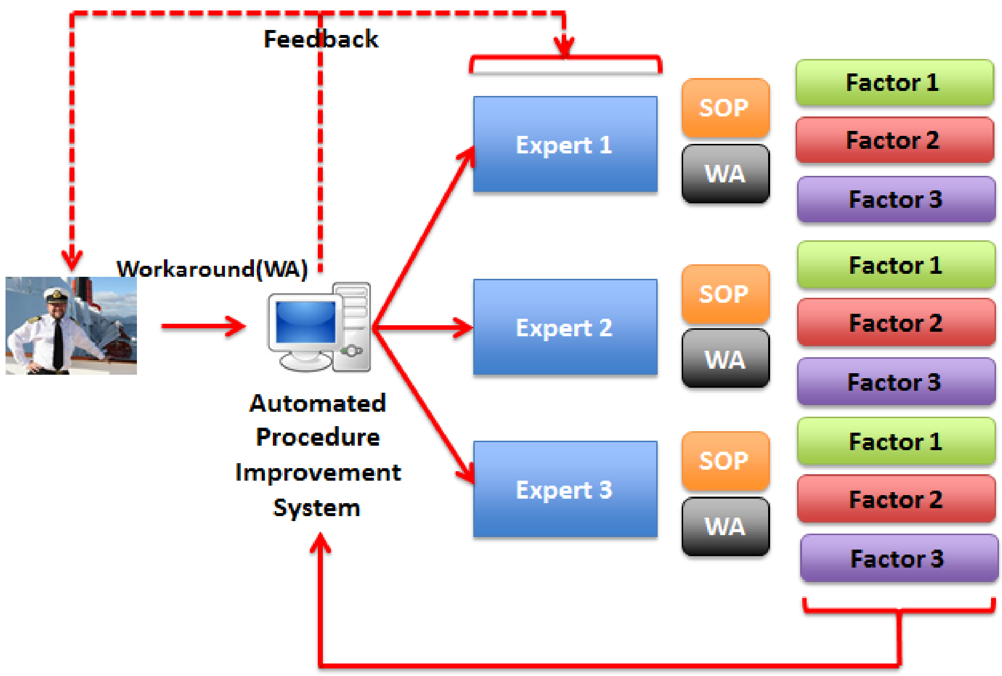

Figure 9-1 Overview of Procedure Improvement Methodology

Procedure Improvement Methodology has also been developed in a software-based platform for the purpose being to ease the work of the managers and improve SOPs in a structured way for enhancing safety culture of crew members.

Its implementation will facilitate the improvement of SOPs and identify the number of impractical SOPs. Considering that the maritime industry is heavily based on SOPs, the adoption of this methodology will have a significant impact in terms of safety culture.

When a seafarer submits an opportunity for improvement, firstly, he/she needs to define the SOP that he/she is proposing suggestion for. Then, the seafarer needs to answer the questions given below:

1. Define the alternative practical way adopted by crew to perform same operation
2. Location
3. What are the reasons (impracticability) for not following the standard procedure?
4. What are the benefits of following alternative practical way that you have described, instead of the standard procedure?
5. What are the risks of following alternative practical way that you have described instead of the standard procedure?
6. Please provide any additional information.
7. Any additional supplementary material can be attached here. (Note: attachments will be used in no way to identify you)

When seafarers submit the suggestion, the case goes into the admin user (HSEQ manager) of the system in an anonymized format thus the admin user does not know which seafarer submits the improvement suggestion.

When the case is received, the admin user assigns the appropriate experts from different but relevant backgrounds for that specific case by utilizing the tool. Number of expert can vary, however, there is a requirement of minimum two experts to have a multi expert decision making process.

The reviewers need to compare the alternative practical way and the original SOP according to the attributes given in figure below:

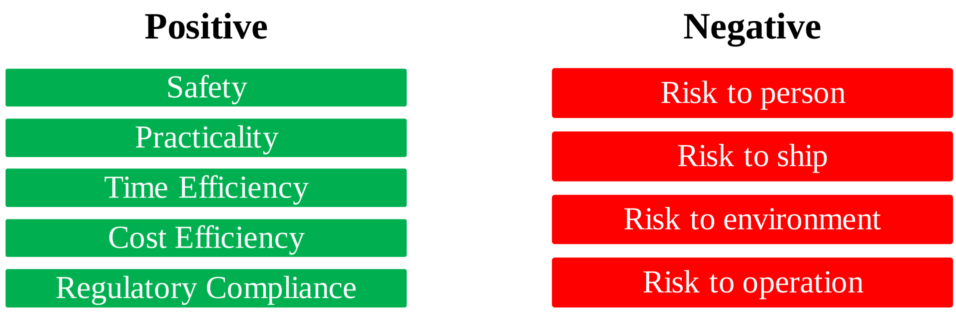

Figure 9-2 Attributes

When all the experts accomplish their reviews and submit their assessments, the fuzzy multiple attributive group decision making algorithm (Ölçer and Odabaşi, 2005) calculates the result. The details of the algorithm and the integration of the algorithm into the procedure improvement tool are given in Appendix H. The generated results suggest that whether the workaround is better than the SOP or not. Good practices are required to be turned into formalised procedures while bad practices should be eliminated. Identification of workarounds may also reveal underlying reasons of the workarounds being practiced and this may provide valuable insight into the limitations in the design of the SOPs.

When the assessment is completed, the result is reviewed by the admin and distributed to all seafarers. All the reviewed suggestions are logged within the tool, hence crew members can log into the system anytime and review previous submitted cases as a self-learning practice. Seafarers can also access all the company SOPs from the "search SOP" section which can be seen at the home screen.

By utilising the Procedure Improvement Tool, shipping companies can continuously improve quality of their procedures and hence enhance operational safety. Safety culture and procedure improvement tool go hand in hand since continuous procedural improvement have a positive effect on safety culture attitudes and perceptions of the seafarers. The homepage of the tool is given below:

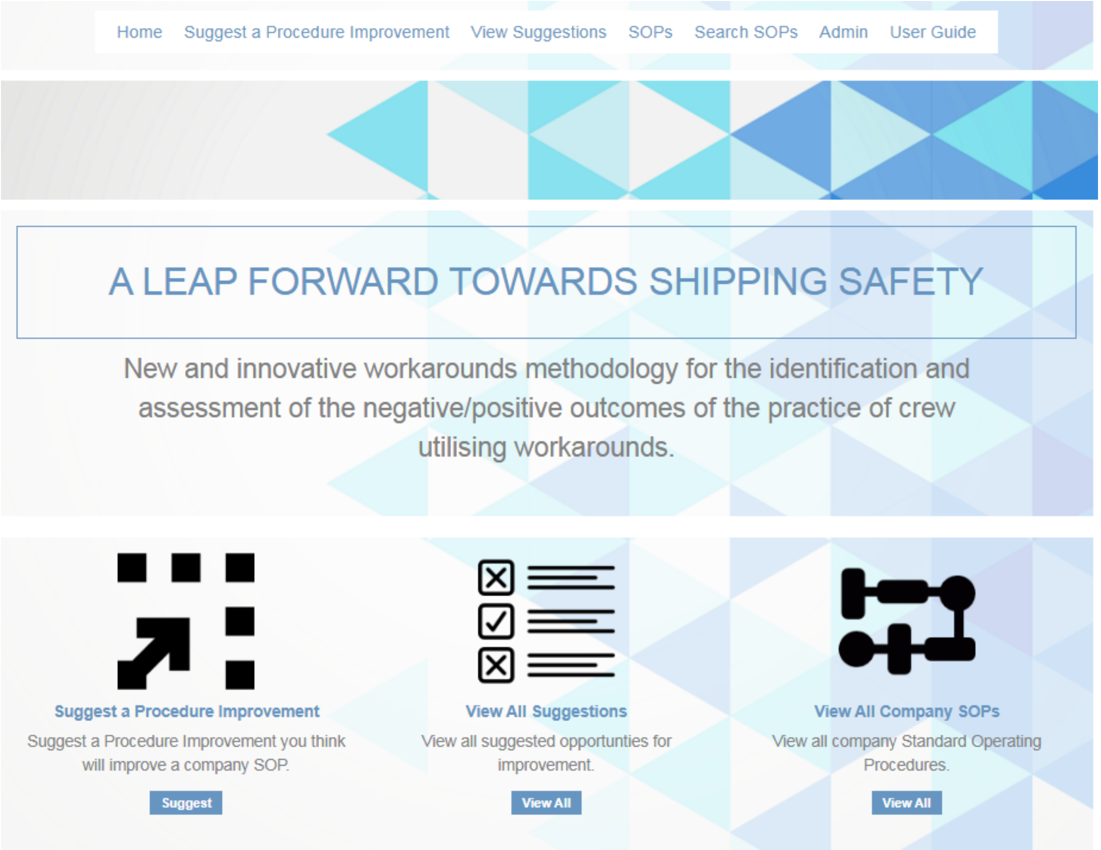

Figure 9-3 Home page of the Procedure Improvement Tool (SEAHORSE, 2017)

The methodology was tested on 107 workaround cases in a workshop. To date, the methodology has received positive feedback from experts in the maritime industry and the need for a methodology which collects, assesses and supports decision making in the organisation is clearly required. Furthermore, the methodology can also be easily adapted and applied in other areas such as the aviation industry.

Even though SOPs are designed to reflect the best way of working, the results showed that in many cases the performed workaround is better than actual SOP (Figure 9-4). In total 23 out of 107 (22%) workarounds were better than the actual SOP according to FMAGDM method.

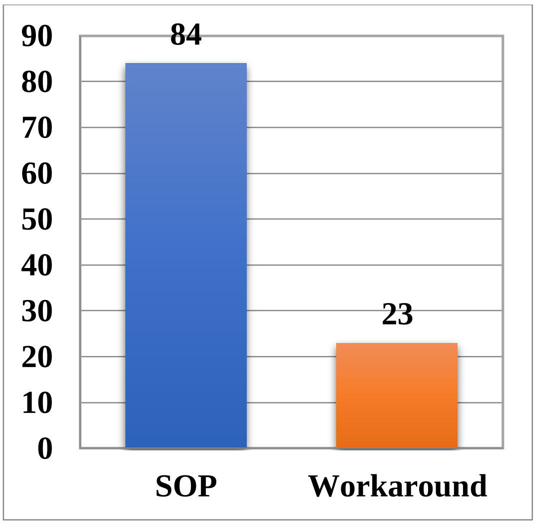

Figure 9-4 Workshop Results

9.2.3 Conclusions of the Procedure Improvement Tool

In conclusion, the role of SOPs within the maritime industry is recognised as paramount in ensuring safety of shipping. Therefore, there is work to be carried out in improving SOPs and it is proposed here that the development of SOPs is to be an iterative process. SOPs are to be developed, then used in daily operations and based on the use seafarer's provided feedback, they should be improved. Figure 9-5 summarizes the overall SOP improvement framework.

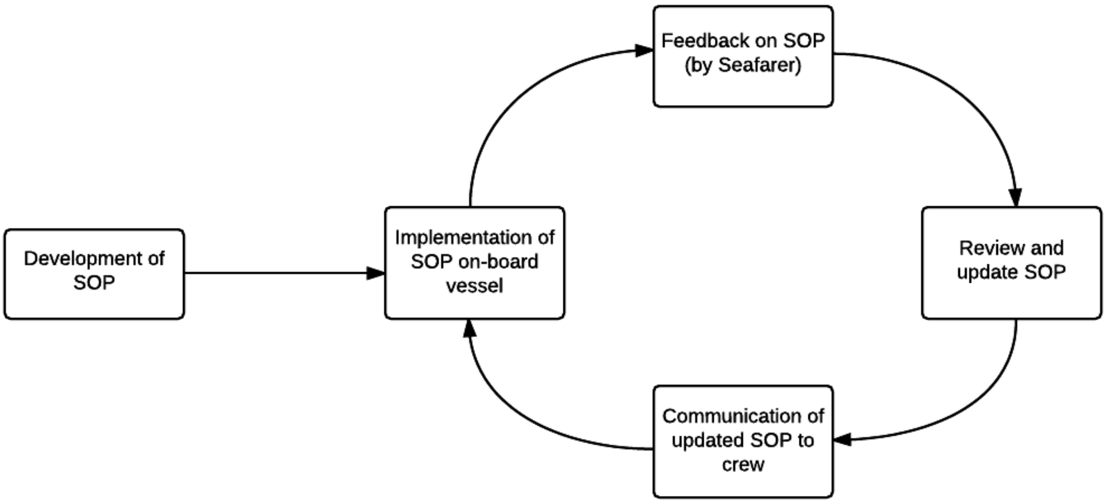

Figure 9-5 Iterative process of design, implementation and refinement of SOPs

9.3 Standard Operating Procedure Development Guide

Standard Operating Procedure Development Guideline was developed after the successful implementation of the Procedure Improvement Tool. The procedure improvement tool identifies the SOPs which have room for further improvements and proposes opportunities for SOP improvement. However, there is a lack of a structured guidance to develop a consistent and comprehensive set of SOPs in the shipping industry. Therefore, firstly an SOP development guideline was developed to demonstrate the best practices for standard operating procedure development. Then, this guideline was converted to a training module which can be utilized to enhance the safety culture maturity levels in their shipping operations.

The development of a set of SOPs is a challenging and time-consuming task, but the benefits of such investment can be seen in safety improvements. The purpose of this document is to provide a best practice guide for the development of SOPs. It is important to note that it is a system which is under consideration and, as such, attention must be given to all parts of the system and this best practice guideline seeks to do so.

Through the guide it becomes clear that there is no single aspect to ensure the development of effective SOPs but instead relies on a number of aspects and it is all of these, together, that result in effective SOPs. The SOP Guideline and the associated template are given in Appendix I and J.

9.3.1 Case Study – Development of a Passage Planning SOP

In order to validate the SOP development guide, a case study was conducted in the Naval Architecture, Ocean and Marine Engineering Department to test and validate the SOP Development Guideline. Four seafarers and two researchers were presented at the workshop. The Best Practice Document was sent to the seafarers prior to the workshop to increase their knowledge and understanding regarding the SOP development. During the workshop, important hints and critical sections were once again communicated to the group. After the introduction session, the seafarers were asked to develop a Passage Planning SOP from scratch by utilizing the best practices guide. An hour was allocated for the group together with a board and markers in order to develop a passage planning SOP. They developed a one page document with a flow chart as stated within the guide (see the Figure 9-6). The developed SOP was compared to two shipping companies' passage planning SOPs to reveal the differences amongst them. As it can be seen from the below diagram, each crew member's duties were clearly stated in the developed document. Even though the flow charts were given in each document, the newly developed SOP clearly stated the how data will be managed at each stage. For example, while highlighting dangerous areas during the passage plan, it was clear that what kind of parameters should be taken into account and with which order.

The panel managed to integrate safety critical information which was not detailed in previous SOPs such as risk assessment. The guide assisted them to generate a concise document and define the duties of each rank without making the SOP unclear or unpractical. The experts' feedbacks were elicited after the SOP development to identify possible improvement areas for the guideline. The guideline was found extremely satisfactory by the panel, only some amendments are recommended to shorten managerial part of the template.

After the validation workshop, the guideline was utilized by shipping companies and researchers to develop structured SOPs and hence enhance the safety standards in the maritime industry.

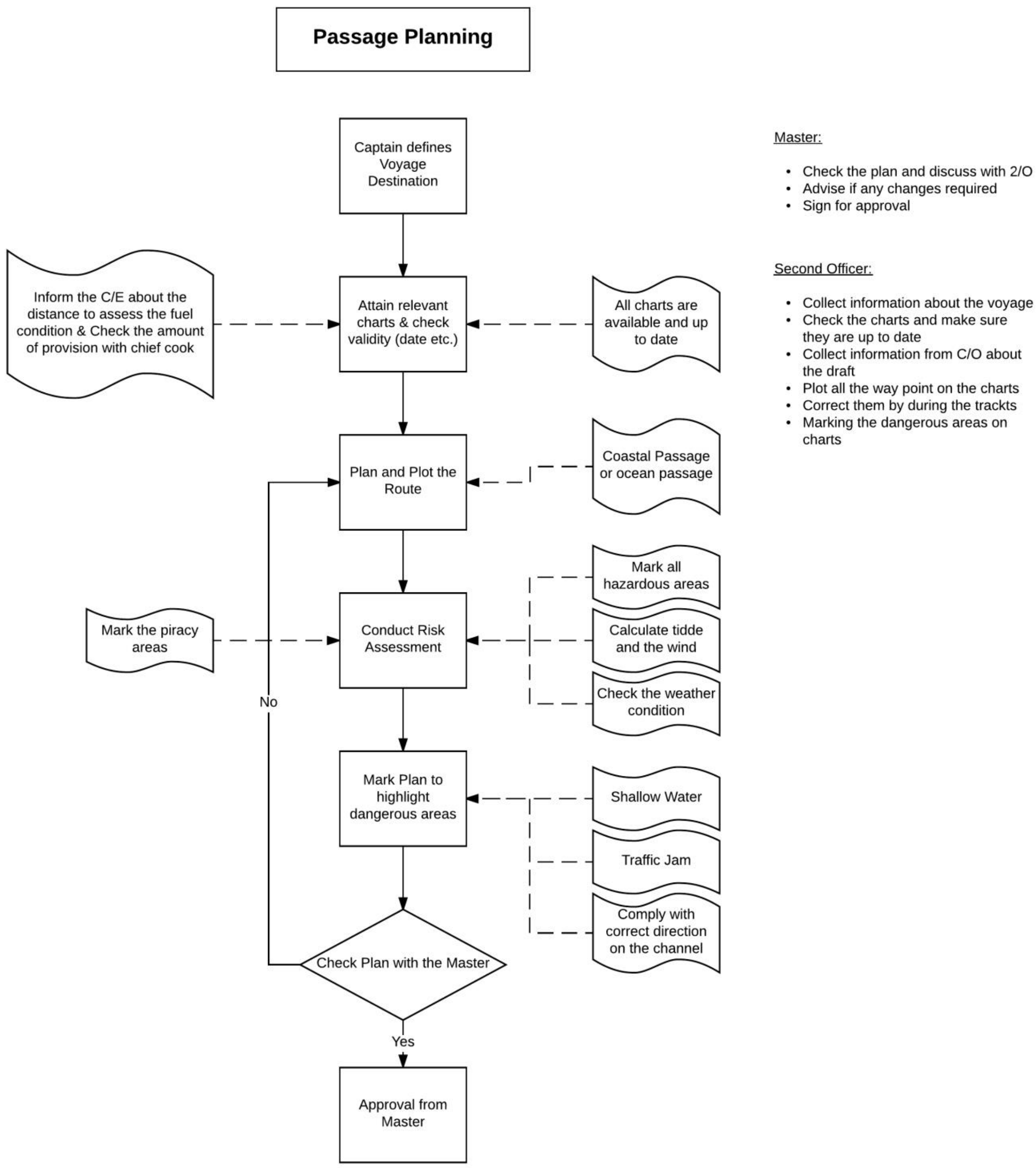

Figure 9-6 Case Study Flow Diagram

9.3.2 Summary of the SOP Development Guideline

The SOP development guideline provides a structured way for developing a standard operating procedure from the scratch or updating an existing one due to an identified impracticability via the procedure improvement tool. The guideline details every single step to have an advanced safety management system and hence improved safety culture maturity levels in shipping organizations. The guideline was utilised by a heavy lifting shipping company to develop a set lifting SOPs. In addition to this, the guideline was also utilised in an internal projects within the Naval Architecture, Ocean and Marine Engineering Department. One researcher developed a more comprehensive and safer Dynamic Positioning (DP) operation SOP for emergency conditions for the offshore industry (Caruso, 2017). The developed DP SOPs were compared with the existing ones in a simulator environment where the new ones were found more comprehensive and quicker to be conducted. The response times during emergencies improved 11% to 39% in-between 6 different DP operations with the utilization of the new SOPs. The new SOPs also removed single point of failure from safety critical systems by introducing check and verify system from the aviation industry.

In conclusion, this guideline assists shipping organizations to develop a more comprehensive and safer set of SOPs. The guide either can be utilized to develop an SOP from scratch or to improve the standards of an existing SOP. Continuous improvement of shipping SOPs will lead organizations to perform shipping operations in a safer manner and enhance safety culture maturity levels of the entire crew consequently.

9.4 Chapter Summary and Conclusions

Two safety culture improvement methods exist in this chapter. Firstly, the procedure improvement tool allows crew members to raise awareness regarding to the impractical SOPs. The Tool provides a structured assessment process for the workarounds submitted by seafarers. These alternative practical ways are assessed and compared with SOPs in order to find the most effective and safe way of working. When the workaround is found a smarter way of working, the SOP development guide is utilised to develop an SOP for a specific task. Secondly, the standard operating procedure development guide provides structured step by step instructions for building up shipping companies' safety management systems. As stated by Mearns et al. (2013) that safety management and safety culture go hand in hand, the utilization of the both initiatives can provide an enhanced safety culture in shipping organizations.

Even though safety culture assessment methods were used to a certain extent in shipping, structured safety culture improvement methods have not yet been proposed to address the identified gaps. It is necessary to identify the appropriate action plans and prioritize them according to the current status of a shipping company. This study is therefore extremely important since it provides a structured improvement means.

10 Discussion and Recommendations

10.1 Chapter Overview

This chapter presents the outcomes generated within this thesis along with demonstration of how the research aims and objectives have been achieved. Novelties and contribution to the field are then presented. Later, limitations of the study are given with the general discussion on the difficulties encountered. Finally, recommendations for future research are made.

10.2 Achievement of Research Aims and Objectives

The main aim of this thesis is to develop a maritime safety culture assessment and improvement framework to enhance safety culture maturity levels in shipping organisations. This aim has been achieved by performing the given objectives of the each chapter and details are given below:

The research objectives defined in Chapter 2 were achieved as below:

- To review the literature on safety culture and identify the pros and cons of different types of safety culture assessment methodologies in other industries and analyse the appropriate methods and systems which are compatible with the maritime industry.

An extensive critical review on safety culture was not only performed in shipping but also in other sectors such as health, aviation and nuclear industries. Milestones of the safety culture research and developed assessment techniques along with their limitations are summarized in Chapter 3. The safety culture studies are found highly fragmented and substandard in the shipping industry since the ISM code fails to provide a structured and comprehensive safety culture assessment and improvement methodology for the maritime industry. Therefore, critical review identified the necessity of a novel safety culture assessment and improvement framework within the maritime industry.

- To develop a comprehensive safety culture assessment and improvement methodology to identify the current levels of safety in shipping companies, address the weaknesses and develop improvement strategies to enhance the safety culture maturity levels.

A novel maritime safety culture assessment and improvement framework has been developed by considering the requirements of the shipping industry with an ultimate aim of enhancing level of safety and avoiding reoccurrences of accidents and incidents. There are three assessment and one improvement sub-methods which are complementary to each other in order to eliminate the limitations of different methods by creating a validation mechanism. Such a comprehensive framework does not exist in the maritime domain. The framework combines subjective and objective assessment techniques for the identification of vulnerabilities within shipping companies and provides structured improvement methodologies to enhance safety culture maturity levels. First time in the shipping industry, the relationships between crew members' safety perceptions and key performance indicators (KPIs) were established (more information about the framework's novelties can be found in section 11.3.)

- To develop questionnaires and semi-structured interviews for crew members and shore personnel to capture their attitudes and perceptions towards safety and develop a benchmark by distributing these questionnaires to different shipping companies.

These objectives were achieved under the safety climate assessment section of the framework. Safety culture questionnaires were developed in several languages and they were distributed to three different shipping companies in order to compare the safety culture attitudes and perceptions of seafarers with the benchmark. Semi structured interviews were also developed in align with the questionnaires to validate certain aspects. Each shipping organization's safety culture levels were analysed and appropriate actions plans were proposed.

- To develop Key Performance Indicator assessment methodology to identify the KPIs which have positive impact on the safety performance and correlate these KPIs with the safety climate results in order to establish the relationship between safety perceptions and safety KPIs.

Key performance Indicators Assessment Method has been developed and implemented to confirm whether survey results are in line with the KPIs and reported near miss data. KPI assessment also identifies and eliminates any distortions of the subjective safety climate data. The KPIs that affect safety performance positively were found and given in Chapter 7. In addition to this, the correlations between KPIs and safety culture dimensions are established and also provided within the same chapter.

- To perform overt observations on board vessels as a complementary study to the overall framework for identifying the crucial parameters that affect seafarers' adherence to safety management rules and identify the affects the workload distribution on safety performance.

The overt observation study was proposed to capture seafarers' attitudes and perceptions, identify their compliance with safety management rules, monitoring the unsafe acts/behaviours together with measuring the impact of workload on their safety performance. This has been achieved by performing two weeks of overt observation in sister ships of a ferry company. 5 officers from each vessel have been observed for their entire shifts & tasks and also the time spent on these tasks were recorded. The safety culture perceptions that lead to different safety performance records were also noted. To the best knowledge of the authors, such a comprehensive observation hasn't been performed in any shipping company yet.

- To develop improvement methodologies and appropriate action plans to address the existing vulnerabilities in shipping companies and to enhance safety.

Two improvement methodologies were developed, namely:

- Procedure Improvement Tool

- The SOP Development Guide

The Procedure Improvement Tool has been utilised by two shipping companies to improve standards of their SOPs. The SOP Development Guide was utilized numerous times by industrial end-users and researchers. The developed SOPs were tested in simulator environments and the new ones were found safer and faster to be conducted.

- To implement the overall safety culture assessment and improvement framework in shipping companies and propose action plans based on the strengths and weaknesses identified.

The maritime safety culture assessment and improvement framework is made available to shipping companies and it was implemented in several shipping companies. The framework recognized potentials for improvements and selected set of improvement techniques were utilised successfully to enhance level of safety culture.

10.3 Novelties and Contributions to the Field

The main novelties achieved within this PhD thesis are given below:

- Even though the ISM Code encourages the implementation of an effective safety culture, it does not provide a structured guidance for shipping organizations to do so. Numerous organizations implemented different techniques to address this issue however the envisaged impact has not yet been achieved. Therefore, the maritime safety culture assessment and improvement framework was developed to enhance safety culture maturity levels in shipping companies. To the best of the author's knowledge, such a comprehensive safety culture study has not been performed in the shipping industry yet. The developed framework combines subjective (questionnaires, interviews, observations) and objective (safety related KPIs, near miss data) assessment techniques and strives for continuous safety culture improvement with the help of structured improvement methodologies. The framework successfully took several constraints into account with the combination of different methodologies. First time in shipping, the relationships between subjective and objective results were established to enhance safety culture maturity levels on board ships. Therefore, the developed framework within this PhD thesis provides significant contribution to the state of the art safety culture research.

- Even though, questionnaires and interviews were utilized heavily in the shipping sector, organizations still do not know their current safety climate levels compared to other shipping organizations. Therefore, the companies participate in safety climate benchmark will be able to compare their seafarers' safety culture attitude and perception levels with other companies. The safety climate assessment results indicated that some of the problems such as language barriers, manning related fatigue and blame culture are widespread within shipping and improvement measures are required for enhancing safety of vessels in order to avoid dangerous accidents and incidents at sea.
- The Key Performance Indicator assessment provides substantial amount of information regarding the safety performance of a company. Some of the KPIs are already in use amongst shipping companies to compare their performances with their competitors such as TRCF and LTIF. However, a study has not yet been performed to indicate what kinds of dynamics have an impact on these KPIs and how further improvements can be achieved regarding these KPIs. Another novelty of this research has been achieved by not only establishing links amongst safety related KPIs but also identifying relationships between safety culture dimensions and the KPIs. These relationships assist shipping companies to invest on right indicators for enhancing their safety performances and hence decreasing the number of accidents.
- In some cases, safety climate results are not sufficient enough to capture underlying factors that lead to different safety performance levels on board ships of a company. Therefore, overt observations are found as crucial for identifying latent factors that affect safety of ships. A novel overt observation module has been proposed to record all the tasks and the time spent on those

amongst entire officers from the beginning of their shifts until the end of it. Such a detailed and comprehensive observation has not yet been performed in the maritime industry. Therefore, it is of paramount importance to utilise the proposed framework to have a better understanding of a company's safety performance.

- The deviation from SOPs is a phenomenon that affects the entire shipping industry and represents a threat to the safety of shipping. Due to a wide range of reasons, seafarers often deviate from SOPs in order to accomplish their tasks and complete their duties. For the first time, Procedure Improvement Methodology developed to capture workarounds performed by seafarers within a company, assess them and compare them to SOPs in order to find the most effective and safe way of working. To date, there is no methodology which captures workaround data from seafarers in the maritime industry, yet the benefits and necessity of this are abundantly clear. This methodology, embedded within the software, is positioned to improve SOPs in organisations working in the maritime industry and therefore lead to improved shipping safety.

10.4 Limitations of the Developed Framework

The safety culture assessment and improvement framework has encountered with some limitations at the development and implementation stage as many other research methodologies. Limitations of this study are given below:

- The safety culture questionnaires were developed by a series of workshops conducted with safety researchers and HSEQ department members of a shipping company, therefore the factor analysis for dimension reductions has not been conducted prior to the questionnaire distribution as company safety representatives wanted to ask all the questions obtained after shortlisting. Therefore, a factor analysis was performed to be used for the future studies in order to decrease the number of variables.

- Enhancing of safety culture maturity levels requires excessive amount of time (Goldberg, 2013) and therefore efficacy of the improvement methodologies and action plans will not be visible within the project duration.
- Key performance Indicator Assessment requires a comprehensive and accurate data reporting strategy to successfully establish all the aforementioned links. The results are therefore totally dependent on the quality of the data reporting the companies have. The existing blame culture also affects the quality of the reporting adversely and hence the quality of the assessments conducted. Therefore, the KPI assessment could not be performed in other shipping companies to generate stronger hypothesis regarding the relationships between the datasets.
- Overt observations require a researcher to spend at least a week by shadowing each officer for a day. However, all operation types of ships are not convenient for this study since accessibility of a ship becomes a crucial issue. In addition to this, the ships should be suitable for accommodating a researcher for the period of the observation. Overt observations could not be performed in another ship due to the time consuming nature of the study. Different operational dynamics of vessels may affect the workload distribution of the crew members and hence the outcome.

10.5 Recommendations for Future Research

Based on the limitations given in previous sections, recommendations for future research are listed below:

1. Safety Culture Questionnaires were only deployed in three shipping companies to generate a benchmark until to date. The questionnaires should be distributed to a larger number of companies in order to increase the accuracy of the benchmark. The framework should be promoted to other types of shipping companies in order to capture problems of different shipping operations.
2. The safety climate questionnaire which was validated via factor analysis, should be used in future safety climate assessment studies.

3. The relationships between the safety perceptions and KPIs should be investigated on various ships to cover different operation types with an ultimate aim of capturing whether the established links are specific to a shipping company or exist at the industry level.
4. Due to lack of proper data reporting mechanisms within the majority of the shipping companies, data collection sheets should be distributed to the ship management personnel to define which safety related KPIs should be collected and with which frequency. The standardization of the data collection process by the maritime regulatory bodies will assist researchers to generate more accurate results and compare the performances of the shipping companies precisely.
5. Overt observation studies details the workload distribution of each crew members and paperwork is found as the main contributor of the many ranks' workload. However the nature of the paperwork should be investigated in future studies by defining which type of paperwork crew spend most of their time. In addition to this, the overt observations should also be performed on other ship types to reformulate minimum safe manning standards.

10.6 Chapter Summary

In this chapter, a summary of the achievement of the research aims and objectives has been presented by also focusing on the difficulties experienced when performing the work. The state-of-the art contributions to the field were clearly demonstrated. Finally, recommendations for future research have been made.

11 Conclusions

The research conducted in this thesis provides substantial amount of information for shipping organizations in order to enhance safety culture maturity levels. The proposed safety culture assessment and improvement method is the most comprehensive framework ever developed with robust improvement techniques.

Firstly, Safety Climate Assessment indicates that majority of the identified issues exist at all the three shipping companies that the case studies were conducted. These problems can be listed as:

- Insufficient Maritime English
- Blame Culture
- Manning related fatigue and stress
- PPEs are not safe for purpose

The maritime regulatory bodies and other stakeholder should take stringent measures for identifying and addressing these problems to achieve an enhanced level of safety. In addition to these, several other issues are found to be widespread amongst shipping organizations such as: lack of a system for fixing impractical procedures and alcohol abuse.

Furthermore, it has been found that relationships between KPIs provide significant insight into a company's safety performance and means for improving safety. Strong correlations have been found between the safety performance of a company and the three KPIs given below:

1. Number of near miss reporting
2. Number of superintendent visit findings
3. Number of corrective maintenance performed

The shipping organization should increase the number of near miss reports and superintendent visit findings as well as decrease the number of corrective maintenance performed in order to have a superior level of safety. Near miss reports and superintendent visits provides substantial information regarding on board issues and as long as these issues are addressed, shipping companies will have less number of lost time incident frequencies and total recordable cases on board. The number of corrective maintenance also has a significant adverse effect on the level of safety.

According to the relationships established between safety culture dimensions and the KPIs;

- Crew members' perception on communication and feedback improves when corrective maintenance performed on board. Predominantly, crew members value the communication and feedback more, when things go wrong on board vessels and the company's timely involvement becomes a crucial safety improvement according to seafarers. However, the proactive communication should be in place to involve crew members continuously and prevent hazardous failures on board.
- The correlations indicated that the presence of an appropriate just culture positively affects safety performance. When the company is implementing an effective just culture approach, the seafarers perform less deviations from procedures.
- Lastly, management visit frequency is considered as assessment of crew members' level of competence and hence improvement of safety performance of a fleet.

Overt observation studies determines that paperwork is one of the major contributing factor of the seafarers' workload and 13-15 hours are spent on paperwork amongst the officers on each ship on daily basis. Officers perform some of these workload on their rest period and hence this is affecting on board safety adversely. In addition to this, different safety culture perceptions of sister ships' captains, led to different work patterns and workload distribution on board ships. On one ship, the master does not allow third mate to berth the ship as he/she thinks these dangerous manoeuvres should be handled by the most expert seafarers. However on the other vessel, the captain allows third mate to develop his/her skills by performing bething/unberthing. The Captain, who doesn't let third mate to manoeuvre the vessel, had a more disrupted work pattern and couldn't accomplish the paperwork as required. This captain therefore used his/her rest period to catch up with the workload. It is of therefore important to perform observational study to gain insight into effects of safety culture differences on board vessels.

Last but not least, a procedure improvement tool and a best practices guideline for SOP development were produced for shipping organizations in order to address deviations from standard operating procedures and continuously improve the quality of the procedures. The procedure improvement tool also captures workarounds performed by seafarers, assess them and compare them to SOPs in order to find the most effective and safe way of working.

In conclusion, it is not possible to gain full insight into a company's safety culture level and capture all the vulnerabilities without performing the overall framework. When the problems are known to ship managements, companies then can prioritize right initiatives to address the identified gaps and hence enhance safety culture maturity levels. The developed improvement methods also provide assistance for organizations to take necessary steps. Nevertheless, as discussed numerous times before, a company never gets a safety culture, it requires continuous consideration and commitment. Therefore, shipping companies should continuously update their safety goals and invest on new initiatives in order to enhance safety culture maturity levels.

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Appendices

Appendix A - Questionnaire Information Section

SAFETY CULTURE SURVEY FOR CREW MEMBERS

YOUR TRUE OPINION IS EXTREMELY IMPORTANT TO ENHANCE SAFETY

Thank you in advance for participating in the safety culture survey. Your feedback is very important for XXX It will allow the company to:

- take the required steps to develop strategies in order to improve the existing safety culture maturity level within the company
- allow the company to support its staff to further enhance safety through appropriate actions

This survey is conducted independently by the University of Strathclyde in collaboration with XXX, to assess safety culture within XXX. The University of Strathclyde guarantees that:

- Survey responses are completely anonymous.
- This survey does not aim to collect any personal information from the participants
- The answers given to open ended questions will be protected and will not be disclosed to any third party.
- XXX will receive only the analysis of the survey as a whole to identify the strengths and action points to be taken to further enhance safety.

It takes 12 to 15 minutes to complete this survey. Please try to answer the questions accurately. For any inquiries related to this survey, please do not hesitate to contact us via the information below:

Contact Person:

Full name: Volkan Arslan

Occupation: Researcher at University of Strathclyde, Glasgow, UK

Email: volkan.arslan@strath.ac.uk

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Address: Department of Naval Architecture, Ocean & Marine Engineering,

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Appendix B – Factor Analysis

Exploratory factor analysis is utilised to demonstrate whether a wide range of dataset (variables) can be reduced to a smaller size while retaining most of the original information (Field, 2013). The exploratory factor analysis is a proven methodology to explore big datasets and to perform dimension reduction for a survey instrument. The methodology has been used by many researchers for dimension reduction for the developed questionnaires (Chang et al., 2008, Frazier et al., 2013, Seo et al., 2004). The EFA was conducted by utilizing principal axis factoring and a direct oblimin rotation on the dataset (Fabrigar et al., 1999)

Within this study, an exploratory factor analysis was conducted via the structure given below:

- Pre-analysis
    - Sample Size
    - Correlation between variables
- Main analysis
    - Factor extraction
    - Factor rotation
- Post analysis check
    - Reliability

Pre-Analysis

The sample size needs to be checked prior to the factor analysis. There is a requirement of more than 300 responses for the factor analysis (Tabachnick et al., 2001). A total of 1229 valid responses were collected via the questionnaires (after the extraction of missing data and do not know answers). Adequacy of the sample was verified through the objective statistics, namely the KMO (Kaiser-Meyer-Olkin) test (Kaiser, 1970). It can be seen from the table below that KMO statistics was found as 0.965 this result was considered as ‘Marvellous’ according to KMO assessment category proposed by Hutcheson and Sofroniou (1999). Barlett’s Test of Sphericity value was also found significant (0.000) which also shows that correlations exist between items. Hence, sample size is found extremely adequate for the factor analysis.

Table B 1 KMO and Bartlett's tests

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.965
Bartlett's Test of Sphericity	Approx. Chi-Square	50429.296
	df	2775
	Sig.	.000

There is also requirement of investigating inter-correlations between the questions prior to the factor analysis. Tabachnick et al. (2001) suggests that a correlation matrix should be constructed and the correlation coefficients should be higher than 0.3. If there are only few correlation coefficients which are higher than 0.3, then a database cannot be used for the factor analysis. The variables were found highly correlated with each other within the dataset.

Factor Analysis

The factor analysis can be utilised either for exploring a sample or generalizing the findings to a sample. In order to explore the questionnaire data, an Exploratory Factor Analysis (EFA) was performed to examine the construct validity of the safety climate questionnaire by utilising principal axis factoring and a direct oblimin rotation functionalities of the SPSS software (Tinsley and Tinsley, 1987). A rotation of a factor eases the process of result interpretations. It can be seen from the table below that fourteen factors had higher initial Eigenvalues than 1, which explained a total of 60.9% of the variance. Therefore 14 factors were retained from the data as shown in Table B 2.

Table B 2 Exploratory factor analysis eigenvalues and percent of variance

Factor	Total	% of Variance	Cumulative %
1	24.186	32.248	32.248
2	3.444	4.592	36.841
3	2.528	3.371	40.211
4	2.225	2.967	43.179
5	1.739	2.318	45.497

6	1.643	2.191	47.688
7	1.574	2.099	49.787
8	1.387	1.850	51.636
9	1.368	1.824	53.460
10	1.231	1.641	55.101
11	1.168	1.558	56.659
12	1.153	1.537	58.196
13	1.046	1.394	59.590
14	1.019	1.359	60.949

It can be seen from the Table B 3 that factors 3, 5, 12 and 14 only had two loadings on them and each factor must have at least three loadings according to (Zwick and Velicer, 1986). Therefore, these four factors together with their variables were removed from the analysis. The remaining 10 factors accounted 52.364 % of the total variance.

Table B 3 Exploratory factor analysis pattern matrix factor loadings

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Q11	.467													
Q57	.456													
Q56	.443													
Q63	.427													
Q55	.410													
Q64	.407													
Q60	.401													
Q10	.399													
Q59	.386													
Q65	.354													
Q54	.303													
Q9														
Q12														
Q28		.619												
Q33		.518												
Q32		.490												
Q24		.486												
Q66		.437												
Q34			.594											
Q42			.394											
Q68														

Q18		-.628							
Q17		-.569							
Q21		-.562							
Q19		-.506							
Q20		-.474							
Q61			.976						
Q62			.974						
Q40									
Q51				.590					
Q50	.327			.467					
Q49				.433					
Q52				.384					
Q48				.305					
Q53									
Q7					.420				
Q16					.386				
Q15					.360				
Q8					.307				
Q14					.306				
Q13					.306				
Q26					.303				
Q4						.724			
Q3						.635			
Q2						.553			
Q6						.531			
Q5						.365			
Q25									
Q45							.630		
Q44							.611		
Q27							.365		
Q43									
Q31								.588	
Q30								.560	
Q29								.355	
Q67				.308				.318	
Q69								.314	
Q35									
Q37									
Q71									-.763
Q70									-.716
Q38									-.448

Q72											-.357			
Q41											-.311			
Q23														
Q1												.434		
Q22							.310					.430		
Q46														
Q47													.478	
Q58													.417	
Q36													.409	
Q39													.332	
Q74														.577
Q73														.434
Q75														

Factor loadings are presented in Table B 3, thirteen questions were removed from the questionnaire due to the in sufficient data loadings (less than 0.3). The data loadings below 0.3 are considered as insufficient (Brown, 2014).

Table B 4 Factor loadings

Factor	Questions	Factor	Loadings
Safety Awareness	Q11. Safety rules and procedures are strictly followed.	1	.467
	Q57. Checklists are essential for safety.	1	.456
	Q56. My ship holds an adequate number of safety meetings.	1	.443
	Q63. Safety briefings and training are professional and effective.	1	.427
	Q55. My ship works to ensure the safety in hazardous areas and during hazardous activities.	1	.410
	Q64. Safety is the top priority for crew on board this ship.	1	.407
	Q60. I always give proper instructions when I initiate any work.	1	.401
	Q10. Operating procedures provided by the company are helpful to the conduct of daily operations.	1	.399
	Q59. Learning from mistakes is a good way to improve overall safety.	1	.386
	Q65. When I joined this ship, I received a proper induction, including familiarization with new tasks.	1	.354
	Q54. Watch hand-overs are comprehensive and not hurried.	1	.303

Adherence to safety rules	Q28. Asking for assistance can make me look incompetent.	2	.619
	Q33. I don't mind when other crew members ignore safety procedures.	2	.518
	Q32. Crew members sometimes carry out non-work activities while on duty.	2	.490
	Q24. Crew members should not question a senior officer's decision even if safety is affected.	2	.486
	Q66. Sometimes, the rules are not followed in order to comply with sailing timetable.	2	.437
Health & Safety	Q18. Suggestions to improve health and safety are welcomed.	4	-.628
	Q17. Crew members are encouraged to improve safety.	4	-.569
	Q21. Staffs from all departments and levels attend safety meetings.	4	-.562
	Q19. I am consulted about the changes that affect safe work practices.	4	-.506
	Q20. I have sufficient control of my work to ensure it is always completed safely.	4	-.474
Fatigue and Stress Management	Q51. Crew members monitor each other for signs of stress or fatigue.	6	.590
	Q50. I have adequate rest on the work schedule cycle that I work.	6	.467
	Q49. The crew is expected to comply with work-rest hour regulation.	6	.433
	Q52. Our crew has adequate training in emergency procedures.	6	.384
	Q67. Safety is a visible part of the selection and recruitment process in this company.	6	.308
	Q48. There is a system in place for observing my rest hours.	6	.305
Procedures	Q7. Crew members are closely monitored to ensure company procedures are always followed.	7	.420
	Q16. I receive feedback about my compliance to safety procedures.	7	.386
	Q15. The crew is always given feedback on accidents, incidents, and near misses that occur on board.	7	.360
	Q8. There is an effective system in place to modify the procedures that are unworkable or impractical for crew use.	7	.307

	Q14. I am satisfied with the follow-up measures taken after accidents, incidents and near misses.	7	.306
	Q13. I am always informed about the outcome of shipboard safety meetings.	7	.306
	Q26. Other crew members encourage me to report unsafe events.	7	.303
Communication	Q4. Operational values, objectives and targets are effectively communicated.	8	.724
	Q3. There is good cooperation between the ship and shore.	8	.635
	Q2. There is good communication about safety.	8	.553
	Q6. The company operates an effective system for reporting safety matters.	8	.531
	Q5. I always ask questions if I do not understand or unsure about the safety instructions given to me.	8	.365
Competence	Q45. I am confident that I can operate all equipment in my work area effectively.	9	.630
	Q44. I feel confident that I will be able to operate effectively in an emergency situation.	9	.611
	Q27. I am confident that I can operate the equipment within my area of responsibility safely.	9	.365
Reporting Culture	Q31. I am encouraged to report all near misses.	10	.588
	Q30. I am encouraged to conduct, or refer to a risk assessment before performing any hazardous work.	10	.560
	Q29. Whenever I see unsafe behaviour, I always report it.	10	.355
	Q69. I fully understand my responsibilities for health and safety.	10	.314
Training	Q71. My company continuously tries to improve the quality of the trainings.	11	-.763
	Q70. The training provided by our company is of a high quality and standard.	11	-.716
	Q38.The company places a high priority on safety training.	11	-.448
	Q72. I have adequate knowledge of the company (Safety) Management System.	11	-.357
	Q41. The company has excellent maintenance standards.	11	-.311
Manning Levels	Q47. I am provided adequate resources (time, staffing, budget, and equipment) to perform my job.	13	.478
	Q58. The company provides sufficient time for the hand-overs when joining the ship.	13	.417

	Q36. Shore side managers never put timetable or costs above safety.	13	.409
	Q39. Manning levels are appropriate for our workload.	13	.332

After the factor analysis, the dimensions given in Table B 5 are generated and the number of questions decreased from 75 to 55.

Table B 5 New Safety Climate Dimensions

New Safety Climate Dimensions	Number of Questions
1) Safety Awareness	11
2) Adherence to Safety Rules	5
3) Health & Safety	5
4) Fatigue and Stress Management	6
5) Procedures	7
6) Communication	5
7) Competence	3
8) Reporting Culture	4
9) Training	5
10) Manning Levels	4
Total=	55

Reliability Analysis of the Factors

The reliability analysis has been performed by using the Cronbach's alpha statistics (Cronbach, 1951). The set of 55 questions showed good reliability (alpha = 0.955). The reliability of the questionnaire instrument increased from 0.896 to 0.955 after the dimension reduction. Reliability scale values of the each dimension is given in Table B 6.

Table B 6 Reliability Scales

Safety Climate Dimensions	Cronbach's Alpha
1) Safety Awareness	0.893

2) Adherence to safety rules	0.689
3) Health & Safety	0.840
4) Fatigue and Stress Management	0.786
5) Procedures	0.828
6) Communication	0.808
7) Competence	0.771
8)Reporting Culture	0.788
9) Training	0.821
10) Manning Levels	0.678

It can be commented that a questionnaire has a high internal consistency and good reliability if the alpha value exceeds 0.7 (Hair et al., 1998). However, Nunnally (1978) indicated that new developed factors can be accepted with alpha value over 0.6, therefore, a sufficient reliability for the safety climate assessment was obtained after the dimension reduction. Confirmatory factor analysis was also performed to assess construct validity.

The set of validated questionnaire will be utilized in future safety climate assessment studies since the previous survey instrument was utilized by also the other shipping companies to generate benchmark amongst them.

Appendix C - Workload Observation Datasheet

Crew Member	Chief Mate
Observation Start Date	06:10
Observation Start Date	20:37

Task	Start Time	End Time	Sailing Zone (Red Zone/Open Sailing/Port)	Physical (Dynamic/Static)	Interruptions (Number)	Talk (Work Related/ Non Work Related)	Talk Level (High/ Medium/Low)	Multitask (Yes/No)	Notes
Filling Deck Log Book	12:48	12:50	Port	Static	1	Work Related	Low	Yes	Talking about a planned safety check, no safety violation
…									
…									
…									

Appendix D - Workload Identification Questionnaire

Please select the statement you agree most with.

Q1. How busy is/was the channel today?

Very Busy ☐ Busy ☐ Moderate ☐ Quiet ☒ Very Quiet ☐

Q2. How /is was the weather conditions today?

Very Good ☐ Good ☐ Moderate ☐ Bad ☐ Very Bad ☐

Q3. How /is was the visibility today?

Very Good ☐ Good ☐ Moderate ☐ Bad ☐ Very Bad ☐

Q4. How do you define your workload throughout the day?

Very High ☐ High ☐ Moderate ☐ Low ☐ Very Low ☐

Q5. Where does the workload peak for you?

Red Zone ☐ Open Sailing ☐

Q6. Are you interrupted often during tasks?

Yes ☐ No ☐

Q7. How often you are interrupted by other crew members while doing your task?

Always ☐ Very often ☐ Sometimes ☐ Rarely ☐ Never ☐

Q8. How much these interruptions impact upon the performance of yourself?

A great deal ☐ Much ☐ Somewhat ☐ Little ☐ Not much ☐

Q9. What is the main cause of interruptions?

Work related communication ☐ Non-work related communication ☐

Q10. What is the level of fatigue during your shift?

Very High ☐ High ☐ Moderate ☐ Low ☐ Very Low ☐

Q11. Do levels of fatigue impact on the way in which a task is performed?

Yes ☐ No ☐

Q12. Are the manning levels are adequate?

Manning levels are generally below that needed☐

Manning levels are reasonable ☐ Manning levels are generally above that needed ☐

Q13. Is there sufficient time to allow tasks to be completed as stated in the standard operating procedures?

Yes ☐ No☐

Q14. At what point are you required to do the most multi-tasking?

Entering Port ☐ Berthing ☐ Leaving Port ☐ Open Sailing ☐

Q15. Of those listed below, tick **three** which you identify at the main drivers of workload.

Number of Crossings per Day ☐ Paperwork ☐ Manning Levels ☐ Seafaring Conditions ☐ Fatigue ☐

Q16. How many hours do you spend on paperwork each day?

Please give a value.

Q17. How often do you manage to complete the associated paper in the allotted time?

Please tick the most appropriate frequency.

Never ☐ One day per two weeks ☐ One day per week ☐ 2-6 days a week ☐ Every day ☐

Q18. On average how much extra time is required **each day** to complete paperwork?

Please give a value.

Appendix E - Case Study - Safety Climate Assessment in a Bulk Carrier Shipping Company

This section details the safety climate assessment of a bulk carrier shipping company. Firstly, the demographic characteristic of the employees are explored in the shipping company. Then, the safety culture factors and the open-ended questions are analysed. Finally, the report provides detailed statistical findings for gaining full insight into the current safety climate level of the company.

Safety Culture Questionnaire Data Collection

The questionnaires were distributed to 87 people in a bulk carrier shipping company. A 100% response rate was gained from the administration of the survey in the company. 100% response rate was achieved due to the small size of the company. The detailed return rates from different groups described below:

- **Crew:** 75 responses out of 75 people (100%)
- **Shore staff:** 12 responses out of 12 people (100%)

Missing data

The data were screened to look for missing and unusual data. The questionnaires asked 87 questions in total and there were 87 responses. There were not any missing responses at the demographic and safety culture factors sections.

Demographics

The following presents the results of the demographics section of the questionnaire. This section provides background information about the participants.

A total of 87 questionnaires were filled and returned. Of these, 75 (86.2%) were completed by seafarers and the remaining 12 (13.8%) were completed by shore personnel.

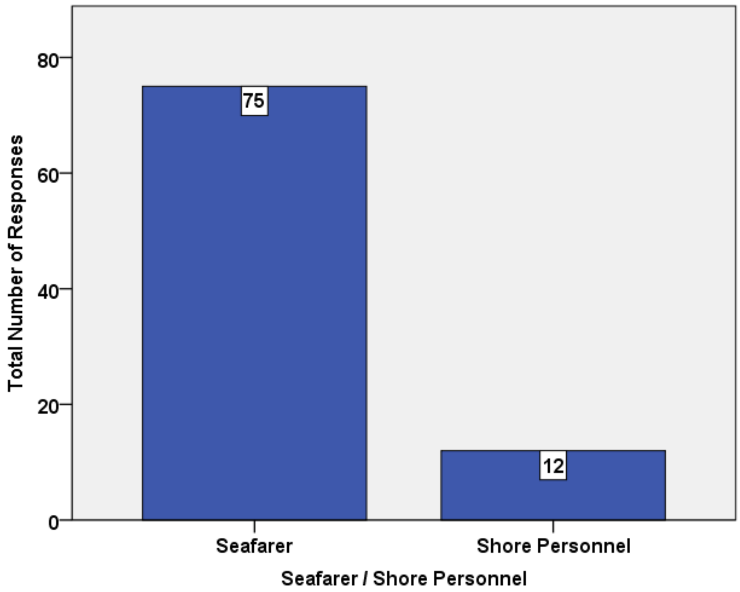

Figure E 1 number of responses

Age

The age distribution of the seafarers and shore personnel is given in Figure E 2. Crew members are mostly younger than shore staff in the shipping company. The majority of the seafarers are between 35 and 44 years of age on board ships and account for 29.1%. The larger part of the shore staff are between 45 and 54 years of age and account for 4.7 % of the all respondents. This also reflects the well-known practice in the maritime industry that when crew members get older they would like to be transferred to shore-based positions for the sake of a more regular life.

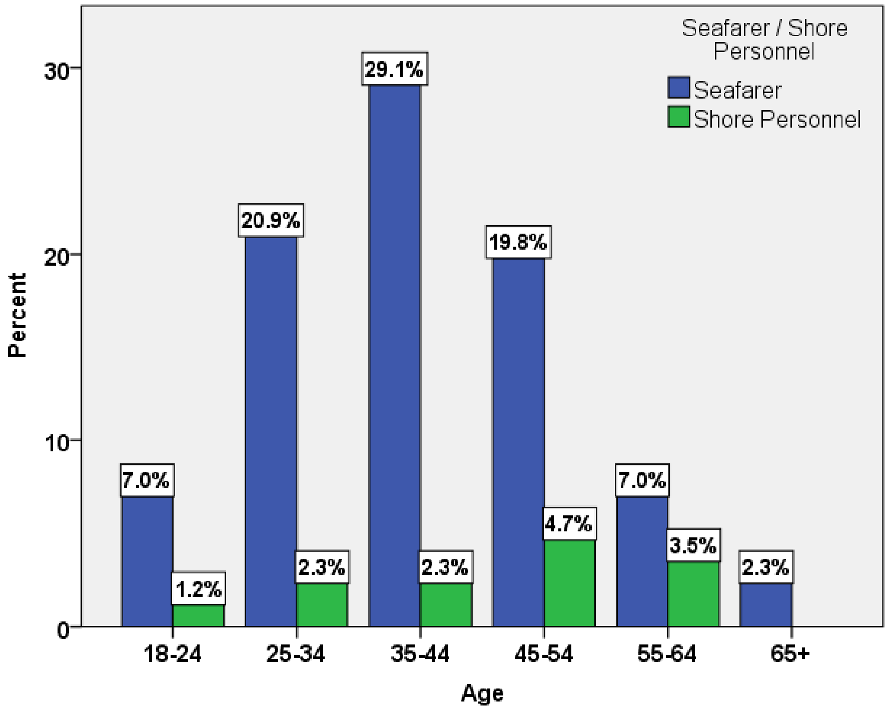

Figure E 2 the age distribution of the respondents

Gender

All of the seafarers are male within the company which accounts for 86.2%. There are slightly more female workers at shore.

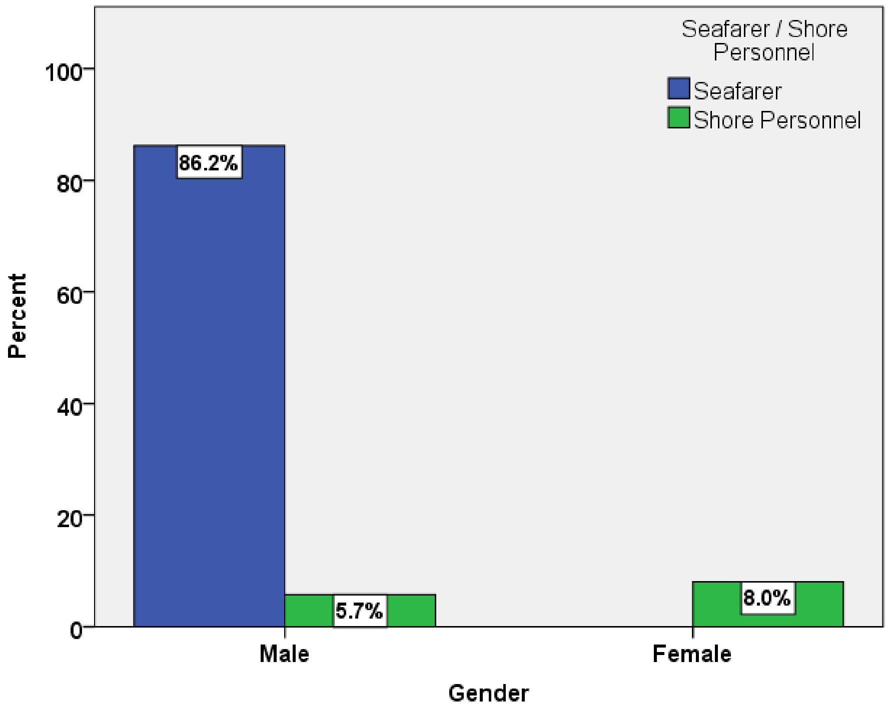

Figure E 3 the gender distribution of the respondents

Departments

The highest percentage of respondents worked in the Deck Department and Engineering Department with 48.8% and 26.3%, respectively. Ratings and Ship Management were with 12.5% and 10%, respectively. Only 2.5% were port officers.

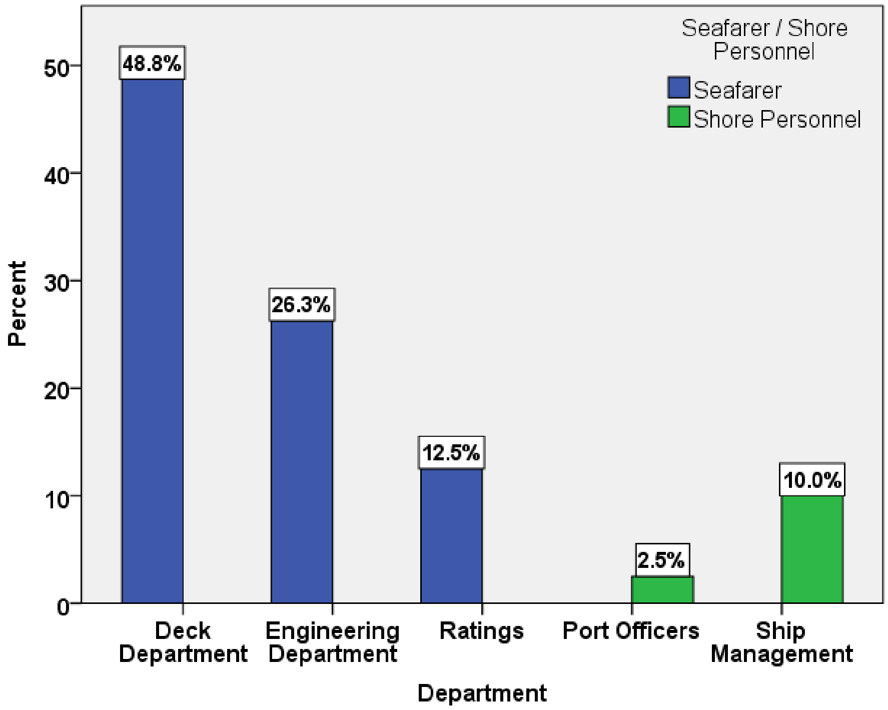

Figure E 4 Distribution of employees amongst departments

Seafarers' Ranks

The distribution of of ranks is given in Figure E 5. Majority of the respondents are bridge officers and able seamen within the company.

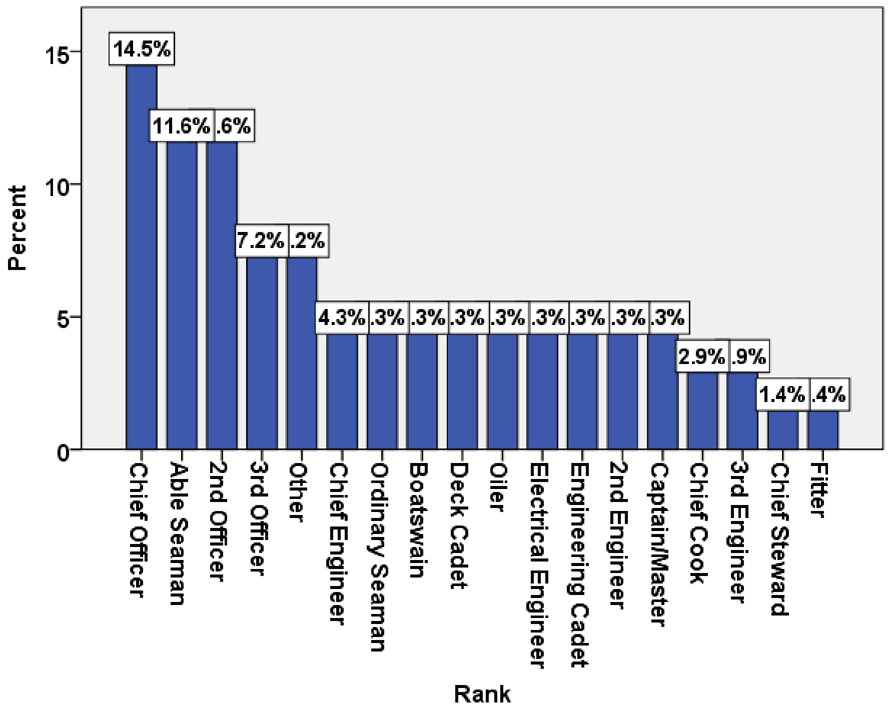

Figure E 5 Distribution of ranks amongst crew members

Nationalities

The majority of the participants are Filipinos (62.7%). Filipinos are followed by Greeks (31.3%) and Romanians (6.0%).

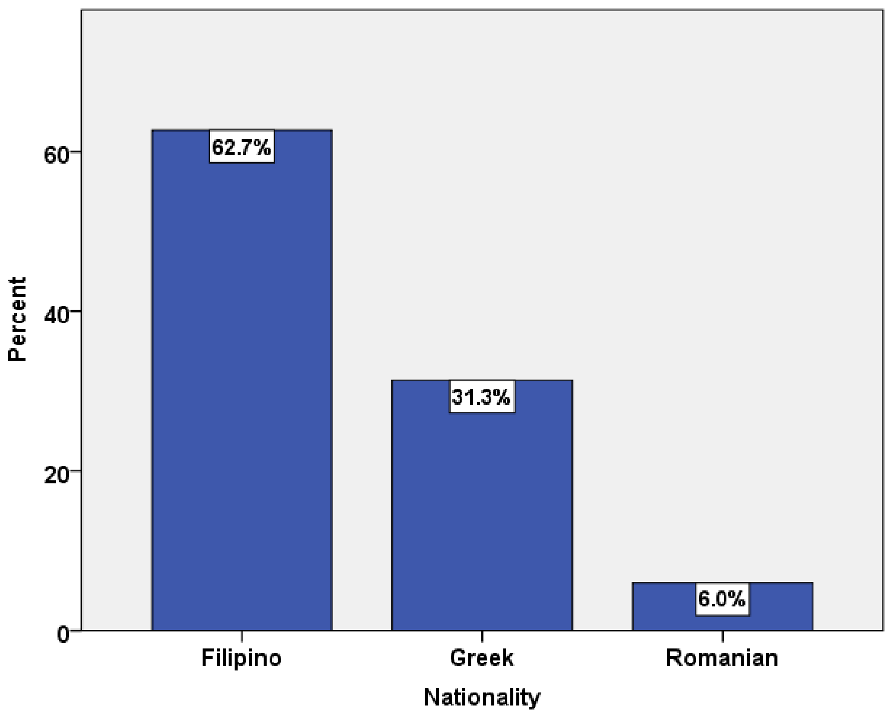

Figure E 6 Distribution of nationalities

Safety Culture Dimension Results

This section presents the attitude and perception results of the employees within the company. In total 75 seafarers and 12 shore personnel completed the survey and all of these responses are included in the following analysis. There was less than 2% of missing data for each question.

The average scores of the each safety climate dimension in the questionnaire were calculated. The results revealed that the highest score was obtained on the **Involvement** factor amongst crew members. Shore staff achieved the highest scores on **Involvement** and **Just Culture** factors. The lowest scores were achieved on **Problem Identification** amongst the crew members and **Safety Awareness** amongst shore personnel. It can be seen from the given table that shore personnel have better safety attitudes and perceptions on several safety related factors than crew members. It can be seen in the Table E 1 that the biggest difference between crew members and shore staff is recorded with 12.7 percent on the feedback factor. This clearly identifies that there is a big difference about how the feedback is managed within the company between crew member and shore staff.

The scores which are lower than 80, are not desirable within organizations. Relevant efforts should be invested to strengthen the identified weaknesses. In the calculation process, each statement has a score varies between 0 and 100, where 0 shows the min score and 100 represents the highest score.

Table E 1 Safety Climate Scores – Bulk Carrier Shipping Company

Safety Climate Dimensions	Scores for Crew Members (%)	Standard Deviation (%)	Scores for Shore Staff (%)	Standard Deviation (%)
1) Communication	80.92	6.46	88.33	5.60
2) Procedures and Safety Rules	80.36	7.01	87.50	9.96
3) Feedback	81.27	7.42	93.33	7.49
4) Involvement	85.19	7.94	95.00	8.72
5) Just Culture	77.53	7.69	95.00	6.74
6) Problem Identification	74.99	8.29	91.06	6.18
7) Priority of Safety	75.59	6.08	84.17	6.97

8) Responsiveness	78.68	6.67	84.33	8.56
9) Safety Awareness	76.42	5.76	81.99	3.94
10) Training and Competence	81.17	6.63	89.17	6.69
Av. Score=	**78.32**		**87.13**	

Communication Statements

The communication factor consists of six statements. The average scores of the each statement for crew members and shore personnel are given in Table E 2. The statement with the lowest score for crew members and shore personnel is: "*Language dialect related issues amongst crew members are not a threat to safety*".

This identifies that the maritime English level is seen as a threat to safety from both sides of the respondents within also the bulk carrier company. There is a need for advanced maritime English courses to tackle with the language related issues. Beside the maritime English, the overall communication was found excellent within the company.

Table E 2 Communication Dimension

Communication		
Statements	**Average Score**	
	Crew Members	**Shore Personnel**
1. Language/dialect related issues amongst crew members are not a threat to safety.	65.86	56.66
2. There is good communication about safety.	82.66	91.66
3. There is good cooperation between the ship and shore.	82.93	91.66
4. Operational values, objectives and targets are effectively communicated.	83.20	95.00
5. I always ask questions if I do not understand or unsure about the safety instructions given to me.	84.86	96.66
6. The company operates an effective system for reporting safety matters.	86.13	98.33

Procedures and Safety Rules Statements

The procedures and safety rules factor consists of six statements. The average scores of the each statement for crew members and shore personnel are given in Table E 3 all the colours which are not green require an immediate improvement. The statement with the lowest score for crew members and shore personnel is: "*I never breach operating procedures, even if the breach is in the company's best interests*". Crew members also stated that sometimes they deviate from the SOPs to maintain the timetable.

Crew members should strictly follow the SOPs in all conditions. The company should emphasize the importance of the SOPs and the procedure violations shouldn't be tolerated within the company. However crew members think that they sometimes need to breach the standard operating procedures due to the commercial pressure and this is considered as an extremely dangerous execution.

Q 12 demonstrates that sometimes crew members deviate from SOPs to maintain a time table due to the contractual requirements. However shore personnel consider that these risky deviations are not happening on board their vessels. Ship management should come together with crew members more frequently and importance of suspending shipping operations due to safety reasons should be communicated to crew.

Table E 3 Procedures and Safety Rules Dimension

Procedures and Safety Rules		
Statements	Average Score	
	Crew Members	Shore Personnel
7. Crew members are closely monitored to ensure company procedures are always followed.	84.53	91.67
8. There is an effective system in place to modify the procedures that are unworkable or impractical for crew use.	80.80	93.33
9. I never breach operating procedures, even if the breach is in the company's best interests.	74.25	71.67
10. Operating procedures provided by the company are helpful to the conduct of daily operations.	82.70	88.33

11. Safety rules and procedures are strictly followed.	82.16	88.33
12. The crew members are never encouraged to break rules to complete a task or maintain the timetable.	77.57	91.67

Feedback Statements

The feedback factor consists of four statements. The average scores of the each statement for crew members and shore personnel are given in Table E 4 and all the colours which are not green require an immediate improvement. The statement with the lowest score for crew members and shore personnel is: "*I receive feedback about my compliance to safety procedures*".

The company should provide feedback about how the employees comply with the rules and regulations. This is of highly significant to achieve envisaged level of safety on maritime operations. Violation of the regulatory compliance can cause severe penalties and even detention of a ship. Therefore, compliance with regulations should be treated as the utmost priority to maintain safety of the fleet and this message should be communicated to crew with their performance about the subject. This would show how important the compliance and encourage crew to adhere to the regulations.

Table E 4 Feedback Dimension

Feedback		
Statements	**Average Score**	
	Crew Members	**Shore Personnel**
13. I am always informed about the outcome of shipboard safety meetings.	84.05	96.67
14. I am satisfied with the follow-up measures taken after accidents, incidents and near misses.	82.13	96.67
15. The crew is always given feedback on accidents, incidents, and near misses that occur on-board.	81.33	91.67
16. I receive feedback about my compliance to safety procedures.	77.81	88.33

Involvement Statements

The involvement factor consists of five statements. The average scores of the each statement for crew members and shore personnel are given in Table E 5 and all the colours which are not green require an immediate improvement. In general, the average scores achieved in the involvement factor is quite high. Especially, shore workers have extremely high scores in this dimension. The statement with the lowest score is the following statement for crew members: "*I am consulted about, and invited to get involved in changes that affect safe work practices*".

Even though, the company succeeded tremendously on the Involvement factor, the crew members' involvement, especially regarding to the changes that affect their working practices should be increased. Therefore, crew members will feel more involved and treat safety as a core value in all maritime operations.

Table E 5 Involvement Dimension

Involvement		
Statements	Average Score	
	Crew Members	Shore Personnel
17. Crew members are encouraged to improve safety.	88.92	95.00
18. Suggestions to improve health and safety are welcomed.	88.80	95.00
19. I am consulted about, and invited to get involved in changes that affect safe work practices.	78.92	91.67
20. I have sufficient control of my work to ensure it is always completed safely.	83.78	95.00
21. Staff from all departments and levels attends safety meetings.	85.60	98.18

Just Culture Statements

The just culture factor consists of six statements. The average scores of the each statement for crew members and shore personnel are given in Table E 6and all the colours which are not green require an immediate improvement. The statement with the lowest score for crew members and shore personnel is: "*Crew members should question a senior officer's decision if safety is affected*".

The crew members should work as a team together with all the ranks on the ship bridge in order to maintain navigational safety. Junior people should be able to speak up if they have a safety concern regarding the safety of the vessel. This practice is of high importance in order to enhance resilience of the crew for preventing accidents and incidents. Accident scenarios should be conducted in a simulator and ship environment where captains should intentionally make wrong decisions to assess junior officers' contribution to safety culture. The company should prioritize the "just culture" approach to establish the envisaged environment. Mistakes should also be treated as learning opportunities in an honest and consistent manner. An appropriate just culture approach will lead crew members to take more responsibility for enhancing safety culture since the honest mistakes are not used to punish individuals within this concept.

Table E 6 Just Culture Dimension

Just Culture		
Statements	**Average Score**	
	Crew Members	**Shore Personnel**
22. Mistakes are corrected without punishment and treated as a learning opportunity.	79.19	96.67
23. The company always tries to resolve any safety concerns and problems identified.	84.53	96.67
24. Crew members should question a senior officer's decision if safety is affected.	64.59	88.33
25. I am able to discuss any concerns I have with my line manager.	82.67	98.33

Problem Identification Statements

The problem identification factor consists of nine questions. The average scores of the each statement for crew members and shore personnel are given in Table E 7 and all the colours which are not green require an immediate improvement. The statement with the lowest score is the following statement for crew members: "*The* *possibility of being involved in an accident is not high in this company* and for the shore staff: *Crew members do not carry out non-work activities while on duty"*.

The problem identification dimension appears to be problematic within the company. First of all, crew members believe that there is a high likelihood of a catastrophic accident within the fleet. The underlying reasons of this perception should be investigated further and appropriate action plans should be taken into consideration. If crew members feel that the company do not try to decrease likelihoods of accidents, they wouldn't be committed to company for running all assets safely.

Majority of the participants asserted that crew members perform non-work related activities. This aspects needs to be investigated by interviews and observational studies since non-work related activities can lead to catastrophic accident since shipping operations requires high alertness and situational awareness all the time.

The results highlight that crew members are hesitant to ask assistance due to the fear of looking incompetent. In order to generate a safer environment, crew members should work as a team and they should provide assistance to colleagues when they are in need.

Furthermore, crew members' responses show that they neither report all unsafe acts nor encourage other colleagues to do so. This may be related to classic blame culture and fear of being punished. The benefit of near miss and unsafe act reporting are crucial for identifying existing problems and therefore taking appropriate measures to solve the issues for shipping companies. Crew members should also identify any procedural deviations performed by others and report to the company for continuous improvement (in an anonymous manner if possible).

Table E 7 Problem Identification Dimension

Problem Identification		
Statements	Average Score	
	Crew Members	Shore Personnel
26. Other crew members encourage me to report unsafe events.	75.41	91.67

27. I am confident that I can operate the equipment within my area of responsibility safely.	85.68	90.00
28. Asking for assistance cannot make me look incompetent.	67.30	93.33
29. Whenever I see unsafe behaviour, I always report it.	78.67	88.33
30. I am encouraged to conduct, or refer to a risk assessment before performing any hazardous work.	85.07	91.67
31. I am encouraged to report all near misses.	81.08	93.33
32. Crew members do not carry out non-work activities while on duty.	64.44	81.82
33. I mind when other crew members ignore safety procedures.	75.47	98.33
34. The possibility of being involved in an accident is not high in this company.	62.67	90.00

Priority of Safety Statements

The priority of safety factor consists of nine statements. The average scores of the each statement for crew members and shore personnel are given in Table E 8 and all the colours which are not green require an immediate improvement. The statement with the lowest score is for the crew members: "*the company takes action(s) not only when an accident occurs* and for the shore personnel: *the company makes too much noise (excessive promotion) about safety"*.

The company should be involved not only in accidents or extreme cases. There should be always plenty of safety initiatives to achieve zero accident targets within an organization. A company which treats safety as a core value should always make much noise about safety. Excessive safety promotion is seen as the way forward for the safety culture enhancement since safety culture requires continuous effort and improvement.

Another striking result of the survey is that employees do not believe the safety performance of the company is increasing compared to previous years. Even though the distribution of the safety culture questionnaires shows that the company is trying to identify problems for enhancing safety culture, they either fail to communicate the efforts they are investing or do not take the appropriate actions after the survey study.

The respondents also raised a problem with the management policy of the company about safety vs timetable. Ship management should act responsible about what they say and what they do. Lastly, crew members find the manning levels are not sufficient for navigating the ship safely. Since the shore personnel have a different opinion about the manning levels, the observation study can provide proof whether the ships are understaffed or not.

Table E 8 Priority of Safety Dimension

Priority of Safety		
Statements	**Average Score**	
	Crew Members	**Shore Personnel**
35. When ship management is informed about accidents, incidents, or near misses, corrective action is taken promptly.	81.87	95.00
36. Shore side managers never put timetable or costs above safety.	64.27	93.33
37. Members of the management team are personally and routinely involved in safety.	82.93	96.67
38. The company places a high priority on safety training.	85.87	96.67
39. Manning levels are appropriate for our workload.	77.03	85.00
40. The company is giving much more attention to safety now, than it did one year ago.	76.53	61.67
41. The company has excellent maintenance standards.	82.67	93.33
42. The company takes action(s) not only when an accident occurs.	63.51	91.67
43. The company makes too much noise (excessive promotion) about safety.	69.73	46.67

Responsiveness Statements

The responsiveness factor consists of ten statements. The average scores of the each statement for crew members and shore personnel are given in Table E 9 and all the colours which are not green require an immediate improvement. The statement with the lowest score for crew members and shore personnel is: "*My attention to safety does not suffer when I have been stressed or fatigued*".

Both seafarers and shore personnel stated that they lose their attention to safety when they are stressed or fatigued. The company should precisely monitor the sign of stress an fatigue as well as the underlying reasons of these two on board. The underlying reason of fatigue and stress is known as the workload which is also directly affected by the insufficient manning levels. Different type of shifts like 6 hours on 6 hours off cause accumulation of fatigue as seafarers cannot have a proper sleep in 6 hour rest period. Observation studies should be utilised to identify the underlying reasons and effects of the workload on each crew member.

Crew member should monitor each other for the sign of stress which can lead to a serious accident on board. A crosschecking system amongst crew members will enhance the resilience of the shipping operations.

Table E 9 Responsiveness Dimension

Responsiveness		
Statements	**Average Score**	
	Crew Members	**Shore Personnel**
44. I feel confident that I will be able to operate effectively in an emergency situation.	82.13	85.00
45. I am confident that I can operate all equipment in my work area effectively.	82.97	85.00
46. My attention to safety does not suffer when I am stressed or fatigued.	59.17	53.33
47. I am provided adequate resources (time, staffing, budget, and equipment) to perform my job.	76.49	86.67
48. There is a system in place for observing my rest hours.	81.08	88.33

49. The crew is expected to comply with work-rest hour regulation.	81.35	93.33
50. I have adequate rest on the work schedule cycle that I work.	78.38	91.67
51. Crew members monitor each other for signs of stress or fatigue.	76.22	80.00
52. Our crew has adequate training in emergency procedures.	83.24	93.33
53. The crew has access to all necessary personal protective equipment (PPE).	84.59	86.67

Safety Awareness Statements

The safety awareness factor consists of 16 statements. The average scores of the each statement for crew members and shore personnel are given in Table E 10 and all the colours which are not green require an immediate improvement. The statement with the lowest score for crew members and shore personnel is: "*Drug and alcohol abuses are not a safety issue in my company".*

As identified in Q61 and Q62, the most alarming issues are identified as drug and alcohol use in the safety culture questionnaires within the company. Drug and alcohol abuses are seen as significant threats to safety of the vessels and seafarers. Drug and alcohol tests should be arranged more frequently to identify possible breaches and eliminate the use of these substances on board.

Crew members highlight that watch handovers sometimes are not comprehensive and sufficient time is not allocated for them within the organization according to results of Q54. Watch hand over notes are extremely crucial to enhance the familiarisation and awareness level of a crew member who joins a new vessel.

Lastly, company should prioritize safety over timetable since a single catastrophe can lead company to lose all their reputation, incomes and assets (Q66). Therefore, expected time of arrival should be postponed if a dangerous situation arises on board and it should be fixed immediately.

Table E 10 Safety Awareness Dimension

Safety Awareness		
Statements	Average Score	
	Crew Members	Shore Personnel
54. Watch hand-overs are comprehensive and not hurried.	79.46	85.00
55. My ship works to ensure the safety in hazardous areas and during hazardous activities.	83.24	88.33
56. My ship holds an adequate number of safety meetings.	83.78	85.45
57. Checklists are essential for safety.	85.28	95.00
58. The company provides sufficient time for the hand-overs when joining the ship.	76.11	80.00
59. Learning from mistakes is a good way to improve overall safety.	80.81	93.33
60. I always give proper instructions when I initiate any work.	84.11	86.67
61. Drug abuse is not a safety issue in my company.	40.81	20.00
62. Alcohol use is not a safety issue in my company.	44.59	20.00
63. Safety briefings and training are professional and effective.	84.05	98.33
64. Safety is the top priority for crew on board this ship.	88.38	100.00
65. When I joined this ship, I received a proper induction, including familiarization with new tasks.	80.81	98.33
66. Expected time of arrival can be postponed in order to follow safety rules strictly on board.	57.57	75.00
67. Safety is a visible part of the selection and recruitment process in this company.	83.73	93.33
68. This company cares about my health and safety.	83.73	96.67
69. I fully understand my responsibilities for health and safety.	86.67	96.67

Training and Competence Statements

The training and competence factor consists of six statements. The average scores of the each statement for crew members and shore personnel are given in Table E 11 and all the colours which are not green require an immediate improvement. The statement with the lowest score for crew members and shore personnel is: *"I am trained to cope with fatigue"*.

Fatigue of seafarers has contributed and still contributes to majority of the accidents. Extra care should be allocated to improve the fatigue management of the employees. Available fatigue management courses of maritime institutions or fatigue management toolkit can be utilised to increase crew members' fatigue management skills. Company can either decrease fatigue of crew members by changing their working hours practices or adding the paperwork duties to the safe manning calculations to have a more realistic on board working hours.

Table E 11 Training and Competence Dimension

Training and Competence		
Statements	**Average Score**	
	Crew Members	**Shore Personnel**
70. The training provided by our company is of a high quality and standard.	82.97	98.33
71. My company continuously try to improve the quality of the trainings.	84.93	93.33
72. I have adequate knowledge of the company (Safety) Management System.	82.19	90.00
73. I am properly trained to deal with unfamiliar situations where safety might be at stake.	80.00	93.33
74. I am trained to cope with fatigue.	74.25	71.67
75. Adequate time is allowed for safety drills.	82.19	88.33

Statistical Results

Differences between Groups

Differences between group means were examined and tested for statistical significance using ANOVA test. This test is utilised to identify statistical differences between different groups such as age, department etc., and by using this method, the chance factor was removed from the analysis. If the generated result (p value) is lower than 0.05 for a question, it means that there is a significant statistical differences (scientifically proved) between different groups responded to that particular question. The average scores of the each age group were represented by utilising the same colour codes which were also used while assessing the results of the overall scores of the safety culture dimensions. The meanings of the each colour are given in Chapter 4.

Effect of Age

The questions which are highlighted in red represents that there is a significant statistical difference between the different age groups and their answers given to the questionnaires.

Table E 12 ANOVA on Age (significant interactions, p-value < 0.05, are shown in red)

Var	p-value	Var	p-value	Var	p-value	Var	p-value	Var	p-value
Q1	0.656	Q16	0.685	Q31	0.225	Q46	0.924	Q61	0.623
Q2	0.674	Q17	0.733	Q32	0.386	Q47	0.570	Q62	0.504
Q3	0.593	Q18	0.290	Q33	0.256	Q48	0.666	Q63	0.584
Q4	0.287	Q19	0.071	Q34	0.743	Q49	0.564	Q64	0.212
Q5	0.751	Q20	0.357	Q35	0.241	Q50	0.552	Q65	0.649
Q6	0.127	Q21	0.995	Q36	0.481	Q51	0.593	Q66	0.829
Q7	0.125	Q22	0.298	Q37	0.813	Q52	0.429	Q67	0.378
Q8	0.375	Q23	0.739	Q38	0.644	Q53	0.427	Q68	0.375
Q9	0.925	Q24	0.065	Q39	0.644	Q54	0.715	Q69	0.222
Q10	0.705	Q25	0.499	Q40	0.888	Q55	0.108	Q70	0.794
Q11	0.878	Q26	0.641	Q41	0.075	Q56	0.358	Q71	0.937
Q12	0.610	Q27	0.944	Q42	0.225	Q57	0.862	Q72	0.334
Q13	0.415	Q28	0.893	Q43	0.629	Q58	0.330	Q73	0.508
Q14	0.664	Q29	0.181	Q44	0.830	Q59	0.556	Q74	0.798
Q15	0.950	Q30	0.842	Q45	0.727	Q60	0.881	Q75	0.677

There are not any statistically significant differences between age groups of this company. The results show that respondents have similar safety culture attitudes and perceptions regardless their ages.

Effect of Gender

The questions which are highlighted in red represents that there is a significant statistical difference between the genders and their answers given to the questionnaires.

Table E 13 ANOVA on Gender (significant interactions, *p-value* < 0.05, are shown in red)

Var	p-value	Var	p-value	Var	p-value	Var	p-value	Var	p-value
Q1	0.299	Q16	0.080	Q31	0.038	Q46	0.552	Q61	0.012
Q2	0.674	Q17	0.717	Q32	0.024	Q47	0.042	Q62	0.012
Q3	0.020	Q18	0.629	Q33	0.003	Q48	0.011	Q63	0.001
Q4	0.039	Q19	0.293	Q34	0.000	Q49	0.032	Q64	0.018
Q5	0.011	Q20	0.179	Q35	0.006	Q50	0.040	Q65	0.000
Q6	0.015	Q21	0.645	Q36	0.000	Q51	0.158	Q66	0.003
Q7	0.102	Q22	0.023	Q37	0.001	Q52	0.038	Q67	0.099
Q8	0.033	Q23	0.036	Q38	0.018	Q53	0.823	Q68	0.038
Q9	0.266	Q24	0.047	Q39	0.055	Q54	0.489	Q69	0.096
Q10	0.110	Q25	0.002	Q40	0.140	Q55	0.138	Q70	0.002
Q11	0.000	Q26	0.041	Q41	0.090	Q56	0.854	Q71	0.001
Q12	0.083	Q27	0.149	Q42	0.000	Q57	0.297	Q72	0.005
Q13	0.014	Q28	0.001	Q43	0.000	Q58	0.144	Q73	0.007
Q14	0.003	Q29	0.045	Q44	0.925	Q59	0.369	Q74	0.162
Q15	0.133	Q30	0.485	Q45	0.921	Q60	0.620	Q75	0.110

Due to difference in sample size and non-homogenous variances, Hochberg's GT2 and Games-Howell post hoc tests were conducted on the statistically significant variables only. A summary of the post hoc tests is outlined in the table below.

Table E 14 Summary of the findings of post hoc tests for interaction of Gender

No	QUESTION	M	F
Q3	There is good cooperation between the ship and shore.	83.5	91.4
Q4	Operational values, objectives and targets are effectively communicated.	83.8	91.4
Q5	I always ask questions if I do not understand or unsure about the safety instructions given to me.	85.6	97.1
Q6	The company operates an effective system for reporting safety matters.	87.0	97.1
Q11	Safety rules and procedures are strictly followed.	81.8	97.1

No	**QUESTION**	**M**	**F**
Q14	I am satisfied with the follow-up measures taken after accidents, incidents and near misses.	83.3	94.3
Q22	Mistakes are corrected without punishment and treated as a learning opportunity.	79.5	94.3
Q23	The company always tries to resolve any safety concerns and problems identified.	85.5	94.3
Q24	Crew members should question a senior officer's decision even if safety is affected.	66.6	82.9
Q25	I am able to discuss any concerns I have with my line manager.	83.8	97.1
Q26	Other crew members encourage me to report unsafe events.	76.2	88.6
Q28	Asking for assistance cannot make me look incompetent.	68.6	97.1
Q29	Whenever I see unsafe behaviour, I always report it.	79.3	88.6
Q31	I am encouraged to report all near misses.	82.0	91.4
Q32	Crew members do not carry out non-work activities while on duty.	65.5	83.3
Q33	I mind when other crew members ignore safety procedures.	77.0	97.1
Q34	The possibility of being involved in an accident is not quite high in this company.	63.8	97.1
Q35	When ship management is informed about accidents, incidents, or near misses, corrective action is taken promptly.	82.8	94.3
Q36	Shore side managers never put timetable or costs above safety.	63.6	97.1
Q37	Members of the management team are personally and routinely involved in safety.	83.8	97.1
Q38	The company places a high priority on safety training.	86.5	97.1
Q42	The company do not only take action(s) when an accident occurs.	65.1	94.3
Q43	The company makes too much noise (excessive promotion) about safety.	68.2	40.0
Q47	I am provided adequate resources (time, staffing, budget, and equipment) to perform my job.	77.2	85.7
Q48	There is a system in place for observing my rest hours.	81.3	91.4
Q49	The crew is expected to comply with work-rest hour regulation.	82.3	91.4
Q50	I have adequate rest on the work schedule cycle that I work.	79.5	88.6
Q52	Our crew has adequate training in emergency procedures.	84.1	91.4
Q61	Drug abuse is not a safety issue in my company.	39.5	20.0
Q62	Alcohol use is not a safety issue in my company.	43.0	20.0
Q63	Safety briefings and training are professional and effective.	85.1	97.1

No	**QUESTION**	**M**	**F**
Q64	Safety is the top priority for crew on board this ship.	89.1	100.0
Q65	When I joined this ship, I received a proper induction, including familiarization with new tasks.	82.0	97.1
Q66	The rules are always adhered prior a sailing goes ahead.	58.0	82.9
Q68	This company cares about my health and safety.	84.8	94.3
Q70	The training provided by our company is of a high quality and standard.	84.1	97.1
Q71	My company continuously tries to improve the quality of the trainings.	85.1	97.1
Q72	I have adequate knowledge of the company (Safety) Management System.	82.6	91.4
Q73	I am properly trained to deal with unfamiliar situations where safety might be at stake.	81.0	91.4

It is obvious from above that females generally scored higher than males except the drug & alcohol use perceptions. Females are only based in shore positions and probably alcohol & drug abuse are known to all ship management but not to crew members of other vessels.

There is a distinct difference between males and females respondents regarding the belief about how the mistakes are treated in the company. Male respondents do not believe that honest mistakes are utilized as learning opportunities as female personnel do. An appropriate just culture approach should be implemented in the company to bring male respondents perception to the same level.

Even though female respondents consider that junior crew can speak up when they have a safety concern, male respondents do not think this is happening within this company. Senior officers should encourage junior officers and ratings to share their safety concerns without disregarding additional expertise and competencies of the senior personnel.

Male participants also have statistically higher concerns scores with regards to the likelihood of having accidents. Male employees believe that possibility of an accident is higher than what female employees think.

The difference of the safety culture results between male and female respondent is similar to the differences between ship and shore since all the female respondents work in on shore position within this company.

Effect of Department

The questions which are highlighted in red represents that there is a significant statistical difference between the departments and their answers given to the questionnaires.

Table E 15 ANOVA on Department (significant interactions, p-value < 0.05, are shown in red)

Var	p-value	Var	p-value	Var	p-value	Var	p-value	Var	p-value
Q1	0.505	Q16	0.065	Q31	0.043	Q46	0.001	Q61	0.032
Q2	0.016	Q17	0.200	Q32	0.233	Q47	0.061	Q62	0.030
Q3	0.155	Q18	0.162	Q33	0.002	Q48	0.049	Q63	0.000
Q4	0.002	Q19	0.000	Q34	0.015	Q49	0.012	Q64	0.036
Q5	0.010	Q20	0.037	Q35	0.001	Q50	0.000	Q65	0.000
Q6	0.013	Q21	0.839	Q36	0.000	Q51	0.009	Q66	0.163
Q7	0.229	Q22	0.000	Q37	0.002	Q52	0.021	Q67	0.109
Q8	0.152	Q23	0.008	Q38	0.142	Q53	0.539	Q68	0.035
Q9	0.011	Q24	0.004	Q39	0.226	Q54	0.191	Q69	0.061
Q10	0.342	Q25	0.000	Q40	0.142	Q55	0.328	Q70	0.000
Q11	0.001	Q26	0.009	Q41	0.047	Q56	0.651	Q71	0.009
Q12	0.014	Q27	0.488	Q42	0.000	Q57	0.095	Q72	0.018
Q13	0.001	Q28	0.006	Q43	0.000	Q58	0.254	Q73	0.003
Q14	0.000	Q29	0.040	Q44	0.089	Q59	0.104	Q74	0.304
Q15	0.010	Q30	0.387	Q45	0.228	Q60	0.751	Q75	0.519

Due to difference in sample size and non-homogenous variances, Hochberg's GT2 and Games-Howell post hoc tests were conducted on the statistically significant variables only. A summary of the post hoc tests is outlined in the table below. The group scoring significantly higher average is highlighted using green colour and the reference groups are shown inside the cell.

Table E 16 Summary of the findings of post hoc tests for interaction of Department

* D: Deck department; E: Engineering department; R: Ratings department; PO: Port Officer department; SM: Ship management department

No	QUESTION	Departments*				
		D	E	R	PO	SM
Q2	There is good communication about safety.	80.0	87.6	84.0	100.0	90.0
Q4	Operational values, objectives and targets are effectively communicated.	81.6	85.7	82.0	100.0	92.5
Q5	I always ask questions if I do not understand or unsure about the safety instructions given to me.	85.8	85.7	78.0	90.0	97.5
Q6	The company operates an effective system for reporting safety matters.	85.1	89.5	86.0	100.0	97.5
Q9	I never breach operating procedures, even if the breach is in the company's best interests.	73.7	75.0	72.0	40.0	80.0
Q11	Safety rules and procedures are strictly followed.	82.1	82.0	82.0	60.0	92.5
Q12	The crew members are never encouraged to break rules to complete a task or maintain the timetable.	77.9	76.0	80.0	100.0	92.5
Q13	I am always informed about the outcome of shipboard safety meetings.	83.1	83.8	88.9	100.0	95.0
Q14	I am satisfied with the follow-up measures taken after accidents, incidents and near misses.	82.1	83.8	80.0	100.0	95.0
Q15	The crew is always given feedback on accidents, incidents, and near misses that occur on board.	80.5	82.9	82.0	100.0	92.5
Q19	I am consulted about the changes that affect safe work practices.	74.9	79.0	88.9	100.0	92.5
Q20	I have sufficient control of my work to ensure it is always completed safely.	83.6	85.7	80.0	100.0	95.0
Q22	Mistakes are corrected without punishment and treated as a learning opportunity.	77.9	70.0	91.1	100.0	95.0
Q23	The company always tries to resolve any safety concerns and problems identified.	83.6	88.6	84.0	100.0	95.0
Q24	Crew members should question a senior officer's decision even if safety is affected.	65.1	66.0	58.0	100.0	87.5
Q25	I am able to discuss any concerns I have with my line manager.	83.6	82.9	78.0	100.0	97.5

No	QUESTION	Departments*				
		D	E	R	PO	SM
Q26	Other crew members encourage me to report unsafe events.	74.2	78.0	70.0	100.0	90.0
Q28	Asking for assistance cannot make me look incompetent.	68.9	62.9	68.0	80.0	97.5
Q29	Whenever I see unsafe behaviour, I always report it.	76.9	81.9	76.0	80.0	90.0
Q31	I am encouraged to report all near misses.	80.5	82.0	80.0	100.0	90.0
Q33	I mind when other crew members ignore safety procedures.	77.9	77.1	72.0	100.0	97.5
Q34	The possibility of being involved in an accident is not quite high in this company.	64.6	62.9	60.0	80.0	90.0
Q35	When ship management is informed about accidents, incidents, or near misses, corrective action is taken promptly.	81.0	85.7	76.0	100.0	92.5
Q36	Shore side managers never put timetable or costs above safety.	57.9	64.2	66.0	80.0	95.0
Q37	Members of the management team are personally and routinely involved in safety.	82.1	83.8	84.0	100.0	95.0
Q41	The company has excellent maintenance standards.	80.5	84.8	82.0	100.0	90.0
Q42	The company doesn't only get actions when an accident occurs.	62.1	72.0	52.0	80.0	92.5
Q43	The company makes too much noise (excessive promotion) about safety.	67.7	69.5	75.6	40.0	34.3
Q46	My attention to safety does not suffer when I am stressed or fatigued.	54.2	72.6	60.0	20.0	60.0
Q48	There is a system in place for observing my rest hours.	81.5	84.0	74.0	80.0	87.5
Q49	The crew is expected to comply with work-rest hour regulation.	80.0	85.0	80.0	100.0	90.0
Q50	I have adequate rest on the work schedule cycle that I work.	77.4	84.0	74.0	100.0	90.0
Q51	Crew members monitor each other for signs of stress or fatigue.	79.5	69.5	72.0	60.0	80.0
Q52	Our crew has adequate training in emergency procedures.	82.6	84.0	84.0	100.0	90.0
Q61	Drug abuse is not a safety issue in	41.5	41.0	44.0	20.0	20.0

No	QUESTION	Departments*				
		D	E	R	PO	SM
	my company.					
Q62	Alcohol use is not a safety issue in my company.	45.1	46.0	48.0	20.0	20.0
Q63	Safety briefings and training are professional and effective.	82.6	84.0	88.0	100.0	97.5
Q64	Safety is the top priority for crew on board this ship.	87.7	87.0	92.0	100.0	100.0
Q65	When I joined this ship, I received a proper induction, including familiarization with new tasks.	79.0	84.0	82.0	100.0	97.5
Q68	This company cares about my health and safety.	83.6	84.8	84.0	100.0	95.0
Q70	The training provided by our company is of a high quality and standard.	83.1	84.0	80.0	100.0	97.5
Q71	My company continuously tries to improve the quality of the trainings.	83.2	86.0	88.0	80.0	95.0
Q72	I have adequate knowledge of the company (Safety) Management System.	82.6	82.0	82.0	80.0	92.5
Q73	I am properly trained to deal with unfamiliar situations where safety might be at stake.	80.0	81.0	78.0	100.0	90.0

The results of the ANOVA analysis between the departments demonstrated that 'Port Officers' and 'Ship Management' departments are more tuned up to align themselves for the safety aspects analysed in this study. The deck, engineering and rating departments feel that safety standards on board vessels are not as high as the shore personnel believe.

In the bulk carrier shipping company, ship management and port officers have higher safety culture perception and attitude averages than the on board departments. Surprisingly, this is the opposite safety culture condition obtained in the tanker shipping company. Ship management personnel of the company have the most superior safety culture scores amongst respondents and they are followed by port officers. There is an obvious different between shore and ship personnel.

The lowest score of the officers and ratings reveals the fact that they are not happy with majority of the safety conditions and measures, and therefore there is a gap between the perceptions of the staff and seafarers. The company should definitely conduct interviews, especially with bridge and engineering departments to gain insight into the low attitude and perceptions scores obtained by these two groups.

Even though port officers have high safety culture attitudes and perceptions, they ascertain that crew members do not strictly follow safety rules and procedures and they violate the rules if they think the breach is in the company's best interest. These types of dangerous practices may result in catastrophes and hence crew members' input should be taken into account to identify dangerous violations and eliminate them.

Officers and rating do not believe that junior personnel can easily raise an issue and speak up if they have a safety concern. This problem is even accepted by senior crew members, however shore personnel do not think that this is the case on board. On board scenarios, drills and training should be arranged to encourage the junior crew members and also inform that they have responsibility to keep the vessel safe as other personnel.

The deck, engineering and rating departments believe that asking assistance can make them look incompetent and also there is a significant statistical difference between ship management and ship personnel's perceptions regarding the likelihood of accidents within the company. Crew members think that it is quite likely to have an unfortunate event on board.

All other groups within the organization think that ship management put timetable and cost above safety. Ship management should definitely change their perspective towards safety culture in order to gain the trust of the shipboard departments. Crew members should be informed that they should suspend any shipping operation if they have a major safety concern regardless its effects on timetable and cost.

Ratings have statistically significant lower scores than port officers and ship management regarding the company's involvement when there is no accident. More regular meeting should be conducted to increase engagement of shore personnel and presence of the company amongst ratings.

Effect of Seafarers' Ranks

The questions which are highlighted in red represents that there is a significant statistical difference between the seafarer's ranks and their answers given to the questionnaires.

Table E 17 ANOVA on Rank (significant interactions, *p-value* < 0.05, are shown in red)

Var	p-value	Var	p-value	Var	p-value	Var	p-value	Var	p-value
Q1	0.862	Q16	0.917	Q31	0.013	Q46	0.429	Q61	0.129
Q2	0.054	Q17	0.325	Q32	0.106	Q47	0.475	Q62	0.105
Q3	0.555	Q18	0.252	Q33	0.005	Q48	0.164	Q63	0.024
Q4	0.492	Q19	0.358	Q34	0.256	Q49	0.318	Q64	0.026
Q5	0.000	Q20	0.006	Q35	0.006	Q50	0.305	Q65	0.126
Q6	0.009	Q21	0.806	Q36	0.461	Q51	0.421	Q66	0.390
Q7	0.339	Q22	0.114	Q37	0.002	Q52	0.248	Q67	0.059
Q8	0.286	Q23	0.019	Q38	0.095	Q53	0.480	Q68	0.085
Q9	0.948	Q24	0.033	Q39	0.471	Q54	0.048	Q69	0.015
Q10	0.606	Q25	0.024	Q40	0.997	Q55	0.296	Q70	0.104
Q11	0.386	Q26	0.354	Q41	0.209	Q56	0.352	Q71	0.247
Q12	0.249	Q27	0.111	Q42	0.026	Q57	0.404	Q72	0.206
Q13	0.007	Q28	0.070	Q43	0.339	Q58	0.101	Q73	0.020
Q14	0.005	Q29	0.570	Q44	0.079	Q59	0.941	Q74	0.651
Q15	0.337	Q30	0.114	Q45	0.144	Q60	0.286	Q75	0.651

Post hoc tests are not performed for the questions since at least one group has fewer than two cases. However, comparison of the average scores revealed that, bridge and engine room officers have higher safety culture attitudes than ratings. In addition to this, lower ranks can be representative of the real ground level problems on board.

Effect of Nationalities

The questions which are highlighted in red represents that there is a significant statistical difference between the nationalities and their answers given to the questionnaires.

Table E 18 ANOVA on Nationality (significant interactions, *p-value* < 0.05, are shown in red)

Var	p-value	Var	p-value	Var	p-value	Var	p-value	Var	p-value
Q1	0.021	Q16	0.208	Q31	0.171	Q46	0.172	Q61	0.046
Q2	0.074	Q17	0.252	Q32	0.020	Q47	0.009	Q62	0.026
Q3	0.000	Q18	0.034	Q33	0.083	Q48	0.042	Q63	0.002
Q4	0.001	Q19	0.570	Q34	0.001	Q49	0.029	Q64	0.016
Q5	0.002	Q20	0.018	Q35	0.000	Q50	0.136	Q65	0.001
Q6	0.000	Q21	0.530	Q36	0.000	Q51	0.440	Q66	0.206
Q7	0.170	Q22	0.038	Q37	0.015	Q52	0.001	Q67	0.052
Q8	0.106	Q23	0.042	Q38	0.070	Q53	0.081	Q68	0.010
Q9	0.655	Q24	0.000	Q39	0.292	Q54	0.083	Q69	0.001
Q10	0.288	Q25	0.000	Q40	0.034	Q55	0.035	Q70	0.023
Q11	0.600	Q26	0.706	Q41	0.068	Q56	0.420	Q71	0.068
Q12	0.138	Q27	0.152	Q42	0.005	Q57	0.043	Q72	0.013
Q13	0.000	Q28	0.000	Q43	0.089	Q58	0.913	Q73	0.010
Q14	0.000	Q29	1.000	Q44	0.121	Q59	0.211	Q74	0.030
Q15	0.585	Q30	0.026	Q45	0.399	Q60	0.200	Q75	0.480

Due to difference in sample size and non-homogenous variances, Hochberg's GT2 and Games-Howell post hoc tests were conducted on the statistically significant variables only. A summary of the post hoc tests is outlined in the table below.

Table E 19 Summary of the findings of post hoc tests for interaction of Nationalities

No	QUESTION	NATIONALITIES		
		Greek	Romanian	Filipino
Q1	Language/dialect related issues amongst crew members are not a threat to safety.	56.2	70.0	70.5
Q3	There is good cooperation between the ship and shore.	91.4	85.0	81.9
Q4	Operational values, objectives and targets are effectively communicated.	92.4	85.0	82.9
Q5	I always ask questions if I do not understand or unsure about the safety instructions given to me.	95.0	85.0	83.3
Q6	The company operates an effective system for reporting safety matters.	97.1	85.0	84.8

No	QUESTION	NATIONALITIES		
		Greek	Romanian	Filipino
Q13	I am always informed about the outcome of shipboard safety meetings.	93.3	80.0	82.9
Q14	I am satisfied with the follow-up measures taken after accidents, incidents and near misses.	92.4	80.0	81.4
Q18	Suggestions to improve health and safety are welcomed.	93.3	80.0	89.0
Q20	I have sufficient control of my work to ensure it is always completed safely.	91.4	80.0	82.4
Q23	The company always tries to resolve any safety concerns and problems identified.	92.4	85.0	85.2
Q24	Crew members should question a senior officer's decision even if safety is affected.	85.7	66.7	62.4
Q25	I am able to discuss any concerns I have with my line manager.	94.3	85.0	81.4
Q28	Asking for assistance cannot make me look incompetent.	84.8	40.0	68.6
Q30	I am encouraged to conduct, or refer to a risk assessment before performing any hazardous work.	91.4	80.0	84.8
Q32	Crew members do not carry out non-work activities while on duty.	76.0	46.7	66.0
Q34	The possibility of being involved in an accident is not high in this company.	82.9	60.0	61.9
Q35	When ship management is informed about accidents, incidents, or near misses, corrective action is taken promptly.	92.4	80.0	80.5
Q36	Shore side managers never put timetable or costs above safety.	86.0	80.0	55.7
Q37	Members of the management team are personally and routinely involved in safety.	90.5	80.0	82.9
Q40	The company is giving much more attention to safety now, than it did one year ago.	62.1	60.0	74.8
Q42	The company do not only take action(s) when an accident occurs.	81.9	70.0	65.4
Q47	I am provided adequate resources (time, staffing, budget, and	82.9	80.0	74.8

No	**QUESTION**	**NATIONALITIES**		
		Greek	**Romanian**	**Filipino**
	equipment) to perform my job.			
Q48	There is a system in place for observing my rest hours.	87.6	80.0	80.5
Q49	The crew is expected to comply with work-rest hour regulation.	89.5	80.0	81.9
Q52	Our crew has adequate training in emergency procedures.	91.4	80.0	83.3
Q55	My ship works to ensure the safety in hazardous areas and during hazardous activities.	88.6	80.0	82.9
Q57	Checklists are essential for safety.	91.4	80.0	85.9
Q61	Drug abuse is not a safety issue in my company.	28.6	40.0	40.5
Q62	Alcohol use is not a safety issue in my company.	29.5	40.0	45.7
Q63	Safety briefings and training are professional and effective.	92.4	80.0	83.8
Q64	Safety is the top priority for crew on board this ship.	95.2	80.0	87.6
Q65	When I joined this ship, I received a proper induction, including familiarization with new tasks.	91.4	80.0	80.5
Q68	This company cares about my health and safety.	92.4	80.0	83.3
Q69	I fully understand my responsibilities for health and safety.	94.3	80.0	85.2
Q70	The training provided by our company is of a high quality and standard.	90.5	80.0	82.9
Q72	I have adequate knowledge of the company (Safety) Management System.	87.6	80.0	81.5
Q73	I am properly trained to deal with unfamiliar situations where safety might be at stake.	87.6	80.0	79.0
Q74	I am trained to cope with fatigue.	66.0	80.0	76.1

The table above demonstrated that Greek employees have significantly better safety culture attitudes and perceptions than the Romanians and Filipinos. In addition to this, Filipinos have significantly better standards than Romanians in some questions.

Greek seafarers find language related issues bigger threat to safety then Filipinos and Romanians do. This may be the representation of the situation that Greek respondents have a better English Levels and they are having difficulties communicating with other groups. Language barriers may lead to severe consequences. A thorough examination should take place to identify the issues raised by Greek employees.

Even though Greek respondents believe that junior officers should question their seniors' decisions if they have a safety concern, Filipinos do not share the same perception. The company should conduct more drills and trainings to engage especially all Filipinos from variety of the ranks to enhance their confidence levels.

Romanians have also big concerns about asking assistance when required. Due to fear of looking incompetent, they prefer not to ask assistance as Greek respondents do. The importance of the team culture and being a resilient crew should be communicated to seafarers during simulator and on board training.

Filipinos have statistically significant lower safety culture perceptions than Greek and Romanians with regards to managers' safety vs cost policy. Filipino respondents believe the company do not prioritize safety as required.

Interestingly, Greek respondents believe that drug & alcohol use is a major problem within the company more than the other nations. This reveals that either Greek participants are more honest and they have courage to point out the problematic safety culture issues or these problems are only known to a specific group within the company. Regardless of the different views on this matter, the company must take rigorous measures to stop alcohol & drug abuse.

Effect of Ships

The questions which are highlighted in red represents that there is a significant statistical difference between the ships which seafarers working on and their answers given to the questionnaires.

Table E 20 ANOVA on Ships (significant interactions, *p-value* < 0.05, are shown in red)

Var	p-value	Var	p-value	Var	p-value	Var	p-value	Var	p-value
Q1	0.001	Q16	0.007	Q31	0.428	Q46	0.065	Q61	0.022
Q2	0.417	Q17	0.354	Q32	0.017	Q47	0.167	Q62	0.059
Q3	0.302	Q18	0.631	Q33	0.027	Q48	0.156	Q63	0.739
Q4	0.097	Q19	0.060	Q34	0.843	Q49	0.272	Q64	0.066
Q5	0.966	Q20	0.659	Q35	0.154	Q50	0.106	Q65	0.354
Q6	0.030	Q21	0.240	Q36	0.061	Q51	0.285	Q66	0.020
Q7	0.822	Q22	0.015	Q37	0.861	Q52	0.411	Q67	0.741
Q8	0.469	Q23	0.328	Q38	0.109	Q53	0.513	Q68	0.396
Q9	0.561	Q24	0.880	Q39	0.399	Q54	0.889	Q69	0.552
Q10	0.506	Q25	0.671	Q40	0.000	Q55	0.755	Q70	0.069
Q11	0.852	Q26	0.117	Q41	0.015	Q56	0.254	Q71	0.487
Q12	0.068	Q27	0.493	Q42	0.215	Q57	0.629	Q72	0.932
Q13	0.628	Q28	0.918	Q43	0.000	Q58	0.162	Q73	0.243
Q14	0.217	Q29	0.556	Q44	0.603	Q59	0.002	Q74	0.439
Q15	0.104	Q30	0.795	Q45	0.671	Q60	0.541	Q75	0.214

It can be seen from above table that the ship they are serving on has a significant influence on only 12 questions. However, just comparing the names of ships in post hoc tests doesn't seem to be very promising as there could be confounding variables hidden behind the names such as the type of vessel, route of vessel, duration at sea, size of the vessel etc. Hence, it would be more appropriate to pool the ships in accordance with one or more of the aforesaid categories for a more useful comparison during the detailed analyses.

Effect of Workplace (sea or shore)

The questions which are highlighted in red represents that there is a significant statistical difference between the workplace that respondents are in and their answers given to the questionnaires.

Table E 21 ANOVA on Workplace (significant interactions, *p-value* < 0.05, are shown in red)

Var	p-value	Var	p-value	Var	p-value	Var	p-value	Var	p-value
Q1	0.134	Q16	0.020	Q31	0.000	Q46	0.373	Q61	0.001
Q2	0.013	Q17	0.120	Q32	0.004	Q47	0.002	Q62	0.001
Q3	0.001	Q18	0.047	Q33	0.000	Q48	0.021	Q63	0.000
Q4	0.000	Q19	0.002	Q34	0.000	Q49	0.000	Q64	0.001

Q5	0.001	Q20	0.003	Q35	0.000	Q50	0.000	Q65	0.000
Q6	0.000	Q21	0.632	Q36	0.000	Q51	0.278	Q66	0.008
Q7	0.021	Q22	0.000	Q37	0.000	Q52	0.000	Q67	0.004
Q8	0.009	Q23	0.000	Q38	0.002	Q53	0.515	Q68	0.000
Q9	0.587	Q24	0.000	Q39	0.018	Q54	0.087	Q69	0.001
Q10	0.039	Q25	0.000	Q40	0.023	Q55	0.056	Q70	0.000
Q11	0.056	Q26	0.000	Q41	0.003	Q56	0.575	Q71	0.003
Q12	0.001	Q27	0.159	Q42	0.000	Q57	0.012	Q72	0.002
Q13	0.000	Q28	0.000	Q43	0.000	Q58	0.257	Q73	0.000
Q14	0.000	Q29	0.008	Q44	0.337	Q59	0.027	Q74	0.152
Q15	0.001	Q30	0.036	Q45	0.557	Q60	0.289	Q75	0.037

Due to difference in sample size and non-homogenous variances, Hochberg's GT2 and Games-Howell post hoc tests were conducted on the statistically significant variables only. A summary of the post hoc tests is outlined in the table below.

Table E 22 Summary of the findings of post hoc tests for interaction of Workplace (sea or shore)

No	QUESTION	Sea	Shore
Q2	There is good communication about safety.	82.7	91.7
Q3	There is good cooperation between the ship and shore.	82.9	91.7
Q4	Operational values, objectives and targets are effectively communicated.	82.7	95.0
Q5	I always ask questions if I do not understand or unsure about the safety instructions given to me.	84.9	96.7
Q6	The company operates an effective system for reporting safety matters.	86.1	98.3
Q7	Crew members are closely monitored to ensure company procedures are always followed.	84.5	91.7
Q8	There is an effective system in place to modify the procedures that are unworkable or impractical for crew use.	79.7	90.9
Q10	Operating procedures provided by the company are helpful to the conduct of daily operations.	82.7	88.3
Q12	The crew members are never encouraged to break rules to complete a task or maintain the timetable.	77.6	91.7
Q13	I am always informed about the outcome of shipboard safety meetings.	84.1	96.7
Q14	I am satisfied with the follow-up measures taken after accidents, incidents and near misses.	82.1	96.7
Q15	The crew is always given feedback on accidents, incidents, and near misses that occur on board.	81.3	91.7
Q16	I receive feedback about my compliance to safety procedures.	77.8	88.3

No	**QUESTION**	**Sea**	**Shore**
Q18	Suggestions to improve health and safety are welcomed.	88.8	95.0
Q19	I am consulted about the changes that affect safe work practices.	78.4	91.7
Q20	I have sufficient control of my work to ensure it is always completed safely.	83.8	95.0
Q22	Mistakes are corrected without punishment and treated as a learning opportunity.	78.1	96.7
Q23	The company always tries to resolve any safety concerns and problems identified.	84.5	96.7
Q24	Crew members should question a senior officer's decision even if safety is affected.	64.6	88.3
Q25	I am able to discuss any concerns I have with my line manager.	82.7	98.3
Q26	Other crew members encourage me to report unsafe events.	74.8	91.7
Q28	Asking for assistance cannot make me look incompetent.	67.3	93.3
Q29	Whenever I see unsafe behaviour, I always report it.	78.7	88.3
Q30	I am encouraged to conduct, or refer to a risk assessment before performing any hazardous work.	85.1	91.7
Q31	I am encouraged to report all near misses.	81.1	93.3
Q32	Crew members do not carry out non-work activities while on duty.	64.4	81.8
Q33	I mind when other crew members ignore safety procedures.	75.5	98.3
Q34	The possibility of being involved in an accident is not high in this company.	62.7	90.0
Q35	When ship management is informed about accidents, incidents, or near misses, corrective action is taken promptly.	81.9	95.0
Q36	Shore side managers never put timetable or costs above safety.	61.9	93.3
Q37	Members of the management team are personally and routinely involved in safety.	82.9	96.7
Q38	The company places a high priority on safety training.	85.9	96.7
Q39	Manning levels are appropriate for our workload.	77.0	85.0
Q40	The company is giving much more attention to safety now, than it did one year ago.	74.1	61.7
Q41	The company has excellent maintenance standards.	82.7	93.3
Q42	The company do not only takes action(s) when an accident occurs.	63.5	91.7
Q43	The company makes too much noise (excessive promotion) about safety.	69.7	40.0
Q47	I am provided adequate resources (time, staffing, budget, and equipment) to perform my job.	76.5	86.7
Q49	The crew is expected to comply with work-rest hour regulation.	81.4	93.3

No	QUESTION	Sea	Shore
Q50	I have adequate rest on the work schedule cycle that I work.	78.4	91.7
Q52	Our crew has adequate training in emergency procedures.	83.2	93.3
Q54	Watch hand-overs are comprehensive and not hurried.	79.5	85.0
Q55	My ship works to ensure the safety in hazardous areas and during hazardous activities.	83.2	88.3
Q57	Checklists are essential for safety.	85.3	95.0
Q59	Learning from mistakes is a good way to improve overall safety.	80.8	93.3
Q61	Drug abuse is not a safety issue in my company.	40.8	20.0
Q62	Alcohol use is not a safety issue in my company.	44.6	20.0
Q63	Safety briefings and training are professional and effective.	84.1	98.3
Q64	Safety is the top priority for crew on board this ship.	88.4	100.0
Q65	When I joined this ship, I received a proper induction, including familiarization with new tasks.	80.8	98.3
Q66	The rules are always adhered prior a sailing goes ahead.	57.6	75.0
Q67	Safety is a visible part of the selection and recruitment process in this company.	83.2	93.3
Q68	This company cares about my health and safety.	83.7	96.7
Q69	I fully understand my responsibilities for health and safety.	86.7	96.7
Q70	The training provided by our company is of a high quality and standard.	83.0	98.3
Q71	My company continuously tries to improve the quality of the trainings.	84.9	93.3
Q72	I have adequate knowledge of the company (Safety) Management System.	82.2	90.0
Q73	I am properly trained to deal with unfamiliar situations where safety might be at stake.	80.0	93.3
Q75	Adequate time is allowed for safety drills.	82.2	88.3

The shore personnel have higher safety culture attitude and perceptions scores than those working at sea. This can also attributed to the shore side workers' lack of understanding of day to day maritime operations. Some of the procedures designed may not be working as intended, herein crew member may perform risky deviations to get the job done. Shore staff should arrange more visits to the fleet and discuss the identified problems with the crew. An effective automated system can be utilised to modify impractical procedures identified by crew members.

Shore staff have higher scores on almost every statement except the company's performance, safety promotions and alcohol & drug use. As aforementioned, the alcohol and drug cases need immediate remedial actions.

The reasons why the shore personnel believe that safety performance is not increasing compared to previous years and company does not make excessive safety promotion should be investigated.

Seafarers believe that the shore personnel only take action when an accident occurs. This belief will decrease seafarers' commitment to the company and their will for improving safety culture standards on board. The company should continuously communicate with the fleet for seeing safety culture enhancement opportunities.

Open Ended Questions

Response Rate

Of the five open-ended questions, there was a much higher percentage of missing data ranging between 10% and 24%. As explained before, open ended questions always have more missing data than other sections since crew members most of time complain that they do not hear results of these studies. There are also parameters preventing employees from answering these questions such as blame culture and time pressure. Language barriers also affect response rates adversely.

What could the company do to improve health and safety?

For the first question, 25 of the 75 either had no response, stated no improvements were needed or they were happy with the current standard. The following is a summary of the suggestions provided by the respondents:

- Improvement of meals available to staff, including provision of clean drinking water.
- Adherence to the drug and alcohol policies.
- Have more safety meeting to discuss various topics, such as hygiene.
- Communication standard to be maintained even during times of stress.

- Working in hot climates strategy.
- Monitoring of health conditions, company SMS and circulars.
- Improved hygiene.
- Provision of personal protective equipment.
- Rest hours.

The respondents are aware that alcohol and drug abuse should be addressed immediately to enhance safety of the fleet. The respondents think that the company needs to invest also on the quality of food, water and hygiene conditions for improving standards.

What could the company do to improve ship safety?

The second question 23 of 75 either did not answer or gave no suggestions of how the company could improve safety. Of the remaining 52, the answers are summarised as follows:

- The current standard of personal protective equipment could be improved to improve safety with some suggesting new PPE should be given on a more frequent basis.
- Many of the respondents stated that there should be more training drills on-board the vessels.
- Respondents raised that more videos should be provided.
- Communication was raised as a potential opportunity for improvement. This includes the relationship between ship and shore and also ensures that all necessary information is passed to the relevant persons including the specific mention of circulars.
- It was recommended that there should be visits to the ship.
- Continual improvement to safety standards.
- Rest hours were identified as important and the management of these.
- Monitoring of safety was also raised and that it should be done on a continual basis.

The quality of the PPEs were also raised within this company as it has been an issue within the tanker shipping company. The insufficient quality of the PPEs is therefore considered as a widespread problem in the shipping industry. Ship management should hold meetings with crew to identify existing problems of current PPEs and the requirements to be taken into account for the next purchases. Crew members also would like to see more training drills and safety promotion to generate awareness and hence avoid accidents by implementing appropriate measures.

What could the company do to improve harbor operations safety (e.g. port)

The third question asks what the company could do to improve harbour operations safety. A total of 35 respondents of the 75 had no suggestions to improve the situation. Of the remaining 40, the following is a summary of their suggestions:

- The predominant grouping of the answers surrounded the concept of information provision. The information relates to the communication between the ship and shore as well as the provision of information to the seafarers on the vessel in a timely manner. This seems to be a key message of the answers by the seafarers. They also identify that there must be the provision of information on the port regulations. There are calls to improve the exchange of information between ship and shore more generally.
- Some state that they must abide by the rules and regulations of the port.
- It is suggested there must be proper cooperation with shore staff and to have good relationships with them.
- Several respondents stated there should be no extra work placed upon crew.

Port operations are extremely demanding and dangerous tasks. After sailing for long hours, crew members also need to accomplish the port operations expeditiously and in a safe manner. An efficient communication is found to be a key remedy by all seafarers for increasing efficiency of the port operation. The operation should also have a comprehensive plan beforehand so there won’t be extra work placed upon crew.

What could the company do to improve office safety?

The majority of the seafarers did not make any suggestions, some citing that they do not have the knowledge to comment, with 51 of 75 seafarers either said they were not able to comment, did not answer, said they thought office safety was currently of a reasonable standard. The remaining 24 seafarers' answers are broadly categorised as follows:

- Company circulars are raised by several respondents; they propose that safety can be improved by the continual monitoring of safety matters in the company circulars and also to ensure the company circulars are always informative.
- Working towards continual safety improvements is suggested including adopting and developing new standards, ensuring equipment is replaced when needed.
- Training is put forward as another suggestion to make improvements, to continuously improve the safety management skills of the on-shore personnel.
- To ensure communication of all necessary safety information.
- Encouragement is made to continually monitoring the situation in the office at all times.

The respondents are aware of how fundamental the general safety culture such as continuous improvement, communication, training and monitoring within the company. Their suggestions should be taken into account to further enhance safety culture maturity levels. As stated by some of the participants, utilizing circular will not only enhance safety culture awareness but also establish a bridge between ship and shore.

What questions should be included in the survey?

The majority of respondents did not suggest any questions to add to the survey. Only 16% of the seafarers (12 of the 75) made suggestions. Suggestions for additional questions focussed around the theme of:

- Health matters, including food, drink, alcohol use, cigarette use and rest of seafarers.
- Salary, particularly the salary of the Filipino seafarers.
- Non-work time, including aspects such as internet access.
- Some proposed the question of what is the benefit of the survey to seafarers. This may not be an actual question to include but show that perhaps the seafarers are not clear on what the benefits of completing the survey are.

It can be seen from the comments above, crew members would like to see that their wellbeing is prioritized and sufficient care should allocated to quality improvement of internet connection, food and drinks. These things may be seen small by the ship management, however, these type of initiatives motivate crew members and they commit themselves to safety of the fleet more.

Overall Results

Safety culture questionnaires were distributed and collected for the analysis in the bulk carrier shipping company. The assessment identified several areas which require further improvements to enhance safety culture maturity levels. The major problems identified within the shipping company are given below:

- **Maritime English/dialects:** Even though, there are only three nations within this company, the level of English is also seen as a threat to safety and the language barrier is perceived as a widespread problem. It is of therefore crucial to enhance the level of seafarers' English proficiency for contributing to the communication dimension of safety culture which is known to be the key element during emergencies. Numerous maritime institutions provide Maritime English courses to tackle with this widespread problem.
- **Blame culture:** Similar to the most of maritime industry, the existing blame culture is seen as a problem within this company, majority of crew members stated through the surveys that the blame culture affects almost every single aspect of the operation. If the company does not implement the just culture approach, the crew members will report less due to a fear of punishment and appropriate lessons will not be learnt to avoid reoccurrences. Adopting a "just

culture" approach requires a strong commitment from top to bottom within a company.

- **Priority of safety:** All the shipping companies need to transfer their goods according to their agreed timetable in order to maintain their profitability in the market. However, only one organizational error can lead a shipping company to lose their reputation and damage their profitability. Therefore, the shipping company makes a clear statement about the safety vs timetable in their Safety Management Manual (SMM). There should be consistency about what the company says and how they react during emergencies. Crew members should always feel the presence of the company and their persistent efforts to enhance safety culture on board.
- **Fatigue and stress:** Fatigue and stress management is also raised as an issue within this shipping company and majority of seafarers do not think that they are capable of coping with fatigue. Similar types of fatigue and stress management training which are delivered in BRM and HELM could be provided to ratings to enhance their stress and fatigue resilience. However, it needs to be understood that fatigue cannot be managed by individuals as it is strongly linked to company's operational practices. Therefore, in addition to the trainings, company may need to look at the root causes of fatigue and take action on root causes that may be caused by operational practices. Shift types and the workloads of the crew members should be thoroughly investigated to identify whether they contribute to fatigue or not.
- **Drug and Alcohol use:** This is one of the most crucial problem identified within the company. The existing problem was confirmed via the safety culture dimension questions and open ended questions. The company's first response should be dealing with this issue.

  The seafaring occupation requires continuous safety alertness to judge and execute safely. Drug and alcohol use not only increase response durations but also can cause crew members to fall asleep on duty. Therefore, the company should have zero tolerance against to this issue and the users should be suspended from the entire maritime community immediately.

Majority of the safety culture findings of the bulk carrier shipping company are similar to the ones that identified in the tanker company such as the maritime English, blame culture and manning related fatigue and stress. It is therefore very important for shipping organizations to address these problems in a collaborative manner.

Appendix F - Case Study - Safety Climate Assessment in a Container Shipping Company

This section details the safety climate assessment of a container shipping company. Firstly, the demographic characteristic of the employees are explored in the shipping company. Then, the safety culture factors and the open-ended questions are analysed. Finally, the report provides detailed statistical findings for gaining full insight into the current safety climate level of the company.

Safety Culture Questionnaire Data Collection

The questionnaires were distributed to 475 people in a container shipping company. A 14% response rate was gained from the administration of the survey in the company. This was the first distributed survey and low response rate was considered as an improvement opportunity for the other questionnaire distributions. The detailed return rates from different groups described below:

- **Crew on board:** 31 responses out of 430 people (7.2%)
- **Shore staff:** 39 responses out of 45 people (86%)

Missing data

The data were screened to look for missing and unusual data. The questionnaires asked 87 questions in total and there were 70 responses. The majority of the demographic questions such as age, gender have zero missing questions.

The final five questions required the participants to write free texts. There are a lot of missing cases within these five answers, as can be expected from open-ended questions. All "Do Not Knows" of the questionnaire were also recoded as missing data for the analysis.

Demographics

The following presents the results of the demographics section of the questionnaire. This section provides background information about the participants.

A total of 70 questionnaires were filled and returned. Of these, 31 (44.3%) were completed by seafarers and the remaining 39 (55.7%) were completed by shore personnel.

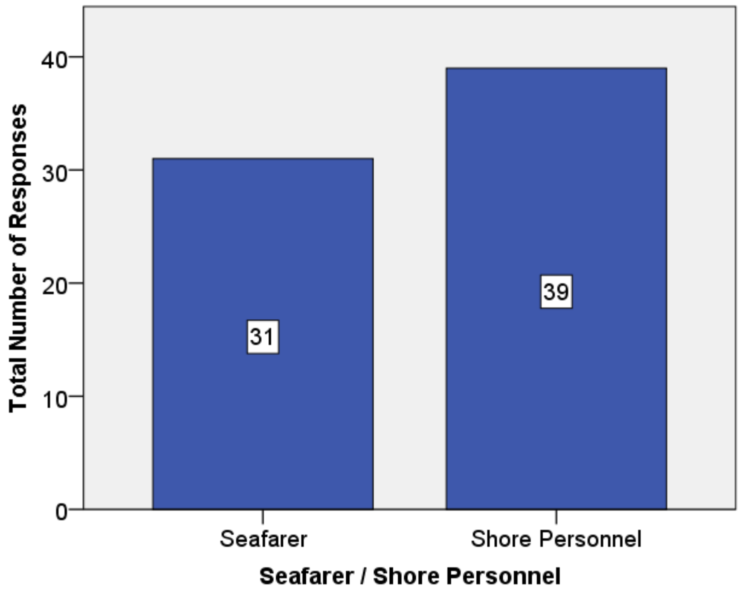

Figure F 1 number of responses

Age

The age distribution of seafarers and shore personnel is given in Figure F 2. Crew members are mostly younger than shore staff in the shipping company. The majority of the seafarers are between 25 and 34 years of age on board ships and account for 24.3%. The larger part of the shore staff are between 35 and 44 years of age and account for 24.3 % of the all respondents. This also reflects well-known practice in the maritime industry that when crew members get older they want to transfer to shore-based positions for the sake of a more regular life. The distribution of shore personnel age reveals that a bell shaped curve can be seen with the highest frequency for the 35-44 age group.

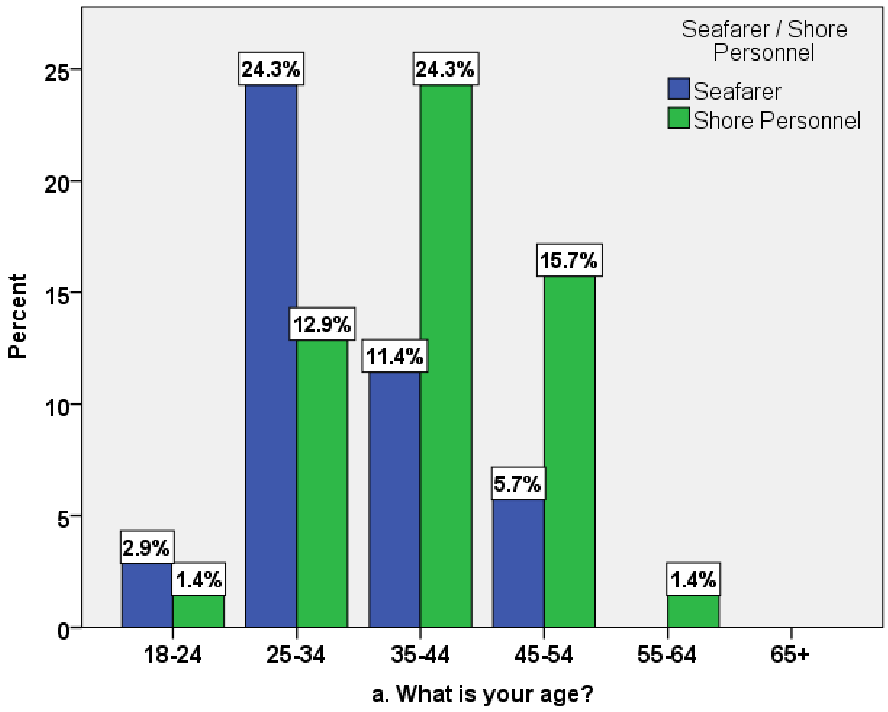

Figure F 2 the age distribution of the respondents

Gender

There are almost equal numbers of male workers on board and on shore. There is not any female seafarer amongst respondents within the company.

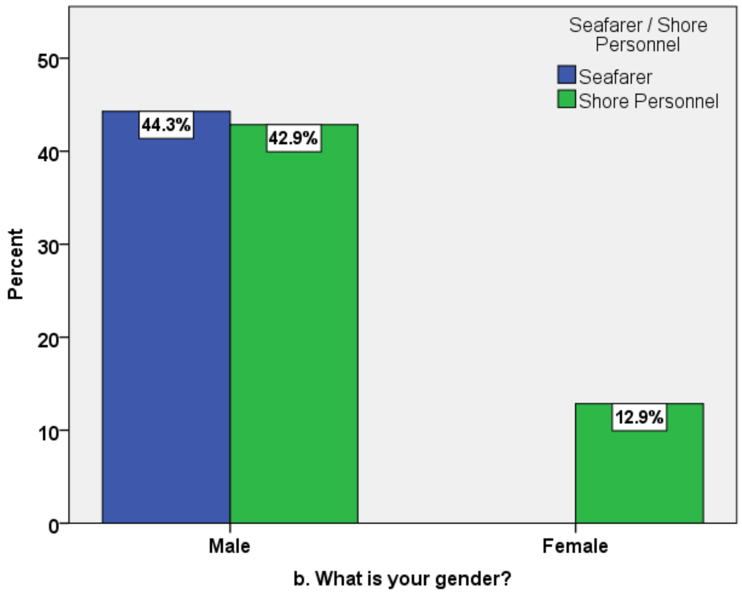

Figure F 3 the gender distribution of the respondents

Departments

The highest percentage of respondents work at the Crew Department and this is followed by Engineering Department with 38.8% and Deck Department with 11.4%, respectively.

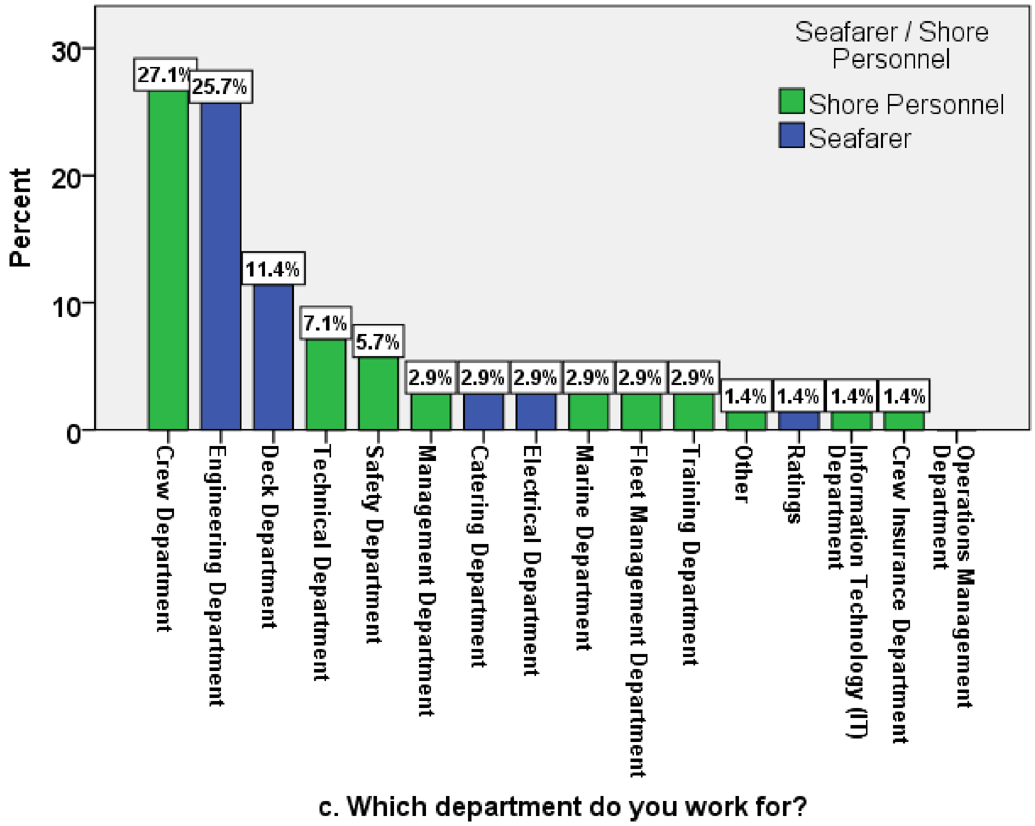

Figure F 4 Distribution of employees amongst departments

Seafarers' Ranks

The distribution of ranks is given in Figure F 5. The majority of the seafarers are 2nd and 3rd engineers which account for 19.4% for the each group. The figure below demonstrates that majority of the respondents are officers.

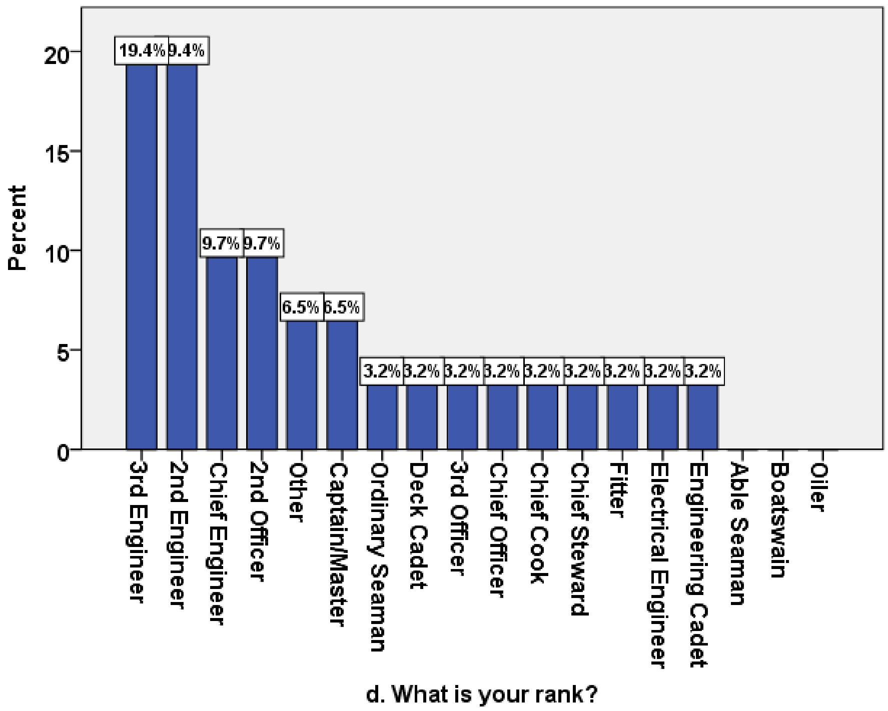

Figure F 5 Distribution of ranks amongst crew members

Working Experience

The majority of the seafarers have 5 years or less working experience within the company. Nevertheless, the shore personnel's average working experience was found as 10 years within the company. This statistic shows that either seafarers transfer to shore positions after a peroid of time or shore personnel are more committed to their company.

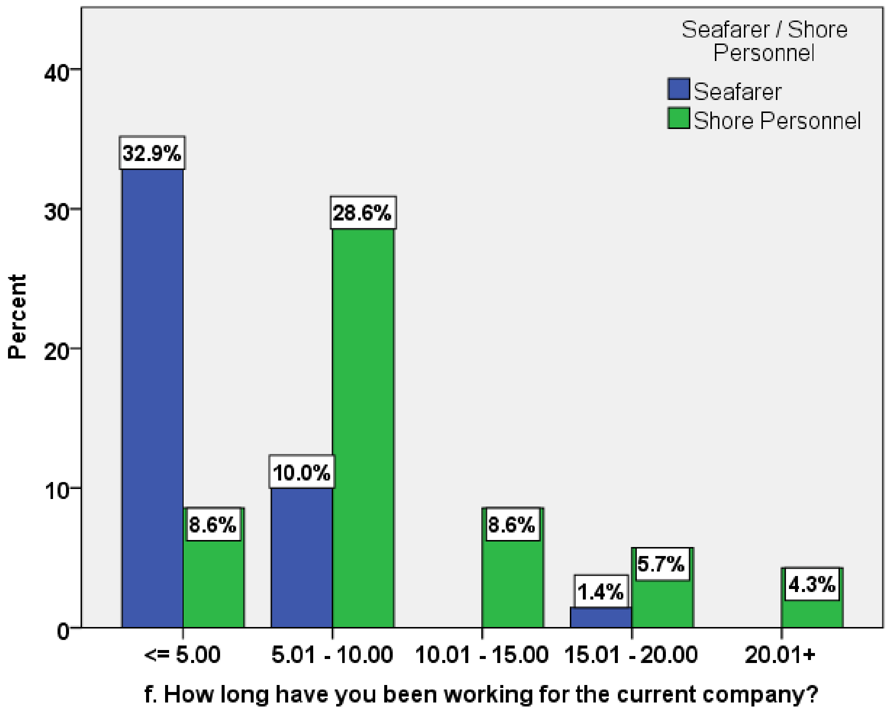

Figure F 6 Work Experience

Safety Culture Dimension Results

This section presents the attitude and perception results of the employees within the company. In total, 31 seafarers and 39 shore personnel completed the survey and all of these responses included in the following analysis. There was less than 7% of missing data for each question.

The average scores of the each safety climate dimension in the questionnaire were calculated. The results revealed that the highest score was obtained on the **Involvement** factor amongst crew members and shore staff achieved the highest scores on the **Feedback** factor. The lowest scores were achieved on **Priority of Safety** amongst the crew members and on **Safety Awareness** amongst shore personnel. It can be seen from the given table that crew members have better safety attitudes and perceptions on several safety related factors than shore staff. It can be seen in the Table F 1 that the biggest difference between crew members and shore staff is recorded with 7.7 percent on the feedback factor. Crew members perceive the level of feedback significantly low compared to shore personnel. The company needs to improve the feedback channels to improve crew members' perception on feedback.

The scores which are lower than 80, are not desirable within organizations. Relevant efforts should be invested to strengthen the identified weaknesses. In the calculation process, each statement has a score varies between 0 and 100, where 0 shows the min score and 100 represents the highest score.

Table F 1 Safety Climate Scores – Container Shipping Company

Safety Climate Dimensions	Scores for Crew Members (%)	Standard Deviation (%)	Scores for Shore Staff (%)	Standard Deviation (%)
1) Communication	77.84	9.41	82.91	7.26
2)Procedures and Safety Rules	77.16	9.90	81.04	6.37
3) Feedback	77.26	12.83	84.96	10.16
4) Involvement	80.65	7.31	81.59	12.09
5) Just Culture	75.32	7.95	76.03	8.82
6)Problem Identification	75.20	6.69	76.80	7.67
7) Priority of Safety	72.84	7.91	77.90	7.52
8) Responsiveness	75.42	8.36	77.08	7.24
9) Safety Awareness	75.63	6.49	75.85	5.66
10)Training and Competence	79.12	8.54	83.01	9.21
Av. Score=	**76.17**		**78.84**	

Communication Statements

The communication factor consists of six statements. The average scores of the each statement for crew members and shore personnel are given in Table F 2 and all the colours which are not green require an immediate improvement. The statement with the lowest score for crew members and shore personnel is: "*Language dialect related issues amongst crew members are not a threat to safety*".

The maritime English level is seen as a threat towards safety amongst all the respondents within the company as it is in the other two companies. The advanced maritime English courses should be delivered and crew members should go through scenarios which includes multinational communication. Communication becomes key during several types of shipping operations such as collision avoidance manoeuvrings where all team member needs to communicate clearly and effectively. There is also a requirement of a continuous effective communication between bridge and engine room to maintain safety on board. Therefore, all crew members should have a satisfactory level of English proficiency for performing all these duties successfully.

According to Q4, crew members do not think that the company communicates operational values, objectives and targets with them effectively. Seafarers should be aware of these in order to achieve and retain an appropriate level of safety culture on board.

Table F 2 Communication Dimension

Communication		
Statements	**Average Score**	
	Crew Members	**Shore Personnel**
1. Language/dialect related issues amongst crew members are not a threat to safety.	54.84	57.44
2. There is good communication about safety.	82.67	87.18
3. There is good cooperation between the ship and shore.	81.29	88.72
4. Operational values, objectives and targets are effectively communicated.	79.35	84.62
5. I always ask questions if I do not understand or unsure about the safety instructions given to me.	89.66	89.47
6. The company operates an effective system for reporting safety matters.	80.00	90.26

Procedures and Safety Rules Statements

The procedures and safety rules factor consists of six statements. The average scores of the each statement for crew members and shore personnel are given in Table F 3 and all the colours which are not green require an immediate improvement. The statement with the lowest score for crew members is: "*there is an effective system in place to modify the procedures that are unworkable or impractical for crew use*" and for shore personnel is: "*I never breach operating procedures, even if the breach is in the company's best interests*".

The operating procedures are developed to describe best way of working in the maritime domain. Deviating from procedures in order to maintain a timetable may lead to severe consequences. The seafarers should always prioritize performing jobs in the safest manner without considering its effects on other elements such as cost and time. Therefore, crew members should be encouraged to follow SOPs strictly in all conditions to maintain safety of the fleet. In addition to this, the company needs to make sure that the monitoring mechanism is in place to identify any possible deviation.

The Procedure Improvement Tool can be introduced to improve unworkable or impractical procedures for crew use. The tool also gives opportunity to crew to improve current shipping procedures and hence the reasons of the deviations are identified and eliminated for enhancing safety and quality of procedures. The enhanced quality of the SOPs will trigger crew members to follow SOPs more strictly. Furthermore, the tool provides continuous SOP improvement which is known to be a prerequisite of a positive safety culture

Table F 3 Procedures and Safety Rules Dimension

Procedures and Safety Rules		
Statements	**Average Score**	
	Crew Members	**Shore Personnel**
7. Crew members are closely monitored to ensure company procedures are always followed.	76.77	85.64
8. There is an effective system in place to modify the procedures that are unworkable or impractical for crew use.	73.55	83.59
9. I never breach operating procedures, even if the breach is in the company's best interests.	74.00	75.14
10. Operating procedures provided by the company are helpful to the conduct of daily operations.	81.29	80.00
11. Safety rules and procedures are strictly followed.	83.33	81.03

12. The crew members are never encouraged to break rules to complete a task or maintain the timetable.	74.84	80.54

Feedback Statements

The feedback factor consists of four statements. The average scores of the each statement for crew members and shore personnel are given in Table F 4 and all the colours which are not green require an immediate improvement. The statement with the lowest score for crew members and shore personnel is: "*The crew is always given feedback on accidents, incidents, and near misses that occur on-board*".

Even though accidents, incidents and near misses are extremely unfortunate events, the companies can improve their safety culture maturity levels by learning from these events. Therefore, crew members should receive feedback about their mistakes leading to these unfortunate events so the same errors will not be repeated.

Crew members are also not satisfied with the follow up measures taken after accidents and near misses. If the corrective actions are not taken on board, the same conditions may lead to similar or even worse types of accidents. It is therefore crucial for seafarers to receive feedback from the company after accidents.

Compliance with rules is of paramount importance in the maritime operations for the enhanced safety. Crew members should acquaintance feedback regarding their adherence with safety rules and regulations.

Table F 4 Feedback Dimension

Feedback		
Statements	Average Score	
	Crew Members	Shore Personnel
13. I am always informed about the outcome of shipboard safety meetings.	80.65	83.16
14. I am satisfied with the follow-up measures taken after accidents, incidents and near misses.	76.13	88.21

15. The crew is always given feedback on accidents, incidents, and near misses that occur on-board.	74.19	85.13
16. I receive feedback about my compliance to safety procedures.	78.00	83.16

Involvement Statements

The involvement factor consists of five statements. The average scores of the each statement for crew members and shore personnel are given in Table F 5 and all the colours which are not green require an immediate improvement. Involvement is the dimension where crew members achieved the highest score. Therefore it can be said that crew members feel involved in this company.

The statements with the lowest scores are the following statements for the crew members*: "I am consulted about, and invited to get involved in changes that affect safe work practices"* and for the shore staff: "*Staff from all departments and levels attends safety meetings"*.

Crew members only would like to be more involved regarding the operational changes that affect their practices. Shore personnel do not believe that all shore staff are represented at the safety meetings.

Shore personnel believe that participant numbers for the safety meeting should be increased and the outcomes of the safety meeting should be communicated to the employees more clearly. In addition to this, shore personnel should be more involved about the changes that affect their working practices.

Table F 5 Involvement Dimension

Involvement		
Statements	Average Score	
	Crew Members	Shore Personnel
17. Crew members are encouraged to improve safety.	81.33	84.62
18. Suggestions to improve health and safety are welcomed.	83.33	85.64

19. I am consulted about, and invited to get involved in changes that affect safe work practices.	72.26	80.51
20. I have sufficient control of my work to ensure it is always completed safely.	83.87	84.10
21. Staff from all departments and levels attends safety meetings.	80.67	71.89

Just Culture Statements

The just culture factor consists of six statements. The average scores of the each statement for crew members and shore personnel are given in Table F 6 and all the colours which are not green require an immediate improvement. The statement with the lowest score for crew members and shore personnel is: "*Crew members should question a senior officer's decision if safety is affected*".

All seafarers should contribute to the safety of shipping according to the level of competence they have. Even junior officers of ratings can identify a problem that an expert seafarer may miss. Therefore, when safety is concerned, they should be able to speak up and tell their ideas. Ratings and junior officers shouldn't be discouraged to tell their safety concerns. The mock accident scenarios should be developed and wrong decisions should be made deliberately by the senior officers to assess the participation of the junior officers and lower ranks. Any input from the junior ranks should be acknowledged by the senior members during the execution of scenarios and more encouragement should be provided to hesitant crew members.

The company should also pay significant attention to "just culture" approach to change respondents' opinion on the treatment of the mistakes. Blame Culture is a common problem in shipping, honest mistakes should not be punished within organizations. One wrong treatment of an error by the ship management will cause crew to become reluctant on reporting the unsafe acts and unsafe conditions occur on board.

Table F 6 Just Culture Dimension

Just Culture	
Statements	**Average Score**

	Crew Members	Shore Personnel
22. Mistakes are corrected without punishment and treated as a learning opportunity.	75.33	77.95
23. The company always tries to resolve any safety concerns and problems identified.	82.00	83.08
24. Crew members should question a senior officer's decision if safety is affected.	63.23	56.32
25. I am able to discuss any concerns I have with my line manager.	80.00	86.15

Problem Identification Statements

The problem identification factor consists of nine questions. The average scores of the each statement for crew members and shore personnel are given in Table F 7 and all the colours which are not green require an immediate improvement. The statements with the lowest scores for crew members and shore staff are: "*Asking for assistance cannot make me look incompetent"* and *"Crew members do not carry out non-work activities while on duty"*.

Q28 highlights a major issue within the organization. Numerous seafarers play different roles to run the ship safely and effectively. Crew members should assist each other on board ships to enhance the resilience of the whole crew and hence improve safety. A resilient crew should work as a unit and each member of the crew should offer assistance to others who are in need for enhancing operational safety. Therefore, collaborative scenarios should be conducted where multitasking is required and encouraged.

According to the respondents, crew members quite often carry out non-work activities while on duty. The types of non-work activities should be investigated thoroughly to eliminate the associated risks. On board observations and semi-structured interviews should be arranged to firstly identify what kind of non-work activities are carried out secondly intervention strategies to eliminate those non-work activities should be developed. The deviation from a critical procedure or a decreased situational awareness due to other activities can trigger errors on board. However, the reason behind non-work activities can also be attributed to the lack of rest period that crew members have and therefore they may have some of their social activities during their shifts.

Shore staff have a few worries regarding the statement ‘crew members can operate the equipment within their area of responsibility safely’. The equipment should always be of high quality and crew members should have sufficient induction/familiarisation training to develop their confidence and skills on equipment they use on board.

Crew members also find the likelihood of accidents quite high within the company. Focused group workshops should be arranged with on board representatives to identify high likelihood & high severity events that may lead to unfavourable situations on board vessels. The appropriate measures should be taken on board to decrease the perception about the possibility of involvement in an accident

Table F 7 Problem Identification Dimension

Problem Identification		
Statements	Average Score	
	Crew Members	Shore Personnel
26. Other crew members encourage me to report unsafe events.	80.00	81.58
27. I am confident that I can operate the equipment within my area of responsibility safely.	82.58	77.78
28. Asking for assistance cannot make me look incompetent.	54.19	47.69
29. Whenever I see unsafe behaviour, I always report it.	81.29	83.68
30. I am encouraged to conduct, or refer to a risk assessment before performing any hazardous work.	82.58	87.03
31. I am encouraged to report all near misses.	81.94	88.21
32. Crew members do not carry out non-work activities while on duty.	59.35	55.76
33. I mind when other crew members ignore safety procedures.	83.87	83.59
34. The possibility of being involved in an accident is not high in this company.	70.97	84.62

Priority of Safety Statements

The priority of safety factor consists of nine statements. The average scores of the each statement for crew members and shore personnel are given in Table F 8 and all the colours which are not green require an immediate improvement. The statements with the lowest scores for crew members and shore staff are:

- *Shore side managers never put timetable or costs above safety.*
- *The company is giving much more attention to safety now, than it did one year ago.*
- *The company takes actions not only when an accident occurs.*
- *The company makes too much noise (excessive promotion) about safety.*

Even though shore side managers think that safety is the first priority amongst their fleet (Q36), crew members believe that managers sometimes put timetable and cost above safety. This perception may directly affect how the crew members navigate the ship in riskier conditions. Most of the time, the deviations due to time pressure are known to the management within the substandard shipping companies, however ship managements sometimes turn a blind eye to this matter. In addition to this, crew members sometimes perform these risky operations to be favourable person within the company, having said that when things go wrong, they are the one to be blamed for the accident. Therefore, the company should communicate clearly that "safety first" is not only a slogan but a real practice on board.

According to Q40, the safety performance of the company is not improving according to respondents, hence more safety improvement initiatives should be introduced within the organization. The company should not only try to improve its safety culture maturity level, but also inform crew members about the implemented safety culture initiatives and achieved impacts.

The company mainly takes action when something goes wrong (Q42). However, ship management's continuous support is key for boosting safety culture on board and avoiding catastrophic events. Regular ship visits should take place and seafarers should feel valued as a part of the company.

The last but not least, the company should make excessive amount of promotion to improve safety standards, however the results are low in Q43. Crew members and ship management should come together more often to discuss the impact of previous safety culture improvement measures. The company should continuously invest and implement state of the art assessment and improvement methods. The crew member who make contribution to the overall safety culture should be acknowledged through the company newsletters.

According to Q39, crew members believe the workload distribution can be improved, hence fatigue and fatigue related accidents can be prevented within the company. The workload caused by paperwork is not considered as an input at safe manning calculations and the crew members' workload are therefore obtained higher than anticipated. Automation and more comprehensive manning level calculations should be implemented to decrease workload of crew within the company.

Maintenance standards are also found problematic by some of the crew members (Q41). Duration of corrective maintenance actions should be treated as a key performance indicator and the company should aim decreasing these durations. Moreover, the proactive maintenance model should be utilized to address problems and failures beforehand which could lead to disruption of a critical operation.

Table F 8 Priority of Safety Dimension

Priority of Safety		
Statements	**Average Score**	
	Crew Members	**Shore Personnel**
35. When ship management is informed about accidents, incidents, or near misses, corrective action is taken promptly.	81.29	89.74
36. Shore side managers never put timetable or costs above safety.	66.21	81.54
37. Members of the management team are personally and routinely involved in safety.	80.00	85.79
38. The company places a high priority on safety training.	80.67	86.84
39. Manning levels are appropriate for our workload.	77.14	83.24

40. The company is giving much more attention to safety now, than it did one year ago.	65.81	68.24
41. The company has excellent maintenance standards.	75.48	83.08
42. The company takes actions not only when an accident occurs.	68.00	64.10
43. The company makes too much noise (excessive promotion) about safety.	59.35	57.30

Responsiveness Statements

The responsiveness factor consists of ten statements. The average scores of the each statement for crew members and shore personnel are given in Table F 9 and all the colours which are not green require an immediate improvement. The statement with the lowest score for crew members and shore personnel is: "*My attention to safety does not suffer when I have been stressed or fatigued*".

As identified in Q50, crew members do not think they have adequate rest hours to perform their jobs safely. Insufficient rest hours lead to accumulation of fatigue and stress amongst crew members, therefore work rest hours should be meticulously investigated by overt observations to gain insight into the main underlying problems of the fatigue on board. Both seafarers and shore personnel also stated that they lose their attention when they are stressed or fatigued (Q46). Decreased situational awareness and attention are attributed to large number of accidents in shipping. In addition to this, crew members do not monitor sign of stress of fatigue of other crew members with this company (Q51). The importance of being a team should be communicated and demonstrated at on board drills.

Another problem identified within this company is that there is a lack of a system for observing work and rest hours of the crew members and also regulatory compliance of the work-rest hours is not monitored thoroughly (Q48). The work rest hour problems are widespread within the industry. Erroneous work rest hour patterns such as 6 hours on – 6 hours off result in accumulation of fatigue and therefore fatigue related accidents. The company therefore should thoroughly investigate the workload of crew members to identify whether sufficient amount of time is allocated for performing duties safely.

Crew members do not think that enough resources are allocated for them to perform their jobs safely. Therefore, they are also not fully confident that they can effectively operate the equipment they are given (Q45). The insufficient resources should be identified via interviews and group discussions with crew to improve the standards and hence safety culture maturity levels.

Table F 9 Responsiveness Dimension

Responsiveness		
Statements	**Average Score**	
	Crew Members	**Shore Personnel**
44. I feel confident that I will be able to operate effectively in an emergency situation.	81.94	82.05
45. I am confident that I can operate all equipment in my work area effectively.	76.13	67.22
46. My attention to safety does not suffer when I am stressed or fatigued.	56.00	58.97
47. I am provided adequate resources (time, staffing, budget, and equipment) to perform my job.	74.19	78.97
48. There is a system in place for observing my rest hours.	79.33	77.30
49. The crew is expected to comply with work-rest hour regulation.	73.33	82.16
50. I have adequate rest on the work schedule cycle that I work.	69.68	80.00
51. Crew members monitor each other for signs of stress or fatigue.	77.42	73.51
52. Our crew has adequate training in emergency procedures.	81.29	85.13
53. The crew has access to all necessary personal protective equipment (PPE).	85.16	85.13

Safety Awareness Statements

The safety awareness factor consists of 16 statements. The average scores of the each statement for crew members and shore personnel are given in Table F 10 and all the colours which are not green require an immediate improvement. The statements with the lowest scores for crew members and shore staff are:

- *Drug abuse is not a safety issue in my company.*
- *Alcohol use is not a safety issue in my company.*
- *Expected time of arrival can be postponed in order to follow safety rules strictly on board.*

The responses of the alcohol and drug use statements identify a crucial problem within the company. The results demonstrate that this problem is widespread and known to all employees. Drug and alcohol use can cause extremely catastrophic accidents on board. Their usage should strictly be prohibited. Alcohol and drug use is a widespread problem within the industry and one of the main underlying reason is known as psychological problems. Isolated shipping environment sometimes may trigger crew members to have psychological break downs and they may try to find permanent cures like drug and alcohol. Therefore, it is of key importance for crew members to access distance social support services in order to overcome this problem.

Moreover, sailing or time schedule are of paramount importance for the shipping organizations and therefore the operation should be suspended if safety is at stake. The company needs to communicate this clearly in order to change the lack of safety awareness within the organization.

Watch hand overs are of crucial importance to build up new crew members' knowledge about the existing problems of a vessel. Crew members can therefore have an insight on which issue to lean on or careful about at the beginning. Skipping these significant processes may lead crew members to rely on an equipment which is faulty and likelihood of an accident due to the lack of information transfer.

Shore personnel believe that number of safety meeting can be increased to discuss safety matters in a more detailed manner. This will also affect crew members' perception of the health and safety policy of the company positively.

Safety briefings and training should be handled in a more professional and effective manner. Majority of the safety culture attitudes and perceptions are observed and absorbed by crew members during safety briefings and trainings.

Table F 10 Safety Awareness Dimension

Safety Awareness		
Statements	Average Score	
	Crew Members	Shore Personnel
54. Watch hand-overs are comprehensive and not hurried.	78.62	80.00
55. My ship works to ensure the safety in hazardous areas and during hazardous activities.	82.58	82.16
56. My ship holds an adequate number of safety meetings.	81.29	78.92
57. Checklists are essential for safety.	83.23	84.32
58. The company provides sufficient time for the hand-overs when joining the ship.	76.77	81.05
59. Learning from mistakes is a good way to improve overall safety.	83.87	87.18
60. I always give proper instructions when I initiate any work.	83.87	83.59
61. Drug abuse is not a safety issue in my company.	49.03	35.26
62. Alcohol use is not a safety issue in my company.	46.45	34.74
63. Safety briefings and training are professional and effective.	74.19	82.11
64. Safety is the top priority for crew on board this ship.	83.87	86.32
65. When I joined this ship, I received a proper induction, including familiarization with new tasks.	81.94	87.69
66. Expected time of arrival can be postponed in order to follow safety rules strictly on board.	55.17	51.11
67. Safety is a visible part of the selection and recruitment process in this company.	81.29	85.26
68. This company cares about my health and safety.	79.35	87.18

69. I fully understand my responsibilities for health and safety.	87.10	86.67

Training and Competence Statements

The training and competence factor consists of six statements. The average scores of the each statement for crew members and shore personnel are given in Table F 11 and all the colours which are not green require an immediate improvement. The statement with the lowest score for crew members and shore personnel is*: "I am trained to cope with fatigue".*

As also stated before, there should be a fatigue management course for employees to observe the sign of fatigue in order to avoid fatigue related catastrophes. Numerous maritime institutions provide this course and also fatigue management toolkits are available throughout the industry.

Crew members also raised awareness with regards to the emergency preparedness. Emergency scenarios should be conducted on board ships and in simulator environments to enhance confidence and competency levels of crew members.

Table F 11 Training and Competence Dimension

Training and Competence		
Statements	**Average Score**	
	Crew Members	**Shore Personnel**
70. The training provided by our company is of a high quality and standard.	80.00	88.72
71. My company continuously try to improve the quality of the trainings.	80.00	84.10
72. I have adequate knowledge of the company (Safety) Management System.	80.67	85.64
73. I am properly trained to deal with unfamiliar situations where safety might be at stake.	78.71	82.05
74. I am trained to cope with fatigue.	74.19	73.68
75. Adequate time is allowed for safety drills.	80.65	83.16

Statistical Results

Differences between group means were examined and tested for statistical significance using ANOVA test. This test is utilised to identify statistical differences between different groups such as age, department etc. and by using this method, the chance factor was removed from the analysis. If the generated result (p value) is lower than 0.05 for a question, it means that there is a significant statistical differences (scientifically proved) between different groups responded to that particular question. The average scores of the each age group were represented by utilising the same colour codes which were also used while assessing the results of the overall scores of the safety culture dimensions. The meanings of the each colour are given in Chapter 4.

Effect of Age

The questions which are highlighted in red represents that there is a significant statistical difference between the different age groups and their answers given to the questionnaires.

Table F 12 ANOVA on Age (significant interactions, p-value < 0.05, are shown in red)

Var	p-value	Var	p-value	Var	p-value	Var	p-value	Var	p-value
Q1	0.556	Q16	0.245	Q31	0.112	Q46	0.537	Q61	0.828
Q2	0.229	Q17	0.318	Q32	0.547	Q47	0.203	Q62	0.825
Q3	0.025	Q18	0.724	Q33	0.505	Q48	0.268	Q63	0.477
Q4	0.244	Q19	0.522	Q34	0.362	Q49	0.29	Q64	0.584
Q5	0.757	Q20	0.191	Q35	0.05	Q50	0.708	Q65	0.136
Q6	0.254	Q21	0.944	Q36	0.015	Q51	0.114	Q66	0.477
Q7	0.264	Q22	0.322	Q37	0.095	Q52	0.487	Q67	0.317
Q8	0.557	Q23	0.006	Q38	0.431	Q53	0.677	Q68	0.176
Q9	0.916	Q24	0.342	Q39	0.143	Q54	0.51	Q69	0.648
Q10	0.012	Q25	0.014	Q40	0.142	Q55	0.237	Q70	0.014
Q11	0.391	Q26	0.542	Q41	0.015	Q56	0.172	Q71	0.053
Q12	0.214	Q27	0.276	Q42	0.608	Q57	0.127	Q72	0.128
Q13	0.43	Q28	0.776	Q43	0.058	Q58	0.579	Q73	0.322
Q14	0.096	Q29	0.166	Q44	0.352	Q59	0.97	Q74	0.309
Q15	0.523	Q30	0.054	Q45	0.352	Q60	0.083	Q75	0.063

Due to difference in sample size and non-homogenous variances, Hochberg's GT2 and Games-Howell post hoc tests were conducted on the statistically significant variables only (the red cells given above). A summary of the post hoc tests is outlined in the table below.

Table F 13 Summary of the findings of post hoc tests for interaction of Age

Q#	QUESTION	18-24	25-34	35-44	45-54
Q3	There is good cooperation between the ship and shore.	73.3	81.5	85.6	93.3
Q10	Operating procedures provided by the company are helpful to the conduct of daily operations.	66.7	81.5	80.8	80.0
Q23	The company always tries to resolve any safety concerns and problems identified.	93.3	77.6	84.8	84.0
Q25	I am able to discuss any concerns I have with my line manager.	80.0	80.0	88.8	80.0
Q36	I am confident that I can operate the equipment within my area of responsibility safely.	40.0	73.6	80.0	74.7
Q41	Crew members do not carry out non-work activities while on duty.	86.7	72.3	84.8	81.3
Q70	The training provided by our company is of a high quality and standard.	93.3	77.6	88.8	88.0

The table above demonstrates the differences between age groups based on the ANOVA analysis. It is evident form above table that younger (18-34) seafarers have lower safety culture attitudes and perception scores than the 35-54 age groups.

18-24 years olds believe that the cooperation between ship and shore is not sufficient as the elders think since young people have more junior ranks and they do not communicate with the ship management as much as their seniors do. Therefore, seniors should pass the significant information to the juniors via internal shipboard meetings to change their perception.

The youngest generation within this company do not find the procedures helpful to conduct daily duties. This perception is found to be extremely dangerous since industry experienced severe accidents due to deviations from SOPs. The importance of following SOPs should be demonstrated on board drills and simulator environments. The company should also closely monitor especially the younger crew to make sure all the SOPs are strictly followed on board.

Another alarming fact about the 18-24 years olds that do not feel confident while using the equipment in their area of responsibility. The company should invest more on training to enhance competency and skills of the young/junior crew members. It is of high importance to bring all crew members to desired level of safety culture since crew members act as a team during emergencies.

25-34 years old crew members find the non-work related activities a major problem and they are also concerned regarding the quality of the training provided by the company compared to other age groups. The company should arrange workshops to elicit respondents' opinions about the underlying reasons of these perceptions.

Effect of Gender

The questions which are highlighted in red represents that there is a significant statistical difference between the genders and their answers given to the questionnaires.

Table F 14 ANOVA on Gender (significant interactions, *p-value* < 0.05, are shown in red)

Var	p-value	Var	p-value	Var	p-value	Var	p-value	Var	p-value
Q1	0.934	Q16	0.714	Q31	0.772	Q46	0.171	Q61	0.169
Q2	0.013	Q17	0.398	Q32	0.213	Q47	0.457	Q62	0.325
Q3	0.452	Q18	0.325	Q33	0.498	Q48	0.101	Q63	0.747
Q4	0.986	Q19	0.280	Q34	0.836	Q49	0.526	Q64	0.495
Q5	0.323	Q20	0.398	Q35	0.376	Q50	0.978	Q65	0.424
Q6	0.459	Q21	0.712	Q36	0.931	Q51	0.307	Q66	0.637
Q7	0.898	Q22	0.480	Q37	0.438	Q52	0.062	Q67	0.810
Q8	0.490	Q23	0.568	Q38	0.937	Q53	0.192	Q68	0.480
Q9	0.146	Q24	0.816	Q39	0.429	Q54	0.054	Q69	0.449
Q10	0.009	Q25	0.360	Q40	0.455	Q55	0.457	Q70	0.912
Q11	0.022	Q26	0.100	Q41	0.682	Q56	0.468	Q71	0.977
Q12	0.927	Q27	0.283	Q42	0.899	Q57	0.724	Q72	0.712
Q13	0.675	Q28	0.290	Q43	0.283	Q58	0.182	Q73	0.894
Q14	0.748	Q29	0.931	Q44	0.213	Q59	0.247	Q74	0.735
Q15	0.959	Q30	0.539	Q45	0.427	Q60	0.786	Q75	0.953

Due to difference in sample size and non-homogenous variances, Hochberg's GT2 and Games-Howell post hoc tests were conducted on the statistically significant variables only. A summary of the post hoc tests is outlined in the table below.

Table F 15 Summary of the findings of post hoc tests for interaction of Gender

No	QUESTION	M	F
Q2	There is good communication about safety.	86.7	75.6
Q10	Operating procedures provided by the company are helpful to the conduct of daily operations.	81.6	73.3
Q11	Safety rules and procedures are strictly followed.	83.0	75.6

It is obvious from above that males generally scored significantly higher than females. Female respondents believe SOPs are not completely helpful and not always followed on board.

The difference between males and females participants may be due to the fact that female respondents tend to be more open in offering their opinion or it may be attributable to the higher level of safety training received by the male seafarers. There is a definite perception difference regarding the usage of procedures between males and females. Female respondents' views on procedures should be further investigated and the reason behind these perceptions should be explored.

Effect of Department

The questions which are highlighted in red represents that there is a significant statistical difference between the departments and their answers given to the questionnaires.

Table F 16 ANOVA on Department (significant interactions, p-value < 0.05, are shown in red)

Var	p-value	Var	p-value	Var	p-value	Var	p-value	Var	p-value
Q1	0.770	Q16	0.573	Q31	0.174	Q46	0.452	Q61	0.016
Q2	0.752	Q17	0.128	Q32	0.299	Q47	0.462	Q62	0.012
Q3	0.595	Q18	0.659	Q33	0.873	Q48	0.758	Q63	0.238
Q4	0.055	Q19	0.113	Q34	0.361	Q49	0.252	Q64	0.494
Q5	0.244	Q20	0.369	Q35	0.083	Q50	0.272	Q65	0.425
Q6	0.029	Q21	0.334	Q36	0.043	Q51	0.664	Q66	0.079

Q7	0.506	Q22	0.129	Q37	0.243	Q52	0.899	Q67	0.667
Q8	0.148	Q23	0.196	Q38	0.685	Q53	0.381	Q68	0.359
Q9	0.999	Q24	0.281	Q39	0.289	Q54	0.999	Q69	0.674
Q10	0.996	Q25	0.018	Q40	0.361	Q55	0.629	Q70	0.531
Q11	0.182	Q26	0.561	Q41	0.743	Q56	0.562	Q71	0.238
Q12	0.044	Q27	0.959	Q42	0.639	Q57	0.978	Q72	0.226
Q13	0.646	Q28	0.821	Q43	0.297	Q58	0.738	Q73	0.632
Q14	0.052	Q29	0.185	Q44	0.993	Q59	0.639	Q74	0.404
Q15	0.442	Q30	0.110	Q45	0.048	Q60	0.626	Q75	0.489

Due to difference in sample size and non-homogenous variances, Hochberg's GT2 and Games-Howell post hoc tests were conducted on the statistically significant variables only. A summary of the post hoc tests is outlined in the table below.

Table F 17 Summary of the findings of post hoc tests for interaction of Department

* D: Deck department; E: Engineering department; C: Crew department; T: Technical department; S: Safety department

No	**QUESTION**	**Departments***				
		D	**E**	**C**	**T**	**S**
Q6	The company operates an effective system for reporting safety matters.	88.6	75.6	88.4	92.0	100.0
Q12	The crew members are never encouraged to break rules to complete a task or maintain the timetable.	90.0	67.8	81.1	80.0	80.0
Q25	I am able to discuss any concerns I have with my line manager.	82.5	80.0	81.1	88.0	100.0
Q36	Shore side managers never put timetable or costs above safety.	80.0	63.5	84.2	72.0	85.0
Q45	I am confident that I can operate all equipment in my work area effectively.	75.0	74.4	71.8	56.0	65.0
Q61	Drug abuse is not a safety issue in my company.	32.5	51.1	31.1	40.0	55.0
Q62	Alcohol use is not a safety issue in my company.	32.5	46.7	32.2	32.0	55.0

The results of the ANOVA analysis between the departments demonstrated that Safety Department has the highest safety culture attitude and perception scores than others as expected.

Engineering department members believe that they cannot effectively report safety matters as other departments do. They are also encouraged to break the rules to maintain a timetable or complete a task. Even though, the primary task of the engine room personnel to ensure that the engine is running, the operation should be suspended when there is a safety concern. Engine room personnel and technical department concern about the company safety policy and they believe that the shore side managers put cost above safety. This is also a representation of the shore side managers' inadequate safety culture maturity level. This company should also go through a big managerial change to adjust their safety culture perceptions completely.

Furthermore, the company needs to take stringent prevention measures regarding to the alcohol and drug use. Even though all departments are extremely concerned about the situation, deck and crew department find this topic statistically more dangerous than others.

Effect of Seafarers' Ranks

The questions which are highlighted in red represents that there is a significant statistical difference between the seafarer's ranks and their answers given to the questionnaires.

Table F 18 ANOVA on Rank (significant interactions, *p-value* < 0.05, are shown in red)

Var	p-value	Var	p-value	Var	p-value	Var	p-value	Var	p-value
Q1	0.934	Q16	0.714	Q31	0.772	Q46	0.171	Q61	0.169
Q2	0.013	Q17	0.398	Q32	0.213	Q47	0.457	Q62	0.325
Q3	0.452	Q18	0.325	Q33	0.498	Q48	0.101	Q63	0.747
Q4	0.986	Q19	0.280	Q34	0.836	Q49	0.526	Q64	0.495
Q5	0.323	Q20	0.398	Q35	0.376	Q50	0.978	Q65	0.424
Q6	0.459	Q21	0.712	Q36	0.931	Q51	0.307	Q66	0.637
Q7	0.898	Q22	0.480	Q37	0.438	Q52	0.062	Q67	0.810
Q8	0.490	Q23	0.568	Q38	0.937	Q53	0.192	Q68	0.480

Q9	0.146	Q24	0.816	Q39	0.429	Q54	0.054	Q69	0.449
Q10	0.009	Q25	0.360	Q40	0.455	Q55	0.457	Q70	0.912
Q11	0.022	Q26	0.100	Q41	0.682	Q56	0.468	Q71	0.977
Q12	0.927	Q27	0.283	Q42	0.899	Q57	0.724	Q72	0.712
Q13	0.675	Q28	0.290	Q43	0.283	Q58	0.182	Q73	0.894
Q14	0.748	Q29	0.931	Q44	0.213	Q59	0.247	Q74	0.735
Q15	0.959	Q30	0.539	Q45	0.427	Q60	0.786	Q75	0.953

Post hoc tests are not performed for the questions since sample size not enough to obtain accurate (scientific) results. Ship names and nationalities were not included in this survey.

Effect of Workplace (sea or shore)

The questions which are highlighted in red represents that there is a significant statistical difference between the workplace that respondents are in and their answers given to the questionnaires.

Table F 19 ANOVA on Workplace (sea or shore) (significant interactions, *p-value* < 0.05, are shown in red)

Var	p-value	Var	p-value	Var	p-value	Var	p-value	Var	p-value
Q1	0.704	Q16	0.108	Q31	0.054	Q46	0.564	Q61	0.017
Q2	0.144	Q17	0.306	Q32	0.476	Q47	0.190	Q62	0.032
Q3	0.022	Q18	0.495	Q33	0.947	Q48	0.586	Q63	0.021
Q4	0.058	Q19	0.029	Q34	0.009	Q49	0.006	Q64	0.475
Q5	0.953	Q20	0.950	Q35	0.000	Q50	0.003	Q65	0.039
Q6	0.001	Q21	0.033	Q36	0.002	Q51	0.304	Q66	0.384
Q7	0.003	Q22	0.459	Q37	0.068	Q52	0.244	Q67	0.202
Q8	0.003	Q23	0.668	Q38	0.054	Q53	0.991	Q68	0.013
Q9	0.795	Q24	0.247	Q39	0.143	Q54	0.691	Q69	0.862
Q10	0.555	Q25	0.022	Q40	0.650	Q55	0.866	Q70	0.009
Q11	0.303	Q26	0.661	Q41	0.035	Q56	0.323	Q71	0.111
Q12	0.102	Q27	0.161	Q42	0.464	Q57	0.653	Q72	0.058
Q13	0.504	Q28	0.287	Q43	0.694	Q58	0.206	Q73	0.311
Q14	0.001	Q29	0.487	Q44	0.965	Q59	0.360	Q74	0.893
Q15	0.010	Q30	0.207	Q45	0.011	Q60	0.892	Q75	0.320

Due to difference in sample size and non-homogenous variances, Hochberg's GT2 and Games-Howell post hoc tests were conducted on the statistically significant variables only. A summary of the post hoc tests is outlined in the table below.

Table F 20 Summary of the findings of post hoc tests for interaction of Workplace (sea or shore)

No	QUESTION	Sea	Shore
Q3	There is good cooperation between the ship and shore.	81.3	88.7
Q6	The company operates an effective system for reporting safety matters.	80.0	90.3
Q7	Crew members are closely monitored to ensure proper procedures are always followed.	76.8	85.6
Q8	There is an effective system in place to fix procedures that are unworkable or impractical for crew use.	73.5	83.6
Q14	I am satisfied with the follow-up measures taken after accidents, incidents and near misses.	76.1	88.2
Q15	The crew is always given feedback on accidents, incidents, and near misses that occur on-board.	74.2	85.1
Q16	I receive feedback about my compliance to safety procedures.	78.0	83.2
Q21	Staff from all departments and levels attends safety meetings.	80.7	71.9
Q25	I am able to discuss any concerns I have with my line manager.	80.0	86.2
Q34	The possibility of being involved in an accident is not high in this company.	71.0	84.6
Q35	When ship management is informed about accidents, incidents, or near misses, corrective action is taken promptly.	81.3	89.7
Q36	Shore side managers never put timetable or costs above safety.	66.2	81.5
Q41	The company has excellent maintenance standards.	75.5	83.1
Q45	I am confident that I can operate all equipment in my work area effectively.	76.1	67.2
Q49	The crew is expected to comply with work-rest hour regulation.	73.3	82.2
Q50	I have adequate rest on the work schedule cycle that I work.	69.7	80.0
Q61	Drug abuse is not a safety issue in my company.	49.0	35.3
Q62	Alcohol use is not a safety issue in my company.	46.5	34.7
Q63	Safety briefings and training are professional and effective.	74.2	82.1
Q65	When I joined this ship, I received a proper induction, including familiarization with new tasks.	81.9	87.7
Q68	This company cares about my health and safety.	79.4	87.2
Q70	The training provided by our company is of a high quality and standard.	80.0	88.7

Shore personnel have reported higher safety culture attitudes and perceptions than seafarers. However, crew members' lower scores can be representative of the real on-board situations.

Crew members believe that adherence to procedures and rules are not satisfactory as shore personnel believe. Seafarers highlight the deficiency of a system to fix unworkable and impracticable procedures. Unfortunately, this may lead seafarers to perform deviations without considering all the risks of the alternative way and hence may cause accidents and incidents on board. The crew members are also not satisfied with the level of feedback provided by the company. The lack of sufficient feedback between sea and shore personnel may decrease the communication level between two parties. The implementation of the procedure improvement tool within the company will not only assist in identifying and fixing impractical procedures but also it will provide automated feedback regarding to the procedural changes.

Crew members find the shore side managers' cost vs safety approach extremely insufficient and they are certainly not happy regarding what company says and what they do during daily ship operations. The shipping company should set their priorities right about the safety & timetable. The ship management should go through safety culture training within this company due to their poor level of safety culture maturity levels.

Crew members also find the rest hours they have significantly low compared to shore personnel. The observation module of the framework can be utilized to identify what crew members' workload comprises of.

As stated in other sections drug and alcohol use requires immediate actions to eliminate the usage of such materials and hence enhance operational safety accordingly.

Open Ended Questions

In total, five open ended questions were asked to the respondents. The questions are:

1. What could the company do to improve health and safety
2. What could the company do to improve ship safety?

3. What could the company do to improve harbour operations safety (e.g. port)
4. What could the company do to improve office safety?
5. What questions should be included in the survey?

The responses of the open ended questions are into categorized and these categories are given for the each question below.

Response Rate

There was a much higher percentage of missing data ranging between 48% and 58% amongst open ended questions. Open ended questions sometimes are left blank since they believe their inputs are not considered as valuable most of the time, therefore they are reluctant to share further insight about the company. Especially in shipping companies where the feedback is not provided in sufficient levels, crew members' contribution to the safety initiatives stay at the surface level.

What could the company do to improve health and safety?

In this section, the majority of the respondent mentioned about extra trainings, quality of the PPEs and balance of the work-rest hours. The most common suggestions to improve health and safety are given below:

- More comprehensive and sufficient training
- More effective communication and having transparency
- Adequate time for rests, increase manning levels
- Proper selection of crew based on qualification and background
- Better and more specialized PPEs

The training is of utmost importance for developing skills of the crew and preparing them for the unexpected. They are slightly worried regarding the company's safety management policy and how they recruit new personnel. The company should always have transparency and have consistent approaches while dealing with problems so crew members may feel the qualification and experience are the only required aspects for the work, therefore they will focus on improving their safety culture attitudes and perspectives accordingly.

What could the company do to improve ship safety?

The majority of the feedback was related to safety training and manning levels for also this question. The most common suggestions to improve ship safety are given below:

- Regular inspections and training
- Increase manning levels
- Follow up accidents and near misses
- Establishment of a reporting for hazardous situations and observations

What could the company do to improve harbor operations safety (e.g. port)

The majority of the respondents highlighted the requirement of robust procedures and best practices to communicate effectively during port operations. The most common suggestions to improve harbour operation safety are given below:

- Communication of the good practices
- More clear procedures
- More people on watch
- Clear communication channels with port authorities

Harbour operations requires involvement of different parties, hence clear communication is crucial to perform the operation in a safe manner. Sufficient manning should be allocated for this operation, crew members should not sacrifice their rest period for the operation due to the pressure of the company or the port procedures. The quality of the procedures should be checked to ensure the best practices are communicated clearly and effectively.

What could the company do to improve office safety?

Safety trainings, seminars and briefings were the most prevalent type of suggestions offered by the respondents. The most common suggestions to improve office safety are given below:

- More frequent trainings, seminars and briefings
- Hazard reporting method for daily feedback
- More ship visits and on board training for also office staff
- Publishing articles and communicating to all departments

The company should arrange more seminars, briefings and training to enhance awareness amongst employees. Increasing number of ship visits will also lead shore personnel to gain insight into the prevailing safety standards on board.

What questions should be included in the survey?

Selection of crew was suggested to be included by some seafarers. The most common responds for this question are given below:

- Selecting of crew
- Bonuses
- Piracy attacks

Crew members would like to have more consistent and transparent recruitment process within the company and they would like to be acknowledged after spending majority of their time on board for the company. Seafarers are concerned about piracy attack and the company should assign security officers to maintain health and safety of their crew.

Overall Results

Safety culture questionnaires were distributed and collected for the analysis in the bulk carrier shipping company. The assessment identified several areas which require further improvements to enhance safety culture maturity levels. The major problems identified within the shipping company are given below:

- **Maritime English/dialects:** The level of English is also perceived as a threat to safety by the majority of the respondents within this company as the two other shipping companies and this has been found as widespread amongst shipping companies as shipping industry have multinational crew. Majority of the shipping operations require effective communication and high English proficiency. The company needs to provide extra English training courses in addition to the existing tests to enhance the level of English within the company. Crew members need to expand their competency on communicating with different ethnic groups in simulator environments prior to working on board.

- **Procedures and Safety Rules:** Seafarers sometimes deviate from the SOPs within this company. In order to understand the underlying reasons of these deviations, workshops should be conducted to elicit crew members' opinions regarding the SOPs that do not work as intended. Feedback of crew members should be collected to improve quality of SOPs in order to close the gap between work as imagined and work as done. The company does not take the necessary measures to monitor whether SOPs are strictly followed or not.
- **Feedback:** Crew members stated that they do not receive sufficient amount of feedback with regards to accidents and near misses. Receiving feedback on previous accidents and incidents will lead crew members to learn from previous mistakes and to retain safety culture more strictly on board. The company should use newsletters and circulars more effectively and more frequently in order to share the lesson learnt with rest of the crew.
- **Just culture:** Similar to the most of maritime industry, the existing blame culture is seen as a problem within the company. The blame culture adversely affects reporting activities and avoiding crew members to take further responsibility due to the fear of sanctions. The company needs to apply the just culture approach and should draw a line between honest mistakes and deliberate violation. Adopting a "just culture" approach requires a massive commitment from top to bottom within a company. The company should treat all the honest mistakes in a consistent and transparent manner to gain the trust of seafarers. Aviation's development in this topic can be utilized to generate a just culture amongst crew members.
- **Problem Identification:** Crew members perform non work activities based on the survey results. These types of activities should be prohibited by the ship management by arranging a series of meetings to identify the activities

and related prevention measures. Shipping operation requires enhanced situational awareness and any distractions from actual duties can cause catastrophic accidents on board.

There is a lack of team culture within the company, therefore, crew members neither ask assistance nor help each other to achieve and retain appropriate level of safety. Accident scenarios should be developed to demonstrate the advantages of working as a unit and cover the weaknesses of each other's in order to generate a resilient environment.

- **Priority of safety:** All the shipping companies need to transfer their goods according to their agreed timetable in order to maintain their profitability in the market. However, only one organizational error can lead a shipping company to lose their reputation and damage their profitability. Therefore, the shipping company makes a clear statement about the safety vs timetable in their Safety Management Manual (SMM).
- **Fatigue and stress:** Fatigue and stress management is raised as an issue by the seafarers and majority of them do not think that they are capable to cope with fatigue. Similar types of fatigue and stress management training which are delivered in BRM and HELM could be provided to ratings to enhance their stress and fatigue resilience. However, it needs to be understood that fatigue cannot be managed by individuals as it is strongly linked to company's operational practices. Therefore, in addition to the trainings, company may need to look at the root causes of fatigue and take action on root causes that may be caused by operational practices.
- **Work-rest hours:** Crew members complained about the manning levels within the company. Seafarers do not believe that they have adequate time to perform their job safely. The amount of paperwork should also be taken into account on safe manning calculations.
- **Drug and Alcohol use:** As also identified in previous shipping company alcohol and drug appear to be major issues within this company. Therefore, the company should have zero tolerance against to this issue and the users should be suspended from the entire maritime community immediately.

Appendix G - The Safety Culture Questionnaires and KPIs Correlations

The analysis identified that KPIs given below have a substantial amount of impact on safety culture questions and hence the topic they are covering.

Table G 1 KPI vs Question Correlation Results

KPIs	How many safety culture questions that the KPI affects	Relationship
Number of average corrective maintenance per ship	10	Positive
Number of near misses	5	Positive
Number of days without an accident	4	Positive
Management visit frequency	3	Positive
Number of First Aid Cases	3	Negative
Total recordable case frequency (TRCF)	3	Negative
Number of internal audit (ISM) findings	3	Positive
Number of unsafe acts	3	Negative

Number of corrective maintenance is found correlated with the majority of the questions, however, some of the identified correlations are found illogical by considering the nature of shipping operations. Rest of the KPIs such as number of near misses and accident numbers has rational significant correlations but the powers of the correlations are found low.

The relationships for each question were detailed and presented separately below.

Question 2

The results demonstrate that there is a significant statistical correlation between the number of average corrective maintenance per ship and the belief which there is a good communication about safety. This belief can be attributed to the requirement of an effective communication when there is a need for corrective maintenance.

Question	**KPI**
Question 2 - There is good communication about safety	Number of average corrective maintenance per ship
Relationship	Positive
Power of the correlation	.431**

Question 3

The results demonstrate that there are significant statistical correlations between the number of days without an accident, the number of average corrective maintenance per ship, the total recordable case frequency and the belief which there is good cooperation between the ship and shore.

Question	**KPI**	**KPI**
Question 3 - There is good cooperation between the ship and shore.	Number of days without an accident	Number of average corrective maintenance per ship
Relationship	Positive	Positive
Power of the correlation	.449**	.372*

Question	**KPI**
Question 3 - There is good cooperation between the ship and shore.	Total recordable case frequency (TRCF)
Relationship	Negative
Power of the correlation	-.356*

Question 4

The results demonstrate that there are significant statistical correlations between the number of days without an accident, the number of average corrective maintenance per ship, the total recordable case frequency and the belief which operational values, objectives and targets are effectively communicated,.

Question	KPI	KPI
Question 4 - Operational values, objectives and targets are effectively communicated.	Total Recordable Case Frequency (TRCF)	Number of days without an accident
Relationship	Negative	Positive
Power of the correlation	-.322*	.506**

Question	KPI
Question 4 - Operational values, objectives and targets are effectively communicated.	Number of average corrective maintenance per ship
Relationship	Positive
Power of the correlation	.346*

Question 10

The results demonstrate that there is a significant statistical correlation between the number of unsafe acts and the belief that operating procedures provided by the company are helpful to the conduct of daily.

Question	KPI
Question 10 - Operating procedures provided by the company are helpful to the conduct of daily operations.	Number of Unsafe Act
Relationship	Negative

Power of the correlation	-.338*

Question 14

The results demonstrate that there are significant statistical correlations between the number of days without an accident, the number of average corrective maintenance per ship, the number of first aid cases and the belief which crew members are satisfied with the follow-up measures taken after accidents, incidents and near misses.

Question	KPI	KPI
Question 14 - I am satisfied with the follow-up measures taken after accidents, incidents and near misses.	Number of First Aid Case (FAC)	Number of days without an incident or accident
Relationship	Negative	Positive
Power of the correlation	-.344*	.324*

Question	KPI
Question 14 - I am satisfied with the follow-up measures taken after accidents, incidents and near misses.	Number of average corrective maintenance per ship
Relationship	Positive
Power of the correlation	.348*

Question 15

The results demonstrate that there is a significant statistical correlation between the number of average corrective maintenance per ship and the belief which the crew is always given feedback on accidents, incidents, and near misses that occur on board.

Question	KPI

Question 15 - The crew is always given feedback on accidents, incidents, and near misses that occur on board.	Number of average corrective maintenance per ship
Relationship	Positive
Power of the correlation	.327*

Question 16

The results demonstrate that there are significant statistical correlations between the number of days without an incident and accident, the number of average corrective maintenance per ship, number of first aid cases (FAC) and the belief which I receive feedback about my compliance to safety procedures.

Question	**KPI**
Question 16 - I receive feedback about my compliance to safety procedures.	Number of First Aid Case (FAC)
Relationship	Negative
Power of the correlation	-.396*

Question	**KPI**	**KPI**
Question 16 - I receive feedback about my compliance to safety procedures.	Number of days without an incident or accident	Number of average corrective maintenance per ship
Relationship	Positive	Positive
Power of the correlation	.397*	.381*

Question 17

The results demonstrate that there is a significant statistical correlation between when the number of average corrective maintenance per ship and the belief which crew members are encouraged to improve safety.

Question	KPI
Question 17 - Crew members are encouraged to improve safety.	Number of average corrective maintenance per ship
Relationship	Positive
Power of the correlation	.596**

Question 18

The results demonstrate that there is a significant statistical correlation between when the number of average corrective maintenance per ship and the belief which suggestions to improve health and safety are welcomed.

Question	KPI
Question 18 - Suggestions to improve health and safety are welcomed.	Number of average corrective maintenance per ship
Relationship	Positive
Power of the correlation	.484**

Question 19

The results demonstrate that there is a significant statistical correlation between the number of average corrective maintenance per ship and the belief which I am consulted about the changes that affect safe work practices.

Question	KPI
Question 19 - I am consulted about the changes that affect safe work practices.	Number of average corrective maintenance per ship

Relationship	Positive
Power of the correlation	.333*

Question 23

The results demonstrate that there is a significant statistical correlation between the number of unsafe acts and the belief which the company always tries to resolve any safety concerns and problems identified.

Question	KPI
Question 23 - The company always tries to resolve any safety concerns and problems identified.	Number of unsafe acts
Relationship	Negative
Power of the correlation	-.345*

Question 24

The results demonstrate that there is a significant statistical correlation between the number of internal audit (ISM) findings and the belief which crew members should question a senior officer's decision if safety is affected.

Question	KPI
Question 24 - Crew members should question a senior officer's decision if safety is affected.	Number of internal audit (ISM) findings
Relationship	Positive
Power of the correlation	.392*

Question 30

The results demonstrate that there is a significant statistical correlation between the number of average corrective maintenance per ship and the belief that I am encouraged to conduct, or refer to a risk assessment before performing any hazardous work.

Question	KPI
Question 30 - I am encouraged to conduct, or refer to a risk assessment before performing any hazardous work.	Number of average corrective maintenance per ship
Relationship	Positive
Power of the correlation	.394*

Question 34

The results demonstrate that there is a significant statistical correlation between number of near-miss events and the belief that the possibility of being involved in an accident is not quite high in this company.

Question	KPI
Question 34 - The possibility of being involved in an accident is not quite high in this company.	Number of near-miss events
Relationship	Positive
Power of the correlation	.345*

Question 36

The results demonstrate that there is a significant statistical correlation between number of first aid case (FAC) and the belief that shore side managers never put timetable or costs above safety.

Question	KPI
Question 36 - Shore side managers never put timetable or costs above safety.	Number of First Aid Case (FAC)
Relationship	Negative

Power of the correlation	-.368*

Question 40

The results demonstrate that there is a significant statistical correlation between total recordable case frequency (TRCF) and the belief that the company is giving much more attention to safety now, than it did one year ago.

Question	KPI
Question 40 - The company is giving much more attention to safety now, than it did one year ago.	Total Recordable Case Frequency (TRCF)
Relationship	Negative
Power of the correlation	-.333*

Question 44

The results demonstrate that there is a significant statistical correlation between when the number of unsafe acts and the belief that crew members feel confident that they will be able to operate effectively in an emergency situation.

Question	KPI
Question 44 - I feel confident that I will be able to operate effectively in an emergency situation.	Numbers of unsafe acts
Relationship	Negative
Power of the correlation	-.440**

Question 49

The results demonstrate that there is a significant statistical correlation between the number of near miss events and the belief that the crew is expected to comply with work-rest hour regulation.

Question	**KPI**
Question 49 - The crew is expected to comply with work-rest hour regulation.	Number of near-miss events
Relationship	Positive
Power of the correlation	.376*

Question 53

The results demonstrate that there is a significant statistical correlation between the number of internal audits (ISM) findings and the belief that the crew has access to all necessary personal protective equipment (PPE).

Question	**KPI**
Question 53 - The crew has access to all necessary personal protective equipment (PPE).	Number of Internal audit (ISM) findings
Relationship	Positive
Power of the correlation	.321*

Question 54

The results demonstrate that there is a significant statistical correlation between the PSC inspection numbers and the belief that watch hand-overs are comprehensive and not hurried.

Question	**KPI**
Question 54 - Watch hand-overs are	PSC inspection numbers

comprehensive and not hurried.	
Relationship	Positive
Power of the correlation	.405*

Question 56

The results demonstrate that there is a significant statistical correlation between the management visit frequency and the belief that ships hold an adequate number of safety meetings.

Question	KPI
Question 56 - My ship holds an adequate number of safety meetings.	Management visit frequency
Relationship	Positive
Power of the correlation	.426**

Question 60

The results demonstrate that there is a significant statistical correlation between the number of near-miss events and the belief that crew members always give proper instructions when they initiate any work.

Question	KPI
Question 60 - I always give proper instructions when I initiate any work.	Number of near-miss events
Relationship	Positive
Power of the correlation	.364*

Question 63

The results demonstrate that there is a significant statistical correlation between the number of internal audit (ISM) findings and the belief that safety briefings and training are professional and effective.

Question	KPI
Question 63 - Safety briefings and training are professional and effective.	Number of internal audit (ISM) findings
Relationship	Positive
Power of the correlation	.339*

Question 68

The results demonstrate that there is a significant statistical correlation between the number of near-miss events and the belief that the company cares about crew members' health and safety.

Question	KPI
Question 68 - This company cares about my health and safety.	Number of near-miss events
Relationship	Positive
Power of the correlation	.422*

Question 71

The results demonstrate that there is a significant statistical correlation between management visit frequency and the belief that the company continuously try to improve the quality of the trainings.

Question	KPI
Question 71 - The company continuously try to improve the quality of the trainings.	Management visit frequency

Relationship	Positive
Power of the correlation	.369*

Question 72

The results demonstrate that there is a significant statistical correlation between the number of near-miss events and the belief that crew members have adequate knowledge of the company (safety) management system.

Question	**KPI**
Question 72 - I have adequate knowledge of the company (Safety) Management System.	Number of near-miss events
Relationship	Positive
Power of the correlation	.349*

Question 75

The results demonstrate that there is a significant statistical correlation between management visit frequency and the belief that adequate time is allowed for safety drills.

Question	**KPI**
Question 75 - Adequate time is allowed for safety drills.	Management visit frequency
Relationship	Positive
Power of the correlation	.348*

Appendix H - Algorithm of the Procedure Improvement Tool

This appendix presents the algorithm of the Procedure Improvement Methodology, developed to support the collection, assessment and decision making related to workarounds practiced in the maritime industry. The methodology consists of three main stages: 1) gathering of workaround data and development of attributes, 2) ranking and selection of alternatives using FMADGM and TOPSIS and 3) final decision-making by administrator and feedback provided to seafarer and reviewers.

Stage 1: Identification and Review of Workaround

The purpose of the first stage of the methodology is to capture workarounds practiced on-board vessels from crewmembers and identify the significant factors to make comparison between SOPs and workarounds. To collect workarounds, there requires to be a formalised means of capturing this data.

When the tool is installed into a shipping company system and appropriate credentials are given to the seafarers, they can go online and report any deviations from SOPs for the assessment process. It is also possible to upload a picture or a video to support the suggestion.

Anonymity of the Data Collection Methodology

Within the design of the Procedure Improvement Tool, anonymity was regarded as a crucial aspect. Indeed, the blame culture is still a predominant factor in the maritime industry and seafarers are reluctant to share information about workarounds because they fear of negative repercussions. In the developed methodology, an identification number is assigned to the each specific workaround submitted. Indeed, the assignment of reviewers of a specific workaround for the assessment process is defined by the administrator based on the identification number. Only at the end of the assessment process, the system matches the identification number with seafarer’s personal information and sends him/her the result. Neither admin nor reviewers are able to see the personal information of a seafarer.

Stage 2: FMAGDM Method for Ranking and Selection of Alternatives

In order to compare the workaround and the SOP, the fuzzy multiple attributive group decision making method (FMADM) was adapted from Ölçer and Odabaşi (2005). This method consists of three distinct states, namely (1) the rating state, (2) the attribute based aggregation state and (3) the selection state. This method leverages reviews by experts, which are elicited through an established workaround assessment form to provide an assessment of the workaround based on a number of attributes. Reviewers/experts are defined as individuals with substantive knowledge of a given area. Experts are given workarounds to assess based on their expertise and this allocation is decided by the administrator. The following subsections details each of the three states in greater detail.

State 1: Rating State

The first state is defined as the rating state. In this state, admin is firstly asked to rate the importance of the each attribute and expert's knowledge about these attributes using a Likert-type scale as high, higher, average, lower and low (See Table H 1).

Set weightings for each attribute

Practicality	3. Average
Time Efficiency	3. Average
Cost Efficiency	3. Average
Regulatory Compliance	5. High
Safety	5. High
Risk to Person	4. Higher
Risk to Ship	4. Higher
Risk to Environment	4. Higher
Risk to Company	4. Higher
Save	

Table H 1 Defining the importance of each attribute

Naturally, each expert has different levels of expertise across the attributes (for instance one expert can have more knowledge about safety but has less knowledge about compliance). Therefore, it is important to utilize heterogeneous group of experts in the aggregation. In the aggregation process, the person calculated as having the most expertise was weighted as “1” and others were compared and weighted relatively with this person. The linguistic terms were converted to standardized trapezoidal fuzzy numbers because linguistic terms are not mathematically operable.

Established conversion scales exist in the conversion of fuzzy data to fuzzy numbers and the conversion scale used is found in Table H 2. The Scale 3 is selected as an appropriate scale. The selected experts are asked to rate the workaround in a questionnaire format. Experts are required to assess the workaround based on a number of predefined subjective attributes, these attributes, now established from an earlier stage, are generic and used for all workarounds regardless of their operation categorisation.

Table H 2 Scales of fuzzy data (Chen et al., 1992).

			1	2	3	4	5	6	7	8
1	**None**									(0, 0, 0.1)
2	**Very Low**	Very Poor			**(0, 0, 0.1, 0.2)**		(0, 0, 0.2)	(0, 0, 0.1, 0.2)	(0, 0, 0.2)	(0, 0.1, 0.2)
3	**Low - Very Low**								(0, 0, 0.1, 0.3)	(0, 0.1, 0.3, 0.5)
4	**Low**	Poor		(0, 0, 0.2, 0.4)	**(0.1, 0.25, 0.4)**	(0, 0, 0.3)	(0, 0.2, 0.4)	(0.1, 0.2, 0.3)	(0, 0.2, 0.4)	(0.1, 0.3, 0.5)
5	**Fairly Low**					(0, 0.3, 0.5)	(0.2, 0.4, 0.6)		(0.2, 0.35, 0.5)	(0.3, 0.4, 0.5)
6	**Mol. Low**							(0.2, 0.3, 0.4, 0.5)		(0.4, 0.45, 0.5)
7	**Medium**	Fair	(0.4, 0.6, 0.8)	(0.2, 0.5, 0.8)	**(0.3, 0.5, 0.7)**	(0.3, 0.5, 0.7)		(0.4, 0.5, 0.6)	(0.3, 0.5, 0.7)	(0.3, 0.5, 0.7)
8	**Mol. High**							(0.5, 0.6, 0.7, 0.8)		(0.5, 0.55, 0.6)
9	**Fairly High**					(0.5, 0.75, 1)	(0.4, 0.6, 0.8)		(0.5, 0.65, 0.8)	(0.5, 0.6, 0.7)
10	**High**	Good	(0.6, 0.8, 1)	(0.6, 0.8, 1, 1)	**(0.6, 0.75, 0.9)**	(0.7, 1, 1)	(0.6, 0.8, 1)	(0.7, 0.8, 0.9)	(0.6, 0.8, 1)	(0.5, 0.7, 0.9)
11	**High - Very High**								(0.7, 0.9, 1, 1)	(0.5, 0.7, 0.9, 1)
12	**Very High**	Very Good			**(0.8, 0.9, 1, 1)**		(0.8, 1, 1)	(0.8, 0.9, 1, 1)	(0.8, 1, 1)	(0.8, 0.9, 1)
13	**Excellent**									(0.9, 1, 1)

Table H 3 Selected Scale for Aggregation.

Likert Scale Statements	Scale 3
1. Very Poor	(0, 0, 0.1, 0.2)
2. Poor	(0.1, 0.25, 0.4)
3. Fair	(0.3, 0.5, 0.7)
4. Good	(0.6, 0.75, 0.9)
5. Very Good	(0.8, 0.9, 1, 1)

State 2: Attribute based aggregation state

The second state is the attribute based aggregation state. Its purpose is to provide an aggregated result for the workaround. In this state, a score is calculated and assigned to each expert for each attribute capturing the expertise of each expert that is a potential means of weighting of each expert within the analysis. This calculation is performed to allow appropriate weighting of the expert opinion and then provide robust results and a higher degree of confidence in the calculations. There are nine subjective attributes for aggregation in order to compare SOPs and workarounds.

The aggregation process follows the below sequence according to the adopted method of (Ölçer and Odabaşi, 2005) and is paraphrased from their paper:

1. Firstly, the degree of agreement (degree of similarity) is calculated, this is denoted by S (R1, R2). In this stage, the method developed by Chen (1995) is utilised to calculate degree of similarity between all possible sets of experts. The degree of agreement is calculated as follows: given we have the opinion of Expert A who gives in trapezoidal number, say $A = (a_1, a_2, a_3, a_4)$ and then Expert B who gives $B = (b_1, b_2, b_3, b_4)$, S(A, B) is calculated as:
$$S(A, B) = 1 - \frac{|a_1-b_1|+|a_2-b_2|+|a_3-b_3|+|a_4-b_4|}{4}.$$
An increase in S (A,B) corresponds to a higher degree of agreement between the experts with a maximum possible value of 1.
2. After the calculation of degree of similarity was performed between all possible pairs of experts the agreement matrix (AM) is calculated. The matrix displays the degree of agreement between every pair of experts. The diagonal

is the degree of agreement of an expert with themselves therefore values on the diagonal are always 1.

3. Average degree of agreement (AA) is then calculated by using AM. The average degree of agreement of expert u, denoted by E_u is calculated as

$$AA(E_u) = \frac{1}{M-1} \sum_{\substack{v=1 \\ v \neq u}}^{M} S(R_u, R_v),$$

where M is the number of experts and E_v corresponds to expert v, $1 \leq u \leq M$ and $1 \leq v \leq M$.

4. The relative degree of agreement (RA) is next calculated as:

$$RA(E_u) = \frac{AA(E_u)}{\sum_{u=1}^{M} AA(E_u)}.$$

5. Consensus degree coefficient denoted by $\mathrm{CC}(E_u)$ of expert E_u is calculated by

$$\mathrm{CC}(E_u) = \beta \cdot we_u + (1 - \beta) \cdot RA(E_u),$$

where $\beta (0 \leq \beta \leq 1)$ represents the relaxation factor. Naturally, when $\beta = 0$ all experts are considered equally and this will occur in a homogeneous group of experts. It is evident that β acts as a weighting of we_u, which denotes the importance of the expert and $RA(E_u)$ which is the relative degree of agreement of the expert. (Ölçer and Odabaşi, 2005) suggest that to one way to assign weightings to experts is to use a moderator who assigns weights to each expert.

6. Lastly, the aggregation results, R_{AG}, of fuzzy opinions are calculated as

$$R_{AG} = CC(E_1) \otimes R_1 \oplus CC(E_2) \otimes R_2 \cdots \oplus CC(E_M) \otimes R_M,$$

where $\oplus$ denotes the fuzzy addition operator and $\otimes$ denotes the fuzzy multiplication operator.

As noted, the above is taken from Ölçer and Odabaşi (2005) more in-depth details of the method can be found there.

To summarise, this method aggregates the ratings provided by the group of experts for each alternative according to subjective attributes. All of experts' ratings for each alternative are aggregated according to subjective attributes and both attributes and experts are weighted according to their importance in the decision-making context expertise.

State 3: Selection state

The third state is the selection state which aims to provide a ranking of the alternatives. After State 2, all aggregated trapezoidal fuzzy numbers were defuzzied to rank the best alternative. Fuzzy numbers are transformed into crisp numbers for evaluation by implementing fuzzy scoring approach (Chen et al., 1992). Weighting of the attributes is considered in this state.

TOPSIS

TOPSIS is utilized as a MADM method in the ranking stage to rank the order of the alternatives. TOPSIS, developed by (Hwang and Yoon, 1981) is well-known with its broad acceptability in many problematic areas and effective for determining best alternatives quickly. The working algorithm of TOPSIS is given below (Ölçer and Odabaşi, 2005):

1. Attribute dimensions are converted into non-dimensional attributes in order to benchmark the attributes and obtain normalised weightings;
2. The normalised decision matrix multiplied with its associated attribute weight is done in order to calculate weighted normalised ratings. There are several methods to calculate the weightings of the attributes such as Weighted Evaluation Technique (WET), eigenvector method and entropy method (Ölçer and Odabaşi, 2005). In the proposed methodology the WET was adopted;
3. Positive ideal and negative ideal solutions are calculated;
4. Separation measures are calculated by Euclidean distance;
5. Similarities to positive ideal solution are calculated;
6. Preference order is ranked amongst alternatives.

Stage 3: Finalised Results and Feedback of Workaround Evaluation

The last stage relates to the decision making process and the distribution of the results.

It is recognised that decision making predominantly involves the consideration of more than one criterion or attribute (Pidd, 2009). An interesting aspect of research investigates the way in which people make decisions, and the work of Kahneman and Tversky (1982) highlights that individuals do not make decisions in a systematic way and there are inherent biases in the decision making processes of individuals. In the decision making process, the decision maker has to identify and consider the relevant stakeholders. The finalised decision ends up to be a compromise between needs and expectations of the different stakeholders identified and, sometimes, it needs to prioritise the wishes of the stakeholders with the most power (Pidd, 2009). Indeed, decision-making is a challenging task, especially when there are varying criteria with which to measure the different alternatives. In order to ensure consistency across experts and facilitate a structured and repeated process of decision-making, the experts' judgments are elicited with a formalised means based on a questionnaire. This helps experts think through the problem based on agreed pre-defined attributes.

In the previous stage of the methodology, experts provide an assessment of the workaround which is then used to provide a finalised aggregated value from the group of experts for the workaround and SOP. This value indicates the extent to which the workaround is better than the SOP, or not. The final stage of the methodology relates to the decision making process.

In order to allow the decision maker to make a judgment on the workaround, a summary is provided to the decision maker to assist them. The decision maker is provided: a written summary of the workaround; the SOP which is being deviated from; a written summary of the risks; a written summary of the benefits; the aggregated results from the heterogeneous group of experts; a breakdown of the attribute based values from the experts' assessments; a breakdown of the experts' assessments. The decision maker is also given associated information about the calculation of the score.

In order to communicate clearly the results, the information is provided in a visual format to enable decision makers to better understand the variation between experts as well as variation between attribute scores. A generic scale has also been developed to assist the decision maker; the scale is used to determine which category the result of the experts' assessments belongs and provide guidance about the appropriate action for the decision maker to choose, this is shown in Table H 4. The decision maker will formulate a decision based on the information.

Table H 4 Guidance Scale (where x denotes the value produced by the FMAGDM method).

Value of Workaround	Guidance
$0 \leq x < 0.4$	SOP should be strictly followed. Value of the workaround highlights severe lack of adherence to key attributes. These types of workaround should be prohibited.
$0.4 \leq x < 0.5$	SOP should be kept as a template, but the information in the workaround can be considered and there is potentially a need for improvement in the SOP.
$0.5 \leq x < 0.6$	Workaround is better but requires discussion of amendments to SOP.
$0.6 \leq x < 1$	The workaround should be converted into SOP to enhance operational safety and meets both the operational realities on-board vessels as well as meeting desired safety levels.

The feedback is to be provided to the seafarer who submits the workaround. Indeed, it is very important to close the loop with who has raised the issue in order to avoid loss of interest and confidence in the system.

The ultimate intention of the Procedure Improvement Tool is the development of the solution identified as best way of working. Sometimes it requires the involvement of multiple stakeholders, including seafarers to discuss the workaround. In these cases, an invitation would be sent to each crewmember to participate in the session, allowing the original seafarers or any other people to be involved in the development of a more suitable SOP. Should seafarers accept then management can build a relationship with the seafarer. In addition, as they are involved in the process of developing the SOP, it is expected that they will buy in to the solution and the solution will ultimately be more effective in the end as the seafarer has more interest in seeing the solution work. The SOP may have more credibility with seafarers as they know that seafarers were involved in the process.

In order to build and maintain trust in management, this type of open dialogue is crucial. Seafarers who perceive management as distant, not fully considering suggested workarounds, not taking appropriate actions for identified dangerous workaround can lead to a lack of trust. Naturally, it takes time to build trust between workers and managers and to do so they must appear to listen and engage in a sensible dialogue and listen to the concerns or suggestions of seafarers. Full consideration and appropriate feedback and action based on the workarounds will help work towards developing a safety culture of which seafarers feel part.

Potential Challenges of the Methodology in Implementation within Shipping Organizations

The above methodology provides a sensible and robust procedure to identify and assess workarounds being carried out in the maritime industry. However, there are a number of challenges associated with this methodology that may arise in the implementation of the methodology on-board vessels and this section seeks to make consideration to these.

First, it has to be considered the fact that the blame culture is still a predominant factor in the maritime industry. Therefore, seafarers could be reluctant to share information about workarounds because they fear that it might backfire on them. The anonymity of the suggestion is a feature that has purposefully introduced in order to reassure seafarers.

Another challenge that has to be addressed is the cases when the workarounds receives negative feedback. Indeed, any rejection of proposed workarounds has to be motivated and adequately communicated to seafarers in order to avoid loss of interest and confidence in the system.

Limitations of Methodology

There are naturally limitations associated with any methodology. This section seeks to address the limitations of the proposed methodology.

The first limitation of the methodology is the degree of information captured associated with the workaround. Seafarers may provide limited information meaning that the subsequent stage is difficult for experts to do as there is limited information about the risks and benefits of performing a task in that way. Furthermore, the seafarer may be biased in the presentation of information and may not report all associated risks as they want this workaround to be accepted. Lastly, a seafarer may not be aware of the risks of the workaround as they have never had any issues whilst performing the workaround.

The second limitation of the methodology is that experts are expected to judge the workaround based on the information provided by the seafarer. This information may be biased and may bias the review of the expert as well. The methodology may have potential to be enhanced by asking the expert to sketch out the benefits and risks associated with the workaround to ensure a full consideration of the workaround.

The deviation from SOPs is a phenomenon that affects the entire shipping industry and presents a threat to the safety of shipping. To date, there is no methodology which is able to capture these kinds of deviations, to assess them and to provide suitable means to identify the safer and most effective way of carrying out a given task. The key contribution of this methodology is the development of a means to collect workarounds, elicit details about workarounds being practiced on-board vessels, assess the workaround and supporting the decision maker in the comparison between it and the related SOP in order to determine the best way of working.

Appendix I - SOP Development Guide

Prerequisites to Develop Standard Operating Procedures

Standard Operating Procedures Development and Review Team

In order to ensure the development and review of SOPs are given the appropriate and required attention, a team should be developed in the organisation whose are responsible for this task. The responsibility may be all or part of their job role depending on their position in the organisation. The team must consist of a relevant group of persons from different backgrounds in the organisation and therefore possess and bring a variety of perspectives to the problem. Consideration must be given to how many are involved in the team. As also stated in the below structure, the ideal number for a team is four. Consistency of the team is crucial and maintaining the same team over an extended time period would be advantageous.

The development and review of SOPs can be sectioned into two distinct tasks. The first is the development of a new SOP, i.e. where no SOP currently exists in the organisation but where there is need of a SOP. The second is to review an existing SOP which is not meeting operational realities and the procedure improvement tool proposed opportunity for improvement regarding to this SOP. An interdisciplinary team should be responsible for the entire process.

It is suggested that the SOP development team should comprise of the following persons:

- HSEQ Manager
- Senior crew member (e.g. Captain/Chief Engineer)
- Seafarer (who is required to perform the SOP in their daily operations)
- On-shore personnel

The roles identified above are a guide, but it is essential for the team to consist of a number of persons pertaining from different backgrounds. The potential value of crew members is not to be underestimated and if possible to involvement of such persons will lead to the development of SOPs which do meet the operational realities of shipping.

Allocation of Resources

In order to develop and maintain a set of SOPs there is a need for a dedicated team and also the appropriate allocation of resources. There is importance for the team to identify that the development of SOPs is part of their job role and the workload associated with this development should be integrated in their designated workload. Without dedicated time and allocation of resources, there may be the perception that the organisation does not take SOPs seriously and this can become a low priority for team members. This allocation of resources aims to achieve buy-in of these team members.

Identification and Understanding of Problem

In the initial stages of the formalisation of SOP Development and Review process, there is the need to address a number of basic aspects which are critical for building upon in future.

Identifying the Desired Purpose and Role of Standard Operating Procedures

An important initial stage for the SOP Review and Development Team is to appreciate the role and purpose of SOPs. It is important within the team to have a shared understanding and work together to gain an in-depth appreciation of SOPs and their impact upon safety. There are a number of established methods which can be used to do this, details are provided on one such method which a group mapping exercise and the steps are detailed as follows:

1. Find a large, blank wall which can be used.
2. Assign one person as the ‘facilitator’, this person will be responsible for ensuring the session runs smoothly.
3. Distribute large Post-It notes, oval shaped are better for this.
4. The facilitator should introduce the focus on the session and describe how it will be carried out.
5. Participants should be asked to write short statements on the Post-It notes and either provide these to the facilitator or place on wall. All participants should add their inputs.
6. The rate of new ideas will eventually decrease and at this stage the facilitator should draw the session to a close.
7. The next stage is for the facilitator to start arranging the Post-It notes into groups. This can be done with the input of the team members.
8. The session should finish with distinct groupings of Post-it notes on the wall. If possible, links should be draw between the groups to identify how they relate to one another.

The purpose of this session is to gain a better appreciation of perspectives in the group of the role of the SOPs and allow participants to engage and share their perspectives. Participants should be encouraged to consider all the aspects that could affect safety adversely.

Building on this, the team should agree on a working definition for Standard Operating Procedures. This definition should be viewed only as a working definition and perceived as malleable where it will be updated as and when necessary in order to reflect changes within the organisation over time. The definition of SOPs should be updated in the SOP manual when changed.

Based on the above outcome, the group should brainstorm to determine the key aspects of SOPs. The team should be able to group Post-It notes into suitable categories. These groups will indicate the key aspects of importance with respect to the development of the SOP. A list of the key important attributes of SOPs should be identified. Alternatively, the Procedure Improvement Tool identifies nine attributes which are keys to consider in the review of an SOP, these are: practicality, time efficiency, cost efficiency, regulatory compliance, safety, risk to person, risk to ship, risk to environment and risk to company.

Identifying and Understanding Relevant Stakeholders

Within this problem there are a number of stakeholders who must be considered when developing and reviewing SOPs. In order for the team to appreciate the stakeholders and their individual interests in the problem, a stakeholder analysis should be conducted. The analysis should identify all relevant stakeholders in the problem, i.e. who does the change in SOPs affect? Stakeholders each have their own agenda and incentives with respect to SOP and these may be conflicting. Stakeholders, due to differences in their knowledge may also have different opinions on what are feasible and infeasible course of action and even what is wanted. As shown in Figure I 1, a simple structure can be used to map out stakeholders based on power and interest, from this it can be better understood how to satisfy stakeholders in which way.

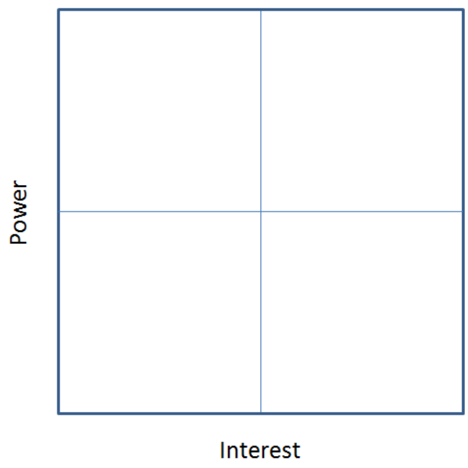

Figure I 1 Power-Interest Stakeholder Matrix

It is key to consider all of those affected by the SOP. What does each stakeholder want? What do they know? Are all viewpoints represented by the team, and if not how are their viewpoints to be taken into consideration? What are their needs? How do they affect each other?

Developing a Board of Representatives for Review Purposes

The development of SOPs will be a collaborative process involving and consulting stakeholders throughout. Prior to being implemented, the SOP will be reviewed by a board of representatives. The board of representatives consists of relevant persons from all involved departments in the organisation. At this stage, the development of this board is necessary. The SOP Development and Review Team must identify and contact all relevant departments who will be affected by SOP development and work with these departments to identify a suitable representative. Involvement of all representatives helps to ensure that each department are involved in the process as opposed to SOPs being forced upon them, thus resulting in greater buy-in to the solutions.

To allow understanding, a short summary of the expectations of the representative should be developed and provided to allow understanding before the representative is involved in the process.

Leverage Internal Knowledge: Involvement of Those Implementing SOPs

There is a wealth of knowledge available from those currently implementing SOPs, internally in the organisation. This knowledge should not be underestimated and insights from these persons will be invaluable in the development of SOPs. Their knowledge and understanding of what is feasible is of high importance and not to be ignored when designing SOPs. In terms of updating existing SOPs these persons are able to identify the strengths and the weaknesses. All those, who are affected by the SOPs should be represented in the development of the SOPs. It is therefore important to involve the seafarer who proposed the opportunity for a SOP improvement via the tool at the SOP development process.

Process for Handling SOP Development

The last aspect in this section is formalising the way in which the team will operate. Simple meeting aspects should be addressed, including agreeing upon roles; meeting timing; frequency of meetings; division of work and so on.

Development of a New Standard Operating Procedure

In some cases an entirely new SOP must be developed and in those cases the following details the best practices of developing a new SOP.

Task Identification

The first aspect is to identify and define the task to be completed. The definition can be a short paragraph. It is important to have a written definition of the task to allow a shared understanding in the team.

Asking the Basic Questions

Ask the basic questions to allow understanding for all in the review team of the task for which the SOP needs to be developed:

i. How the task is currently performed?
ii. When is the task performed, is it routine (scheduled) or non-routine (reactive)?
iii. Where does this SOP take place, what location(s)?
iv. Who carries out this SOP, what is their job role, language skills, technical knowledge etc.?
v. What are the risks associated with the task?

Identification of Relevant Guidelines/Rules/Regulations

Prior to developing a SOP it is important to identify any pre-existing guidelines, rules and regulations to which they must adhere. A summary can be made of relevant guidelines.

Read Relevant Documents/Conduct Interviews with Stakeholders

In some cases, there may be existing documents which are available relating to the task the SOP is to address. Identify and read all relevant documentation existing in the organisation as these can form a basis for the development of the SOP.

Conduct interviews with stakeholders and develop a map of the process of the task. Invite stakeholders to look at the map and offer their opinions on this, this will help to build a comprehensive map. Ensure the map is in a graphical format, bring extra copies to allow stakeholders to draw on it and amend as appropriate. Encourage them to add in arrows, amend wording and so on. The review team (team member) should update the map and have a finalised version in a computerised format.

At this stage it is necessary to identify whether there are any alternative means of performing the task, for example suggestions submitted by crew members.

Analysis of Alternatives & Decision

Given a set of alternative means of performing the SOP (if there are more than one possible way), the Procedure Improvement Tool can be used to compare these based on a set of attributes and subject to an expert review panel. The key part of this stage is to decide on alternative(s).

Generic Procedure and Key Questions for Developing a SOP

The following is a list of questions and instructions to support the development of SOPs. To ensure consistency across SOPs a generic template is created and this is shown in Appendix J, the template should be completed by following the questions/instructions detailed here. A case study demonstrating the application of these is provided in Section 9.3.10 and this can be consulted as and when necessary. The following is an iterative process and the team may need to work through the document as suits themselves.

The generic SOP template is segmented into five parts. The template ensures consistency in the format of all SOPs and will lead to a more professional perception of the SOPs. It also means that crew members will know how to use the SOPs and can ensure that each will have the same structure. The following addresses each part of the documentation. Although it is discussed in order, it may be that this is an iterative process and sections may not be filled out in order, but should be carried out as is best for the team.

It is recommended that the SOP is sectioned as:

Content

1. **Cover page**
2. **Part 1: Information for seafarers**
    a. **Section 1 – Description of SOP**
    b. **Section 2 – Hierarchical Flow Chart**
    c. **Section 3 – Definitions of Distinct Types of SOPs**
    d. **Section 4 – Flow Diagram and Required Resources**
3. **Part 2: Information for managers**
    a. **Section 1 – Management System**
    b. **Section 2 – Human Factors**
    c. **Section 3 – Equipment**
    d. **Section 4 – Inspection, Maintenance and Certification**
4. **Glossary and definitions**
5. **Appendix**

Sectioning the document in this way allows the relevant persons to locate the desired information easily. The layout is such that all necessary documents for a user are located together.

Document Pre-Face/Title Page

i) Add SOP title, SOP ID, approval date, version number, date effective (this will be completed at the end of the process).
ii) Add a short description of the purpose of the SOP, keep this clear and concise.
iii) Identify which departments are affected by the SOP.
iv) Add any specific guidance on how to use the SOP.
v) Check which documents are included in the SOP and indicate they are included using the check-boxes.
vi) Detail any training which is required prior to implementation of the SOP.

PART 1: INFORMATION FOR SEAFARERS

SECTION 1

i. Include the description of the SOP, purpose of SOP, and include any relevant definitions required for technical terms. If there are a significant number of technical definitions it may be best to provide these at the end of the document in a specific section. For technical definitions, these should be added as the document is developed.

ii. Keep text short, use bullet points where possible. Write in chronological order where appropriate.

SECTION 2

The purpose of this section is to provide a hierarchical flow chart which allows users to identify which specific documents are relevant to the type of task they want to perform. This stage provides the necessary steps to build a hierarchical flow chart. The key aspect is that is must be clear and that users are directed to relevant extra detail; the number of levels will vary based on the SOP, but users are encouraged to think about the appropriate level of disaggregation.

This flow chart can be drawn by hand or online, as is convenient for the team but for the final version this should be a computerised version to allow for improved clarity. Based on the outline of the SOP, identified through existing documents or interviews with stakeholders, using the critical parts create a hierarchical flow diagram that can be used to help guideline seafarers so they understand the overall process of the SOP and help direct to appropriate checklists and process flow maps.

i. Identify what the procedure is (SOP). Make/draw a box at the top of the page, write in the box what the procedure is. This should be a short phrase if possible. **Example:** ‘Lifting Operations’.

ii. Consider whether there are any variations of the procedure which require a categorization, i.e. are there multiple types/ /classifications within this procedure? If no, move to step vi. If yes, how should these be classified? At this stage it is best to make broad categorisations. For the given number of categorisations are identified, create relevant number of boxes underneath the top-box. Write a short statement capturing the distinct procedural variation/classification/etc. Link top-box to these with arrows. **Example:** for Lifting Operations, ‘Routine’ and ‘Non-Routine’ lifts can firstly be distinguished between.

iii. Consider: are there any varieties of the procedure which would make this inapplicable? Do we need to form a new classification? Add in extra box if necessary.

iv. Within each classification, identify whether different categories exist, if there are no categorization in the procedures go to vi. What are the criteria for the different categories, how can a seafarer identify this is the task they want to carry out? Give names to each different category procedure. In each category, create a bullet point list with key criteria which encapsulates the different category. Make it short and readable. Create a bullet point list to summarise the key features of the each category of the procedure. **Example:** for lifting we have 'Routine' and 'Non-Routine' lifts. These can be distinguished between. These can be broken down into 'Routine repetitive lifting operations using the same equipment' and 'Routine lifting operations with loose lifting equipment' for Routine and 'non-routine - simple', 'non-routine complicated' and 'non-routine heavy' for non-routine lifts.

v. Consider: is this an easy way for seafarers to identify the procedure meets the criteria.

vi. In each box, a unique number should be added. This number will be used to cross reference between the flow chart, checklist and hierarchical flow chart.

What has been created is a hierarchical chart which a seafarer can use to identify what checklist and process flow chart is relevant to them.

SECTION 3

i. List all defining criteria for all categorisations listed in the hierarchical flow chart.

SECTION 4

Each category in the procedure requires the following to be considered.

i. Identify the key stages of the procedure and create a process flow chart, showing the flow of work

ii. Break down each key stage into tasks. List these tasks.

iii. What persons are needed to be involved/present? Detail this in a list.

iv. For each person, identify the tasks for which they are responsible.

v. Consider: can each person physically and time wise complete all the tasks assigned to them? What other tasks will they be doing?

vi. Identify what level of expertise is required they must have, enter in the document. Use bullet points if possible.

vii. Consider: are the tasks feasible? Are they in the chronological order? Does the flow chart represent the main tasks to be performed?

viii. What relevant expertise and/or experience do the persons involved in the lift need to have?

ix. What documentation needs to be sought?

For each category of the procedure do the following.

i. What are the sub-tasks to carry out this procedure? Write these in chronological order, make the tasks clear and short, identify a goal of each sub-task. What needs to be completed before beginning a sub-task and what needs to be completed by the end of the sub-task?

ii. Are any tasks missing? Add in if appropriate.

iii. Review: can the procedure be completed based on these? If no, add in as needed.

iv. For each sub-task identify which steps are critical? Make a list of steps for each sub-task. For each sub-task, write in the associated steps in chronological order.

v. Consider: are all critical steps included? Is any single or multiple things missing that could lead to an incident? Are steps completed as and when necessary?

vi. Identify who must do what steps.

vii. Review: Is a person asked to do too many tasks?

viii. If generic checklists exist, link to generic check-lists as appropriate, otherwise write out in full.

ix. Using the critical steps for each subtask, amalgamate these to develop a check-list. To help readability it may be clearer to divide have sections for each sub-task. Long check-lists may appear overwhelming. By breaking it into sub-tasks it will help the seafarer understand the overall process and identify the stages within the procedure. Multiple check lists will be needed for one SOP if there are different tasks within the SOP that are significantly different from one another as identified above.

PART 2: INFORMATION FOR MANAGEMENT

SECTION 1: MANAGEMENT SYSTEM

i. What is the importance of the management system upon safety in the procedure? Write a short statement highlighting importance.
ii. What measures will be used to assess whether there is a safe working environment? Develop these measures and create a list.
iii. Identification of what the desired level of safety is in terms of number of accidents related to the procedure.
iv. What management stance is taken if crew members do not have training, equipment is not to standard etc.?
v. How will incidents be recorded?
vi. What do seafarers need to know?
vii. How will the SOP be reviewed? Provide details.
viii. What periodic reviews will take place? How often, by whom, etc.?
ix. How will non-periodic reviews be handled? Detail the ways in which non-periodic reviews can arise, identify how to gain information and how these reviews will be structured.
x. What technical expertise is required?
xi. Are all crew members who would be expected to carry out this procedure appropriately trained?
xii. Ensure documentation is established to maintain records of what each person has received in training.
xiii. Do crew members need further, specific training?
xiv. Prohibition of seafarers undertaking the task if they do not have appropriate training.

SECTION 2: HUMAN FACTORS

i. What are the most significant human factors related to this procedure?
ii. How are these taken into consideration?
iii. Create a detailed overview of how each of the factors will be appropriately accounted for in the SOP.

SECTION 3: EQUIPMENT

i. What equipment is needed to perform the task?
ii. What requirements are there for the equipment to be operated?
iii. What training is required?
iv. Is appropriate signage, documentation displayed upon the equipment?
v. What safety equipment is needed?
vi. Are all relevant areas marked with appropriate signage?
vii. What equipment documentation exists? List all.

SECTION 4: INSPECTION, MAINTENANCE AND CERTIFICATION

i. How will the equipment be inspected?
ii. How often will the equipment be inspected?
iii. How will it be maintained, who is responsible, what checks?
iv. What documentation is used as guidance, i.e. manufacturer's documents?
v. List all special circumstances after which additional inspection checks must be made.

Based on Entire Document:

Have sufficient safety steps been taken? Is this a safe procedure? Is the procedure feasible? Does any of the crew members have more than they can manage? In terms of the layout, is it feasible for them to move to appropriate areas in the ship? Is it written in language and terms used by seafarers? Is it at an appropriate reading level? Do management have appropriate information and guidance? If there are issues, update relevant sections as necessary.

Record Keeping

Some SOPs will require associated records to be kept of when and by whom the task was completed. A relevant form should be developed to allow this including date, time and location of task performed. Create relevant documentation as necessary and add into the SOP. Steps required when filling the document should be detailed as necessary. Ensure the need to complete forms is clearly stated in the SOP and the forms are made available.

Robustness Check and Initial Evaluation of SOP by Team

The team developed a number of attributes which the SOP must have. These attributes should be used here to thoroughly review the developed SOP. Attributes provide a rigorous and repeatable means of testing the SOP.

It may be advantageous at this point to identify where the system may fail. One way to do this is through fault tree analysis. Fault trees are simple diagrams which adopt a top-down approach to deduce how an undesired event, in this case a maritime incident. This fault tree analysis allows understanding of how the system may fail, the visual representation aids in understanding and identification can be made of the more vulnerable parts of the system. From this analysis, it allows the team to identify whether the SOP puts in place appropriate measures to militate against these risks.

To construct a fault tree:

- Identify the top event, the undesired outcome of system failure
- Adopting a top down approach identify sub events which can cause the top event
- Use AND/OR gates as appropriate thinking of the logic of the events, whether multiple failures must occur in the system for the top event to be realised or whether the top event can be realised through multiple events happening individually.

Feedback in a system can result in undesired events and occasionally a set of actions may also result in an undesired and unanticipated outcome. Think about feedback in the system, are there any unintended outcomes of practicing the SOP which can lead to negative effects somewhere else in the system?

Can the SOP be applied across the fleet of vessels or does it need to be changed for any vessel?

Review of SOP by Crew

It is crucial that those implementing the SOP are invited to review the SOP. Therefore, interviews should be help with relevant persons in the organisation. The interview will involve one of the members of the team and they can present to the seafarer the developed SOP. The seafarer should be asked to review the description, check-list, and graphical representation and asked to provide feedback. Visiting the seafarer on-board vessels will allow better understanding for the team member as the seafarer is able to show how the SOP may not work.

A list of questions should be developed to ensure that the seafarer is asked relevant questions with respect to the SOP. An example set of questions is detailed below.

a. Is the SOP feasible with consideration to physical and temporal aspects?
b. Does the SOP identify all the critical points which must be done while performing this task?
c. Could this conflict with any other task?
d. Is the SOP clear and concise?
e. Is the language understandable, are these the terms used in daily operations?
f. Is there anything missing from the check-list, that could lead to failure or multiple aspects which if not completed could lead to failure?
g. Is there anything incorrect with the order of the check-list?
h. Is the diagram clear?
i. Is there any vessel which is may not work for?
j. Are there any scenarios that it would not work for?
k. Is this how the task would generally be completed?

All of the feedback from the seafarer should be taken into consideration. The team member should make a written summary of all feedback from the seafarer and write it up as appropriate so that it can be shared with other members of the team. Minor adjustments can be made easily however, major issues may lead to a complete restructuring of the SOP.

Testing of SOP in Simulator and Drill Exercises

For some SOPs it will be possible to use drills or simulators to test the SOP. These should be used as and when deemed appropriate. They can provide valuable insight into the SOP in a simulated environment and can provide valuable feedback, highlighting any issues with the SOP.

Board of Representatives' Review of SOP

All SOPs should undergo a final review by the Board of Representatives to gain approval. This board, with representatives from all relevant departments should sign off the SOP. The SOP should be sent to all relevant representatives with a required sign-off date clearly stipulated. Directions should be given in how these representatives should provide feedback to the board.

Returned feedback should be collated by one member of the board and reviewed as necessary. Updates should be made as necessary.

Update All Relevant Guides

Update all documentation as necessary.

Summary of Process

The following, Figure I 2, is a summary of the process detailed above.

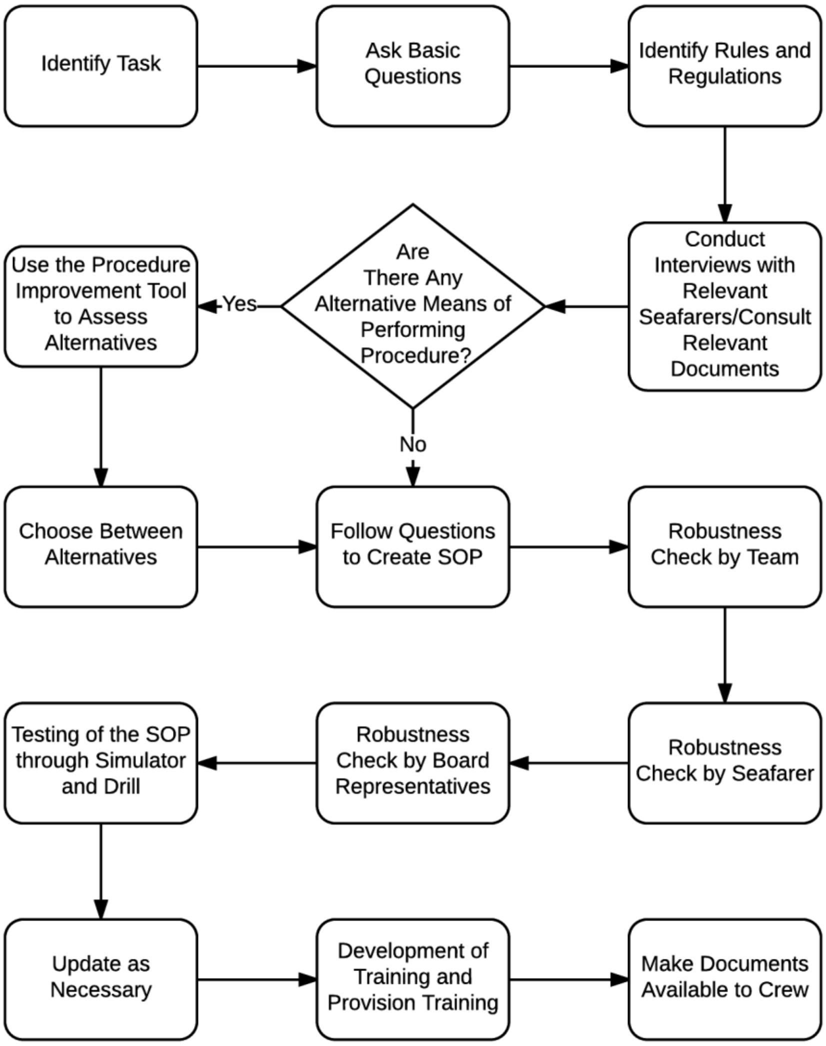

Figure I 2 Summary of Process of SOP Development

Reviewing and Updating Existing Standard Operating Procedures

SOPs should be viewed as working procedures, in that they are in a continual state of change and updated as and when necessary. A SOP will never be in its final state but always undergoes iterations as and when needed. In many cases a SOP will exist, but due to certain circumstances the SOP will require to be amended to better suit the changing operational realities on-board vessels. The following documents a process to allow such updating.

Identification of SOP

The first aspect is to identify the SOP which requires updating and familiarisation with the SOP. This can be done by consulting the manual. It may be of interest to note when the SOP was last updated.

Identification of Issues with SOP

The updating of an SOP will be motivated by a review (periodic or non-periodic); issues during real-life operations (e.g. an incident); issues during a drill or simulator exercise; reporting of deviations to SOP through reporting (e.g. through Procedure Improvement Tool.

No matter which of the above listed ways motivated the need for a change, the team should look to attain all relevant documentation. If no documentation or insufficient documentation exists then the team should identify relevant persons and conduct interviews to gain understanding of where the SOP is not meeting operational realities.

The issues with the SOP should form a list and identification should be made to highlight the parts of the SOP that failed.

Updating the SOP

Minor issues with the SOP can be updated. However, major issues with the SOP may result in significant changes.

Developing an Effective SOP Manual and Communication of SOPs to Crew members

Once developed, the SOP must be converted into a written document. In order to ensure the success of the SOPs they should be clearly and concisely written.

SOP Manual

It is recommended that a SOP manual is developed which contains all of the organisation's SOPs. The manual should be structured in a logical and clear way allowing for seafarers to quickly identify the SOP they require. The following structure is recommended:

TITLE PAGE
CONTENTS PAGE
CHAPTER 1: INTRODUCTION
CHAPTER 2: USING SOP MANUAL
CHAPTER 3: PROCESS OF REVIEWING AND CREATING SOPS
CHAPTER 4: SOPS
SECTION 4.1: BRIDGE OPERATIONS
SECTION 4.2: ENGINE ROOM OPERATIONS
SECTION 4.3: DECK OPERATIONS
SECTION 4.4: CARGO OPERATIONS
CHAPTER 5: FEEDBACK ON SOP

Articulation of SOP

The articulation and communication of SOPs are critical to the success. It is crucial that SOPs are understandable, thus the SOP should be written clearly and concisely. Care must be taken as the crew are most likely to be multicultural and therefore the likeliness of different native languages and reading skills should be considered. Where possible, use same phrasings used by crew members to ensure the understanding. Ambiguity leads to confusion, misinterpretation, frustration with the potential outcome that the SOP is ignored and perceived as irrelevant.

Placing Importance on Safety Culture in the Organisation

A vital aspect of the success in the overall safety culture in the organisation; if the organisation appears to be committed to safety and takes it seriously, these views are more likely to be held by a larger majority of the organisation. It is therefore of importance to ensure that the organisation at different levels gives the appropriate attention to SOPs. At an organisational level, the dedication of a team to SOP development will highlight the importance of SOPs to seafarers. However, the managers are of key importance. It is essential that managers buy-in to SOPs and ensure that they remind seafarers to adhere to SOPs, highlighting the importance of safety. When SOPs are introduced or revised the entire crew should be informed. Managers should ensure that their crew members understand the changes. They must also ensure the new SOP is enforced immediately.

Ensure that managers/seniors stress the importance of the SOPs, place importance on them. Seafarers will take their lead from their senior managers, if the manager emphasizes the importance of the SOPs and adherence to them, then, so will the seafarers.

In order for a manager to understand their influence upon the adherence of SOPs by seafarers, a session might assist to help them understand and refresh why SOPs are of such importance.

The safety culture is reflected by the entire perspective of the organisation to SOPs including timely updated, taking into consideration feedback, making changes when appropriate, timely introductions, managers perspective of SOPs, presentation of SOPs (manuals etc.) and thus all of these should be considered.

Implementing SOPs

Whether a SOP has undergone review or a new SOP has been developed both require to be implemented in the organisation and this is an important aspect for consideration.

Updating SOP Manual

New SOPs should be entered into the manual; this must be done promptly each time, and a time stamp should be given to when the SOP was last updated for user information.

Updated SOPs should replace existing SOPs, again this should be done promptly. A date identifying when it was last revised should be made clear in the document for user information.

Identify and Inform Relevant Persons

Relevant persons, based on their roles, should be identified and the SOP change should be communicated via email. This should also be reinforced by those in charge (i.e. line managers) also highlighting the changes. They should welcome any clarifications and in the initial stages should make an effort to ensure that the SOP is being adhered to. Without proper initial integration, seafarers may not take it seriously. Another information channel can be created where each SOP can be linked to the relevant ranks and hence only a certain group will be informed about when there is a change on a SOP.

Assess and Organize Required Training

The organisation should identify whether the new SOP requires additional training for any crew member. If additional training is required, the organisation must develop a suitable training program and identify which members of the crew require that training. The training must be developed and undertaken by crew before the SOP can be implemented.

Reviewing SOPs

Periodic Reviews

Over time, it may arise that SOPs are outdated and no longer fit for purpose as vessels and technology change. It is therefore required that periodic reviews take place to identify whether SOPs are still performing well and fit-for-purpose or whether they need to undergo revisions. Therefore, it is crucial for periodic reviews to take place. A fixed time should be identified for how often SOPs should be reviewed, it is suggested that SOPs are checked on a yearly basis. These pro-active reviews ensures that SOPs continue to be serving their purpose, the proactive approach allows identification of issues prior to an incident and it shows that the organisation is committed to ensuring that they have the best procedures. This proactive review will also filter down the levels showing the importance of SOPs and likely result in more commitment to the SOPs by seafarers.

It is recommended that the following steps are followed in a review:

1. Identify a subset of SOPs which need to be reviewed based on time. The subset of SOPs should be from the same type of operations.
2. Invite a representative from relevant departments to review the SOPs.
3. Identify issues.
4. If minor issues, rectify SOP appropriately.
5. If major issues, SOP Review and Development team to address.
6. Publish new SOP in manual and circulate to all crew members.
7. Managers should emphasize the relevant crew of changes in SOP.

11.1.1.1 Non-Periodic Reviews

Non-periodic reviews may take place after a number of aspects: 1) after events in which an incident has occurred due to a human or an organizational error, 2) issues identified during drills/exercises and 3) reporting of issues with SOP by seafarers or submitted via the tool. No matter which way the issue with the SOP is identified it is necessary to ensure that the SOP is reviewed to identify what went wrong and how best to amend the SOP to militate against these effects in future.

1. Conduct interviews/invite feedback from seafarers involved in the incident or reporting of SOP.
2. Identify any relevant documentation and read.
3. Identify areas where the SOP requires to be changed.
4. SOP Review and Development team to update as necessary.
5. Publish new SOP in manual and circulate to all team members.
6. Managers should emphasize to the relevant crew about changes in SOP.

Supporting Feedback from Seafarers on SOPs

Supporting seafarers in the communication of feedback related to SOPs which do not meet operational realities is of key importance. As explained before, the Procedure Improvement Tool supports the collection of data regarding workarounds (i.e. non-standardized means of working which deviate from the SOPs) practiced on-board vessels. It also supports the review of these workarounds with respect to a predefined set of attributes and the workaround is reviewed by an expert group based on the attributes. Importantly, the methodology supports the submission of workarounds anonymously. Allowing seafarers a convenient and anonymous way of submitting workarounds allows identification of which SOPs do not meet operational realities and those which could be improved. It may mean that a superior way of working is identified by the crew member and this may directly replace the existing SOP. However, it may be more likely that the SOP/workaround may need amendments prior to implementation.

The workaround assessment team and SOP development team can comprise of same people or work in collaborative way to creates SOPs from scratch or improve the poorly written ones. The methodology also importantly provides a feedback loop to ensure that the original seafarer submitting the workaround data receives feedback of the review of the workaround.

Appendix J - The SOP Development Template

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SOP Title:	**Title**		
SOP ID: xx	**Approved:** dd/mm/yyyy	**Version:** ###	**Effective:** dd/mm/yyyy
Standard Operating Procedure:	Short description.		
Departments Affected:	Please list.		
Guidance on SOP Use	Any specific, critical guidance.		
Specific Training Necessary	Please list.		
Included Documents	Description of SOP Standardized check lists Hierarchical flow diagram	☒ ☒ ☒	

(Organization Name)

Official Documentation of Standard Operating Procedures

Part 1: Information For Seafarers

Section 1: SOP Definition

SOP Title:	**Title**
Description of SOP	Short description
Purpose of SOP	Please detail.
Relevant Definitions of Technical terms for SOP	Please list.

(Organization Name)

Official Documentation of Standard Operating Procedures

Part 1: Information For Seafarers
Section 2: Hierarchical Flow Chart

SOP Title:	**Title**

Guidance:

- Use the hierarchical chart below to identify the categorization of the procedure you wish to perform.
- To find the associated appropriate documentation use the associated code number to look find relevant checklists, flow diagram and written details. E.g.…
- Criteria for each of the below categorizations can be found in Section XX-XX, if needed.
- *Please list any other specific guidance here.*

DIAGRAM HERE

(Organization Name)

Official Documentation of Standard Operating Procedures

Part 1: Information For Seafarers

Section 3.1 Definitions/Criteria

SOP Title:	**Title**

Definition of X and Y.

*A … is defined as **'X'** if it meets the following criteria:*

1. *X*
2. *Y*
3. *Z*

*A … is defined as **'Y'** if it meets the following criteria:*

1. *X*
2. *Y*
3. *Z*

<table>
<tr><td colspan="3">(Organization Name)

Official Documentation of Standard Operating Procedures</td></tr>
<tr><td colspan="3">Part 1: Information For Seafarers

Section 4.1.1: Flow Diagram of Procedure for XX</td></tr>
<tr><td>SOP Title:</td><td colspan="2">Title</td></tr>
<tr><td colspan="2">Create a separate flow chart for each category of the procedure in SOP

Flow Diagram of Procedure for XX:

DIAGRAM HERE</td><td>Required Persons & Tasks in Procedure:

Crew member 1
• Task 1
• Task 2
• Task 3

Crew member 2
• Task 1
• Task 2
• Task 3

Experience Required of Involved Crew Members
• A
• B
• C

Required Documentation and Control Mechanisms:

(List)</td></tr>
</table>

(Organization Name)

Official Documentation of Standard Operating Procedures

Part 1: Information For Seafarers

Section 4.1.2: Sub-Tasks & Checklists for XX

SOP Title:	**Title**

The following is a breakdown of the sub-tasks required in order to complete the procedure XX. Appropriate checklists can be found in the Appendix of the document. *One for each categorization of the procedure.*

Please read through all associated documentation carefully prior to performing the procedure.

The stages of the lift can be categorized into the following sub-tasks which are listed in the order they are expected to be carried out:

For example:

1. *Conduct a risk assessment (generic):*

    1.1. X ☐

    1.2. Y ☐

    1.3. Z ☐

2. *Conduct job safety analysis:*

   2.1. X ☐

   2.2. Y ☐

3. *Z ☐*

4. *Hold toolbox talk*

   4.1. X ☐

   4.2. Y ☐

   4.3. Z ☐

5. *Complete safety checklist (See Appendix XX for checklist) ☐*

6. *Complete 10 questions for a safe lift (See Appendix XX for list of questions)*

   6.1. Complete all questions ☐

If the answer to any question is no, then do not perform lift ☐

(Organization Name)

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Part 2: Information For Management

Section 1.1: Management System

SOP Title:	**Title**

MANAGEMENT SYSTEM

Provide details as necessary. Break down into sections if needed. Use bullet points where possible.

(Organization Name) Official Documentation of Standard Operating Procedures	
Part 2: Information For Management **Section 1.2: Human Factors**	
SOP Title:	**Title**

HUMAN FACTORS

Provide details as necessary. Break down into sections if needed. Use bullet points where possible.

(Organization Name)

Official Documentation of Standard Operating Procedures

Part 2: Information For Management

Section 1.3: Equipment

SOP Title:	**Title**

EQUIPMENT

Provide details as necessary. Break down into sections if needed. Use bullet points where possible.

(Organization Name)

Official Documentation of Standard Operating Procedures

Part 2: Information For Management

Section 1.4: Inspection, Maintenance And Certification

SOP Title:	**Title**

INSPECTION, MAINTENANCE AND CERTIFICATION

Provide details as necessary. Break down into sections if needed. Use bullet points where possible.