University of Southampton

Faculty of Engineering and the Environment

School of Engineering

Decision Making Procedures of Vessel's Shipboard Management

by

Gobikrishnan Veluplay

Thesis for the degree of Doctor Philosophy

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Abstract

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This research study offers a contribution to the field of shipping and safety using secondary evidences from shipping accident reports by MAIB and primary evidences from a questionnaire survey and a semi-structured interview completed by shipping company managers and seafarers who work on UK either registered vessels or hold a UK Certificate of Competency (CoC) while working on non-UK vessels. The study has been initiated from three research questions: 1. To what extent do, the human element affect the safety of a ship? 2. What is the relationship among safety practice aspects in the shipping industry? and 3. How can human errors and their impact be prevented? The study first reviewed a wide body of literature on issues related to safety culture which included a brief comparison between the safety perspective of maritime and aviation industries. With the help of the extant knowledge obtained from the literature, this research embarked on providing an explanation of the gap that existed in the safety culture in the maritime industry.

Followed by the literature, the study analysed the trend of the shipping accidents and the root causes of human error to understand further about the occurrence of the casualties. The analysis has shown a downward trend of accidents; however, the occurrences of very serious accidents are higher than less serious accidents. The analysis of shipping accidents reports from MAIB has also revealed various root causes of human errors that contributed to the occurrence of shipping accidents. Identification of the root causes of accidents led to a questionnaire based safety practice survey completed by 317 seafarers. Hierarchical Cluster analysis has been used to classify the selected safety aspects into two clusters based on their internal consistency. Multiple Regression Analysis has been used to identify the parameters based on the seafarer's perception that, influence the safety culture in shipping based on the seafarer's perception. Three parameters have been shown to have a particularly close relationship with safety culture which are: communication and language barrier; health awareness; and job satisfaction.

A semi-structured interview has been conducted among 10 shipping company senior managers and seafarers. The interview contributed to the identification of six safety practice themes. Bringing light to the safety culture issues, this study has attempted to expand the boundaries of research on the subject and contributed to a more holistic understanding of the various underlying factors that influence safety and the effectiveness of maritime regulation in the industry.

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Research Thesis: Declaration of Authorship

Print name: Gobikrishnan Veluplay

Title of thesis: Decision making procedure of vessel's shipboard management

I declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University;
2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
3. Where I have consulted the published work of others, this is always clearly attributed;
4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
5. I have acknowledged all main sources of help;
6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
7. None of this work has been published before submission or Parts of this work have been published.

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Abbreviations

AIS	-	Automatic Identification System
BCA	-	British Sociological Association
BPA	-	British Ports Association
CoC	-	Certificate of Competency
EMSA	-	European Maritime Safety Agency
FSA	-	Formal Safety Assessment
GISIS	-	Global Integrated Shipping Information System
HFACS	-	Human Factors Analysis and Classification System
IAEA	-	International Atomic Energy Agency
ICS	-	International Chamber of Shipping
ILO	-	International Labour Organisation
IMO	-	International Maritime Organisation
ISM	-	International Safety Management
LNG	-	Liquefied Natural Gas
LRFP	-	Lloyd's Register Fairplay
MAIB	-	Marine Accident Investigation Branch
MAIB	-	Marine Accident Investigation Board
MAIB	-	Marine Accident Investigation Branch
MCA	-	Maritime and Coastguard Agency
MLC	-	Maritime Labour Convention
NMD	-	Norwegian Maritime Directorate
NRC	-	National Research Council
NTSB	-	National Transportation Safety Board
PIS	-	Participation Information Sheet
PPE	-	Personal Protective Equipment
QS	-	Quality & Safety

SMS	-	Safety Management System
SOLAS	-	Safety of Life at Sea
SPSS	-	Statistical Packages for the Social Sciences
STCW	-	Standards of Training, Certification and Watchkeeping
UKMPA	-	United Kingdom Marine Pilot Association
UKMPG	-	United Kingdom Major Ports Groups
UN	-	United Nation
UOS	-	University of Southampton
VTS	-	Vessel Tracking System

Chapter 1 Overview and Background of the Study

1.1 Introduction

Many factors underpinning maritime accidents have been identified and regulations have been implemented to improve the safety of the maritime industry (Transport, 2019). However, the occurrence of accidents and their severity is unpredictable. Environmental conditions, technical failures, route conditions, ship-related factors, human errors and cargo related factors are among the main causes (Akten, 2006). Rothblum (2000) has explained that most of the accidents occurred because of human errors and the manners in which organizational factors influenced the way people performed. Therefore, implementation and strict control of regulations will have major impacts on reducing the effects of human error and organizational factors (Ganguly, 2011).

Improved or new safety regulations are developed after the occurrence of serious accidents that cause loss of live and property and environmental damages. These regulatory improvements have been imposed to prevent recurrence of the accidents (Ceyhun, 2014). The incident of the 'Herald of Free Enterprise', for example, is the main reason for the establishment of the International Safety Management (ISM) Code (IMO, 1998b),. an international standard for the safe management and operation of ships and pollution prevention, which was introduced by the International Maritime Organisation (IMO) in mid-1998 (IMO, 1998a).

Since the ISM Code was implemented there has been improvement in the safety of shipping (Tzannatos and Kokotos, 2009). However, maritime accidents are still happening on a daily basis around the globe. A total of 24545 accidents have been recorded world-wide from 2005-2014 (Allianz, 2015). This indicates that there is a gap in the effective implementations of the ISM Code. Additionally, a study on Greek-flagged vessels proved that, the problem is not in the code, but from the way the shipping companies implemented the code (Tzannatos and Kokotos, 2009). This is because, when the ISM Code was implemented on Greek-Flagged vessels, it has shown a drop in the number of accidents (Tzannatos and Kokotos, 2009). Based on the reading, the researcher believes that that the problem could be in the manner of the ISM Code being implemented and not in the Code itself. Otherwise, there will be no drop in the accident numbers on Greek-Flagged vessels. It is possibly a reflection of the lack of understanding and training on the ISM Code, which is either a result of profit-oriented companies or poor awareness on safety aspects. Hence, handling human errors with better understanding and implementation of safety regulations is important.

Thus, research on the shipping accidents trends, factors associated, and their root causes of accidents and safety parameters are topical and of practical significance. While the statistical analysis of accidents can illustrate the importance of the problem and lead to conclusions concerning the efficiency of regulatory changes, understanding the factors that contribute to the creation of risks is more challenging. In this respect, the perception and the views of shipping company managers and seafarers working on board ships can provide useful insight about the prevailing safety practice and changes in its perception. In addition, it also will be beneficial to outline the decision-making procedures for vessel's shipboard management. This research undertakes both quantitative and qualitative studies on the seafarers' perception of safety practice in shipping industry. The framework, research objectives and questions, and the report outline are presented in the next section.

1.2 Framework of the study

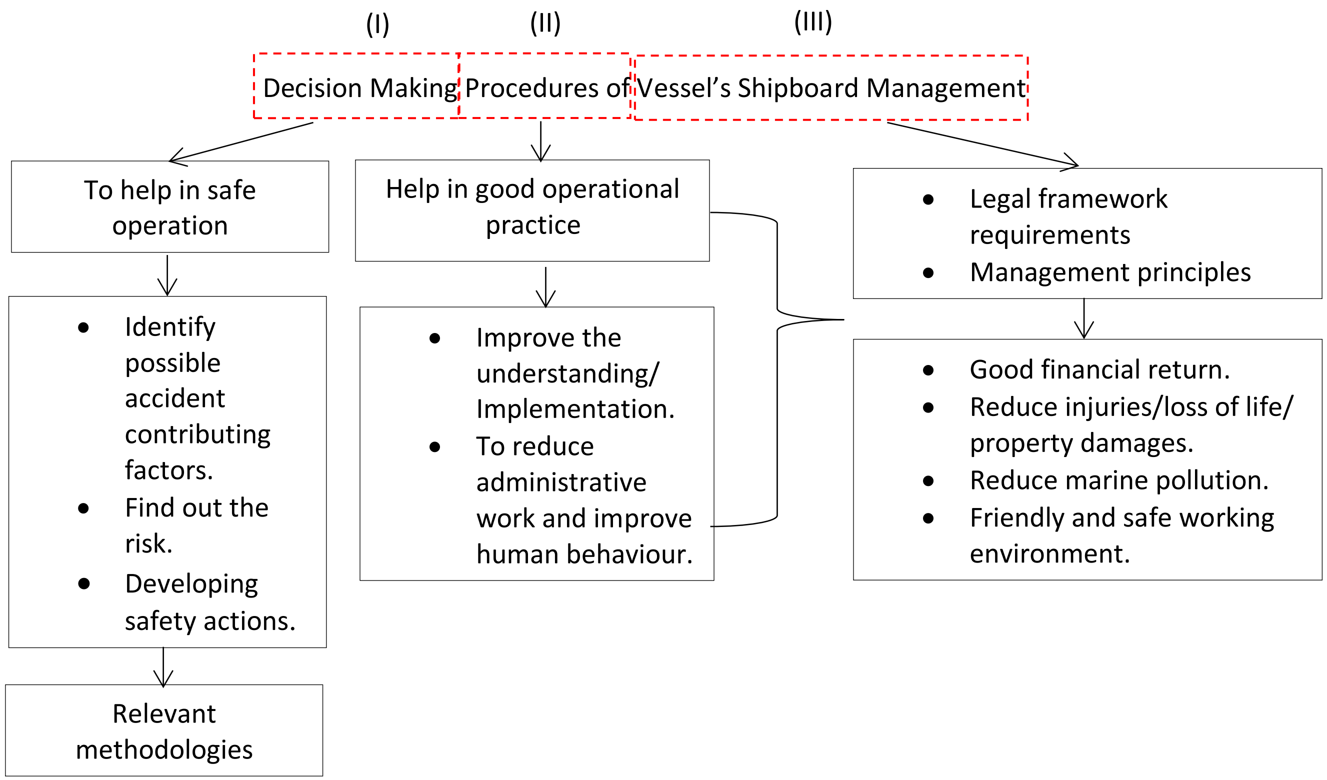

Figure 1 The elements of the study

Figure 1.1 shows the framework of this study. The research title of this study is divided into three parts: (I) decision making, (II) procedures and (III) vessel's shipboard management. In part I, the decision-making process, the identification of the causal factors of accidents and theirs risk are vital. Choosing appropriate methodologies for data analysis is important to obtain the intended results. These have been covered in the Chapter 4 (Section 4.3) and 5 where both quantitative and qualitative methods have been used. The data then was analysed using statistical analyses such as Human Factors Analysis and Classification System (HFACS), Hierarchical Cluster Analysis and Multiple Linear Regression Analysis. Previous studies in maritime safety have applied similar methodologies and have proven to be appropriate to be used in analysing safety culture related data/study (Singh, 2014; Ek, 2006a). The application of the chosen methodologies and analyses have helped to identify the possible accident contributing factors and the underlying risks in the industry. Then, upon identifying the causal factors, appropriate decisions can be made based on reliable resources to enhance maritime operations. As such, the researcher has gathered safety actions recommended by Marine Accident Investigation Branch (MAIB) into the HFACS framework where relevant safety actions can be referred based on types of human error (Appendices P, Q, R & S).

In part II, the study focuses on implementation and recommendation of the safety procedures. Having good procedures alone is not enough but how are they put into practise is important. Hence, it is necessary to have better exposure and understanding of the safety procedures or standards before the implementation. Therefore, the researcher has applied an interview survey method and utilised the evidence of this data for a better understanding and implementation of safety standards and practices to reduce the occurrence or the impact of human error (Chapter 6: Section 6.3 & Chapter 7: Section 7.2).

Part III, emphasising on the effective implementation of legal framework requirements, focuses on effective safety structure and management principles for continuous improvement (ICS, 2013). Besides identifying the threats and improving the understanding and implementation of safety standards and practices, it is also vital to be aware of the legal framework requirements and management principles. These have been seen from the perception of shipping personnel where they have given their opinion about the importance of legal framework requirement and the ways to improve safety (Chapter 6: Section 6.3 & Chapter 7: Section 7.2).

Hence, by applying all above methods, the researcher strongly believes the maritime industry or the shipping companies can expect a good financial return, reduced the number of marine casualties (McSween, 2003), reduced injuries, loss of life and property damages, reduced marine pollution and safer working environment (Elms and Low, 2013).

1.3 Objectives and research questions

There are several issues with ship safety and the management aspect is one such aspect. Within this aspect, there is a top-down approach where one looks at the regulatory regime and the management practices then, identifies the weaknesses and strengths. There is also a way of approaching it from bottom-up by surveying the perception of the people at risk understand the management practices and the way they link the various aspects of management with feeling safe. In this study, the researcher has applied bottom-up approach because:

1. The way seafarers' feel about management and safety procedures is no guarantee for safety
2. There is always a difficulty in interpreting subjective judgements to objective conclusions
3. The statistics involved include small consistent samples but may not reflective of the overall views.

There is also a significant body of research approaching the matter in the same way and this provides the justification for adding on with a new extensive survey as

a) Confirming previous results;

b) Extending them to other fleets; and

c) Making progress towards understanding the research questions identified.

Therefore, after concerning above approach and justification, the research has developed the following aim, objectives and research questions. The aim of the project is to study the safety problems which affect the shipping industry. This aim will be met through four objectives:

1. To analyse the causes of human error and the rates of maritime accidents.
2. To study and identify the relationships seafarers perceive to exist among various safety parameters on-board ships.
3. To identify the safety aspects that shipping personnel believes contribute most towards an improved on-board safety culture.
4. To recommend methods to reduce the impact of human errors that could be used as a reference for decision makers in international shipping companies to augment their information on policy and management.

To further emphasise and understand the objectives, the following questions were developed:

- To what extent does the human element affect the safety of ship?
- What is the relationship among safety practice aspects in shipping industry?

- How human errors and its impact can be prevented?

1.4 Outline of the study

The thesis is comprises eight chapters namely: Chapter 1 – Overview and background of the report; Chapter 2 – Current safety effectiveness in the shipping industry; Chapter 3 – Chosen research methodology; Chapter 4 – A study on accidents involving merchant vessels; Chapter 5 – safety practise in the UK shipping industry – A quantitative assessment; Chapter 6 – Insights of safety practises in the shipping industry – A qualitative assessment; Chapter 7 – Discussion; and Chapter 8 - Conclusion.

Chapter 2 reviews six different areas of knowledge that are closely related to this research project, namely: structure of safety culture; safety management in shipping organisations; human behaviour towards safety of vessels; strategies in aviation industry in comparison to maritime industry; implementation and effectiveness of regulations; and followed by conclusion and research gap. First part, structure of safety culture gives a broad overview on the development of the safety and different aspects of safety practice, which concern the safety in shipping industry. In the second part, safety culture issues related to an organisation such as company and crew management and awareness towards reporting culture are highlighted. In the third part, different types of human errors and causal factors affecting the safety are discussed. In part four, a description on the importance and effectiveness of the ISM Code for safe management has been presented. In the last part of this chapter strategies towards ensuring in the aviation industry are described, ensuring that lessons from that can be learnt for the maritime.

Chapter 3 introduces the research design and the research methods employed in this study. This includes the methods used to analyse ship accident reports to identify the factors affecting maritime safety. It is also including all the steps involved in conducting the questionnaire survey (pilot and main study) such as institutions and respondents identification, questionnaire design and ethical procedures. Finally, techniques for the analysis of the data are discussed. The aim of this chapter is to give the reader the insight into the analytical foundations of this study. In addition, this chapter reflects the researcher's experience from the time of data collection and analysis, which provide many insights into the research questions.

Chapter 4, 5 and 6 present the finding from the statistical analysis, questionnaire survey and semi structured interview. These chapters take in the different aspects of the safety practice such as accident trends, factors contributing to the accidents and relationships among various aspects of safety practise in the UK shipping industry based on the shipping personnel perception.

Chapter 7 brings in all the findings on safety practice together and discusses the relationship between them, showing the importance of their interaction on the decisions and outcomes affecting the main problems of this research.

Chapter 8 highlights the contributions of this study to the shipping industry which can be adapted to enhance the safety. Some limitations the in present research are outlined followed by suggestions for future research that can logically follow on from this study.

Chapter 2 Current Safety Effectiveness in the Shipping Industry

2.1 Introduction

This chapter explores issues that are relevant to the safety of the maritime industry. The seven sections in this chapter discuss:

- Structure of the safety culture
- Safety culture in a shipping organisation
- Human behavior towards safety of vessels
- Strategies in aviation sector in comparison to shipping sector
- Implementation and effectiveness of safety regulations
- Conclusion
- Research gaps

The main purpose of this chapter is to explore issues related to safety from perspectives of management practices, crew, organisation and the safety regulations.

2.2 Structure of the safety culture

2.2.1 Levels of safety culture

Safety culture is defined as the product of attitudes, perceptions, competencies and patterns of behaviour that determine the commitment, style and proficiency of an organisation's health and safety management (Health and Commission, 1993). The concept of safety culture is used to refer to the behavioural aspects (what people do) and the situational aspects of company (what the organisation has) (Human Engineering, 2005). Oltedal (2011), who studied safety culture and safety management within the Norwegian-controlled shipping industry, has pointed out that both organisational culture (risk perception, standards and moral principles) and managerial features (commitments and supports) influence safety. Spencer-Oatey (2008) has defined culture as orientations to life, beliefs, policies, procedures and behavioural conventions that are shared by a group of people that influence each member's behaviour and interpretations.

Fleming (2001) also proposed a safety culture maturity model with the objective of helping organisations identify the level of maturity of their safety culture. In this model, there are five levels of maturity such as emerging, managing, involving, cooperating and continual. However, the author highlighted that an organisation's level of safety culture maturity is determined on the ratings of ten elements. These ten elements are management commitment and visibility; learning organisation; productivity versus safety; safety resources; participation; communication; shared perceptions about safety; trust; industrial relations; job satisfaction and training. The safety culture maturity model is significant to organisations that fulfil a number of specific criteria that includes:

- A suitable safety management system.
- Technical failures are not the main factor of accidents.
- Compliance with health and safety law.
- Safety should be driven by awareness and not by the avoidance of prosecution.

In addition to that, Hudson (2001) also proposed a safety culture maturity model by modifying the initial model proposed by Westrum (1993) which had only three stages namely pathological, bureaucratic and generative. Previously, Reason (1997) has also proposed two additional levels such as ‘reactive’ and ‘proactive’ as extensions of Westrum’s original model. Later, the model extended to five stages replacing the ‘bureaucratic’ with ‘calculative’ (Hudson, 2001) as shown in Figure 2.

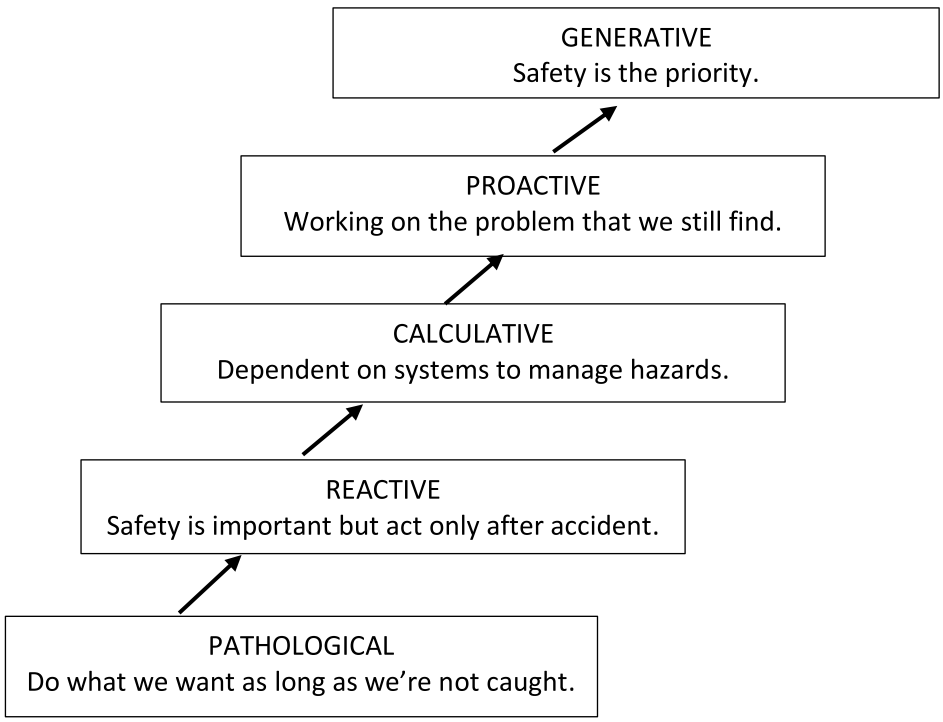

Figure 2 Safety culture model of Hudson (Hudson, 2001)

According to the International Atomic Energy Agency (IAEA, 2002), there are three stages of development of safety culture. Each stage involves a different awareness of the effect in safety of human behaviour and attitudes. At the first stage, an organisation sees safety as an external requirement from the government, the legal framework and/or regulatory bodies. There is certainly not much awareness of the behavioural and attitudinal aspects of safety. Safety is seen as a technical issue, to be achieved through compliance with rules and regulations. At the second stage, an organisation considers safety to be an important goal, even in the absence of external requirements. Safety is often seen as a target or goal, with accountabilities for achieving the goal/s specified. At this stage, the organisation discovers that the goal is achieved when the safety trends have improved. At the third stage, an organisation adopts the idea of continuous improvement and applies the concept to safety by emphasising more on communication, training, management style and improving efficiency and effectiveness. An organisation should not be fully focused only on these three stages but also be associated with other characteristics such as commitment and effort to bring a change to safety (IAEA, 2002).

Hudson (2003) described each stage of development of safety culture. The pathological stage describes safety as a problem caused by employees. They only react to safety matters to avoid prosecution from regulatory non-compliance. At the reactive stage, the employees know that safety is important, but they fully understand the significance of safety only after a serious accident. At the calculative stage, safety is determined by management systems, with ample collection of data. Employees have also more understanding about the system. However, the data are not fully analysed to enhance safety. At the proactive stage, future occurrence is focused instead of just analysing past data. At this stage, the collaboration between employers and employees increases. Finally, at the generative stage, safety is considered as an essential part of the business. The company uses human errors to improve safety rather than to just talk about it.

There are several differences between the models proposed by Fleming and Hudson. The two models have used different aspects to measure the maturity of safety culture. However, Fleming's model is comprehensive and theoretical because the author has highlighted 10 more elements, which evaluate the maturity of safety culture effectively. These 10 elements are appropriate as they cover various aspects which are relevant to safety culture of an organisation. By evaluating these, the safety culture of an organisation can be discovered in depth. Hudson's model is more to practical and efficient in its own way. The author focused on the practical side to evaluate the maturity of safety culture, which is from neglecting safety standards (as long as we're not caught syndrome - pathological) to a stage where they get awareness (safety is the priority attitude – generative). However, application of both theoretical and practical methods are appropriate in measuring the maturity level of safety culture in an organisation as It will cover every aspect that is necessary.

The literature presented in this sub-section shows the evolution of different levels and stages of a safety culture maturity model. The maturity model concept is essential because it enables organisations to identify and establish their current level of safety culture maturity in order to improve the safety. This way could make the organisations to understand well about their system and about what will work better towards a safer working environment.

2.2.1 Various aspects of safety practice

According to the safety culture concept reviewed by Guldenmund (2000), there is a wide range of safety practice aspects to be assessed. Many researchers label safety aspects differently and include a variation of items within aspects that makes comparisons of the safety culture research to be complex (Ek, 2006a). Guldenmund (2000) has claimed management aspects, risk, safety arrangements, procedures, training and work pressure were among the most often measured safety aspects in safety culture research. The different aspects of safety practice, which concern industrial practice, including those in shipping, are summarised in Table 1.

Table 1 Different aspects of safety practice

Safety aspects	**Opinions and explanations by various researchers**
Job satisfaction	• It reflects pleasure or an emotional state resulting from the appraisal of one's job. It is also considered as reliable indicator of work-related well-being (Nielsen *et al.*, 2013). • It influences behaviours and attitudes of employees (Weisman and Nathanson, 1985). • Job satisfaction of an employee can influence the level of service provided positively or negatively (Morris, 2001). • It has a direct effect on an employee's intention to leave or stay in the organisation (Hu *et al.*, 2003).
Learning culture	• Important aspect for an employee to learn from information gathered and to be willing to introduce changes when necessary (Reason, 1997). • It is a good approach to safety (Ek, 2006a).
Reporting culture	• An approach to report incidents or anomalies using an appropriate medium for further action to avoid such occurrence and as a lesson to others. It is also an initiative to learn from past accidents (Ek, 2006a; Transport, 2019).
Flexibility	• It concerns the ability to transform the work in order to faces challenges such as during periods of high work load or in an emergency situation (Ek, 2006a). • It is also related to an individual's skills and experiences in handling a task (Cooper Ph. D, 2000).
Organisational management	• Management is an important factor in the safe operation in ship operations (Moore and Bea, 1995; Boniface and Bea, 1996a; Boniface and Bea, 1996b). • Poor company management can affect maintenance and operation of a ship (Brown and Haugene, 1998). • An organisation can have informal control mechanisms that influence the formation of a culture (Shea, 2005). • Management commitment is an important factor of an organisation (Flin, 2003). • There is a relation between management's leadership and approach to safety (O'Toole, 2002).
Risk perception	• An employee's good risk perception reflects good safety level (Rundmo *et al.*, 2011). • It may influence risk-taking behaviour at an individual level (Rundmo *et al.*, 2011). • Poor risk awareness is a significant problem and a threat to safety (Patraiko, 2006).

	• Seafarers with less experience pose poor risk perception compared to those with more experience (Bailey *et al.*, 2006).
Working situation	• Refers to the working environment that enables personnel to perform effectively (Oswald, 2012). • There is a positive connection between work environment and job satisfaction and this influences work performance (Sousa-Poza and Sousa-Poza, 2000; Gazioglu and Tansel, 2006; Skalli *et al.*, 2008). • It can determine an individual’s perspective on risk and safety (Ek, 2006a).
Attitude towards safety	• This factor is associated with risk perception and safety – related behaviour. It also refers to individual and organisational attitudes concerning the importance of safety (Ek, 2006a). • It is a positive engagement shown in the organisation that seeks to anticipated and plan for unexpected events (Rochlin, 2003).
Communication	• Good communication can prevent, trap and mitigate errors. Safety culture emphasises on good communication and listening skills in order to reach situational awareness of risk (Ek, 2006a). • Good communication results in better safety standards and effect of safety policies (Holt, 2008). • It is vital to make sure that the right persons are kept informed of the state of the system to enable them to take relevant decisions (Ek, 2006a).
Competence	• This is determined by sufficient training and skills. It is crucial to emphasise the importance of reporting and to implement corrective actions appropriately (Storgård *et al.*, 2012). • Inadequate education and training are among the causes that are linked to accidents in the maritime sector (Squire, 2005).
Importance of regulations	• Safety regulation can be an important defense against shipping accidents (Størkersen, 2015). • Regulations motivate maritime organisation to take safety precautions (Knapp and Van de Velden, 2011).
Health awareness	• Health related issues among seafarers has increased by 50% upon boarding a ship (Âkerstedt, 2006; Rydstedt and Lundh, 2010). • There is a positive relationship between health management and safety performance (Mearns *et al.*, 2003).

Ten aspects/variables of the safety practice that have been identified in the published literature as having an impact on safety culture were selected and included in the consultation questionnaire created for this research. This researcher has improvised the scope of the existing safety aspects based on literature review and discussions with experts in the field. The 10 safety aspects were working environment satisfaction, reporting culture, communication and language barrier, competency level, shore management support, health awareness, safety culture, importance of maritime regulations, risk awareness and job satisfaction. The explanation of each safety aspect is presented in Chapter 3 Section 3.3. In short, all the aspects will be evaluated based on a questionnaire using the Likert scale. The data obtained from the questionnaire will then be analysed using statistical analyses.

2.3 Safety management in shipping organisation

The literature in this section will focus on safety management practices (based on five elements of ship management) and human resource management to highlight practices in the maritime industry in managing and manning crew. The importance of awareness of reporting culture in the industry will be explained as well.

2.3.1 Company and crew safety management practice

In order to gain a proper understanding of safe management practice within the shipping industry, knowledge of safety management systems and an awareness of importance of standard regulations are necessary. Besides that, organisational aspects play an important role on safety as well (Reason, 1997). Fundamentally, most accidents occur because of breakdowns in physical components, human error and/or organisational factors. Management control is one of the significant aspects of organisational factors. A well-developed safety management system in a shipping organisation will always be a fundamental root in improving safety performance (Reason, 1997).

A number of major accidents, for example the sinking of Herald of Free Enterprise, highlighted the role of management control in safety (Cox and Cox, 1996). Management control is defined as formal, information-based routines and procedures that managers use to maintain or alter patterns in organisational activities (Simons, 2013). The incident of the Herald of Free Enterprise created a huge impact, which had led to changes and addition of new chapters in the SOLAS particularly Chapter IX (management for the safe operation of ships) which aims to make ISM Code mandatory (IMO, 1998b). The ISM Code requires a safety management system (SMS) to be established by the company for the safe operation of a vessel. The SMS will be a platform to manage the crew and the voyage efficiently. A safety management system provides a model (annex) for marine accident investigators to facilitate a structured approach to accidents investigation. The models is useful to help investigators focus on problem areas in management which identify the causes of the accidents and the reasons for safety failures can be found and recommendations made to prevent similar events in future (Withington, 2006).

In another study, Ek *et al.* (2014) compared the relationship of several safety aspects such as communication, crew behaviour, work situation, justness, reporting, learning, risk perception, flexibility and attitudes on Swedish vessels. The result of the study showed a close relationship between the communication, reporting and work situation aspects. The study showed that a good instruction and communication always leads to a good working environment. This emphasizes the importance of safety management practices as required by the ISM code. For example, ISM Code has a requirement for a procedure for the entire task done on board the ship during normal operations and emergencies and a designated person ashore to serve as the link between the ships and shore staff (ISM Code, 2005). Certainly, the ISM code has made shipping safer and cleaner over the past two decades since it became mandatory on 1st July 1998. As a proof, in 2005, the IMO maritime safety committee collected data on the impact of the code from an international group of experts from which they concluded that tangible positive benefits are evident as a result of the result of the code, as it has embraced as a positive step toward efficiency through a safety culture (Vandenborn, 2018).

According to the IMO, 'an organisation that practices safety culture is one that gives priority to safety and realizes that safety has to be managed like any other areas of the businesses' (IMO, 2013b). In the shipping industry, it is in the professionalism of seafarers that the safety culture must take root. The role of culture of the shipping industry is always reflected by the attitude and performance of the seafarers (Harkness, 2000), for example where commercial expediency puts the seafarers' lives at risk (as in the case of Herald of Free Enterprise). IMO's strategy and approach towards safety culture is driven by an organisation's structure and control system in order to produce desired behaviour norms and safety outcomes (Oltedal, 2011).

In addition to the ISM code, studies also have suggested several steps to improve an organisation's performance. For example, Ing and Bussow (2013) has suggested that an organisation's performance and success can be improved through best practice. Ship management comprises functions and services like crewing; technical management; financial management; quality and safety; and procurement: see Figure 3 (Ing and Bussow, 2013). According to the author, the financial management aspect was added into the study that is less a service provided to a ship owner but relevant to the ship manager himself and functioning as an enabler to provide the services rendered in an efficient and transparent way. There is no connectivity among the elements but they have significant role individually on a specific department. However, this researcher believes there is a linkage among all the elements. This is because without one element the other elements will not function efficiently. Technical management is dependent on having the right financial backing. Quality is dependent on the right physical assetts being procured. Crew training and behaviours affect safety and quality of performance. And so on.

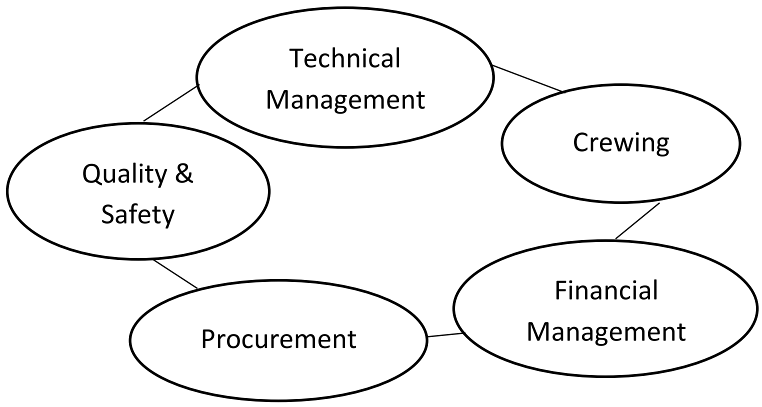

Figure 3 Five elements Ship Management (Ing and Bussow, 2013)

Crewing is an important ship management service that is rated as one of the current challenge for ship managers or manning agencies (Ing and Bussow, 2013). Ing and Bussow (2013) recommended shipping companies to employ crew by themselves rather than through manning agencies or by closely managing the hiring process together with the agency to hire crew in order to avoid partiality and able to hire the appropriate and qualified crews. The study also highlighted challenges faced by the crew. Based on their in-depth interview, many experienced seafarers say: 'gone are the days when the crew would hang out together in their spare time, making music, playing games and enjoying their time together'. The isolation among the seafarers, poses a challenge to teamwork and safety of the vessel. The study summarized key element of best practice in crewing such as: invest in culture and teamwork; invest in crew welfare; integrate training appraisal and development management systems; use a combination of personal and computer-based training; and use an integrated crewing solution onboard and onshore (Ing and Bussow, 2013).

Technical management is another challenging element after crewing for ship management. Ensuring technical availability of a vessel and balancing maintenance costs is the responsibility of chief engineers on board and superintendents in the office, who combine their skills and experience to achieve that. Challenges in term of cost pressures, increasing complexity of commercial and regulatory affect the technical management (Ing and Bussow, 2013). Key elements of best practice in technical management have been identified as: pay attention to hull maintenance; manage a key element of the maintenance budget such as dry dockings; and harmonize and centralize the management of master data (Ing and Bussow, 2013). These elements could enhance the efficiency of the technical management and thus better ship management.

Finance and Accounting departments do not have direct influence on a company's financial performance. However, their role is crucial in providing accurate data to ensure other departments of the company make the right decisions (Ing and Bussow, 2013). Based on the findings through in-depths interviews, Ing and Bussow (2013) have highlighted several issues such as: finance teams are not well integrated into the operational businesses; complexity build up in the Finance departments is grown in many businesses; and process and data collecting and reporting systems have only little use. Therefore, finance management can be improved through elements of best practice such as: integrate operations with finance; simplify the accounting structures; and automate reporting. These elements could improve the company's financial performance.

The role of Quality & Safety (QS) officers has increased significantly with rise of regulations, competitive pressures and safety concerns, in which, has indicates more importance has been given on safety related issues (Ing and Bussow, 2013). However, statistics show fires and explosions are being the third main reasons for the total loss of vessels, while, foundering and stranding are first and second reasons respectively, where it indicates that the safety concerns are still lacking (Lloyd's Fairplay, 2010). Based on Port State Control statistics, fire safety measures onboard are lacking and this poses risks (DNV, 2012). Findings have highlighted several elements of best practice in quality and safety management such as: deploy and monitor regular crew training on safety issues; use integrated quality & safety solution; have risk assessment integrated in regular processes; and nurture a 'no accusation/blame' culture (Ing and Bussow, 2013).

Another crucial role for every ship manager to keep the vessel ready to sail is by managing the procurement of spares, supplies and services. There are several challenges facing ship managers in managing procurement such as: data quality to reduce wrongly ordered parts; a lot of communication with the supplier; increasing reliability and quality demand that changes the treatment of suppliers to a long-term; etc. (Ing and Bussow, 2013). Several elements of best practice in procurement have been recommended such as: communicate with supplier electronically; automate and simplify the process; plan demands fleet-wide; reduce number of suppliers; and no purchase outside the system (Ing and Bussow, 2013).

Resources and capabilities create the base for the formation of sustainable competitive advantage in an organisation along with management control (Progoulaki and Theotokas, 2010). Resources can be classified into three groups: physical capital resources (plants, equipment, finance); organisational capital resources (organisational structure, control systems, human resource systems); and human capital resources (skills, judgement and intelligence of employees) (Barney, 1991). 'Capabilities' is defined as the skills an organisation needs to take full advantage of its asset or resources (Progoulaki and Theotokas, 2010). In other words, when the human resource management (resources) fails to be efficient then it can affect the capabilities of the skills of an organization. For example it could lead to crew incompetence and causes shortage of seafarers (Progoulaki and Theotokas, 2010).

The shortage of seafarers are among the problems faced by the stakeholders in the global shipping (Caesar *et al.*, 2013). One of the causes of the shortage is long working hours or getting less holidays (Lundh, 2010). Such practices may affect work efficiency and safety. Nguyen *et al.* (2014) has identified several factors leading to shortage of seafarers such as poor human resource practices, poor working conditions, low salary, unfair promotion and organisational injustice. This indicates that the management gives more attention to just narrow financial and monetary aspects instead of quality and safety.

Poor manning is another example of inefficient human resource management. Shipping companies are increasingly depending on manning agencies for the employment of seafarers as it is cheaper/low hiring cost. This has led to problems for example lack of seafarers with sufficient qualification or training. Shipping companies' performance can be affected by the manpower provided by agents. Shipping companies lose the advantage of exploiting the quality of their seamen. Hence, the quantity of seafarers is not a problem but the quality and the related cost is (Progoulaki and Theotokas, 2010). Therefore, Progoulaki and Theotokas (2010) have suggested that shipping companies should emphasize on the quality of the seafarers by having access and gain information regarding the seafaring labour market. It is obvious that minimizing cost for important aspects such as safety training and employment for more profit will have an impact on the overall performance of an organisation in long run. Rather than cutting cost for important aspects, shipping companies should invest more on safety and hiring for better quality and performance.

To overcome the issues related to human resources management, companies should play an effective role to provide good service quality. For example, after hiring the crew, the companies should train them with technical skills, knowledge and in process or interactive skills (Kundu, 2000) or just improve the training of seafarers in the first place. Welfare and sufficient support are also needed for the crew to perform better. In other words, one's competency or productivity level is always influenced or boosted by rewards or appreciations (Kochanski and Risher, 1999).

2.3.2 Awareness towards reporting culture

Improved regulation and better safe practices are implemented as a result of major accidents that receives pressure from many parties (Psarros *et al.*, 2010). However, this culture is not effective for long term because improved regulations and safe practices were restructured based on major accidents and does not include other small accidents. Therefore, in addition to the new and revised regulations, reporting culture of every incidents take place on board ship should also be practiced effectively as required by the ISM code (ISM Code, 2005). This will be useful to learn from past incidents in order to prevent the same errors or mistakes, which could lead to accidents

(Transport, 2019). However, due to blame culture in the industry, reporting culture has not been fully applied.

The information from reported incidents is not only benefits the seafarers but the industry as a whole. For example, the information will be very useful for Formal Safety Assessment (FSA) (Psarros *et al.*, 2010). The concept of FSA developed in the Cullen report, involved the identification and assessment of hazards in life cycle of a project through all its stages of development to final decommissioning and abandonment (Eve Coles, 2013). According to IMO, FSA is a way of ensuring that action is taken before a disaster occurs (FSA, 2002). It is also a rational and systematic methodology for assessing the risks associated with shipping activity and for evaluating the costs and benefits of IMO's options for reducing these risks (FSA, 2002). FSA was developed partly at least as a response to Piper Alpha disaster in 1988, where an offshore platform exploded in the North Sea and 167 people lost their lives (FSA, 2002), which is now applied to the IMO rule making process (Psarros *et al.*, 2010). Therefore, by providing sufficient information on every incident that takes place through reporting culture, FSA would be able to identify potential hazards, cost and risk and the actions to be taken to prevent occurrence of similar incidents.

However, poor incident reporting culture is an obstacle to providing better data for maritime safety enhancement. Such data should be distributed by the Flag State or other relevant organisation, but such an act has rarely been fulfilled and lacks detailed studies (IACS, 2008); which indicates a poor incident reporting culture in shipping. Whereas, road transport has good data compared to the maritime industry as all the reports of accident fatalities and injuries in the former are identified between police and hospital records (Alsop and Langley, 2001; Blincoe *et al.*, 2002; Sciortino *et al.*, 2005; Amoros *et al.*, 2006; Ward *et al.*, 2006). As mentioned in the paragraph above, one of the main reasons of poor reporting culture is the blame culture that exists within the industry. However, this researcher believes that bringing in a just culture attitude could improve the reporting behaviour. Just culture forgives involuntary mistakes which is reassuring for the crew and staff. Therefore, the complete details of incidents are necessary in order to assist the relevant authority to enhance safety. In the presence of complete data, a high quality FSA can be produced.

Based from the previous FSA studies, there is a possibility that under-reporting of accidents is a problem in providing sufficient information. Therefore, in attempting to verify this, Psarros *et al.* (2010) has compared the data available from two different databases such as Lloyd's Register Fairplay (LRFP) and Norwegian Maritime Directorate (NMD). They have used the accident data of tanker (above 100 GRT) registered in Norway trading in Norwegian territorial waters and Norwegian International Register from the period between 1997 and 2007. The number of records was 179 from NMD and 133 from LRFP. The result shows that reporting performance of NMD is 41% and of LRFP is 30%. In addition, important information such as vessel's size and the severity of the accidents were missing. Ek *et al.* (2014) recommended that database developers and casualty investigation units' should cooperate to provide more relying information service in order to improve the results of the FSA studies.

In a study by Jacobsson *et al.* (2011), the learning attitude by employees from incidents is labelled as very essential for improving safety especially in the process industry. In this case, learning is defined as the ability of an employee in an organisation to identify the causes of accidents that happened at work place and then to transform them into initiatives to help in preventing further accidents. Many industries such as the aviation industry, medical care and the process industry are now practicing this 'learning from an incident' culture. However, learning from past incidents is hindered due to poor or lack of further actions after reporting an incident (Jacobsson *et al.*, 2011). Based on reading and analysis, this researcher believes learning attitude is definitely a right way to improve safety. This attitude should be encouraged by the companies so that it can become part of the culture of their company. As mentioned in previous paragraphs, an organisation can practice just culture or giving appreciations or rewards for portraying or practicing learning from past incidents.

Once reporting an accident or incident, further investigation and detailed analyses are needed as they could reveal weaknesses that initiates the occurrence of the incident (Reason, 1997; MAIB, 2012). These weaknesses could be from the equipment used, processes involved or the on-board crew. Thus, this can prevent the similar incident under the same circumstances that has the potential for a serious accident. However, one's actions of reporting always depend on their willingness to do it so and the willingness of their management to take further actions (Cooke and Rohleder, 2006). They also depend on the seriousness of the incident according to the person involved. Along the process of learning, one should focus on fewer matters, for instance, about the measures that had been taken upon the occurrence of incidents, the proper measure that an organisation could benefit for learning, and comparing actual learning with potential learning (Jacobsson *et al.*, 2011; Transport, 2019). There is space for improvement in current maritime practice.

In this case, actual learning is not effective all the time compared to potential learning. In actual learning, one will follow safety instructions based on the regulations, company or the on-board management. However, learning from a shipping organisation or company is not easy to achieve (Jacobsson *et al.*, 2011) because it is based on regulations and not from experience. In addition, after an incident took place, technical measures, improvement or changes of working procedures or additional training are always limited in an organisational learning context (Hale, 2008). The effectiveness of any measures of shipping organisation learning does not stay for long period compare to potential learning (Kjellén, 2000). Table 2 shows the model of six levels of learning. The model for evaluating the actual level of learning from incidents was initially developed by Hare (1967) and was updated by Kjellén (2000). The content of Table 2 (Jacobsson *et al.*, 2011) also outlines to what extent the lesson learned is applied to similar situation. It is also related to what extent does organisational learning is involved in matters such as technical issues.

Table 2 A model for level of actual learning from incidents (Jacobsson et al., 2011)

Level	Main Characteristics and explanation	Examples
0	No learning	Repair of failed equipment
1	The learning process only happens at specific place where the incident occurred.	Discussions within a shift and notes in a logbook. Involves less documentation.
2	The learning process is broader than in Level 1 but still at the place, the incident occurred.	Changes in particular procedure with documentation and some information or trainings.
3	The learning process happens at site level or in company and applying the lessons to other relevant places or systems.	Changing of procedures or training. All changes are documented.
4	The learning process is similar to level 3 and additionally included generic lessons in the management system.	Major changes in engineering specifications, working procedures, training programme requirements for the site. All changes are documented.
5	The learning process at this level is higher and lessons are brought to the corporate top management.	Fundamental changes in corporate safety, health and the environment (SHE) policies.

Kjellén (2000)also presented the steps involved in the potential learning process from an incident. He suggested five steps as follows:

- Data collection and reporting
- Analysis and evaluation
- Decisions
- Implementation
- Follow-up

The learning process starts when an incident is reported then further information is collected. The information can be on the location the incident takes place, types of ships, severity of the incident and most importantly the causes of the accident. Then, an analysis and evaluation are performed to clarify the real situation and the root causes of the incident. Hollnagel (2004) defined root causes as product of conditions and factors that leads to accidents or incidents while Kjellén (2000) has defined the root causes as the most fundamental cause of accidents or incidents.

Based on the root causes of the incident, an effective and an appropriate decision is to be made and implemented in a way that it could prevent similar incidents in future, thus enhancing safety. Regular follow-ups are needed as it will make sure everything is on right track. Thus, there is no proof of having a better method than learning from incidents for the enhancement of safety (Jacobsson *et al.*, 2011).

Both Kjellén (potential learning) and Jacobsson (actual learning) suggest different ways of learning from incidents. However, the purpose or the objective is the same, which is to improve safety and prevent similar incidents. In Jacobsson's model, the author has focused on actual learning where the learning process begins only at specific places when an incident takes place and impovements have been made along the process. It is also relies on safety standards from shipping organisations or on-board management, which is difficult to obtain. However, Kjellén's approach is to study past incidents from which data will be collected and analysed for to make decisions, implementations and follow-ups. This researcher believes potential learning is effective at all times as it is based on actual incidents that happened and would enable the seafarers to get exposure to the root causes and for appropriate actions to be taken. This way is efficient and can be easily understood by the seafarers; learning and understanding regulations and standards take varies in different companies.

The literature presented in this section has discussed the importance of incident reporting culture and how it can assist in improving the safety in maritime culture. It also has highlighted the availability and usage of accident reporting databases in regarding to assist FSA studies. A model of level of learning from accidents has also been discussed to emphasize the need of reporting.

2.4 Human behaviour towards safety of vessels

In this section, the literature will be on the types of human errors and their causal factors. Then, a comparison will be made between the aviation and marine sector on the strategies to combat human factors in transforming the safety to a higher level. The comparison particularly between these two sectors is focused because these are global transport modes. At the end of this section, a good understanding on human error and the ways to improve safety will be achieved.

2.4.1 Human errors

Generally, when it comes to marine casualties, human errors are frequently linked as the main contributing factors (Rothblum, 2000; O'Neil, 2003; Darbra and Casal, 2004; Toffoli *et al.*, 2005; Allianz, 2018). Although, it is impossible to directly observe human errors, it is possible to indirectly observe human errors through observation of human behaviour (Hollnagel, 1998). Human behaviour is defined as the actions or reactions of a person influenced by culture, tradition and human physiology (Schiffer, 2002). Human errors can be described as making an incorrect decision, an improperly performed action, or an improper lack of action (Rothblum, 2002). Gil de Egea (2003) stated that human errors are developed from the management deficiencies, the personnel's physical and mental conditions, and the personnel's qualifications. There are several other aspects of psychological processes such as perception, attention, memory, thinking, problem solving and decision making that are believed to be among the main causes of human error (Senders and Moray, 1991). Table 3 shows different perceptions of researchers on human error.

Table 3 Definition of Human Error

Definition
Anything human (Lutzhoft, 2004).
Aspects of human capabilities/ unacceptable performance (RINA, 2004).
An act that cause large amount of casualties in the maritime domain (Koester, 2001).
Factors such as environment, organisation & job and characteristics of human and individual that effect behaviour at work which might affect health and safety (HSE, 1999).
Evaluation of human behaviour against performance standard (Hollnagel, 1998).
Human and organisational error taxonomy (Reason, 1997).
Result of psychological processes on different levels (Senders and Moray, 1991).
Slips, lapses, mistakes and violations (Reason, 1990).
Errors of omission, errors of commission, extraneous acts (Swain and Guttman, 1982 & 1983).
Skill, rule and knowledge based behaviour (Rasmussen, 1981).

Human error can be classified into three categories namely: system-induced error; design-induced error; and human-induced error (Meister, 1971; Baker *et al.*, 2002). System-induced errors indicate deficiency in the way a system was implemented. This includes mistakes in designating the numbers and types of personnel, in system operating policies, in training, in data resources, in logistics, in organizational responsibilities, and in maintenance requirements and support.

Design-induced errors are developed as consequences from human incompatibilities with the design of equipment (Sulaiman *et al.*, 2012). The operators are challenged with the equipment design characteristics, which substantially increase the risk for error. These include inadequate workspace for maintenance, poor colour/contrast of displays screens, inadequate labeling of controls and difficulties to reach valve location (Meister, 1971).

Human-induced errors are defined as characteristics of people that influence the potential for errors (Meister, 1971; Chan *et al.*, 2016). There several types of human-induced errors such as: fatigue, disorientation, distraction, impaired attention, lack of motivation, forgetfulness, complacency, confusion, incorrect expectancy, excessive stress, boredom, inadequate skills and knowledge, and inadequate perceptual or cognitive ability (Chan *et al.*, 2016; Oluseye and Ogunseye, 2016). Such factors pose high risk towards occurrence of errors and even potential to cause errors or accidents (Meister, 1971; McSweeney *et al.*, 2009).

Caridis (1999) has mentioned that the number worldwide maritime accident has not reduced even in the presence of advanced marine technologies. The highest proportion of maritime casualties is related to human factors, this comprises of 75% - 96% of overall maritime accidents (Wagenaar and Groeneweg, 1987; Rothblum, 2000; Anderson, 2003; Gregory and Shanahan, 2010). Studies have shown that human errors contribute to various types of accident as shown in Table 4.

Table 4 Different types of accidents

Types	**Percentage (%)**
Tanker accidents (Transportation Safety Board of Canada, 1993)	84 – 88
Towing vessel groundings (Cormier, 1994)	79
Collision (Britain and Bryant, 1991)	89 – 96
Fires & explosions (Britain and Bryant, 1991)	75

A series of major accidents such the incident of MV Santa Cruz II and U.S Coast Guard Cutter Cuyahoga (1978) and the Torrey Canyon incident (1967) highlighted the need of managing human errors. One way to identify the types of human errors related to the maritime industry is to study the incidents and determine how they happen. Research on human error is in the interest of many researchers and organisations, because human error related incidents have created awareness globally (Wagenaar and Groeneweg, 1987; Reason, 1990; Brown and Haugene, 1998; Schröder *et al.*, 2009; Kongsvik *et al.*, 2010).

In this sub-section, the definition, types and the consequences of human error have been discussed. Based on the literature, human error has been highlighted as one of the main factors of maritime casualties that needs strong attention to reduce its impact on maritime safety. In the next section, causal factors of human error in maritime industry and safety strategies in aviation industry will be discussed.

2.4.2 Causal factors of human errors

Based on a comprehensive analysis of the human elements, it is proven that mental and emotional factors and physical conditions, for instance diet or illness are some of the main contributing factors of human errors (IMO, 2001). The frequent intake of alcohol or drugs for the purpose of relaxation can lead to human errors (IMO, 2006; Oluseye and Ogunseye, 2016). The heavy workload at ports and on-board ship (Patraiko, 2006; Xhelilaj and Lapa, 2010), the age of seafarers (Jagosh *et al.*, 2017) and communications problems (de la Campa Portela, 2005; Papachristou *et al.*, 2015) are also among potential factors of human error. The “can do” attitude of seafarers, is a significant problem because of the nature of seafaring which promotes a culture of self-reliance (Patraiko, 2006). According to de la Campa Portela (2005), many advanced and high-tech equipment’s has been used on vessels yet there are no reduction in the number of human errors.

In an analysis based on the Marine Accident Investigation Board (MAIB) accidents reports, Baker and Seah (2004) have identified several human error causal factors such as: knowledge, skills and awareness; risk tolerance; procedures; watch handoff; communications; weather; fatigue; and maintenance related human errors. These causal factors were identified as primary or contributing root causes of human error (Baker and Seah, 2004).

On the other hand, a study by the U.S. Coast Guard (1995) showed 10 human factors areas that need to be improved to prevent casualties. These factors are: fatigue; inadequate communications; inadequate general technical knowledge; inadequate knowledge of own ship systems; poor design of automation; decisions based on inadequate information; poor judgement; faulty standards, policies, or practices; poor maintenance; and hazardous natural environment. These factors are summarized below.

Fatigue

Fatigue has been one of the main causes of human error (NTSB, 1981; Jepsen *et al.*, 2015; Grech, 2016). It can lead to disastrous outcomes in terms of poor health and also diminished performance (Josten and Thierry, 2003; Jepsen *et al.*, 2015). Fatigue is not uncommon in the maritime industry due to the short passages, higher levels of traffic, reduced manning, increasing demand and workload (Hetherington *et al.*, 2006; Jepsen *et al.*, 2015). Longer duty hours and hours worked in the last three days are linked with marine accidents as a result of fatigue (Raby and McCallum, 1997; Grech, 2016). The grounding of Exxon Valdez in 1989 is closely associated with fatigue as a contributing factor. In the 24 hours prior to the grounding of the vessel, the watchkeeper had only 5 or 6 hours of sleep (NTSB, 1981; Jepsen *et al.*, 2015). McCallum *et al.* (1996) identified that fatigue contributed to 16% of serious vessel casualties and 33% of personnel injuries. According to International Labour Organisation (ILO, 1996), all shipping companies and seafarers should obey the normal working hours standard for seafarer. A seafarer can only work maximum 14 hours in any 24-hour period and 72 hours in any seven-day period. The minimum hours of rest shall not be less than 10 hours in any 24-hour period and 77 hours in any 24-hour period. By obeying these basic rules, fatigue could be prevented as the human body system needs a break to refresh and restart all over again efficiently. However, the main issue is that seafarers do not always comply with this rule due to commercial and management pressure and crew shortages.

Inadequate communication

Shipping requires good communication as the personnel have to communicate in their daily work between shipmates, masters and pilots, ship-to-ship and ship-to- Vessel Tracking System (VTS) (Papachristou *et al.*, 2015). Apart from that, a good communication is also needed between Search and Rescue (SAR) response operators and the crew of the distressed vessel (Nordström *et al.*, 2016). According to MAIB (2009), inadequate information and communication about a vessels's during an accident have been identified as factors that need improvement for example for incidents such as flooding and foundering of the Abigail H (MAIB, 2009), capsizing of the Costa Concordia (MIT, 2013) and the grounding and flooding of the Commodore Clipper (MAIB, 2015). Based on the explanation the need of effective procedures and training for the crew to enhance their communication skills is necessary.

Inadequate general technical knowledge

Inadequate general technical knowledge has been identified as one of the contributing factors of casualties (Wagenaar and Groeneweg, 1987; Bielić *et al.*, 2017). This is about handling and operating any technologies or equipment on-board ship, where senior seafarers often find difficulties due to lack of exposure and generation gap. In addition, an ineffective relationship between human and technology remains one of the factors that contribute to the development of human error (Bielić *et al.*, 2017). M ariners that are involved in such casualties are often lack knowledge in the proper use of technology such as radar and automated systems, in which, it indicates poor management role in providing sufficient training. A standardized equipment design and appropriate training could help to prevent such error (Rothblum, 2002).

Inadequate knowledge of own ship systems

Inadequate knowledge of own ship operations and equipment is another frequent contributing factor of accidents (Bielić *et al.*, 2017). The factor has developed because of working culture of the crew and pilots that worked on ships of different sizes, with dissimilar equipment and carrying different cargoes. Moreover, new and more complex automated systems, which are constantly introduced on board vessels have caused difficulties for a seafarer to keep pace with frequent changes. As such, studies showed that poor knowledge of the own ship systems contributed to 15% of ship accidents (Bielić *et al.*, 2017). Therefore, updated and frequent trainings should be given to seafarers to enable them to be up-to-date with current technologies and ships they are on board.

Poor design of automation

Poor design of shipboard automation is another cause of accidents. As the influence and usage of automation increased on board ships, the role of the seafarers has changed considerably, from main operator to an observer (Bielić *et al.*, 2017). Hence, lack of practice or applying the knowledge has led to a possibility of losing such knowledge and skills (Bielić *et al.*, 2011). Moreover, it will be difficult for the seafarers to handle or detect if there is any fault in the shipboard automation. Therefore, the role of equipment designers is crucial to consider how a given piece of equipment will support the mariner’s task and how it will fit into the entire workspace used by the mariner, in addition to specific shipboard automation trainings (Rothblum, 2002).

Decisions based on inadequate information

The seafaring profession is a field of work that the seafarers have to make navigation decisions throughout their passage based on all available information on board. Many casualties happened due to the failure to consult the available information, for example: misinterpretation/insufficient information from the radar or an echo- sounder; bridge supports often are not marked; or buoys may be off-station. These may lead to navigation errors that poses high risks (Rothblum, 2002).

Poor Judgement

Poor judgement is often associated with experience of the seafarers. A seafarer who possesses good seamanship skills will be able to make smart judgement in case of an emergency. However, poor seamanship skills will lead to unwanted incidents such as passing too closely, excessive speed, and ignoring of potential risks (Rothblum, 2002).

Faulty standards, policies, or practices

Accidents that happened due to this factor are always linked to lack of availability, precise, written, and comprehensible operational procedures on board. In the absence of a well-written manual during an emergency, the chances for a correct and on-time response is less. It is crucial to have a complete procedures and a checklist before a passage to prevent risky situation (Rothblum, 2002).

Poor maintenance

Several studies have emphasized the risks posed by poor maintenance of ships (Bryant, 1991; National Research Council (NRC), 1991; US Coast Guard, 1995). Poor ship maintenance is very risky and is associated with dangerous work environment and this causes fatigues as a result from the need to make emergency repairs (Rothblum, 2002). Furthermore, study shows that, there are cases where maintenance works are carried out but maintenance manuals or old usage instructions are not replaced (Bielić *et al.*, 2017). Hence, poor maintenance could led the safety of shipping industry to be ineffective (Dimailig *et al.*, 2011) and exposes to the high risk of fires and explosions (Bryant, 1991).

Hazardous natural environment

Hazardous natural environment could be natural phenomena such as current, tide and tidal stream, severe wind, reduce visibility (fog, heavy snow and rain), storm seas and darkness (Akten, 2006). The occurrence of natural phenomena is unpredictable, but its effect can be prevented, for example, the occurrence of a bad weather is unpredictable, however, precautions can be taken prior to the voyage to prevent unwanted incidents. It is in the responsibilities of the master to obtain the forecast and ensure the ship is in good condition before a passage (Rothblum, 2002).

2.5 Strategies in aviation sector in comparison to shipping sector

The air transport industry is similar in many ways to the shipping industry in terms of its role and responsibilities and in terms of the human and organisational factors that affect safety (Turan *et al.*, 2016). Likewise, the stakeholders highlighted that the two transport sectors have strong emphasis on safety. However, there are differences in how safety is managed and negotiated by these sectors. Table 5 (Turan *et al.*, 2016) shows the differences of state-of-the art between these two sectors.

Table 5 Differences of state-of-the art between air and shipping transports (Turan *et al.,* 2016)

Issue	Air Transport	Marine Transport
Stakeholders	• Has few secondary stakeholders to manage such as: Air Transport Management (ATM) and airport services. • Less stakeholders reduce safety related negotiations.	• Has broader varied category of secondary users such as: Vessel Traffic Service (VTS), agents, towage companies, pilot companies, stevedoring, ship owners, etc. • Increase safety related negotiation with many stake holders.
Training	• Human Factor (HF) training is mandated for all personnel. • Effectively assessing and evaluating training and trying to improve.	• Human Factor (HF) training is mandated for certain grades of staff. • No much effort to assess and evaluate training.
Regulations	• Highly regulated industry. • Less tolerant to safety related matters (European Union (EU) and United States (US) aviation safety regulators have the power to ban airlines that fail to meet safety requirements from entering European airspace). • Enforcing regulations and assisting organisations in understanding how to meet safety requirements by implementing and monitor the effectiveness of safety initiatives.	• Highly regulated industry. • Lack of a mandatory quality approval system for flag states (leading to huge safety inconsistency between the potential and actual safety of the maritime system). • Enforcing regulations but ineffective in implementing and monitoring the effectiveness of safety initiatives.
Other challenges	• Increased amount of paperwork and task loads, but the workloads decrease due to automation on the flight deck. • Multicultural crews are not seen as a safety challenge as the standard operating procedures constitute a good solution to prevent possible problems that could arise from this factor.	• Paperwork on the bridge is reported to increase the workload. • Multicultural crews are often seen as a significant safety challenge.

Passenger airline service has become very safe with only one passenger fatality per 7.1 million air travellers (Hersman, 2011). The International Air Transport Association reported that there was only one accident for every 1.6 million flights (Hersman, 2011). The awareness and improvement in safety have come from various sources over years such as from better aircraft design and manufacture (technological improvements in aircraft, avionics, and engines), effective accident investigations (cockpit voice recorders and flight data recorders), pilot raining (understanding human factors and applying it to trainings and regulations) and learning from the past accidents (Oster *et al.*, 2013).

In the maritime industry, the European Transport Safety Council reported that the passenger fatality rates in shipping are 1 per 6.8 million passengers (Koornstra *et al.*, 2003). However, the high number of accidents in shipping sector has increased the safety concern among the stakeholders. Table 6 represents the number of accidents (involving cargo and passenger air crafts/ships) in the two sectors in the period 2011 to 2014.

Table 6 Number of accidents (total losses) in aviation and marine sectors

Year	Aviation Sector	Shipping Sector
2011	47	95
2012	23	123
2013	29	112
2014	21	88
2015	16	85

The statistics in Table 6 (EMSA, 2015; ASN, 2016) represent the world-wide total number of accidents (total losses) in aviation and shipping sector. There are two kinds of losses namely total loss and average loss. Total loss can be further classified into actual loss or constructive loss. Actual total loss is occurred when the insured cargo or the vessel is physically destroyed, where there is no possibility of salvage or recovery of the goods or the vessel. Meanwhile, constructive total loss is take place when the cargo or vessel is damaged such that the cost of saving and repairing of the goods or vessel is more than their value (Gauci, 2012). Based on the table, the number of accidents in marine sector is high compared to the aviation sector. In that case, statistics showed the total number of active merchant ships trading internationally and above 500GT (51400) (Statista, 2016) are higher than active commercial aircrafts (23,600) that includes passenger and cargo aircraft (The Telegraph, 2016). This indicates that the high number of ships and their activities increases the risk of accidents and exposed them to many threats at sea. The relatively high levels of training and regulatory controls, as discussed above, make organisational issues more important than human errors in aviation when compared to other sectors (including the maritime sector) (Johnson and Holloway, 2007).

In this sub-section, strategies adopted by the aviation industry in incorporating human factors into airline operations have been discussed. Also, shipping is predominantly a cargo transport sector, while aviation is predominantly a passenger transport sector. This could be the reason why effective safety measures are given more priorities in aviation sector than in the shipping sector.

2.6 Importance and effectiveness of the ISM Code for safe management

The ISM Code is an international standard for the operation and management of ship safety and pollution prevention (ISM Code, 2005). The main reason of the application of the ISM Code is to develop a good safety culture in the shipping industry (ISM Code, 2005). The International Safety Management (ISM) code was developed to provide an international standard for the safe management and operation of ships and for pollution prevention. The development of the code was initiated when there was issues concern about poor management standards in shipping (ISM Code, 1998). Further investigations into accidents exposed major errors on the part of management and in 1987; the IMO Assembly has called the Maritime Safety Committee to develop guidelines concerning safe operation. The ISM Code then, became mandatory in mid-1998 (ISM Code, 1998). From the date the ISM Code became mandatory, it is applied to passenger ships including passenger high-speed craft and to all commercial ships such as oil tankers, chemical tankers, gas carriers, bulk carriers and cargo high-speed craft of 500 Gross Tonnage (GT) (ISM Code, 1998). The ISM Code, also introduces an objective, which requires a Safety Management System (SMS) to be established by shipping company (ISM Code, 1998). The SMS is very important to keep the ship safe and thus, reduce accidents and environmental pollution (Gasparotti *et al.*, 2008).

It is notable that a well-established ISM Code is vital for the global improvement in safety and reduction in pollution (Withington, 2006). Once a structured SMS has been established based on the ISM Code's requirements, a company is in a better position to investigate incidents, identify weaknesses and the root causes of incidents, which, helps the company develop safer working practices (Withington, 2006).

Though, the ISM code has a role for pollution prevention, the International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL 73/78) is main international marine environmental convention covering prevention of pollution of marine environment. It was developed by the IMO in an effort to minimise pollution of the oceans and seas from shipping (IMO, 2005a). The Protocol of 1978 was adopted in response to a spate of tanker accidents in 1976-1977. In general, the Convention includes regulations aimed at preventing and minimizing pollution from ships both accidental pollution and from routine operations, which currently includes six technical Annexes (IMO, 2005a).

Oltedal (2011) has explained the 'level of understanding and implementation of the ISM Code by the shipping companies' as one of the factors that hinders the effectiveness of the ISM Code. Their level of understanding and procedures to implement the Code are inadequate as they stressed more on an administrative side such as procedures, checklists and other means to control human behaviour; these only tend to increase the level of possibly unnecessary work instead of efficient work style. This indicates that "the ISM Code itself is flawed because it encourages technical/bureaucratic compliance (Oltedal, 2011). Flag state administrations have a major role as regulators of the ISM Code to ensure that shipping companies and ships under their registry comply and implement necessary requirements (IMO, 2002). Another major factor is high cost of documentation, training, human resource and auditing faced by small shipping companies (IMO, 2005c; Choi, 2006). This factor hinders the companies to implement the Code effectively. Anderson (2007) has identified fatigue as another factor for the ineffective implementation of the ISM Code, which develop due to the reduction of crew whilst ships increase in size, as the shipping companies more particular in reducing crew to save cost. Anderson (2007)raised a question "…how can safe practices in ship operations exist if the people carrying out those operations are fatigued?". This explains that lack of crew will increases the workload for the remaining small team of crew, which could affect them due to enormous stress and lack adequate rest that causes failure in carrying out their duties appropriately as required by the ISM Code (Anderson, 2007).

Tunidau and Thai (2010) highlighted several factors that are essential to the successful implementation of the ISM Code. The factors are development of a safety culture; training and development of shipping personnel; leadership and commitment of senior management; employee involvement and empowerment; enforcement capability of flag state administration; and streamlining the administration process. These factors are summarised below.

Development of a safety culture

The ISM Code is crucial to eliminate substandard ships and develop a safety culture (IMO, 2005c) in the shipping industry (Lloyd's List, 2002). IMO (2013b) has stated that '…effective implementation of the ISM Code should lead to a move away from a culture of 'unthinking' compliance with external rules towards a culture of 'thinking' self-regulation of safety is the development of a 'safety culture…'. In other words, every individual from of an organisation should feel responsible for actions taken to improve safety and performance in order to enhance the safety culture (IMO, 2005c).

Training and development of shipping personnel

An increased integrative training and familiarisation between ship and shore based staff would facilitate the implementation of the Code (IMO, 2005b) and also will lead to increased awareness and ensures safe management of a ship (Le Meur, 2003; MacLean, 2005). Mallows (1997) has claimed that the training of ISM Code auditors is necessary for the verification of compliance audits. Therefore, training and development of the personnel as well as a continuous support from the government agencies are crucial for the successful implementation of the Code.

Leadership and commitment of senior management

The commitment of top managers and safety awareness on board ships are important factors for the effective safety management system (SMS) (Hernqvist, 2001). The success of a shipping company as a result of the implementation of ISM, is always associated with the leadership and commitment of senior management (Anderson, 2003). According to Pun *et al.* (2003), senior management is the main driver of SMS because their leadership is vital for the corporate wide safety initiatives and management practice in compliance with the ISM Code. This researcher believes that this is true that senior management plays an important role in the implementation of the SMS. This is because a good leadership encourages best practice amongst employees, to perform better by complying with company policies and directives on safety regulations or standards. These arguments indicate the importance of top management commitment in the successful implementation of the Code.

Employee involvement and empowerment

The involvement of the employee is necessary for the development and improvement of the ISM procedures and training manuals (IMO, 2005b). Campbell (2004) stated that the employees are responsible for their personal safety, the safety of co-workers and the environment. Therefore, the opportunities to make decisions and contribute ideas should be given to the employees for a healthier and safer work place. This could be useful at the sea if in the case an emergency that requires immediate decisions to ensure the safety of the crew and the ship (Tunidau and Thai, 2010).

Enforcement capability of flag state administration

The flag state administration has an important role as regulator of the ISM Code to ensure that shipping companies and ships under their registry comply and implement the Code (IMO, 2002). Therefore, the flag state should nominate classification societies to conduct statutory surveys of ships on their behalf, and also be responsible for the assessment and audit of shipping companies and ships against ISM Code (MCA, 2015). Botterill (2002) and DPC (2002) have claimed that deficient ship operators may arise due to the negligence of the flag states in carrying out their responsibilities as required by the Code. This is because, the ship owners and flag state administrators may have little enforcement structure or do not have necessary resources for successful implementation of the Code (Botterill, 2002; DPC, 2002). Flag state administration should therefore ensure appropriate enforcement and monitoring of the ISM Code implementation by shipping companies.

Streamlining the administration process

The implementation of the ISM Code would be easier through the reduction of the administrative processes, such as by reducing the amount of paperwork that require by the SMS (IMO, 2005b). To overcome this issue, the use of information technology such web-based programs, identification and integration of documentary requirements would be appropriate. This way will ease the workload of the seafarers and they would have ample time to focus on the navigational and other related work (Anderson, 2003; Choi, 2006). However, this researcher believes that hiring a person to handle paperwork would be ideal and it is potential to reduce many hassles. Of course, this is dependent on an individual company's practice and philosophy.

2.7 Conclusion

The fundamental key element to create the awareness towards maritime safety is to understand the concept of safety culture. By understanding this concept, one would be able to understand the importance of the safety culture. Therefore, the literature review in this chapter has covered various aspects and issues of safety in the shipping industry. For example, the researcher has explained about the fundamental structure of safety culture and how it is practiced in shipping organisation. The researcher has also discussed about factors affecting safety culture for example human error. In addition, a comparison has been done between aviation and shipping sector to explore the strategies used to sustain excellent safety practice. The comparison study has revealed many useful strategies applied in aviation sector, which, can be utilised in shipping. Like maritime industry, aviation industry is also affected by the human elements in their operation. However, the tactic used by aviation differs to maritime and which, makes aviation safer to manage the human element to improve the safety, offers possible solutions for the shipping industry. For instance, in aviation industry, human factor training is mandatory for all personnel, whereas in the shipping industry, it is limited for certain grades (Turan *et al.,* 2016).

Based on the literature, human error has been highlighted as one of the main reasons for the deficiencies of safety in the industry. The problems associated with safety are commonly due to inadequate communication, inadequate knowledge and poor maintenance of the ships. These issues can be managed with an effective implementation of the safety regulations, where, the implementation and effectiveness of regulations have been discussed in this chapter.

Therefore, this study has been built upon a thorough review on previous studies, where, the researcher believes there is a study needed to explore further on safety culture in the maritime industry. This has been supported by the identified research gap which is explained in the next section.

2.8 Research gaps

Table 7 Summary of previous studies concerning maritime safety

Authors	Title	Scope	Method	Conclusion
Nikcevic Grdinic (2015)	Legal regulations in the function of ensuring ship safety	Compliance to regulations to enhance ship safety	Literature review	Proper implementation of international conventions and regulation are important to keep the ship safe.
Slišković and Penezić (2015a)	Descriptive study of job satisfaction and job dissatisfaction in a sample of Croatian seafarers	Determine the level and sources of job satisfaction and job dissatisfaction	Online survey	Main sources of job satisfaction are: financial stability and security, the ratio of work days to days off, and the quality of days off, and the nature and dynamics of the work
Ceyhun (2014)	The impact of shipping accidents on marine environment	To investigate the effects of shipping accidents on marine environment in Turkish Seas	Literature review and accident statistics	Improved standards for ships, management and seafarers should be more taken into account
Nguyen *et al.* (2014)	Current Challenges in the Recruitment and Retention of Seafarers	Seafarers shortage issue	Case study	The development of effective human resource strategies for companies in order to improve their recruitment and retention rates
Nielsen *et al.* (2013)	Relationships between work environment factors and workers' well-being	Physical/psychosocial or cross-cultural differences factors towards job satisfaction	Questionnaire survey	Emphasise the importance of situational factors in the understanding of well-being among workers and organisation factors are vital

	in the maritime industry			for the well-being of employees
Barsan *et al.* (2012)	Factors of human resources competitiveness in Maritime Transport	Training as an important criterion of competitiveness	Case study	Sufficient training is vital in ensuring the competitiveness of the ship and reduce the risk of accidents
Lu *et al.* (2012)	Effects of national culture on human failures in container shipping	Examine the effects of seafarers' perceptions of national culture on the occurrence of human failures affecting work safety in shipping operations	Questionnaire survey	Need development of national culture theory and their managerial implications for reducing the occurrence of human failures in shipping operations
Knudsen and Hassler (2011)	IMO legislation and its implementation: accident risk, vessel deficiencies and national administrative practices	Factors inhibits the effectiveness of the regulations	Empirical study	Administrations and the structural weakness of the IMO/member state link is the core implementation problem that urgently needs to be dealt with if marine safety is to be improved.
Oltedal (2011)	Safety culture and safety management within the Norwegian-controlled shipping industry	Influential safety culture factors	Interview, Case study and questionnaire survey	Underreporting of experiences found to be a problem besides shipping companies management
Ganguly (2011)	Human vs work place management in modern organisations	Role of regulations and how companies complying with it for the safety and health of their employees	Literature review	Error management and reducing on-the job injuries can save employers money on healthcare, disability and workers' compensation costs
Lundh (2010)	Exploring the interaction between the crew and their adaption to the development of the work situation	To investigate the interplay between the ship, the technological system on board	Questionnaire survey, interviews &	Sufficient training, skills and knowledge are needed to adapt with the improved technologies

	on board Swedish merchant ships	and the human system	observations	
Horck (2010)	Meeting diversities in maritime education	Creating awareness on dilemmas and challenges when working in a multicultural environment	Phenomenography and discourse psychology	Cultural background of crews and good communication skill are important
Hansen *et al.* (2008)	Major differences in rates of occupational accidents between different nationalities of seafarers	The connection between health and accident rates among South East Asian (Philippines) and Western and Eastern Europe	Case study	Seafarers from Philippines are healthy and have lower risk of occupational accidents, but it was due to poor underreporting culture
Andresen *et al.* (2007)	Working unusual hours and its relationship to job satisfaction: a study of European maritime pilots	Analyses the level of job satisfaction and its predictors	Job Descriptive Index (JDI)	Working conditions should be improved in order to prevent health problems
Håvold (2007)	A study of seafarers working for Norwegian shipping companies	Examines the association between national culture and the safety orientation of seafarers	Questionnaire survey	Different culture and language increases the risk of safety on board
Hetherington *et al.* (2006)	Safety in shipping: the human element	Common themes of accidents, the influence of human error and interventions to make shipping safer	Literature review	Among various safety aspects, individual and organisation factors are among the main causes of accidents
Bailey *et al.* (2006)	Perceptions of risk in the maritime industry: ship casualty	To consider perceptions of risk among various groups	Questionnaire survey	There were significant differences in perception of risk between groups of respondents along the lines of occupational hierarchy and influenced by working experience

Horck (2006)	A maritime safety challenge and its impact on maritime education and training	How the Maritime Education and Training (MET) can address the safety issues in the industry	Phenomenography, discourse analysis and discourse psychology	Cultural background and poor communication skill are potential to cause accidents
Akten (2006)	Shipping accidents: a serious threat for marine environment	Causes and ways to handle shipping accidents	Literature review and accident statistics	Improved standards for ships, seafarers and shipping management will make a major impact on shipping safety for safer shipping and cleaner oceans
Benton (2005)	Multicultural crews and the culture of globalisation	Problems at sea arise from multicultural crews	Case study	Effective education program that emphasises critical thinking skills and knowledge about diversity and trans-cultural interactions
Rothblum (2000)	Human error and marine safety	The causes of accidents in the presence of advanced technology	Literature review	Reduced human errors (communication) can design technologies, work environments, and organizations which support the human operator and foster improved performance and fewer accidents

The Table 7 shows that a diverse sample of studies about crews and maritime safety exists. It is evident that a major part of the studies is done on subjects related to factors of accidents. However, few studies are focused on how to handle the problems, or why they still exist, while plenty of suggestions and recommendations have been made. Based on the discussion in this chapter and Table 7, it is observed that a research gap is existing in the literature within the shipping industry in improving the safety level. Although there are studies on safety aspects such as communication, competency, cultural aspects, reporting culture and job satisfaction, the researcher intended to further study on other safety aspects to determine the safety culture in the industry. This is because most studies focused on only the main factors of accidents but did not highlight the connections between each and every root cause or how one factor influences/triggers another factor. In addition to that, the gap in the studies, factors inhibit the effectiveness of standard regulations and on-going occurrence of human error will also be studied. The effectiveness of standards regulation is important as some companies lack exposure on effective implementation; this prevent them from performing well in term of staff work performance or profit. By identifying these factors and the causes of the problem, measures and strategies to improve the safety level can be developed. In addition, this table shows also that there are different approaches that have been also applied in this study, which need to be mentioned and linked with the chosen methodology.

Chapter 3 Chosen Research Methodology

3.1 Introduction

This chapter focuses on the research methodology adopted to answer such questions, involving both qualitative (maritime accident report analysis and semi-structured interview) and quantitative aspects (questionnaire survey). In addition to this, the methodologies were also chosen to achieve the aim of the PhD project through four objectives as follow:

1. To analyses the causes of human error and the rates of maritime accidents.
2. To study and identify the relationships seafarers perceive to exist among various safety parameters on-board ships.
3. To identify the safety aspects the seafarers believe contribute most towards an improved on-board safety culture.
4. To recommend methods to reduce the impact of human errors that could be used as a reference for decision makers in international shipping companies to augment their information on policy and management.

The first objective will be studied through a ship accident report analysis and semi-structured interview (qualitative method). The second objective will be studied through a questionnaire survey (quantitative methodology). The third and fourth objectives will be studied based on the semi-structured interview (qualitative methodology).

3.2 Qualitative research method

Social sciences' scholars highlight two methods to conduct research, namely qualitative and the quantitative methods (Xue, 2012). The term qualitative method refers to any kind of research that produces findings that are not based on statistical procedures or other means of quantification (Oltedal, 2011). Strauss and Corbin (1990) clarified that some of the qualitative data might be quantified but the analysis itself is qualitative. Qualitative research comprises of an investigation that (Mack *et al.*, 2005):

- Look for answers to a question
- Thoroughly uses a predefined set of procedures to answer the question
- Gathers evidence
- Produces finding that were not determined in advanced

This method is appropriate to understand the changing aspects of a workplace and draw out the causations (Whitfield and Strauss, 1998). The ability to provide complex textual descriptions of how people experience a given research issue is the main strength of qualitative research. This method is also effective in identifying intangible factors such as social norms, socio economic status and gender roles, in which, whose role and impact may not be readily apparent (Mack *et al.*, 2005).

There are five main qualitative methods: phenomenological, ethnographic, grounded theory, case study and narrative (Hancock *et al.*, 1998). The types of data collection associated with these five methods are summarised in the Table 8 below. Among these techniques observation, interviews and reviewing text are commonly used in research (Sauro, 2015).

Table 8 Features of the five qualitative methods

Techniques	**Data collection**
Phenomenological	• Interviews • Reading documents • Watching videos • Visiting places/events
Ethnographic	• Observations
Grounded theory	• Open and axial coding techniques
Case study	• Document/report study • Observations • Describing an event
Narrative	• Stories from individual/documents

By using different techniques, hidden features in employment relationship (based on contract/agreement between employer and employee with mutual obligations to work and to pay for the work) can be revealed (Bhattacharya, 2012). As an example, Kunda (2009) has pointed out his success to expose the inconsistency between documented company procedures and actual practices by using observation and documentary analysis techniques. Oltedal (2011) had also been used qualitative methods such as document study, case studies, interviews, participatory observation and participation in maritime forums in her safety culture research. To further support the argument, Denzin and Lincoln (1998) mentioned that this method would enable description, testing and examination of causal relationships between variables. In this study, phenomenological and case study have been utilised for the qualitative data collection.

3.2.1 Case Study

Case study is a commonly used qualitative technique to be used in social sciences and found to be very useful. A case study is the exploration of an individual, group or phenomenon (Starman, 2013). It is also often used for an in-depth exploration from multiple perspectives of the complexity and uniqueness of a specific event, policy or system (Simons, 2009). Document study is a method of data collection of case study technique that does not require participation of the subjects or the person involved (Oltedal, 2011). The purpose of choosing this approach is to address one of the objectives of the main research project, which is 'to analyse the causes of human error and the rates of maritime accidents'. In obtaining the relevant information, official maritime accident investigation reports from the UK Marine Accident Investigation Branch (MAIB) are to be studied in order to understand the safety management culture in the industry based on the factors that cause accidents and the recommendations made to improve the safety. In addition to this, accident reports were chosen for the analysis because report are intended to explain the causes of system failures and they are evidence of various team of experts and are the results of lengthy investigation process (Johnson, 2001).

The document study in this research involved three steps such as: step 1 – data collection and occurrence sequence determination; step 2 – factors identification and classification: and step 3 – safety actions development (Soliwoda, 2014). These steps are illustrated in the Figure 4 and explained below.

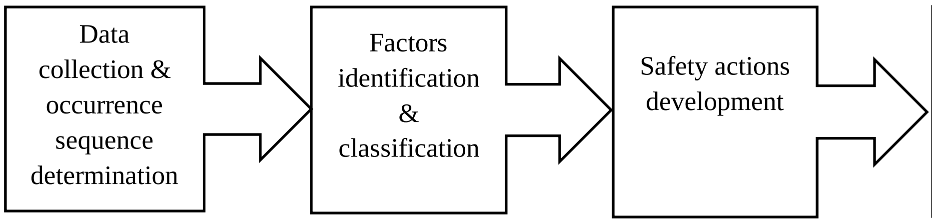

Figure 4 Steps of accident report analysis

Step 1: Data collection and occurrence sequence determination

The first step of the accident report analysis involves collecting accident reports to gather the accident information in determining the causes. The accidents being studied in this research are those that happened in the UK jurisdiction and involving vessels of various flag states and crews of different nationality. After collecting the reports and the related information, a sequence of events and circumstances will be developed. At this stage, all the factors that associated with the incident will be identified.

Step 2: Factors identification and classification

This step involves the classification of the unsafe acts or conditions identified in the first step into human factor group such as slip, lapse, mistakes and violation (Soliwoda, 2014). The identified factors will also be classified into four levels of Human Factor Analysis and Classification System (HFACS), in which, will be elaborated in Section 3.4.1.

Step 3: Safety actions development

The final step of the analysis involves safety actions' development, which will be based on recommendations made by the MAIB, which are complied with the regulations. In this section, all the identified causal factors, grouped into four levels of HFACS, will be tailored with relevant recommendations to prevent similar factors to recur. The identifications of the safety actions will be useful to be adapted to improve the current safety culture in the industry.

The document study technique will incorporate valuable insights into understanding how safety culture and safety management interact and influence accidents. This could also provide a better understanding of shipping companies' approach to safety management (Oltedal, 2011).

3.2.2 Phenomenological

Phenomenology is developed in early 20th-century European philosophy. Phenomenology is a qualitative technique that focuses on experiences and events which involves the use of depth description and close analysis of lived experience to understand how meaning is created through embodied perception, rather than to explain or quantify it in any way (Stewart, 1974; Sokolowski, 2000). This technique does not include a hypothesis about the data collected as it is solely concerned with study of the experience from the perspective of the participants.

There are a number advantages associated with phenomenology technique as following (Sokolowski, 2000):

- It explores the meaning or key of an experience rather than measurements or explanation.
- Contribute to the development of new theories.
- Able to collect data, which is seen as natural rather than artificial.
- Appropriate to understand people's meanings.
- Useful to adjust to new issues and ideas as they emerge.

Phenomenology makes use of variety of data collection methods including interviews, reading documents, watching videos and visiting places/events. The main idea of the methodology is to be less structured and more open-ended to encourage respondents to share their experiences.

In this study, interviews are used to gather the information about the safety culture and human error in shipping sector. An interview is a conversation between an interviewer and interviewee where, the purpose is to gather detailed information about a particular issues or topics based on the interviewee's experiences (Flinders, 1997). Besides conducting one-to-one interviews, group interviews are also popular (Marshall and Rossman, 2014). An interview is the most common method of data collection in qualitative research (Jamshed, 2014). The main aim of research interview is to explore the views, experiences, beliefs or motivations of individuals on specific matters, which in this study it is on safety culture issues. This method could provide a detailed understanding of an issue than would be obtained from quantitative method. Therefore, interviews are appropriate where detailed insights are required from individual participants. In general, there are three types of research interviews namely: structured, semi-structured and unstructured which are described in Table 9 (Alshenqeeti, 2014; Marshall and Rossman, 2014):

Table 9 Types of research interviews

Research Interviews	Descriptions
Structured	• Verbally administered questionnaires. • Predetermined questions with little or no variation and without further follow-up questions. • Fast and easy to conduct. • Only allow for limited participant.
Semi-structured	• It has a set of same questions to be answered by all respondents. • Consist of several key questions that assist to define the areas to be explored. • More flexible. • It provides the respondents with some guidance on what to talk about. • It is an in-depth interview where the respondents have to answer preset open-ended questions.
Unstructured	• Does not reflect any predetermined theories or ideas. • Start with an opening question for example 'can you tell me about your experience?' and the interview will progress based on the initial response. • Usually very time consuming. • Can be difficult to manage and to participate in. • It is vital when significant depth is required

In this study, the researcher has adopted one-to-one and group based semi-structured interview to gather information from shipping company senior managers and seafarers. This is because the semi-structured interview is flexible in how and when the questions are asked and how the interviewee can respond. It also allows more space to the interviewee to understand and answer on their own term compared to structured and unstructured interviews.

Planning of semi-structured interviews

Before conducting a semi-structured interview, it is best to prepare a set of questions that are likely to yield as much information about the topic of interest. It is also important to set good questions for example an open-ended questionnaire that require more than a yes or no answer, neutral and understandable (Gill *et al.*, 2008). The process for conducting a semi-structured interview is: i. survey plan, ii. develop instruments, iii. data collection, iv. analyse data and writing results. These steps are explained in the following paragraphs.

i. Survey plan

In a survey, it is important to identify the most suitable respondents or participant that are relevant to the particular study. Therefore, shipping company senior managers and seafarers are the most suitable participants as the study is about the safety culture in shipping sector. The respondents are from various companies and education institute. According to the ethical elements of research (UOS, 2012), it is advisable not to reveal the identities of the respondents or companies/institutions involved in the study.

Then, deciding the sample size is also crucial before conducting the interview. Although large number of sample could provide a broader range of information, data from only a few individuals who have experienced the phenomenon and who can voluntarily provide a detailed information of their experience are suitable to be considered. A typical sample sizes for phenomenological studies range from 5 – 25 respondents (Morse, 1994; Creswell, 1998). In this study, the researcher has abled to get 10 respondents.

ii. Develop instruments

The next step is developing the interview questions and protocol. In this study, the researcher has developed two sets of questionnaires (refer to Appendix A & Appendix B) where one is for the shipping company managers (five respondents) and the other is for seafarers (five respondents). In general, there are three parts in the questionnaire namely: A. Background; B. Company/ship safety culture facts; and C. Opinions on results from safety culture survey. Each questionnaire contains various questions that are relevant to both managers and seafarers. In addition to that, the researcher has also developed a script and explanation (refer to Appendix C & Appendix D) for each of the questionnaires to ease the understanding of the respondents.

iii. Data Collection

Before conducting the interview, respondents should be informed about the study details, ethical principles of the interview such as anonymity and confidentiality (Gill *et al.*, 2008). This would assist the respondents of what to expect from the interview and will ease the interview process.

Then, the interviews should be conducted in places free from distractions and most importantly at the locations that are most suitable for the respondents. In this study, the researcher has conducted the interview at the respondent’s work place and also via telephone as it is easier for them to take part in the interview due to their busy work schedule.

To ensure that the interview is productive and interactive, it is important to the interviewer to possess skills and techniques. This would enhance the possibilities of getting comprehensive data during the interview. It is also crucial that the interviewer to present himself as the listener and ask participants/interviewee to give explanations of their experience of that particular issue (Starks and Brown Trinidad, 2007). For example, a successful interviewer should have the following criteria (Harvard.edu, 2017):

1. Knowledgeable: well understand with the focus of the interview.
2. Structuring: gives objective for interview and asks whether interviewee has questions.
3. Gentle: lets the interviewee finish, gives them enough time to think and tolerates pauses.
4. Clear: asks simple, easy and short questions.
5. Steering: knows what he/she wants to find out.
6. Ethically sensitive: is sensitive to the ethical dimensions, ensuring the interviewee aware of the motive/objective of the research and that his/her answers will be treated confidentially.

In this study, the researcher has gained the skills and techniques of doing an interview by understanding all the above criteria and he has applied them during the interview. Also, the researcher started the interview with general questions such as ‘can you briefly give an introduction about yourself?’, ‘what is your age?’, and ‘where you come from?’. The main aim of these questions is to create a friendly and comfortable environment to carry on further with the interview.

The interviews took a duration of 1 hour to 1 hour 30 minutes. During the interview, the researcher took notes and recorded the whole conversation. The recording of the conversation was useful to have the interview data captured effectively because not all information could be written down during the interview. Considering the ethical requirements and confidentiality of the respondents, all the recorded data has been stored safely at the University of Southampton.

iv. Analyses of data and writing results

After completing all interview sessions, all the interview data should be well transcribed in order to analyses the data efficiently. In this study, the researcher transcribed the recorded audio manually and took notes while conducting the interview. There are few steps in analyzing interview responses as following (Boyce and Neale, 2006):

- Read the responses and identify the patterns or themes among the participants. It is also can be useful to work with specialized software, which makes it easier to group the interview responses. In this study, the research has used NVivo software (refer to Section 3.4.5) to group the responses.
- Group the responses according to the identified patterns or themes and questions.
- It is also to analyses the responses carefully to identify if there are responses that seem to have been given totally opposed to those that participants that answered in only a few words.

In this study, all the responses have been grouped into two categories, which are the managers and seafarers. The findings from the interviews are presented in Chapter 6.

3.3 Quantitative research method

Quantitative research method is an approach that deals in numbers, logic and an objective point (Labaree, 2013). Generally, quantitative methods emphasize objective measurements by examining the relationship among variables (Creswell and Clark, 2007). According to Ross (2005) a variable is a factor that comprises of two of more properties and if a property can change either in quantity or quality, then it can be referred as a variable. Variables are any factors such as performance, weight, time and treatment which used to measure on a sample of subjects (Hopkins, 2008), where, they can be measured or analysed statistically on structured research instruments (Creswell and Clark, 2007; Labaree, 2013).

There are three main types of quantitative research methods such as descriptive, experimental and causal comparative (Leedy and Ormrod, 2005). These methods are elaborated in Table 10.

Table 10 Types of quantitative research methods

Methods	Explanations
Descriptive	• An approach that examines a situation. • This method involves identification of a particular variable based on an observational basis or examining the correlation between two or more variables (Williams, 2011). • Techniques used to collect data: correlational, developmental design, observational studies and survey. These techniques are applicable to experimental and causal comparative methods as well (Williams, 2011).
Experimental	• Examines the treatment of a problem into the study group and then measures the outcomes of the treatment. • Three types: pre-experimental, true experimental and quasi-experimental (Leedy and Ormrod, 2005).
Causal comparative	• Examines how the independent variables are influenced by the dependent variables. • Involves cause and the effect relationships between variables (Williams, 2011).

In this study, a descriptive method is adopted through a questionnaire survey to develop an understanding of the safety culture in the shipping industry and associate the output with the findings of a ship accident report analysis in Chapter 4. The chosen participants of this survey are seafarers as they are the most relevant people to answer the questions related to safety culture of the maritime industry. A survey is the most commonly used research design in health services research and the social sciences (Mathers *et al.*, 2009). It is also a flexible approach used to investigate various range of topics. In supporting this approach, Mathers *et al.* (2009) have highlighted several advantages of using a survey which are explained in the Table 11 below.

Table 11 Features of using a survey to gather evidence

Advantages	Explanations
Internal and external validity	• A survey on random sampling technique will produce a sample, which is representative of the particular population under study and will produce findings, which may be generalised to the wider population.
Efficient	• Uses small sample sizes to generate findings, which can be used to draw conclusions about the whole population. • Cost-effective.
Covers geographically spread samples	• Participants who are widely dispersed can be accessed easily through postal questionnaires and telephone interviews.
Ethical advantages	• Confidential as the information of the participants are not exposed.
Flexible	• Can be combined with other methods such as in-depth interviews or focus group to produce better data.

There are seven steps in conducting a survey research as follows (Burgess, 2001):

- Step 1 - Define research aims
- Step 2 - Identify the population and sample
- Step 3 – Decide how to collect data
- Step 4 – Design a questionnaire
- Step 5 – Run a pilot survey
- Step 6 – Carry out the main survey
- Step 7 – Analyses the data

The seven steps are explained in the following paragraphs by relating it to the research project of this study.

Step 1 – Define research aim

The main concern of a good research design is to ensure that the questionnaire design addresses the needs of the research (Burgess, 2001). The purpose of this survey is to address one of the objectives of this study, which is: ‘to study and identify the relationships between safety culture aspects in the shipping industry’. Therefore, all the questions were developed relevant to the objective.

Step 2 – Identify the population and sample

After defining the research aim, the next important step in a survey is to define the population of individuals whose opinions are sought (Mitra and Lankford, 1999; Baxter and Babbie, 2003).

Populations may be as broad as the general population in a state or country, or specific on a particular interest (Needham *et al.*, 2008).

The particular population of this study is the community of seafarers. According to MCA (2006), a 'seafarer' means any person who is employed or engaged or works in any capacity on board a ship. Hence, seafarers involved in this study include a range of respondents working as engineers, deck officers, ratings and cadets. The respondents comprised both UK and non-UK seafarers. To be more specific, non-UK seafarers are those who work on UK registered vessels or those who use the UK Certificate of Competency (CoC) to work on non-UK registered vessels. Since the respondents of this study are from a range of different companies, nationalities and working on vessels of different flags, it is difficult to determine the population size. In a circumstance of unknown population size, a standard maximum possible population proportion is advisable to be used. Commonly, the maximum of 50% (0.50) of the population proportion is used which represents half of the actual population size (Krejcie and Morgan, 1970; Cochran, 1977, 2007). In this case, the standard population proportion is used to calculate the sample size.

Once the population is defined, it is necessary to choose a method for selecting a sample that represents the population from which it was drawn. Sample size is an important criterion for a study design that can influence the detection of significant differences, relationships or interactions (Peers, 2006). The sample size formula used in this study was based on Cochran's (1977, 2007) formula. The definition of the formula (equation 3.1) and the calculation of the sample size are presented below.

$$\underline{n}_o = \frac{(\underline{t})^2 \times (p)\,(q)}{\underline{d}^2}, \tag{3.1}$$

Where $\underline{n}_o$ = required minimum sample size,
Where $\underline{t}$ = value for selected alpha level of 0.25 in each tail = 1.645 , The value that a test statistic must exceed in order for the null hypothesis to be rejected,
Where p = population proportion = 0.5,
Where q = 1 - p = 0.5,
Where $(p)\ (q)$ = estimates of variance = 0.25, and
Where $\underline{d}$ = the acceptable margin error for proportion being estimated = 0.1

Step 3 – Decide how to collect data

Before conducting a survey, the researcher should decide whether the survey is to be completed directly by the respondent or through an interviewer to overcome literacy or language problem. It is also important to explain to the potential respondent why they have been chosen to answer the questions and this should be persuasive in order to improve response rate (Burgess, 2001). This can be achieved by sending them a letter that explains what the questionnaire is about, the purpose of the survey, how the respondent's details will be kept confidential and why its completion is of value (Burgess, 2001). Then the researcher should consider how to distribute the questionnaires, which they have few options such as by post, email or hand them directly to the respondents (Burgess, 2001; Mathers *et al.*, 2009).

In this study, the researcher has prepared two versions of questionnaires: English and Mandarin (refer to Appendices H and I), the latter for Chinese sailors. More details on the design and structure of the questionnaire are explained in step 4.

The survey was conducted in two different places: at Maritime Academy A and Shipping Company B: according to the ethical elements of research (UOS, 2012), it is advisable to not reveal the identities of the respondents or companies/institutions involved in the study - refer to Section 3.5. Before conducting the survey, permission was obtained from the institute/company by sending them a consent letter with the researcher's contact details and a participation information sheet (PIS) as required by the Ethics Committee of the University of Southampton (see attachment in Appendices J and K). Then, upon deciding the appropriate dates for the survey, the questionnaires were distributed by email and handed directly to the respondents. Different ways of questionnaire distribution were chosen based on the availabilities of the respondents. At Maritime Academy A, the questionnaires were handed directly to the respondents (seafarers) as they were at the academy for their training. However, the respondents at the Shipping Company B were seafarers who were sailing during the time of the survey and this is the reason why the questionnaires were sent to them by email.

The completed questionnaires at Maritime Academy A were collected directly by the researcher and those from Shipping Company B were sent back by email. The response rate was 100% in Maritime Academy A for the particular group of seafarers as permitted by academy's authority and for Shipping Company B, the response was unable to be identified as the questionnaire form has been sent to the company manager by email and they distributed to different ship that they are in charged.

Step 4 - Design a questionnaire

After the indicators and variables of interest have been identified and their components have been defined, the researcher can begin designing the questionnaire. Design of the questionnaire can be split into three elements (Burgess, 2001) such as:

- Determining the questions to be asked.
- Selecting and specifying the question type.

- Designing the question sequence and overall questionnaire layout.

The explanations for these elements are in the next paragraphs.

Determining the questions to be asked

In this step, a connection needs to be developed between the research aims and the individual questions by the research issues. In this study, the relevant questions were determined based on the literature as discussed in Chapter 2. A total of 61 questions related to 10 different safety practice aspects were developed.

Selecting and specifying the question types

The two most common types of survey questions are closed-ended and opened-ended questions. In close-ended questions, the respondents are given a list of predetermined responses from which to choose their answer. The list of responses should include every possible response and the meaning of the responses should not overlap. Commonly, closed-ended questions can answered with ‘yes’ or ‘no’ or they have a limited set of possible answers such as multiple choices (A, B, C, or All of the above) or 5-point scale based answers (Farrell, 2016). Moreover, the questions of this type are conclusive in nature as they are designed to create data that is easily quantifiable. These questions are also easy to code and that makes them useful when trying to prove the statistical significance of a survey’s results besides allowing the researchers to categorise respondents into groups based on the options they have (Penwarden, 2013).

In opened-ended questions, the respondents are required to provide more than one answer. The answers would come in the form of a list, a few sentences or something in detail. The questions of this type are usually used during an interview, to find out more about a person or a situation or when getting to know about a new person (Penwarden, 2013). Although the respondents’ answers are richer in quality, these type of questions are only suitable with smaller population as the amount of effort it takes to digest the information of a larger population can sometimes be massive (Penwarden, 2013).

In this study, closed-ended questions were used. There are several reasons for choosing the questions of this type such as:

- These are easier and quicker as the respondents of the study are busy and not all the time available on shore.
- It is easier to compare the answers of different respondents.
- The answers are easier to code and analyse statistically.

Designing the question sequence and overall questionnaire layout

A good questionnaire should avoid unnecessary headings and numbers. It includes a title with the questions and answer choices attractively and neatly laid out (Burgess, 2001). The Likert scale was used to develop the questionnaire. This is the most commonly used scale in surveys (Allen and Seaman, 2007). The Likert scale is a psychometric response scale developed by Dr. Rensis Likert, which is mainly used in questionnaires to obtain participant's degree of agreement with a statement or set of statements (Dane, 2013). Respondents are asked to indicate their level of agreement based on a 5-point scale such as: Strongly Disagree, Disagree, Neither, Agree and Strongly Agree. Some researchers use different numbers of the scale, which adds additional granularity. A numeric value is assigned for each level on the scale, which usual starts at 1 and increases by one for each level.

The questionnaire for this study uses a 6-point scale such as: Don't Know, Strongly Disagree, Disagree, Not Sure, Agree and Strongly Agree. The numeric value assigned for this scale is starting at 0 and finishing at 5. The scale is illustrated in the Figure 5.

Don't Know	**Strongly Disagree**	**Disagree**	**Not Sure**	**Agree**	**Strongly Agree**
0	1	2	3	4	5

Figure 5 Scale used in the study

These numeric values will be used to calculate the mean values, $\overline{x}$ to estimate the level of agreement. A mean value is the average found by dividing the sum of a set of numbers by count of numbers as shown in the equation 3.2.

$$\text{Mean, } \overline{x} = \frac{\sum x}{n} \tag{3.2}$$

Where $\sum x$ = sum of a set of numbers and

n = count of numbers in a set.

To support the mean value, the standard deviation is essential. The standard deviation is a measure of the spread of scores within a set of data (Altman and Bland, 1995). It is used in conjunction with the mean to summarise data (Altman and Bland, 2005). The standard deviation formula is:

$$\sigma = \sqrt{\frac{\sum (X-\mu)^2}{n}} \tag{3.3}$$

Where,

σ = population standard deviation
Σ = sum of $(X - \mu)^2$ for all data
X = value in the data

μ = population mean

n = number of scores in sample.

The questionnaire has 11 sections and consists of 64 items. The descriptions of each section and a brief elaboration on the ten safety aspects are concluded in the Table 12.

Table 12 Descriptions of the sections of the questionnaire

Sections	Name	Explanations
1	Background information	Contains three items: gender, age and working experience.
2	Working environment satisfaction	Contains five items related to clear working procedures, recognitions and appreciations.
3	Reporting culture	Contains seven items related to habits of reporting every risky incident that happens on board.
4	Communication and language barrier	Contains seven items related to the importance and capability of understanding the standard language on board.
5	Competency level	Contains five items related to appropriate skills and trainings needed for seafarers.
6	Shore management support	Contains seven items related to matters on support and assistance from shore management to the offshore personnel.
7	Health awareness	Contains seven items related to awareness among offshore personnel on their rights on health & safety at work and getting enough rest.
8	Safety awareness	Contains six items related to attitudes and responsibilities towards safety at work.
9	Importance of maritime regulations	Contains six items related to implementation and compliance of the regulations.
10	Risk awareness	Contains five items related to the seafarers' awareness in conducting any task with full cautious.
11	Job satisfaction	Contains four items related to how the seafarers are being appreciated and given opportunity to share their opinions on safety matters on board.

The current method for assessing safety culture in this research is based on 10 aspects of safety culture which had been used in various studies (refer to chapter 2, section 2.2.2), and the researcher believes that these aspects provide a valuable and practically useful view of a safety culture within shipping organisations. The 10 aspects are working environment satisfaction; reporting culture; communication and language barrier; competency level; shore management support; health awareness; safety awareness; importance of maritime regulations; risk awareness and job satisfaction. An overview of the content of each aspect will be illustrated here.

Working environment satisfaction

Working environment satisfaction is achieved when the work place that is safe, supportive and understanding. Such a work place enables personnel to perform effectively (Oswald, 2012) and influences an individual's perspective on risk and safety in shipping sector (Ek, 2006b). There is a positive connection between work environment and job satisfaction on the one hand and improved work performance on the other hand (Skalli *et al.*, 2008). Therefore, working environment satisfaction aspect is must be studies as it has an important role in safety practice.

Reporting culture

A reporting culture encourages institutionally the seafarer to report incidents or anomalies using a well-functioning reporting system, which is then used further to prevent similar occurrence in the future (Ek, 2006b). According to Transport (2019), reporting incidents are useful to increase transparency and also for a continuous learning in the industry. Reason (2000) highlights reporting culture could also be essential to effective risk management. However, studies have shown that a reporting culture is lacking in the shipping industry (Storgård *et al.*, 2012) despite the compulsory character of the International Safety Management (ISM) Code, which require shipping companies to establish a system for reporting incidents and near misses (ISM Code, 2005). These explanations give a clue that necessary action needs to be taken to increase the awareness of the importance of reporting culture.

Communication and language barrier

Communication is vital to guarantee that the right people are kept informed of the state of the system in order to make the right moves and decisions (Ek, 2006b). Holt (2008) claimed that good communication is an important element of safety that could result in better safety standards and effect of safety policies. The use of a common language is crucial for efficient communication in the normal daily work both on board the ship and in seeking assistance from the managing office. The ISM Code requires shipping companies to ensure that all personnel receive all the information on the safety management system (SMS) in a language understood by them. The company should also ensure that the ship's personnel are able to communicate effectively while carrying out their duties related to the SMS (ISM Code, 2005). This reinforces the fact that communication and language barrier is an important aspect in safety practice that needs to be studied.

Competency level

The competency level of employees depends on effective education and training. Inadequate education and training are among the causes linked to accidents in the maritime sector (Squire, 2005). In this study, seafarers were asked to assess their competency level they believe they reflect and how such level contributes towards the safety of the ship's operation. Based on regulation requirements, seafarers are required to have specific training and able to display the abilities required by their job and have examined and deemed competent. Hence, the competency level aspect is another important factor of safety practice that needs to be studied.

Shore management support

Shore support is crucial to assist a ship to perform all operations smoothly and safely. These safety aspects assess the importance of ship-shore interface management in achieving safety on-board the ship (O'Toole, 2002). It addresses the question whether the needs of seafarers such as information and advice on safety and work-related issues, healthcare and training are being received. In fact, the shipping trade or activities cannot survive only with the help of ships and seafarers, and therefore the intervention and support from shore management are important. Without the involvement of shore management support, it is not possible for a ship to perform all the operations on its own. Hence, this brings in the need to study the importance of shore management support.

Health awareness

In this contex, health awareness is defined as conscious perception of physical and health status that allows one to recognise harmful life style or surroundings that could affect their health. It is also defined as the pursuit of optimum health (Ladki *et al.*, 1998). This parameter is assessed by a number of questions related to the seafarer's routine and lifestyle. Studies have revealed that poor health awareness could increase the risk of fatigue or injuries and also will diminish work performance and safety (Josten and Thierry, 2003). Studies have also showed that health related issues among seafarers have increased by 50% upon boarding ship. For example, the physical and psychosocial stresses among seafarers remain significant despite the improved environment on board ships. Seafarers' health is always being affected by poor management strategies, reductions in crew sizes, which eventually increase the working hours and overload paperwork, which have the potential to lead to fatigue (Squire, 2005).

Safety Awareness

Perceptions of senior managers towards safety in an organisation are reflected in the safety culture and behaviour of workers (Schein, 2010). This aspect comprises items such as following safety procedures; sufficient safety training; frequent fire drills; and adequate training in emergency procedures. This parameter asks the seafarers about their overall perspective of safety culture on ships. It is then used as the independent parameter and compared with the seafarer's answers on other safety aspects to assess which of these aspects were consistent with responses of good safety culture prevailing. On the other hand, everything to do with shipping has to have an element of safety culture, which, makes people to aware about working safely (Birkett, 2017). Without an effective safety culture people would not aware about preventing accidents and deal with them as and when they happen. This is the reason the safety culture aspect is included in this study.

Importance of maritime regulations

Safety regulation and its implementation influences industrial performances of hazardous activities from health, safety and environmental considerations (Baram *et al*., 2013). In the shipping industry, safety regulations can decrease the frequency of accidents and also motivate maritime organisations to take safety precautions more seriously (Størkersen, 2015). The seafarer's perception on importance of maritime regulations will be assessed by several questions related to the seafarer's responsibilities and compliance to the regulations. It is important for the seafarers to fully understand and obey the regulations and hence, this aspect is included in this study to determine whether the seafarers in the UK shipping industry are aware, the importance of maritime regulations as a part of safety practice.

Risk awareness

Seafarer's risk awareness is an indicator of the actual shipboard safety level such as hazard, gain or loss and uncertainty (Grabowski *et al.*, 2007). It may be directly or indirectly affected by an organisation's safety management procedures (Rundmo, 1997). As an initiative, in Norway, many regulations have been implemented as priority is given to safety in the offshore industry. The existence of hazardous risk that lead to risk of occupational accidents and major accidents highlight the importance of having such regulations (Rundmo, 1997). In this section, the level of risk awareness among the seafarers was assessed based on questions related to their working procedures and styles. Hence, risk awareness is a vital aspect to study safety practice in the UK shipping industry.

Job satisfaction

Job satisfaction is closely linked with performance. A satisfied work force will create a good atmosphere within the organisation or on board, which will encourage the crew to perform better and thus enhance the safety. Moreover, a person with high level of job satisfaction, will portrait positive attitudes towards the job, while a person with low level of satisfaction will possess negative attitudes towards the job (Pushpakumari, 2008). An organisation plays an important role to create a satisfied work force (Pushpakumari, 2008). For example, working environment based on contract length, schedule and time off, ship life category, continuous support and motivation (equal treatment and rewards) from the company and supervisor, and professional development will attract and motivate employees to keep coming to work and achieve better work performance (Hu *et al.*, 2003). Since job satisfaction has a huge impact of work performance, it is important to include this aspect to study the safety practice in the UK shipping industry.

Step 5 – Run a pilot survey

A pilot study is commonly referred as a 'mini scale version' or a 'trial' of a main study (Polit-O'Hara and Beck, 2006). Baker and Risley (1994) highlighted that a pilot study is often used to pre-test or try out a research instrument. Therefore, it is useful to conduct a pilot study prior to the main study to determine if the items are yielding the kind of information that is needed (Simon, 2011). Various researchers have recommended a sample size of 10 to 30 respondents is reasonable to enrolling in a pilot (Bell, 1995; Hill, 1998; Hertzog, 2008). A pilot study has potential to identify a number of logistical issues or factors (as shown below) that could enhance the strategy of a main study (Simon, 2011):

- Check that instructions are comprehensible
- Check the wordings of a questionnaire
- Check the reliability of the chosen questions and the results
- Check the statistical and analytical processes to determine if they are efficient

By identifying these factors, many hassles such as difficulties in responding and misleading, inappropriate or redundant questions could be avoided (Simon, 2011). Conducting the survey personally and individually with a small group of respondents is a good way to proceed with a pilot study. After conducting the survey, a Reliability analysis (discussed in sub-section 3.3.1) is required to measure the consistency of questions. In general, the outcome of a pilot study can be one of the following (Thabane *et al.*, 2010):

- Stop – main study not feasible.
- Continue but modify protocol – feasible with modifications.
- Continue without modifications but monitor closely - feasible with close monitoring.

- Continue without modifications – feasible as is.

After completing the pilot study, a well written report or outcome of the study is needed. The report should explains the actual improvements made to the study design or the research process as a result of the pilot findings (Simon, 2011). Based on the findings of the pilot study of this project, a main study has been continued with several modifications to the questionnaire. In this study, the outcome of the pilot study has been presented in Chapter 5 Section 5.2.

Step 6 – Carry out the main survey

After relevant changes are made to the questionnaire, the researcher can conduct the main study. At this stage, the organisations, individuals (respondents), and the methods of questionnaire distribution of the survey should be finalised. After confirming an appropriate date, the researcher can conduct the survey and starts the data collection. The next step is to determine how to analyse the data to obtain the results.

Step 7 – Analyse the data

The last step in the survey is the data analysis process. The data were studied and analysed to measure the relevant output of the study. Several statistical analyses such as reliability analysis and cluster analysis were applied to analyse the data by using the Statistical Package for the Social Sciences (SPSS) (Sarstedt and Mooi, 2014). These statistical analyses are discussed in detail in the next sub-section. Basic techniques such as descriptive and frequency analysis were also used to identify the demographic of the respondents and the details of the answers given by the respondents.

3.4 Data analysis

Two different software such as NVivo and SPSS and various analysis have been utilised in this study to analyse data that are obtained from both qualitative and quantitative methodologies. NVivo has been used to analyse the data gathered from interview survey. NVivo is a qualitative data analysis (QDA) computer software produced by QSR International. The software enables a researcher to work systematically and to prevent oversight (or pertinent use) of any information from the data collected. It also allows the users to classify, sort and arrange information (Zamawe, 2015). SPPS is a software package that is widely used in social science for statistical analysis. It is a very comprehensive, easy-to-use set of data and predictive analytic tool (Sarstedt and Mooi, 2014).

Three different analyses have been used namely Human Factors Analysis and Classification System (HFACS), reliability analysis and cluster analysis. HFACS framework is used in the ship accident reports analysis to identify various human factors that caused maritime accidents.

Reliability analysis is essential in a quantitative study to determine the reliability level of a questionnaire before the main study. Cluster analysis is used to analyse and identify the relationships among different safety culture aspects.

3.4.1 Human Factors Analysis and Classification System (HFACS) Framework

HFACS framework was originally developed for the United States Navy and Marine Corps as an accident investigation and data analysis tool (Shappell and Wiegmann, 1997). HFACS which was developed based on Reason's (1990) model of active (human errors) and latent failures (causes of human errors) has been very relevant for investigating human error in accidents (Celik and Cebi, 2009). HFACS framework had been implemented in various industries such as in high-risk industry including rail and maritime, mining, and healthcare (Diller *et al.*, 2014). The HFACS framework describes human error at four levels namely: Level - 1 unsafe acts, Level 2 – preconditions for unsafe acts, Level 3 – unsafe supervision and Level 4 – organisational influences (Shappel and Wiegmann, 2000). At each level of HFACS, there are causal categories, which were developed to identify the active and latent failures. The framework for HFACS is illustrated in Figure 6 (Shappell and Wiegmann, 1997; Diller *et al.*, 2014) and a brief descriptions of the four levels and their sub-categories is elaborated in the following paragraphs.

Therefore, the researcher has applied this methodology into the study to identify the most frequent level of human errors and their root causes that led to accidents or near miss. These will give a better understanding about the accidents happened and insight on further steps to be taken.

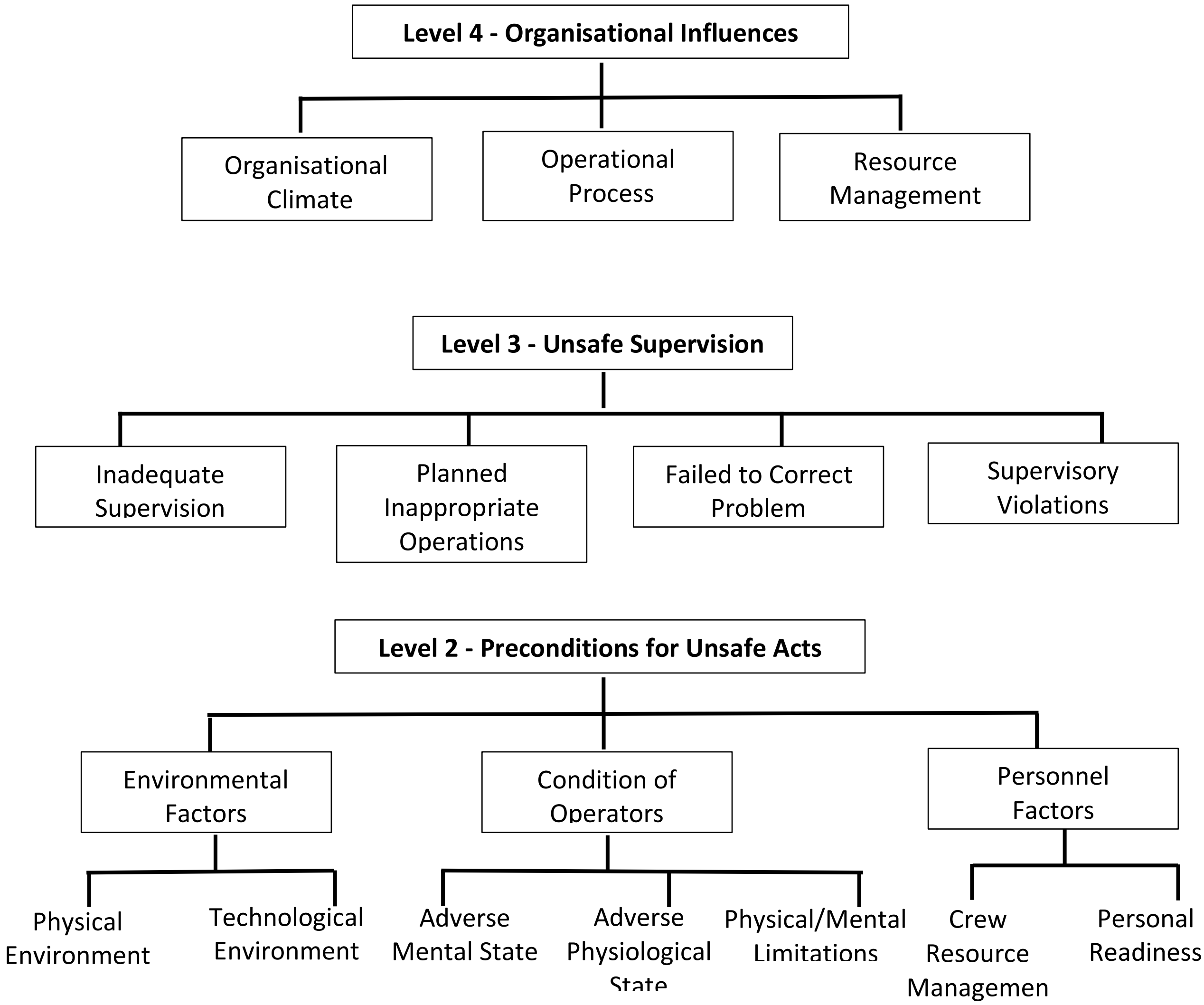

Figure 6 HFACS Framework

Level 1 – unsafe acts is divided into two categories namely errors (unintentional mistakes) and violations (non-compliance with rules and regulations). Each category has several sub-categories: errors - decision errors, skill-based errors and perceptual errors; and violations – routine violations and exceptional violations. All the elements of level 1 is summarised in Table 13 (Shappell and Wiegmann, 1997; Diller *et al.*, 2014).

Table 13 Features of Level 1 – Unsafe Acts

Categories	**Explanations**
Error	
Decision errors	• Decision error occurs when the personnel lack in knowledge, information or experience.
Skill-based errors	• Skill-based errors occur when the personnel make a mistake in a task that is familiar to them. • These errors take place due to poor attention and memory, and unstandardized procedures and techniques.
Perceptual errors	• These errors arise when sensory input is degraded. • For example, the personnel may misjudge the distance or location in poor weather or restricted visibility environment.
Violations	
Routine violations	• Related to behaviours such as breaking the rule or procedures that has become a normal way of working within the work group, in which, often overlooked or tolerated by management. • Personnel often involved in routine violations due factors such as: to save time and energy; lack of enforcement of the rule; perception that rules are too restrictive; and creates perception among new workers where routine violations are the norm and not realising that this is not the proper way of working.
Exceptional violations	• These types of violations take place when a new problem arises and the personnel willing to disobey the rule even though aware that they are taking a risk. • These violations represent a behaviour, which is outside the norms, and regulations that are not tolerated by management.

Level 2 of the HFACS describes the preconditions for unsafe acts. This level includes three categories namely: environmental factors, condition of operators and personnel factors. The first category, environmental factors has two sub-categories namely: physical environment and technological environment. The second category that is the condition of operators includes three sub-categories namely: adverse mental state, adverse physiological state and physical/mental limitations. Last category, personnel factors, has two sub-categories namely: crew resource management and personal readiness. All the elements of level 2 are summarised in Table 14 (Shappell and Wiegmann, 1997; Diller *et al.*, 2014).

Table 14 Features of Level 2 – Preconditions for Unsafe Acts

Categories	**Explanations**
Environmental factors	
Physical environment	• This refers to factors that include weather, lighting, noise, excessive clutter and room layout.
Technological environment	• This factor focuses on a variety of issues related to the design of equipment and controls, display and interface characteristics, checklist layouts and automation.
Condition of operators	
Adverse mental state	• It refers to factors that have arises due to mental conditions that negatively affect performance, such as fatigue, stress or distraction.
Adverse physiological state	• It refers to acute physiological conditions that affects safe operation, such as illness or physical fatigue.
Physical/mental limitations	• This factor refers to the circumstances such as permanent physical or mental disabilities that may adversely affect performance. • For examples: poor vision, lack of physical strength or chronic mental illnesses.
Personnel factors	
Crew resource management	• It refers to a variety of communication, coordination, planning and teamwork issues that impact performance.
Personal readiness	• It refers behaviours that are not adhering to regulations related to crew rest requirement, alcohol consumption or medication.

Level 3 of HFACS describes the unsafe supervision, which is divided into four categories: inadequate supervision, planned inappropriate operations, failed to correct problem and supervisory violations. All the elements of level 3 are summarised in Table 15 (Shappell and Wiegmann, 1997; Diller *et al.*, 2014).

Table 15 Features of Level 3 – Unsafe Supervision

Categories	Explanations
Inadequate supervision	• This factor arises when the management of personnel and resources provides inadequate trainings, guidance and operational leadership.
Planned inappropriate operations	• This factor includes all aspects of inappropriate crew scheduling and operational planning such as crew pairing, crew rest and managing the risk associated in a task.
Failed to correct problem	• It refers to problems among personnel, equipment, training or anything related to safety are known to the supervisor but overlooked.
Supervisory violations	• This includes the behaviour of managers in which, disobey rules, regulations, instructions or standard operating procedures.

Level 4 of HFACS, organisational influences, includes three categories namely: organisational climate, operational process and resource management. All the elements of level 3 is summarised in Table 16 (Shappell and Wiegmann, 1997; Diller *et al.*, 2014).

Table 16 Features of Level 4 – Organisational Influences

Categories	Explanations
Organisational climate	• It refers to several factors that influence personnel performance, for examples policies, command structure or culture.
Operational process	• It refers to organisational decisions and rules, which affect the personnel such as time pressures, schedule or performance standard.
Resource management	• This factor refers to the allocation and maintenance of organisational resources such as human resources, monetary/budget resources or equipment/facility resources.

3.4.2 Reliability analysis

Reliability is a measure of the consistency of a method or an instrument (Sullivan, 2011; Sydorenko, 2012). It is also a main concern when a psychological test is used to measure some quality or behaviour (Rosenthal and Rosnow, 1991). An instrument is considered reliable if it measures the true score of the construct without any errors (Sydorenko, 2012). There are three most common ways of measuring reliability for any empirical method (Drost, 2011; Kline, 2014):

- Test-retest reliability (r_{tt})
- Parallel forms reliability
- Internal consistency reliability

These three different ways of measuring reliability are summarised in the Table 17.

Table 17 Different ways of measuring reliability

Types of reliability	**Explanations**
Test-retest reliability (r_{tt})	• It is used if a test produces the same score for each of the respondents when they complete the test on different occasions. • It is the correlation between the tests scores of respondents measured at two different points of time. • Questionnaires which measure abilities and personality traits, the test-retest reliability coefficient should be higher than 0.70 (Kline, 2014).
Parallel forms reliability	• It is measured by the correlation between two different versions of the same test.
Internal consistency reliability	• Most commonly used measure of reliability. • Easy to compute using software. • It is used to measure how consistently respondents respond to one set of items. • It measures consistency within the instrument and how well a set of items measures a behaviour or characteristics within the test. • This measure of reliability is described most often using Cronbach's alpha. • It estimates how well the set of items on a test correlate with one another. • Commonly used in scale-based questionnaires. • More items will increase internal consistency reliability. • A value of Cronbach's alpha $\propto$ above 0.6 is considered acceptable (Deković *et al.*, 1991; Holden *et al.*, 1991; Loewenthal, 2001; Ek, 2006b; Hair *et al.*, 2006).

Based on the three different reliability measures, the internal consistency reliability is used in this study to measure the consistency of the questionnaire because it is the most relevant way to measure a scale-based questionnaire. Cronbach's alpha, α is an important criterion in determining the internal consistency. This will be explained in the next paragraph.

Cronbach's alpha is a widely used to measure the internal consistency of a construct, which is represented through a set of variables (Sydorenko, 2012). Equation (3.4) shows how $\propto$ coefficient relates the number of items, m, in a section of a questionnaire and proportion of average inter-item covariance to the average variance of items. If the items are standardised, then the term $\overline{Cov}/\overline{Var}$ will be substituted by the average inter-item correlation, $\overline{r}$ (equation 3.5).

$$\alpha = \frac{m\,.\overline{Cov}/\overline{Var}}{1+(m-1).\overline{Cov}/\overline{Var}}, \tag{3.4}$$

$$\alpha = \frac{m\,.\overline{r}}{1+(m-1).\overline{r}}, \tag{3.5}$$

If there is no correlation between the items, the $\propto$ coefficient will be zero. Alternatively, if there is a perfect inter-item correlation, then the $\propto$ correlation will be 1. The value of $\propto$ also depends on number of items, m, which means the higher the number of items the higher the value of Cronbach's $\propto$ will be (Sydorenko, 2012).

3.4.3 Hierarchical Cluster Analysis

Hierarchical Cluster analysis is an exploratory analysis that tries to discover structures within the data. It is an appropriate method for identifying homogenous groups of objects called clusters (Borgen and Barnett, 1987; Sarstedt and Mooi, 2014). It groups data objects based only on information found in the data that illustrate the object and their relationships. Objects such as cases or observations in a specific cluster share many characteristics, but are very dissimilar to objects not belonging to that cluster (Sarstedt and Mooi, 2014).

The objective of cluster analysis is to identify groups of objects (in these case, safety culture aspects) that are reflecting the seafarer's awareness towards safety and assign them into clusters. After having decided on the clustering variables (the ten safety culture aspects - refer to Section 2.2.2), the next step is to decide on the clustering procedure to form groups of objects. This step is important for the analysis, as various procedures require different decisions prior to analysis, in which SPSS software will be used for this purpose. There are three different approaches in performing the cluster analysis namely: hierarchical methods, partitioning methods (k-means) and two-step clustering (Sarstedt and Mooi, 2014). Each of these methods follows a different approach to grouping the most similar or closely related objects into a cluster and to determining each object's cluster groups. In other words, an object in a particular cluster should be similar as possible to all other objects of that cluster and dissimilar as possible from objects in different clusters (Sarstedt and Mooi, 2014). The three different methods of cluster analysis are outlined in the Table 18 (Rokach and Maimon, 2005).

Table 18 Three methods of Cluster Analysis

Methods	Explanations
Hierarchical cluster	• It is the most common method. • Generates a series of models with cluster solutions from 1 (all cases in one cluster) to n (all cases are an individual cluster). • It can cluster variables together like factor analysis. • It can handle nominal, ordinal and scale data.
Partitioning methods (k-means)	• It is a method to quickly cluster large data sets. • Should define number of clusters in advance. • Useful method to test different models with a different assumed number of clusters.
Two-step clustering	• A method that identifies the groupings by running pre-clustering first and then by hierarchical methods. • Appropriate to handle large data sets that would take a long time to compute with hierarchical cluster methods. • Can handle scale and ordinal data in same model.

In this study, the hierarchical cluster method is used to identify the relationships among safety culture aspects. The reason for this is that this method has performed better than the other methods in comparative studies and it has been strongly recommended by Borgen and Barnett (1987) when one chooses a clustering method. Moreover, Ek *et al.* (2014) have also used the similar method in their study to identify the relationships between safety culture aspects of Swedish ships.

Hierarchical clustering

As mentioned in the Table 18 above, hierarchical clustering is one of the most common and straightforward methods (Romesburg, 2004). To form clusters using this method, the researcher must select:

- A criterion to standardise the variables
- A criterion for determining similarity or distance between cases
- A suitable linkage measures
- A criterion to present the output - Dendrogram

The first step in performing hierarchical clustering in SPSS software is to standardise the variables and then determine how to measure distance or similarity between cases. The following paragraphs explain about these two procedures.

Standardisation of variables

There are many approaches to standardisation of variables. The present study considers only the case involving numerical variables. The standardisation approach used in this study is the z-score. This is used to transform normal variants to standard score form based on the formula given below (Milligan and Cooper, 1988):

$$Z_1 = \left(U - \overline{U}\right)/s, \tag{3.6}$$

Where U = is the original data value,

Where $\overline{U}$ = the sample mean, and

Where s = standard deviation.

Determining distance between cases

Both 'distance' and 'similarity' are closely related; for example, as the distance between two cases decreases, their similarity should respectively increase. Several methods can be used to measure distance depending on the types of variables such as continuous or dichotomous (Yim and Ramdeen, 2015). Continuous variables are variables that have two or more categories while dichotomous variables have only two categories. Because the variables used in this study are continuous, therefore this section will focus on measures used to calculate distance for continuous variables.

In this study, the Pearson Correlation Coefficient, r is used to determine the distance of the variables. This is a measure to identify the strength and direction of a linear relationship between two variables (quantitative continuous variables) E and F which can be defined as (Ahlgren *et al.*, 2003):

$$r = \frac{\sum(E-\overline{E})(F-\overline{F})}{\sqrt{\sum(E-\overline{E})^2\sum(F-\overline{F})^2}} \qquad 3.7$$

Where E and F denote the means of two variables and
Where r denotes the values of the correlation,

In a sample, the values of the Pearson Correlation Coefficient are denoted as r and it is within the range between -1 to 1 as shown below.

$$-1 \le r \le 1$$

Positive values of r denote positive linear correlation, negative values denote negative linear correlation and a value of 0 denotes no linear correlation. In other words, the closer the value is to 1 or -1, the stronger the linear correlation.

At each step in the procedure, the Pearson Correlation distance between all pairs of cases and cluster is calculated. In addition to this, an additional decision must be made to decide how best to calculate the Pearson Correlation distance when there is more than one case per cluster. This can be achieved by selecting the linkage measure. There are main three types of linkage measures namely single linkage, complete linkage and average linkage. Each type of linkage measures is explained in the Table 19 (Yim and Ramdeen, 2015).

Table 19 Types of linkage measures

Types of linkage measures	Explanations
Single linkage	• Referred as nearest neighbour or minimum method. • It defines the distance between two clusters as the minimum distance found between one case from the first cluster and one case from second cluster. • For instance: if cluster 1 contains cases *a* and *b*, and cluster 2 contains cases *c*, *d* and *e*, then the distance between cluster 1 and cluster 2 would be the smallest distance found between the following pairs of cases: (*a, c), (a, d), (a, e), (b, c), (b, d)* and *(b, e).* • Disadvantages: Single linkage may produce chaining among the clusters which means that several clusters may be joined together because one of their cases is within proximity of case from other cluster. This happens because the smallest distance between pairs is the only value taken into consideration. Since the steps in hierarchical clustering are irreversible, this chaining effect can affect the cluster solution.
Complete linkage	• Referred as furthest neighbour or maximum method. • This method is opposites of the single linkage, as it considers the furthest distance between pairs of cases. • Even though this solves the problem of chaining. It creates another problem. For example, based on the above cases *a, b, c, d* and *e*, if e differs from the rest of the cases, then cluster 1 and cluster 2 may no longer be joined together because of the difference in scores between *(a, e)* and *(b, e)*. In this method, outlying cases prevent close clusters to merge together because the measure of the furthest neighbour will worsen the effects of outlying data.
Average linkage	• Average linkage is a method to use to overcome the limitations of single linkage and complete linkage. • Gives a more accurate evaluation of the distance between each case in the first cluster. • A measure that calculates the distance between each case in the first cluster and every case in the second cluster and then averaged. • Based on the previous example, the distance between cluster 1 and cluster 2 would be the average of all distances between the pairs of cases as listed above: (*a, c), (a, d), (a, e), (b, c), (b, d)* and *(b, e).* • By gathering information about the variance of the distances provides the average distance value a more accurate reflection of the distance between two clusters of cases.

Based on the information above, each linkage measure defines the distance between two clusters in a unique way. In this study, the average linkage measure is chosen because it has a direct impact on the clustering procedure and the way in which clusters are merged together

(Mazzocchi, 2008). In conclusion, all the above steps in Cluster Analysis are illustrated on Figure 7.

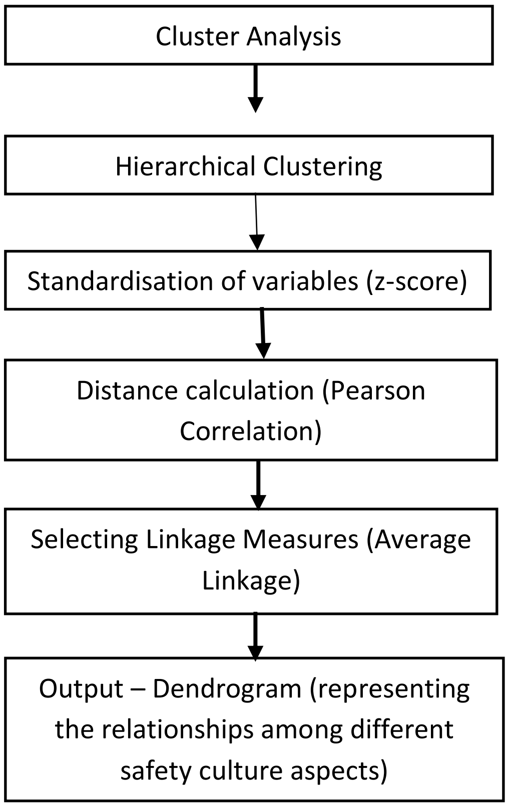

Figure 7 Steps in performing Cluster Analysis

3.4.4 Multiple Linear Regression Analysis

Multiple linear regression analysis is a quantitative research method, which is widely used in the studies that involves modelling and analysis of several variables. In other words, it is a method applied to test the nature of relationships between a dependent variable (Y) and one or more independent variables (X) by fitting a linear equation to observed data (Barrett, 1974; Chatfield, 1983; Harel, 2009; Draper and Smith, 2014). A dependent variable is the variable being tested and measured in an experiment. An independent variable is one that is changed or controlled in an experiment to test the effects on the dependent variable (Chatfield, 1983). The multiple linear regression equation is as follows:

$$\hat{Y} = b_0 + b_1X_1 + b_2X_2 +_{\dots} + b_pX_p \, , \qquad 3.8$$

Where,

$\hat{Y}$ = is the predicted or expected value of the dependent variable,

X_1 ... X_p= independent variables,

$b_0 =$ Beta coefficient value of Y when all the independent variables ($X_1 \ldots X_p$) are equal to zero, and

$b_1 \ldots b_p$ = estimated regression coefficients.

Coefficient of Determination R-Square

The R-value is the correlation coefficient that is used to measure the strength between two variable (X and Y) and it that takes values from -1 to +1. R-squared is the squared correlation coefficient and it is a statistical measure of how close the data are to the fitted regression line. It is also known as the coefficient of determination or the coefficient of multiple determination for multiple regression. R-squared is defined as the percentage of the response variable variation that is explained by a linear model (Barrett, 1974; Harel, 2009). In other words, it is the percentage of variance in Y that can be explained by X. It is also can be defined as follows:

R-square = Explained variation / Total variation, or

$$R^2 = \frac{\sum(\widehat{y_i} - \bar{y})^2}{\sum(y_i - \bar{y})^2} \qquad 3.9$$

Where,

$\sum(\widehat{y_i} - \bar{y})^2 =$ Regression sum of squares or explained variation, and

$\sum(y_i - \bar{y})^2 =$ Total sum of squares or total variation.

The value of R-square is always between 0 and 100%. 0% indicates that the model explains none of the variability of the response data around its mean. 100% indicates that the model explains all the variability of the response data around its mean (Barrett, 1974; Harel, 2009). In other words, the higher the R-squared, the better the model fits the data.

However, R-squared cannot determine whether a regression model is adequate. In some circumstances, one can have a low R-squared value for a good model or a high R-squared value for a model that does not fit the data. A low R-squared value can be obtained for a good model for the following reasons (Barrett, 1974; Harel, 2009; Draper and Smith, 2014):

- The r-squared value is entirely expected to be low in some fields that attempts to predict human behavior. Generally, these fields have R-squared values lower than 50%. This is because, humans are harder to predict.
- A low R-squared value can be obtained for a good model if it has statistically significant predictors.

Adjusted R-Square

Another important criterion in multiple linear regression analysis is adjusted R-squared. The adjusted R-squared is a modified version of R-squared that has been adjusted for the number of predictors in the model. Since adding variables to the regression model will always increase information, therefore, the adjusted R-squared (R_a^2) was introduced for better comparisons (Barrett, 1974; Harel, 2009). The adjusted R-squared can be defined as follows:

$$R_a^2 = 1 - \frac{\frac{1}{n}\sum_{i=1}^{n}(y_i - \hat{y_i})^2}{\sum\frac{(y_i - \bar{y})^2}{p} - 1} \qquad 3.10$$

Where,

n = Sample size,

$\frac{1}{n}\sum_{i=1}^{n}(y_i - \hat{y_i})^2$ = Mean squared error, which assess the quality of the independent variables,

$\sum(y_i - \bar{y})^2 =$ Total sum of squares or total variation, and

p = Number of independent variable included in a regression model.

Standard Error of the Estimate

The standard error of the estimate is a measure of the accuracy of predictions made with a regression line (Cohen *et al.*, 2013). In other words, the smaller the standard error of the estimate is, the more accurate the predictions are. The standard error of the estimate can also be defined as follows:

$$S_{est} = \sqrt{\frac{\sum(y_i - \hat{y_i})^2}{n}} \qquad 3.11$$

Where,

$S_{est} =$ Standard error for estimate, and

$\sqrt{\frac{\sum(y_i - \hat{y_i})^2}{n}}$ = Square root of mean squared error.

T-Test

The t-value is a standardised value that is calculated from sample data using t-test. T-test is a measure used to compare a sample mean to a hypothesised value during a hypothesis test (Cohen *et al.*, 2013). The significance value or know as p-value is used to determine statistical significance in a hypothesis. T-test can also be defined as follows:

$$t = \frac{\bar{X} - \mu}{\frac{S}{\sqrt{n}}} \qquad 3.12$$

Where,

$\bar{X} =$ Sample mean

$\mu =$ Population mean

S = Sample standard deviation

n = Sample size

3.4.5 NVivo

NVivo is a widely used tool by qualitative researchers to evaluate, interpret and explain social phenomena. It is widely used in many fields such as social science, education, healthcare and business (NVivo, 2012). This tool analyses unstructured or semi-structure data like interviews, surveys, field notes, web pages, audio-visual material and journal articles. NVivo allows the users not only store original records in full texts through project documents, but also can help to keep or organise thoughts and ideas through making nodes, setting up documents attributes or nodes attributes, adding memos, building up models, tables or data bites, editing codes and fins links among them or even with background information and literature library.

Once an NVivo project is created, the researcher can create, edit, explore or browse the data and nodes. Nodes are created to represent the ideas or categories that have been discovered from the answers (data) given by the interviewee. Coding is considered as the key process of analysis through NVivo (Richards, 2008). In short, nodes were described as the place to store identified ideas or categories, while coding is the way in which to store pointers to the text about those ideas. Coding not only eases a researcher to find quickly all the relevant data to answer the research questions, but also helps to obtain and refine clues from the data. Moreover, memo can be used to keep notes, sets are used to sort and manage the data orderly (Richards, 2008).

There are several process in analysing qualitative data using NVivo as shown in Figure 8 (NVivo, 2012). There are six steps in analysing data in NVivo for example import, explore, code, query, reflect, visualise and memo. Explanation for each of the steps are presented in Table 20 (NVivo, 2012).

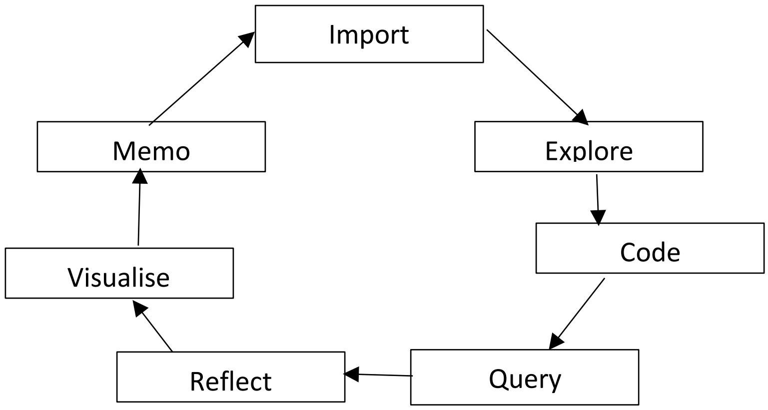

Figure 8 Steps in analysing data in NVivo

Table 20 Data processing in NVivo

Steps	Process
Import	Bring in interview documents.
Explore	Open and explore the interview documents.
Code	Make a node for interested keywords or information.
Query	Run a search query to find out if there are any respondents used similar keywords or information.
Reflect	Gather the query results of the interested node and review all the material in one place.
Visualise	Display a word tree to view how the respondents talk about the interested keywords or information.
Memo	Record the insights and apply the information on the memo when write up the report or the findings.

In this study, the researcher transcribed the notes from interview into 44 detailed NVivo nodes. The aim of transferring the raw data into NVivo is to try to find out; what do the respondents have answered and what are the differences and similarities between the two groups of respondents (seafarers and managers). By answering these questions, the point of view of the respondents on safety culture can be identified. To serve this aim, the data was coded and grouped (themes) until answers can be deprived clearly.

3.5 Ethical considerations

The methods used in this research were in strict compliance with the British Sociological Association's Statement of Ethical Practice (BSA, 2004) and the requirement of the Ethics Committee in the Faculty of Engineering and the Environment at the University of Southampton (UOS, 2012). According to the rules of the University, prior to embarking on the project, the researcher must seek approval from the Ethics Committee. The following are the details for both interview survey and questionnaire survey regarding ethics requirements:

Interview survey

In December 2017, the researcher has provided the Ethics Committee with two questionnaire forms for both managers and seafarers (Appendix A and Appendix B), questionnaire scripts for both managers and seafarers (Appendix C and Appendix D) a consent letter (Appendix E) and participant information sheet (PIS) (Appendix F). After reviewing all the documents, the interview survey was deemed suitable by the Ethics Committee, which subsequently gave approval to proceed with the study.

Questionnaire survey

In August 2016 (pilot study) and January 2017 (main study), the researcher has provided the Ethics Committee with two questionnaire forms (English - Appendix G & Mandarin – Appendix H), a consent letter (Appendix I), participant information sheet (PIS) (Appendix J) and an outline of the research project (Appendix K). After reviewing the proposals, in September 2016 and February 2017 the proposed researches, the pilot and main study, were deemed suitable by the Ethics Committee, which subsequently gave approval to proceed with the study.

On completion of the survey, keeping the identities of the respondents confidential is an important ethical element of the research. To comply with this element, no column was included in the questionnaire for the name of the respondent or the name of their company or rankings. For analysis, the questionnaire, however, the researcher has only retained the gender, age and number of years of working experience.

Concealing the identities of the shipping company and the maritime academy in this report was also an important ethical element of research and this element has been highlighted by Christians (2000). In this report, the researcher has referred the names of the organisations involved as Maritime Academy A and Shipping Company B for protecting their identities.

Chapter 4 A Study of Accidents Involving Merchant Vessels

4.1 Introduction

The main purpose of this chapter is to achieve the first objective of the main study, which is "to analyse the causes of human error and the rates of maritime accidents". To achieve the objective a review and an analysis on previous shipping accident statistics and investigation reports have been conducted and presented in the following sections. By reviewing different types of accidents, which are varied in term of types of ships and nature of accidents, the most common causes of accidents can be addressed, and further actions can be taken to prevent similar causes. The reviewing process (document study) has been discussed in detail in chapter 3 (section 3.2).

4.2 Summary of accident statistics

This section discusses a review on shipping accident rates, in which, involved UK flag vessels. The reason behind choosing only UK flag is to avoid bias in the data involving various flags, moreover, according to UK Ship Registry Advisory Panel (UKSR, 2016), the UK flag has the potential to be the flag of choice for quality owners and has a global reputation for maintaining the highest international standards. In this review, information such as number of accidents, nature of the accidents, types of vessels and accident categories were gathered from Global Integrated Shipping Information System (GISIS) (2016). The data from GISIS was chosen because the data has more information compared to other database and it is from the IMO. The IMO Secretariat in compliance with the decisions by IMO Members has developed GISIS. The information supplied to the IMO Secretariat by Maritime Administrations, in compliance with IMO's instruments (IMO, 2017). The main purpose of the review is to highlight the accidents' trend and their severities from the period between 1999 and 2014. This period includes the year after the introduction of ISM Code, which was held in 1998. The reason to study accidents after the implementation of the ISM Code is to identify how well the code has improved the standard for the safe management and operation of ships. Before the implementation of the ISM Code, there was rising concern about poor management standards in shipping (ISM Code, 1998). After investigations were made, it was found that there was major errors on the part of management, and in 1987 the IMO Assembly adopted resolution A.596(15), which called upon the Maritime Safety Committee to develop guidelines concerning shore-based management to ensure the safe operation of vessels above 500 Gross Tonnage (GT) (ISM Code, 1998). The ISM Code in its mandatory form was adopted in 1993 by resolution A.741 (18) and entered into force on 1 July 1998 (ISM Code, 1998).

4.2.1 An overview of the number of accidents and its severity

This section reviews the ship accidents based on official reports, including an overview of the nature of accidents, the types of vessels involved and accident categories. Table 21 which is based on the information available in GISIS (2016), represents 316 accidents involved UK Flagged ships from the period between 1999 and 2014. In total 381 vessels were involved where, at least one vessel is UK flagged in each accident; however, the details of other flags in the accidents are missing in the database. In general, the statistics are only including commercial vessels and vessels above 500GT.

Table 21 Total Number of Shipping Accidents of UK Flag Vessels (GISIS, 2016)

Year	Number of accidents	Number of vessels	Vessel types
1999	20	23	General cargo ship, Oil tanker, Ship structures carrier, Towing/Pushing Tug, Fishing vessel, Passenger ship, Ro-Ro
2000	21	28	General cargo ship, Passenger ship, Ro-Ro, Fishing vessel, Ship structures carrier, Oil tanker, Refrigerated cargo ship, Dredger & Container ship
2001	12	15	Passenger ship, Research ship & Ro-Ro
2002	17	21	Ro-Ro, Passenger ship, General cargo & Fishing vessel
2003	16	17	General cargo ship, Liquefied gas tanker, Bulk carrier, Container ship, Oil tanker & Fishing vessel
2004	12	16	Ro-Ro cargo ship, Tanker & General cargo ship
2005	8	11	Container ship, offshore support vessel, Tanker, Passenger ship &oil tanker
2006	58	69	Ro-Ro Vessel, Bulk carrier, General cargo, Tanker, Container ship, Passenger vessel, Supply vessel & Liquefied gas tanker
2007	40	45	Ro-Ro vessel, General cargo, Tanker, Container ship, Passenger vessel & Liquefied gas tanker
2008	28	32	Passenger ship, Container ship, General cargo, Fishing Vessel, Supply vessel & Ro-Ro cargo ship
2009	25	30	Container ship, General cargo ship, passenger ship, Bulk carrier, supply vessel & Ro-Ro cargo ship
2010	18	21	Container ship, General cargo ship, passenger ship, Tanker & Ro-Ro cargo ship
2011	22	27	Container ship, General cargo ship, passenger ship, supply vessel & Ro-Ro cargo ship
2012	6	8	General cargo ship, passenger ship, Dry cargo carrier & Ro-Ro cargo ship
2013	8	11	General cargo ship, Ro-Ro cargo ship, Commercial fishing vessel, platform supply vessel, passenger ship & Bulk carrier
2014	5	7	Chemical tanker, general cargo, passenger ship & Ro-Ro cargo ship
Total	**316**	**381**	

The trend of accidents on a year-by-year basis is illustrated in Figure 9 based on the information tabulated in Table 21. The accident rates show a downward trend. Although the results showed a decreasing trend, there is a dramatic increase in number of accidents in the period between 2006 and 2007. This indicates a connection between the number accidents in and around European waters and the shipping boom and subsequent slump towards 2008 (EMSA, 2008). Studies showed that although the number decreased gradually which gives plenty of time for owners and operators to do the maintenance that has delayed during the boom period, but many will not do so because they have reduced funds due to the previous cost of pollution and accidents (EMSA, 2008). In addition to the number of accidents, the research had also analysed the accidents from various criteria such as the severity of an accident, the accident's causes and its implications to the personnel, organisations, properties and environment.

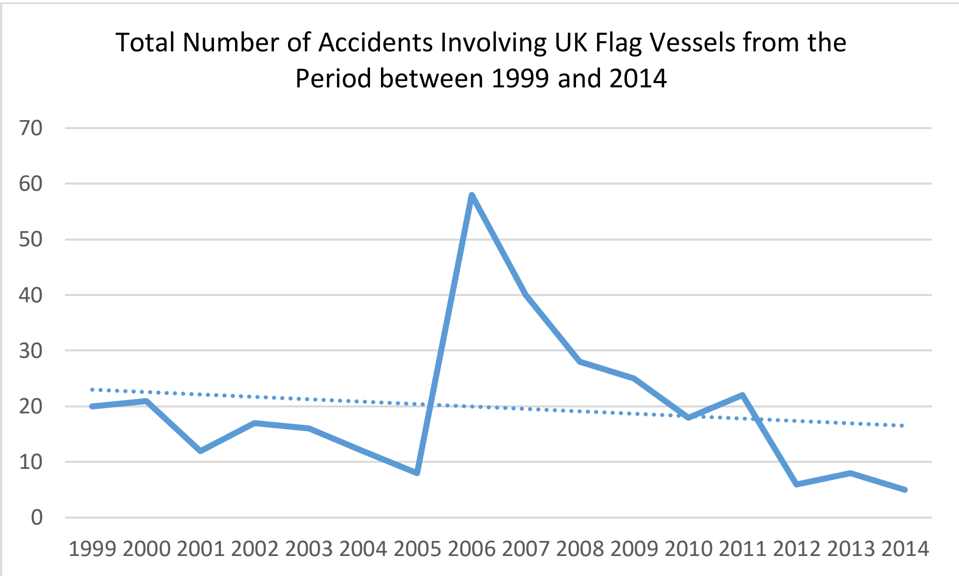

Figure 9 The UK Flag Vessels' Accident Trend (GISIS, 2016)

This study focused only on vessels that comply with ISM Code and the period after the introduction of ISM Code (to see how the code has improved the safety. The severities of shipping accidents are described in three different categories namely very serious, serious and less serious. An accident is labelled as very serious casualty depending on the implication it has caused such as ship total lost, fatality or severe environmental damages. A serious casualty is an accident that involved fire, collision, grounding or heavy weather damage, which inhibits the vessel to continue its passage. The less serious casualty is an accident that does not apply the characteristics of very serious or serious casualties, but it is an accident that caused minor injuries or damages or none of these (EMSA, 2015).

Figure 10 which was developed based on the accidents statistics available on GISIS (2016), illustrates the severity of the accidents. 60% of the total 316 accidents were categorised as very serious (30%) and serious accidents (30%). This indicates that those accidents had caused severe damages to the environment, loss of lives, or financial loss. However, only 3% of the accidents were under the less serious category. The severities of 37% of the total accidents were unspecified due to insufficient information.

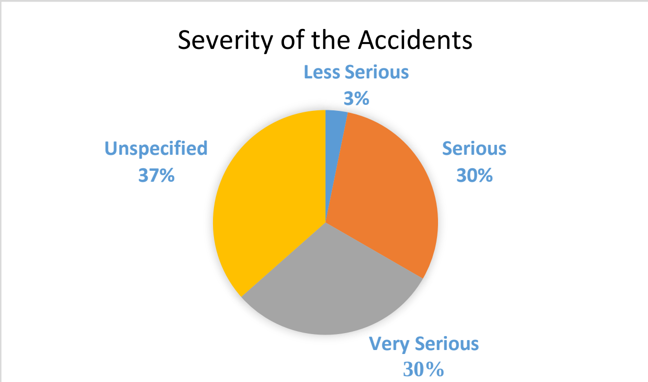

Figure 10 Severity of the Accidents (GISIS, 2016)

4.2.2 Types of vessels and the nature of the accidents

Table 22 which was tabulated based on the information available on GISIS (2016), represents the types of vessels involved in the accidents studied in this study. The implication is that in the 316 accidents, 381 vessels were involved, where in some of the accidents two or more ships were involved. Approximately, 19.7% of the accidents involved container ships. General cargo vessels constituted the next highest proportion (19.2%), followed by passenger vessels (16.8%). Other types of vessels were involved in accidents but in smaller proportions compared to container ships, passenger ships and general cargo vessels. 20.7% of the vessels are unspecified in regards of their types as the GISIS was unable to provide due to insufficient information.

Table 22 Types of Vessels Involve in the Accidents (GISIS, 2016)

Types of Vessels	Number	%
Tanker	27	7.1
Barge/Tug	7	1.9
Container Ship	75	19.7
General Cargo Ship	73	19.2
Passenger Vessel	64	16.8
Supply Vessel	10	2.4
Bulk Carrier	7	1.9
Ro-Ro Cargo Ship	30	7.9
Fishing Vessel	9	2.4
Unspecified	79	20.7
Total	**381**	**100**

Table 23 which was tabulated based on the information available on GISIS (2016), represents the nature of the accidents and their percentages. The findings show that accidents related to hull, machinery or equipment damages were the highest. The next highest proportion is contact (11.9%), followed by collision (11%). Apart from that, stranding/grounding and fire & explosion were also among the highest types of accidents, which comprises 9.5% and 6.7% respectively. Again, 28.7 % of the accidents are unspecified as the GISIS was unable to provide due to insufficient information.

Table 23 Nature of Accidents (GISIS, 2016)

Types of Accidents	**Number**	**%**
Collision	36	11
Stranding/Grounding	31	9.5
Fire & Explosion	22	6.7
Contact	39	11.9
Accidents on-board	30	9.2
Fatal Accidents	10	3.1
Hull/Machinery/equipment Damages	65	19.9
Unspecified	94	28.7

According to the statistics, the accident frequencies for the last decades have increased in general (EMSA, 2015; Bužančić Primorac and Parunov, 2016), even though there is a slight decrease for UK flagged vessels (refer to Figure 9). Therefore, sufficient information of the past incidents such as types of accidents and its causes are essential as it would prevent similar accidents in the future (Ek, 2006a). This is because, past information could enable mariners to learn from other's mistakes and improve safety (Ek, 2006a).

4.3 An analysis of ship accident reports

In the previous section, the ship accident statistics (from 1999 to 2014) involving UK flag vessels were explored. Based on the statistics, the accident rate shows a decreasing trend. However, 60% of the accidents fell under very serious and serious casualty categories. This indicates that more attention should be given to identify the causal factors of accidents and measures to reduce their impacts. Therefore, the researcher has intended to do an analysis on ship accident reports by the Marine Accident Investigation Branch (MAIB) because as this organisation work to identify the causes of accidents and to share information with the industry so that they can learn from the experiences and made recommendations as a result (Butt *et al.*, 2012). The analysis will focus on 30 ship accident reports from the period between 2000 and 2016 that have taken place after the introduction of the International Safety Management (ISM) code in 1998 presuming the existence of a functional Safety Management System (SMS) ashore and on-board to ensure compliance with the code. In qualitative studies the aim is not to be representative of the population and no rules for sample size (Nastasi, 2014). However, when comes to a larger population, purposeful random sampling is useful to be applied. This strategy adds credibility to a sample when the potential purposeful sample is larger than one can handle. Since this is a random sampling, it uses small sample sizes and again the goal is credibility, not representativeness or the ability to generalise

(Nastasi, 2014). Previous studies on report analysis in shipping research area have not set particular number of reports for analysis, for example, in 2011, (Schröder-Hinrichs *et al.*, 2011) has 41 reports and in 2014, (Singh, 2014) has only used 15. Since there is no limit, the researcher has used 30 reports (32%) out of 94 reports available on MAIB for this study. Based on the reports, the causal factors of human error behind the accidents are highlighted and these are then grouped, with relevant recommendations made by maritime authority namely MAIB. The analysis was based on three steps (refer to Section 3.2.1): step 1 – data collection and occurrence sequence determination; step 2 – factors identification and classification: and step 3 – safety actions development (Soliwoda, 2014). The analysis and the findings in each step will be explained in the following sub-sections.

4.3.1 Data collection and occurrence sequence determination

To gain a better insight about the causes of maritime accidents and its potential recommendations, an analysis of accident reports has been carried out. As previously mentioned, 30 reports from MAIB (Appendix L) were used to identify the causal factors of various types of ship accidents that happened in the UK. The analysis focused on accidents involving merchant vessels. The merchant vessel was classified based on the types of cargo (general cargo, oil, chemicals, gas etc.) it carries, gross tonnage and the voyages it undertakes. Merchant vessels should comply with standard regulations such as SOLAS and ISM Code (MCA, 2012). The breakdown of the analysed accident investigation reports is given in Table 23.

Table 24 Breakdown of accident investigation reports analysed

Accident categories	**Number of reports analysed**
Fire & Explosion	4
Grounding	13
Collision	7
Capsize & Sinking	2
Contact	3
Gas Leakage	1
Total	**30**

As the first step of this analysis, reports were collected and studied, and then all the relevant information of the accidents were recorded. The information gathered for this study was year of occurrence, vessel types, nature of accident, causal factors, consequences and recommendations. The information is summarised and presented in Appendix M, N and O.

Based on the information in the above tables, there are three categories of accidents namely: less serious, serious and very serious. The definitions of each category had been discussed in Section 4.2.1. Out of 30 accidents, 46.67% (14) were serious, 33.33% (10) very serious and 20% (6) less serious. In the 30 accidents, a total of 126 various causal factors have been identified. These factors are grouped by using Human Factor Analysis and Classification System (HFACS) framework, which were discussed in Chapter 3.

4.3.2 Factors identification and classification

Table 25 Four Levels of Human Errors (from MAIB, 2012)

Levels	Sub-categories		Frequencies
Level 1 - Unsafe Acts	Errors	Decision errors	14 (11.11%)
		Skill-based errors	21 (16.67%)
		Perceptual errors	6 (4.76%)
	Violations	Routine	6 (4.76%)
		Exceptional	2 (1.59%)
		Total	**49 (38.89%)**
Level 2 – Preconditions for Unsafe Acts	Environmental factors	Physical environment	4 (3.17%)
		Technological environment	9 (7.14%)
	Condition of operators	Adverse mental state	5 (3.97%)
		Adverse physiological state	2 (1.59%)
		Physical/mental limitations	2 (1.59%)
	Personnel factors	Crew resource management	5 (3.97%)
		Personal readiness	8 (6.35%)
		Total	**35 (27.78%)**
Level 3 – Unsafe Supervision	Inadequate supervision		5 (3.97%)
	Planned inappropriate operations		12 (9.52%)
	Failed correct problem		5 (3.97%)
	Supervisory violations		8 (6.35%)
		Total	**30 (23.81%)**
Level 4 – Organisational Influences	Resource management		1 (0.79%)
	Organisational climate		5 (3.97%)
	Organisational process		6 (4.76%)
		Total	**12 (9.52%)**

Table 25 tabulated those findings of the HFACS classification in a form of levels, sub-categories and frequencies. The four levels and sub-categories above were originally from the HFACS framework, while, the frequencies were calculated based on the 126 causal factors that were identified. Once the causal factors were grouped into four levels of human error, a comprehensive insight of the accidents can be revealed.

Overall, the findings show that Level 1 - unsafe acts related human errors were the most frequent contributing factors which comprises 38.89% overall. Level 2 – preconditions for unsafe related human errors were 27.78%, followed by Level 3 – unsafe supervision that is 23.81%. Level 4 – organisational influences related human errors were the least contributing factors comprise 9.52%.

The table reveals that at Level 1 - unsafe acts, skill-based errors were associated with the largest percentage (16.67%) of accidents. The most common skill-based errors encountered were lack of sufficient trainings and skills, and poor navigational practices. Among the remaining categories of unsafe acts, accidents associated with decision errors constituted the next highest proportions, which is 11.11%. In other studies, Ziarati and Ziarati (2007) have pointed that decisions errors specifically poor decision-making is one of the most dominate causes of accidents. Research by the International Chamber of Shipping ICS (2013) revealed that for approximately every 330 unsafe acts, 30 are likely to result in minor injury. Of these 30 injuries, one is statistically likely to cause fatality, permanent disability or time lost from work, which indicates the severity of consequences owing to unsafe acts.

Accidents associated with Level 2 – preconditions for unsafe acts constituted the next highest contributing factor (27.78%) after unsafe acts. At this level, technological environment such as poor design of the engine room, watch alarm malfunction and inability to use the advanced navigational system (the employees are not well trained to use advanced navigation system such as auto pilot and radar) is among the most contributing factors, which is 7.14%. Adverse mental state (3.97%) and crew resource management (3.97%) have equally contributed towards accidents. According to U.S. Department of Defense (2005), preconditions for unsafe acts such as inattention, distractions and fatigue are among the main factors that led accidents. In other studies, preconditions for unsafe acts is in the range from 23.4% (Singh, 2014) to 56.4% (Schröder-Hinrichs *et al.*, 2011). These percentages show the importance of identifying precisely the factors associated at this level to determine the appropriate strategies for preventing future accidents.

Level 3 – unsafe supervision was identified as the third most accident-contributing factor (23.81%). At this level, planned inappropriate operations-related errors comprise 9.52% of the 126 causal factors. Factors such as poor risk assessment practices and inadequate preparation for emergency are among the main accident contributors at this level. In other studies, unsafe supervision is in the range from 3.9% (Baysari *et al.*, 2008) to 29.3% (Singh, 2014) compared to other causal factors. This statement emphasises the importance of giving more attention to the factors at this level to prevent further human error resulting in accidents.

Factors at level 4 – organisational influences were identified as the least contributing factors of accidents, at 9.52%. Lack of proper SMS, inadequate procedures and documentation, and poor ship maintenance were among the main factors that have caused accidents, as evidenced in the official data, but it cannot be true all the time. Sometimes, poor implementation of SMS and incompliance to safety regulations (poor ship maintenance) can be the main factors of accident. Various studies have showed organisational influences in the range from 4.3% (Patterson and Shappell, 2010) to 59.4% (Baysari *et al.*, 2008). These percentages show the importance of identifying precisely the factors associated at this level to determine the appropriate strategies for preventing future mishaps.

A summary of these can be found in Table 26. The table shows that many studies from various fields such as shipping, mining, civil aviation and railway have applied the HFACS. The samples of accidents were chosen from the period after the introduction of ISM Code (as explained in section 4.3). It is evident that human errors do exist in almost all the industries and is a potential threat to safety. However, the types or levels of most common human errors are varied. When comes to the results in shipping, the most potential type of human errors differs in the all three studies. In the first study by Schröder-Hinrichs (2011) has identified human errors from Level 2 as the most contributing factors of accidents followed by Level 1, Level 4 and Level 3. Contrastingly, Singh (2014) has discovered human errors from Level 3 as the most potential threat to safety followed by Level 1, Level 2 and Level 4. Meanwhile, the current study has contradicted all the studies, however, the risk of the human errors is the same regardless of levels, but the identification of the levels would ease the research to find the possible ways to reduce its impact. This can be concluded that period and external factors such as weather, economy, and natural disasters could be the reasons that led to difference in results in three different years. The results of the review showed that, overall, preconditions for unsafe acts represented 32.74% of the total accidents followed by unsafe acts at 31.31%, organisational influences (17.54%) and unsafe supervision (18.41%). This clearly shows that the unsafe acts and preconditions for unsafe acts remain as the most contributing factors of accidents in different areas besides shipping. Therefore, based on the findings, there is a causal link between human error and accidents.

Table 26 Percentage of HFACS causal factors identified in different accident investigation report analysis

HFACS application	Area	Number of accident reports	Unsafe acts		Preconditions for unsafe acts		Unsafe supervision		Organisational influences	
			No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Current study	Shipping	30	49	38.89	35	27.78	30	23.81	12	9.52
Singh (2014)	Shipping	15	156	24	152	23.4	190	29.3	151	23.3
Schröder-Hinrichs *et al.* (2011)	Shipping	41	75	20	208	56.5	21	5.7	51	13.9
Patterson and Shappell (2010)	Mining	508	481	42	416	36.8	186	16.4	49	4.3
Li *et al.* (2008)	Civil aviation	41	107	32	84	25.5	82	24.8	57	17.3
Baysari *et al.* (2008)	Railway	40	49	13	83	23.1	14	3.9	214	59.4
Reinach and Viale (2006)	Railway	6	12	33	9	25.0	6	16.7	9	25.0
Gaur (2005)	Civil aviation	48	37	38	23	23.7	12	12.4	25	25.8
Total/Average			**966**	**31.31**	**1010**	**32.74**	**541**	**17.54**	**568**	**18.41**

4.4 Safety actions taken and recommendations

The next step after the identification and classifications of the causal factors is to develop relevant safety actions to prevent similar factors to arise again in the future and to improve the safety. Safety actions applied in this study were the recommendations made by the MAIB, in which, have been incorporated in four different levels of human factors. The researcher has picked the recommendations according to the appropriate types of human error (sub-categories) and then has summarised and tabulated the information in Appendix P, Q R and S according to four levels of human factors.

The Appendix P, Q, R and S have highlighted the safety actions relevant to different types of errors, in which, were developed depending on the nature of the accidents and factors involved. These safety actions are appropriate as they were recommended by the MAIB based on actual accident investigations and can be used by mariners as a guideline when encountering similar problems. The rationale of this study is, it is essential to analyse and categorise such complex accidents for evaluating the implications of human errors in maritime safety based on previous accidents and incorporating the findings to improve the current safety level. The safety actions as tabulated in above tables can be useful and suitable to be referred in future if seafarers encounter any types of human error.

Chapter 5 Safety Practice In the UK Shipping Industry - A Quantitative Assessment

5.1 Introduction

This chapter presents results from a safety culture survey via questionnaires in two maritime institutions/organisations. The purpose of this chapter is to achieve the second and third objectives of the PhD project, which are: “to study and identify the relationships seafarers perceive to exist among various safety parameters on-board ships” and “to identify the safety aspects the shipping personnel believes contribute most towards an improved on-board safety culture”. The findings are elaborated in three sections. In the first section, the discussion is focuses on the pilot study, in which the demographic profiles of the respondents and the result of the reliability analysis is explained. Second section presents the findings of the main study, which includes summaries of the safety culture aspects, the results of the cluster analysis and multiple linear regression analysis.

5.2 Pilot study

In this study, 30 respondents were drawn from the Maritime Academy A that met the study protocol. The respondents consisted of seafarers of various nationalities and rankings who are currently engaged with training at the academy. The survey was conducted from the period between 1 October 2016 and 31 December 2016 (as requested by the researcher for the data collection) and was permitted by the Ethics Committee of the University. The main purpose of this pilot study is to identify factors that could enhance the strategy of main study such as: if the responders able to complete the scales in the questionnaire without any problems; and if the items used to measure a given safety practice aspects were internally reliable (consistency between items in the questionnaire).

A reliability analysis is therefore vital to examine the consistency of the questionnaire. According to Peter and Peter (2008), questionnaires with multi-item scales should be evaluated for reliability, before it is proceeded for the actual study. In this study, an internal consistency reliability method is used. Internal consistency (consistency/how closely related different items of the questionnaire) is appropriate to be determined before a test can be employed for research or examination purposes to ensure consistency (Tavakol and Dennick, 2011). In other words, it is also ensuring all the items in a test measure the same concept and it is connected to each other within the test. The level of internal consistency reliability is based on Cronbach’s alpha ($\propto$). Alpha was developed by Lee Cronbach in 1951, to provide a measure of the internal consistency of a test or scale (Cronbach, 1951). The values of Cronbach’s alpha is varies from 0 to 1 (Andale, 2016). According to Deković *et al.* (1991), Holden *et al.* (1991), Loewenthal (2001), Ek (2006a) and Hair *et al.* (2006), an alpha value above 0.6 is considered acceptable.

In addition to alpha (∝), an item-total correlation, r (correlation between the items) value is also necessary to clearly portrait the consistency of the items. Item-total correlation is used to measure the relationship or correlation between items in a questionnaire. According to Coniam and Falvey (2000), values of an item-total correlation between 0 and 0.19 indicate that the item has poor correlation between other items, values of 0.2 -0.39 indicate good correlation, and values of 0.4 and above indicate very good correlation. The main interest of the study is to focus on items with correlation 0.2 and above (that poses good and very good correlation among each other), to highlight that the items are measuring the same parameter of that section.

5.2.1 Profiles of respondents

In total, 30 respondents participated in the survey. 90% of them were male and 10% were female. A large number of the respondents were aged below 31 (86.7%) while only four respondents (13.3%) were aged between 31 and 40. Among all the respondents, none of them had working experience of more than 20 years. 56.7% (17) of the respondents have up to 2 years of working experience and 16.7 % of them had 3-5 years of working experience. The number of respondents with working experience of 6-10 years and 11-20 years were equal, at 13.3%. Table 27 summarises the demographic details of the pilot study respondents.

Table 27 Demographic Profiles (Pilot study)

	Category	Frequency, N	Percentage (%)
Gender	Male	27	90.0
	Female	3	10.0
Age	<31	26	86.7
	31 – 40	4	13.3
	41 – 50	0	0
	51 – 60	0	0
	>60	0	0
Working Experience (Years)	0 – 2	17	56.7
	3 – 5	5	16.7
	6 – 10	4	13.3
	11 – 20	4	13.3
	>20	0	0

5.2.2 Reliability Analysis

This sub-section presents the results of the reliability analysis. This analysis has been applied to ten sections of the questionnaire, which represent the ten safety practice aspects, namely: working environment satisfaction; reporting culture; communication and language barrier; competency level; shore management support; health awareness; safety culture; importance of maritime regulations; risk awareness and job satisfaction. The findings of each sections are summarised in separate tables incorporating information such as:

- **Variables**: Representing the items (questions) in each section
- **Item-total correlatio**n, r: Correlation between items.
- **Cronbach's alpha, $\propto$:** The value of internal consistency of the items.

Working Environment Satisfaction

Working Environment Satisfaction was assessed by seven items (W1 to W7). The variables W2 and W3 were dropped due to low item – total correlations, r = -0.119 and 0.039 respectively, which are lower than the recommended value (r > 0.2) (Coniam and Falvey, 2000). The remaining five variables (W1, W4, W5, W6 and W7) were retained as variables demonstrating internal consistency in this analysis. The standardised Cronbach's alpha ($\propto$) yielded a value of 0.651 ($\propto$ > 0.6) and hence, these five items are internally consistent. Details of the reliability statistics are shown in Table 28.

Table 28 Statistics for Measures of Working Environment Satisfaction

Variables	Item – Total Correlations
W1	0.444
W4	0.284
W5	0.296
W6	0.508
W7	0.539
Number of responses, N = 30 Scale used: 0 = Don't Know to 6 = Strongly Agree ***Standardised Cronbach's Alpha, $\propto$ = 0.651**	

Reporting Culture

Reporting Culture was assessed by eleven items, in which, only seven were identified as reliable measures. The variables R4 (r = 0.092), R7 (r = -0.082), R10 (r = 0.127) and R11 (r = -0.321) were dropped due to low item – total correlations (r < 0.2). All the remaining items (R1, R2, R3, R5, R6, R8 and R9) indicated good correlations. The standardised Cronbach's alpha ($\propto$) value was 0.759 ($\propto$ > 0.6). Hence, these latter eight items are internally consistent. Details of the reliability statistics are shown in Table 29.

Table 29 Statistics for Measures of Reporting Culture

Variables	Item – Total Correlations
R1	0.491
R2	0.664
R3	0.526
R5	0.453
R6	0.423
R8	0.519
R9	0.396
Number of responses, N = 30 Scale used: 0 = Don't Know to 6 = Strongly Agree ***Standardised Cronbach's Alpha, $\propto$ = 0.759**	

Communication and Language Barrier

Communication and Language Barrier was measured by eight variables Com1 to Com8. Variable Com1 was dropped from the analysis due to low item-total correlations, r = -0.179 (r < 0.2). The correlations between the remaining variables was very good ($r >$ 0.4) except for variable Com8 which has good correlation ($r =$ 0.396). The standardised Cronbach's alpha ($\propto$) value was 0.740 ($\propto$ > 0.6). Hence, these seven items (Com 2 to Com 8) are internally consistent. The key statistics from the reliability analysis are summarised in Table 30.

Table 30 Statistics for Measures of Communication and Language Barrier

Variables	Item – Total Correlations
Com2	0.510
Com3	0.535
Com4	0.508
Com5	0.490
Com6	0.445
Com7	0.404
Com8	0.390
Number of responses, N = 30 Scale used: 0 = Don't Know to 6 = Strongly Agree ***Standardised Cronbach's Alpha, ∝ = 0.740**	

Competency Level

Competency level was measured by five variables Competency1 to Competency5. All the items were correlated very well (r > 0.5). The standardised Cronbach's alpha (∝) was 0.813 and so, all the items are internally consistent. Details of the reliability statistics are shown in Table 31.

Table 31 Statistics for Measures of Competency Level

Variables	Item – Total Correlations
Competency1	0.552
Competency2	0.699
Competency3	0.725
Competency4	0.549
Competency5	0.565
Number of responses, N = 30 Scale used: 0 = Don't Know to 6 = Strongly Agree ***Standardised Cronbach's Alpha, ∝ = 0.813**	

Shore Management Support

Shore Management Support was measured by seven variables Shore1 to Shore7. All the items correlated very well (r > 0.3) and the standardised Cronbach's alpha (∝) was 0.688. Therefore, all these seven variables are internally consistent. The details of the reliability statistics are summarised in Table 32.

Table 32 Statistics for Measures of Shore Management Support

Variables	Item – Total Correlations
Shore1	0.225
Shore2	0.525
Shore3	0.308
Shore4	0.367
Shore5	0.522
Shore6	0.423
Shore7	0.436
Number of responses, N = 30 Scale used: 0 = Don't Know to 6 = Strongly Agree ***Standardised Cronbach's Alpha, ∝ = 0.688**	

Health Awareness

Health Awareness was assessed by ten items and nine were well correlated (r > 0.2). Variable Health8 was dropped due to low item – total correlation value, r = 0.105 (r < 0.2). The standardised Cronbach's alpha (∝) value was 0.827 which indicates very good reliability and so, these nine items are internally consistent. The details of the reliability statistics are summarised in Table 33.

Table 33 Statistics for Measures of Health Awareness

Variables	Item – Total Correlations
Health1	0.518
Health2	0.711
Health3	0.637
Health4	0.647
Health5	0.364
Health6	0.267
Health7	0.536
Health9	0.702
Health10	0.473
Number of responses, N = 30 Scale used: 0 = Don't Know to 6 = Strongly Agree ***Standardised Cronbach's Alpha, ∝ = 0.827**	

Safety awareness

Safety awareness was measure by eight variables Safety1 to Safety8. However, variables Safety1 and Safety2 were dropped due to low item – total correlations, 0.156 and 0.128 (r < 0.2) respectively. The remaining variables recorded r above 0.20, which indicates good correlation. The standardised Cronbach's alpha (∝) value was 0.650 and the six items are internally consistent. The details of the reliability statistics are summarised in Table 34.

Table 34 Statistics for Measures of Safety culture

Variables	Item – Total Correlations
Safety3	0.245
Safety4	0.498
Safety5	0.608
Safety6	0.286
Safety7	0.357
Safety8	0.444
Number of responses, N = 30 Scale used: 0 = Don't Know to 6 = Strongly Agree ***Standardised Cronbach's Alpha, ∝= 0.650**	

Importance of Maritime Regulations

Importance of Maritime Regulations was measured by six variables Imp1 to Imp6. All the items were well correlated (r > 0.4). The standardised Cronbach's alpha (∝) value was 0.770 and so, all these six items are internally consistent. The details of the reliability statistics are summarised in Table 35.

Table 35 Statistics for Measures of Importance of Maritime Regulations

Variables	Item – Total Correlations
Imp1	0.510
Imp2	0.648
Imp3	0.603
Imp4	0.431
Imp5	0.621
Imp6	0.436
Number (N) of responses, N = 30 Scale used: 0 = Don't Know to 6 = Strongly Agree ***Standardised Cronbach's Alpha, ∝ = 0.770**	

Risk Awareness

This section was measured by five variables Risk1 to Risk5. The item – total correlation of all the variables were above 0.20. The standardised Cronbach's alpha (∝) value was 0.676 and so, again, all the variables are internally consistent. The details of the reliability statistics are summarised in Table 36.

Table 36 Statistics for Measures of Risk Awareness

Variables	Item – Total Correlations
Risk1	0.295
Risk2	0.236
Risk3	0.669
Risk4	0.421
Risk5	0.559
Number (N) of responses, N = 30 Scale used: 0 = Don't Know to 6 = Strongly Agree ***Standardised Cronbach's Alpha, ∝ = 0.676**	

Job Satisfaction

Job Satisfaction was measured by five variables Job1 to Job5. The variable Job1 was dropped due to low item – total correlation value, r = 0.129 (r < 0.2). However, the remaining four items were well correlated (r > 0.4). The standardised Cronbach's alpha (∝) value was 0.798 and therefore, all the variables are internally consistent. Details of the reliability statistics are shown in Table 37.

Table 37 Statistics for Measures of Job Satisfaction

Variables	Item – Total Correlations
Job2	0.672
Job3	0.480
Job4	0.626
Job5	0.693
Number of responses, N = 30 Scale used: 0 = Don't Know to 6 = Strongly Agree ***Standardised Cronbach's Alpha, ∝ = 0.798**	

Conclusions

The findings of Reliability Analysis of all the sections are summarised in the Table 38. Due to low correlations, some items were dropped from the final version of the questionnaire to enhance its consistency. The Cronbach's alpha, $\propto$ values of all the sections are acceptable, as almost all alpha values exceed 0.70. The item-total correlations, r for all the remaining items indicate good correlation. Therefore, the pilot study analyses showed that the survey instrument had sufficiently good reliability or internal consistency to enable use of the questionnaire for the main study.

Table 38 Summary Statistics

Sections	Cronbach's Alpha, ($\propto$)	Remaining Number of Items	Item – Total Correlations, $\boldsymbol{r}$
Working Environment Satisfaction	0.651	5	>0.2
Reporting Culture	0.759	7	>0.4
Communication and Language Barrier	0.740	7	>0.3
Competency Level	0.813	5	>0.5
Shore Management Support	0.688	7	>0.2
Health Awareness	0.827	9	>0.2
Safety awareness	0.650	6	>0.2
Importance of Maritime Regulations	0.770	6	>0.4
Risk Awareness	0.676	5	>0.2
Job Satisfaction	0.798	4	>0.4

5.3 Main study (Factor Analysis, Hierarchical Cluster Analysis & Multiple Linear Regression Analysis)

After modifying the questionnaire (removing less consistent items) upon completing the pilot study, the main study was conducted. The survey and the data collections were held from the period between 10 February 2017 and 10 March 2017. The respondents of the study were drawn from two different institutions namely: Maritime Academy A and Shipping Company B. The respondents were of different nationalities and working on vessels of different flags. The population size needed for the study was determined based on the following calculation (refer to equation 3.1 – chapter 3):

$$\underline{n_o} = \frac{(1.645)^2 \times (0.5)\,(0.5)}{(0.1)^2}$$

$$= 68$$

The population size was determined using the standard population proportion and therefore, the above calculation shows the minimum population size or respondents the researcher should obtain and the more the better (Sadler *et al.*, 2007). In this study, the researcher managed to obtain 317 respondents/questionnaires in total, which indicates precise sample size. The next step after determining the population size is to distribute the questionnaires.

Two methods of questionnaire distribution were adopted such are by email and hand them directly. 250 questionnaires were distributed at the Maritime Academy A and obtained 142 completed questionnaires in return. However, for Shipping Company B, a copy of the questionnaire was send to the managing director of the company by email as requested by the company because the seafarers (175 of them in total from seven different ships) were sailing at the time of the survey. Then, the managing director of the company returned the completed 175 completed questionnaires (several times on different dates) to the researcher by email. Overall, 317 questionnaires were received out of 385 distributed. The response rates of this study are 100 for Shipping Company B and 68% for maritime Academy A.

The response rate of 70% and above for responses by email (Dillman, 1978, 2000) and 65% and above by face-to-face (Sitzia and Wood, 1998; Gilbert, 2001) are considered achievable and acceptable for the main study. These rates indicate that the obtained number of questionnaires is sufficient for this study.

5.3.1 Profiles of respondents

A total of 317 respondents were participated in the survey. 95.6% of them were male and only 4.4% were female. All the respondents were aged below 60 and more than half were aged below 31 (56.5%). Respondents aged in the range 31-40 were the second highest which comprise 28.7%, followed 41-50 at 11.4% and 51-60 at 3.5%. The respondents were also varied in terms of working experiences. 30.9% of all the respondents had approximately 2 years of working experience. 26.8% of them had experience in the range 3-5 years and 25.2% in the range 6-10 years. However, only a small proportion have working experience more than 10 years, in which, 12% in the range 11-20 years and 5% above 20 years. Table 39 summarises the details of the demography.

Table 39 Demographic Profiles (Main study)

	Category	Frequency, N	Percentage (%)
Gender	Male	303	95.6
	Female	14	4.4
Age	<31	179	56.5
	31 – 40	91	28.7
	41 – 50	36	11.4
	51 – 60	11	3.5
	>60	0	0
Working Experience (Years)	0 – 2	98	30.9
	3 – 5	85	26.8
	6 – 10	80	25.2
	11 – 20	38	12.0
	>20	16	5.0

5.3.2 Summaries of the safety practice aspects

The detailed information and summaries for all the ten aspects are presented in Appendix U. In this section, the overall output of the survey is presented. The level of agreement of a item and section is based on the mean values,$\bar{x}$ (refer to chapter 3 – section 3.3, equation 3.2). The calculation of the mean was based on the average numeric values of the scale (Don't Know-0, Strongly Disagree-1, Disagree-2, Not Sure-2, Agree-4 and Strongly Agree-5) – refer to Table 40. Mean values in the range between 0-3.9 and 4-5 indicate 'negative responses' and 'positive responses' respectively. Problems in safety culture will be reflected if and only if the respondents gave negative response equal to or more than 20% on an item or section (Ek, 2006a). In addition to this, the researcher has also presented the missing values of the data, which represents the number of respondents that did not answer an item; these were treated as missing values. The following paragraphs discuss the findings of the frequency analysis.

Table 40 Features of Mean

Mean	**Level of Agreement**
0 – 0.9	Don't know
1.0 – 1.9	Strongly disagree
2.0 – 2.9	Disagree
3.0 – 3.9	Not sure
4.0 – 4.9	Agree
5.0 – 5.9	Strongly agree

Table 41 Summaries of Frequency Analysis

Safety culture aspects	**Mean, $\overline{x}$**	**Positive responses, %**	**Negative responses, %**	**Missing values, %**
Working environment satisfaction	4.00	83.2	16.7	0.6
Reporting culture	4.07	81.5	18.4	0.6
Communication and language barrier	3.90	79.1	20.4	3.3
Competency level	4.20	90.7	9.0	1.5
Shore management support	3.69	68.7	30.6	4.8
Health awareness	3.97	80.0	19.3	4.8
Safety culture	4.16	90.4	9.0	3.3
Importance of maritime regulations	4.17	86.5	12.9	3.3
Risk awareness	4.04	80.8	18.7	2.7
Job satisfaction	4.09	84.8	14.3	3.6

Table 41 represents the summaries of frequency analysis of the 10 safety culture aspects. As mentioned at the beginning of this section, a mean value above 4.0 ($\bar{x}$ > 4.0) indicates that the particular item or section was agreed and/or strongly agreed by most of the respondents, which indicates positive responses. Mean value below 4.0 ($\bar{x}$ < 4.0) indicates that most respondents were in opinion such as 'don't know', 'strongly disagree', 'disagree' or 'not sure' with a particular item or section, which indicates negative responses. Among 10 safety culture aspects, seven obtained mean values above 4.0 and three below 4.0. However, none of the seven aspects have had obtained the highest mean values, 5.0.

For working environment satisfaction aspect ($\bar{x}$ =4.00), most respondents experienced very friendly and organised environment. they feel safe working in their company as ther working procedures are clear and their work is appreciated by the company. However, aproximately 16.7% of the respondents found their work environment has not given them sufficient fulfilment where they felt that the company not aprreciating their work or the working prcedures were not clear and well written.

Most respondents (81.5%) were of the opinion that they are practising the reporting culture on board ship ($\bar{x}$ =4.07). According to them, they report near miss and every incidents which includes injuries or equipment damages due to their mistakes. Most respondents were also agreed that they learnt from past reports and find it very useful. However, a group of respondents (18.4%) have admitted that they were not practising reporting culture and do not take reports seriously as they not learn much from the reports or useful for their near future voyages.

One issue within the communication and language barrier is the language differences in multi-cultural and multi-lingual crews that increases the risk of safety ($\bar{x}$ =3.90). The findings showed that atleast 50.2% of the respondents believed that language differences are a threat to safety. Horck (2005) concluded similarly in his study, that culture-communication becomes a threat to the safety. He has also highlighted that lack of knowledge in a standard language on board will becomes a safety risk and that particular crew become alienated. Therefore, the management role is important on this issue to provide appropriate communication trainings to their personnel, which has been a criterion of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) (2010).

Competency level is an important criterion for seafarers as required by the regulation. Many respondents (90.7%) are apparently complied with the regulations with mean value, $\bar{x}$ = 4.20. The results showed that most of the respondents have good knowledge and trainings approriate to their work. They believe that all their education trainings are relevant in practice and necessary to work safely on board ship. Contrastingly, 9% of them were of the opinion that they have not got sufficient knowledge or trainings and believed it may be an obstacle to work efectively.

In shore management support aspect, two issues concern the respondents. Firstly, about 48.9% yielded negative responses for the statement ‘management do not put pressure on the employees to achieve target’. This shows that many respondents were working under pressure. Secondly, about 40.1% of the respondents did not agree with the statement ‘management never put schedule or cost above safety’. This shows that the management gave more priorities to profits rather than on safety. Concerning the management factor, Hollnagel (2009) has highlighted social pressure from managers and organisational pressures were among the main reasons of safety inefficiencies. Another view on this issue by Carrillo (2005) is that profitability and safety are interlinked and if either one is overlooked it will causes negative consequences.

In health awareness, the mean value is close to 4.0 ($\bar{x}$ = 3.97). According to (Ek, 2006), an item or a section is considered relecting a problem in the safety culture only when the negative response rate exceeded 20% and above. However, the findings showed that the negative response of this aspect is 19.3% which is less than 20% indicating that there is no problem in this aspect. On the other hand, the positive response rate was 80%. When the data was examined individually, it was shown that majority of the respondents have either agreed or strongly agreed to all of the items in this section. The following are the examples of the items: “I am getting enough sleep’; I am getting enough rest hours; the company cares about my health and safety; the crew is not encouraged to put health issues in second place to achieve a target; the crew is expected to follow the work/rest cycle;and I have time to do my work”. In general, safety standards and regulations reflected the concern for health of seafarers on board. However, the main problem is that these regulations are not regularly implemented (Zakaria, 2009). Therefore, the companies should effectively look into this matter and seaferes should care for their own health and safety and for other co-workers (Zakaria, 2009).

Most of the respondents (90.4%) were agreed that they have awareness towards safety ($\bar{x}$ = 4.16). The results showed that they follow the safety regulations and frequently performed fire drills. Many also experienced that the safety training on-board is sufficient and get adequate traing in emergency procedures. However, approximately 19.3% of the respondents believed that the safety trainings and procedures were not sufficient and in certain occasions they tend to take shortcuts in work. This reflects dissatisfaction among the seafarers regarding the safety trainings provided by their companies. It will be better if the companies take relevant measures by having a discussion session with their employees to improve the safety of the company and employees.

A majority of the respondents (86.5%) were aware of the importance of maritime regulations ($\bar{x}$ = 4.17). The results showed that most of them do not break the rules and regulations and are all well exposed to the regulations. They were of the opinion that their companies follow the regulations effectively for the safety of the company and employees. On the other hand, aproximately 12.9% of the respondents were believed that their companies were not fully complied with the regulation and they were not aware of the consequences in the absence of safety regulations, in which led them to break the rules.

Many respondents (80.8%) were aware of the risk on board ship ($\bar{x}$ = 4.04). To avoid unnecessary incidents, the respondents do work safely and felt safe and not at risk of injury while working. However, 18.17% of the respondents were not feel safe and believed the work environment is not safe for all the crews. The results were also showed that they are concern about the risk of injuries while working.

Approximately 84.8% of the respondents were satisfied with their job ($\bar{x}$ = 4.09). Most of them were comfortable to ask for assistance or interact with everyone on-board. They were also agreed that all the suggestions to enhance safety are appreciated and getting proper instructions for every task. Contrastingly, 14.3% of the respondents experienced dissatisfaction towards their job. They were not comfortable talking to their co-workers and not getting proper instructions for every task. The results were also highlighted that the company does not appreciate the suggestions from the respondents.

The main purpose of the frequency analysis is to yield results that can be used to identify problems in safety aspects. In the next section, the relationships of these safety aspects will be discussed based on the findings of cluster analysis. This will futher improve the understandings about the safety aspects and the safety culture in the industry.

5.3.3 Reliability of the Survey Instrument (Factor Analysis)

Appendix V presents the results obtained from assessing the reliability of the questions used to in measuring safety practice in the UK shipping industry. The table has eight columns. The Safety practice aspects column presents the 10 safety practice aspects that were used to measure the relationships of the safety aspects in UK shipping industry. The observation column indicates the number of non-missing observations for each item. The sign column indicates the direction in which an item entered the scale. A positive sign indicates that the item was entered in its observed format; a negative sign indicates that the item was reversed. In this study, all the safety practice aspects measurement items were entered as observed.

The item-test correlation column shows how each item is correlated with the overall scale. The results in Appendix V indicate that, most of the items have a correlation coefficient of above 0.5, however, all the items in working environment satisfaction (W1, W4, W5, W6 and W7) and reporting culture (R5, R6, R8 and R9) have correlation below 0.5. This indicates that these items need to be removed from the scale because it is not correlated to the overall scale.

Table 42 presents the results after removing all the items from working environment satisfaction and reporting culture. Overall, all the items were produced correlation above 0.5 except item safety7 and Imp4, which indicates they should be removed from the scale. However, removing these items would not significantly change the overall scale, as shown by their alpha values in the alpha column. Therefore, they were not removed in this study.

Next to the item-test correlation column is the item-rest correlation column. The item-rest correlation column shows how each item is correlated with a scale computed from only the other 46 items. The results in the item-rest correlation column indicate that all the items significantly correlated with each other where the correlations are all above 0.5.

The other column in the table is the average inter-item covariance column, which is a measure of how much; on average, the items vary from each other. The results in the table indicate that on average the items have a variation coefficient of 0.639. The variation coefficient demonstrates that there is minimal variation between the items.

The last column is the alpha column, which can be interpreted as “the squared correlation between the score a person obtains on a particular scale (the observed score) and the score he or she would have obtained if questioned on all possible items in the universe (the true score)”, (Norusis, 2010). The output of this column indicates how the alpha scale would change if the item was deleted from the scale. Overall, the table shows that the alpha coefficient if the safety practice aspects is 0.9879, which is slightly above the acceptable value of 0.90. This alpha value is then being acceptable because it is not too far from the acceptable range. This therefore indicates that the eight safety practice aspects were measuring the safety practice relationship in the UK shipping industry.

To sum up, this section aimed to assess the reliability of 10 safety practice aspects in measuring safety practice in the UK shipping industry. The assessment was accomplished with Cronbach’s alpha test. The results from the Cronbach’s alpha test indicate that the questions from working environment satisfaction and reporting culture was not a good measure of safety practice. Therefore, the items were removed. Other questions such as Safety7 and Imp4 were also had low correlation; however, the items were not removed because its removal would not significantly improve the overall measurement scale. Nevertheless, the overall alpha scale (α= 0.9879) is above minimum of 0.70, which indicates that the eight remaining safety practice aspects were a reliable measure of safety practice. This means that the questions for the eight safety practice aspects can be used to assess the measurement of the relationship among the safety practice aspects in the

UK shipping industry. Overall, the analysis has reduced the data by removing inconsistent variables and simplified the number of interrelated measures.

Table 42 Reliabity test final results for survey instrument (Factor Analysis)

Safety Practice Aspects	Obs	Sign	item-test correlation	item-rest correlation	average interitem correlation	alpha	Item lable
Communication and language barrier							
com2	317	+	0.9006	0.8954	0.6354	0.9874	All the instructions are easily understood.
com3	317	+	0.9034	0.8983	0.6353	0.9874	I have received sufficient training on how to communicate in emergency situations.
com4	317	+	0.6558	0.64	0.6446	0.9879	It is easy to talk with team members.
com5	317	+	0.6498	0.6338	0.6448	0.9879	It is easy to talk with the Master and Officers.
com6	317	+	0.6506	0.6346	0.6448	0.9879	I can deliver any messages/ideas/instructions clearly.
com7	317	+	0.7119	0.6982	0.6425	0.9878	Language differences in multi-cultural crews are not a threat to safety.
com8	317	+	0.9028	0.8976	0.6354	0.9874	There is good communication on this ship about safety issues.
Competency Level							
competency1	317	+	0.9047	0.8996	0.6353	0.9874	I have good knowledge about my job.
competency2	317	+	0.9051	0.9	0.6353	0.9874	I have received the appropriate education.

competency3	317	+	0.9043	0.8992	0.6353	0.9874	I have received the training necessary to work safely on this ship.
competency4	317	+	0.9034	0.8982	0.6353	0.9874	The training I have undertaken is relevant in practice.
competency5	317	+	0.9041	0.899	0.6353	0.9874	The training and education I have received are essential for me to work effectively.
Shore management support							
shore1	317	+	0.9034	0.8982	0.6353	0.9874	The company management staff are friendly.
shore2	317	+	0.9043	0.8992	0.6353	0.9874	Management support the employees to perform well.
shore3	317	+	0.7147	0.7011	0.6424	0.9878	Management do not put pressure on the employees to achieve targets.
shore4	317	+	0.5938	0.5759	0.6469	0.988	I do not experience conflicts with my employers.
shore5	317	+	0.715	0.7014	0.6424	0.9878	Management staff regularly give importance to problems raised by employees.
shore6	317	+	0.5167	0.4965	0.6498	0.9882	Management is working for good safety.
shore7	317	+	0.5881	0.57	0.6471	0.988	Management never put schedule or cost above safety.
Health awareness							
health1	317	+	0.8911	0.8854	0.6358	0.9874	I am getting enough sleep.

health2	317	+	0.9025	0.8973	0.6354	0.9874	I am getting enough rest hours.
health3	317	+	0.9048	0.8997	0.6353	0.9874	The company cares about my health and safety.
health4	317	+	0.9182	0.9138	0.6348	0.9874	Suggestions to improve health and safety are welcomed.
health5	317	+	0.9181	0.9137	0.6348	0.9874	I fully understand and am aware of my responsibilities for health and safety.
health6	317	+	0.9181	0.9137	0.6348	0.9874	Management encourages safe work.
health7	317	+	0.9168	0.9123	0.6348	0.9874	The crew is not encouraged to put health issues in second place to achieve a target.
health9	317	+	0.7583	0.7465	0.6408	0.9877	The crew is expected to follow the work/rest cycle.
health10	317	+	0.9157	0.9112	0.6349	0.9874	I have time to do my work.
Safety Culture							
safety4	317	+	0.9177	0.9133	0.6348	0.9874	The safety training on-board is sufficient.
safety5	317	+	0.9142	0.9096	0.6349	0.9874	Fire drills are performed frequently.
safety6	317	+	0.9177	0.9133	0.6348	0.9874	My co-workers do not pressure me to take shortcuts in my work.
safety7	317	+	0.393	0.3698	0.6544	0.9884	I am familiar with the on-board safety goals.
safety8	317	+	0.9186	0.9143	0.6348	0.9874	Crews have adequate training in

							emergency procedures.
Importance of maritime regulations							
Imp2	317	+	0.9192	0.9149	0.6348	0.9874	This company follows all the regulations for the safety of the company and employees.
Imp3	317	+	0.8662	0.8592	0.6367	0.9875	This company follows the regulations effectively.
Imp4	317	+	0.3919	0.3687	0.6545	0.9884	I am aware the importance of maritime regulations.
Imp5	317	+	0.9189	0.9146	0.6348	0.9874	I understand the consequences in the absence of safety regulations.
Imp6	317	+	0.9162	0.9117	0.6349	0.9874	All the employees are well exposed to the regulations.
Risk awareness							
Risk1	317	+	0.9179	0.9135	0.6348	0.9874	I am aware of the risk of working on-board.
Risk3	317	+	0.9189	0.9145	0.6348	0.9874	I feel safe while working.
Risk4	317	+	0.9162	0.9117	0.6349	0.9874	The working environment is safe for all the crews while working.
Risk5	317	+	0.9166	0.9122	0.6348	0.9874	I am not at risk of injury while working.
Job satisfaction							
Job2	317	+	0.5937	0.5757	0.6469	0.988	I am comfortable asking for help when unsure how to do a task.

Job3	317	+	0.5952	0.5773	0.6469	0.988	I get proper instructions for any work I do.
Job4	317	+	0.5952	0.5773	0.6469	0.988	My suggestions to enhance safety are appreciated.
Job5	317	+	0.5941	0.5762	0.6469	0.988	I am comfortable to interact with everyone on-board.
Test scale					0.639	0.9879	

5.3.4 Hierarchical Cluster Analysis

This section will discusses about the relationships among 10 safety culture aspects that exist in maritime industry through cluster analysis. The findings are presented in two forms namely: Cronbach's coefficient alpha, observed correlations and attenuated correlations and dendrogram.

5.3.4.1 Cronbach's coefficient alpha, observed correlations and attenuated correlations

The Cronbach's coefficient alpha values high compared to the common cut-off value which is 0.6 (Hair *et al.*, 2006) underlining that these nine aspects are related and measuring the same aspects. To ensure a high degree of internal consistency, the values of Cronbach's alpha should be significantly larger than the correlations between aspects corrected for attenuation. The results presented in Table 43 highlight a high degree of internal consistency, as the values of Cronbach's alpha are fairly larger than the correlations between aspects corrected for attenuation.

Table 43 Cronbach's coefficient alpha, observed correlations and attenuated correlations for the nine safety aspects

	Working environment satisfaction	Reporting culture	Communication and language barrier	Competency level	Shore management support	Health awareness	Importance of maritime regulations	Risk awareness	Job satisfaction
Working environment satisfaction	**0.66**	0.70	0.77	0.51	0.70	0.67	0.77	0.74	0.71
Reporting culture	0.50	**0.78**	0.64	0.41	0.59	0.52	0.67	0.60	0.61
Communication and language barrier	0.54	0.49	**0.75**	0.69	0.76	0.58	0.77	0.68	0.74
Competency level	0.37	0.32	0.53	**0.76**	0.45	0.43	0.61	0.51	0.54
Shore management support	0.53	0.49	0.61	0.37	**0.86**	0.71	0.66	0.60	0.66
Health awareness	0.50	0.42	0.46	0.35	0.61	**0.86**	0.72	0.67	0.69
Importance of maritime regulations	0.42	0.40	0.45	0.36	0.42	0.45	**0.46**	0.94	0.87
Risk awareness	0.52	0.45	0.50	0.38	0.48	0.53	0.55	**0.73**	0.85
Job satisfaction	0.49	0.46	0.55	0.40	0.52	0.54	0.50	0.62	**0.72**

***Cronbach's coefficient alpha values are presented in bold and in the diagonal, observed correlations between safety aspects are below the diagonal and correlations corrected for attenuation are above diagonal**

5.3.4.2 Dendrogram Relationships among nine safety practice aspects

The results from the cluster analysis, in terms of the relationships among the nine safety practice (independent parameters) are presented as a dendrogram in Figure 11. The bars in the graph represent the strenght of the relationship, in which the more related the aspects, the smaller the distance between them. The vertical axis represents the distance/similarity between any two

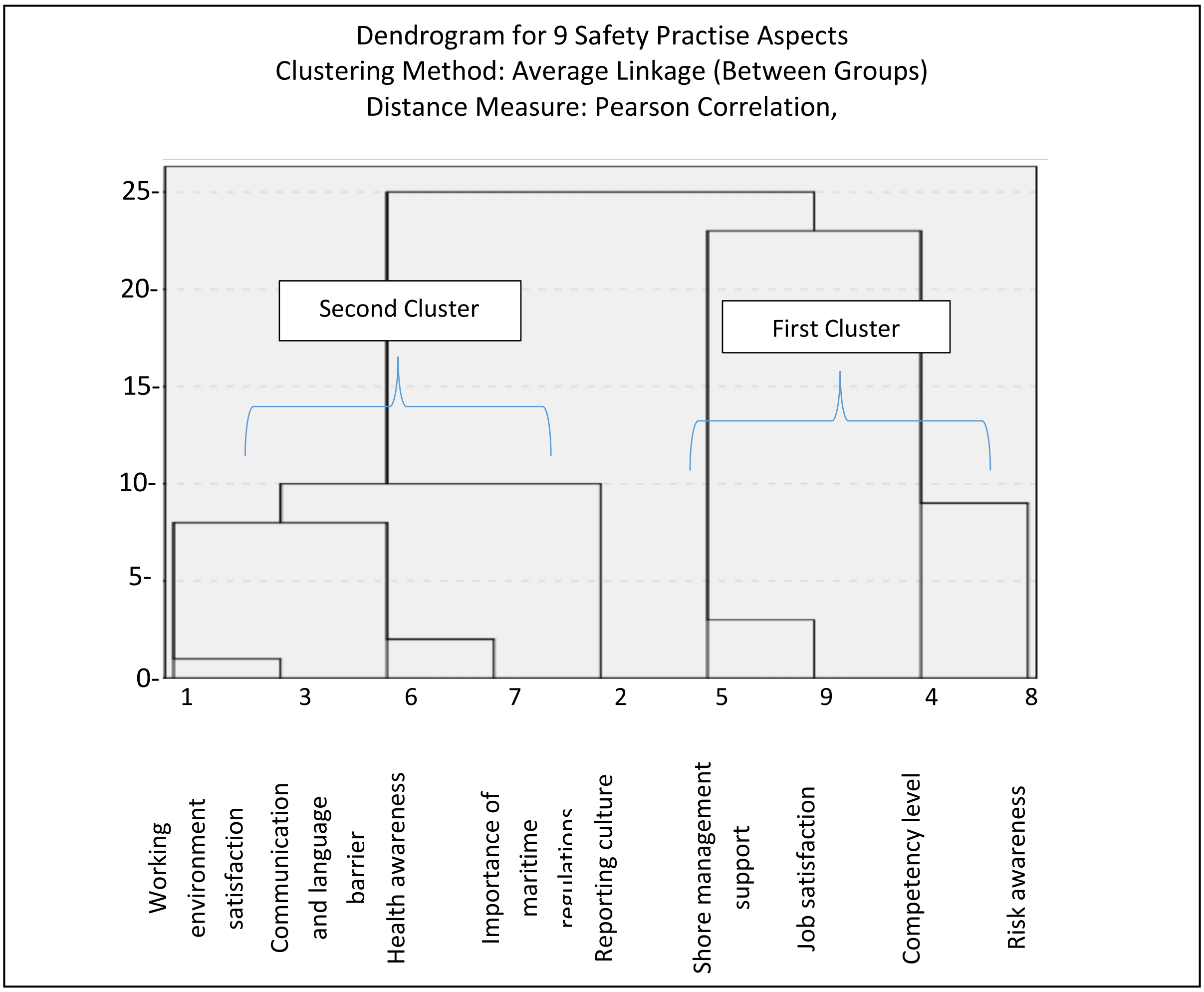

Figure 11 Relationships among nine safety practice aspects

variables.In SPSS the actual distances (Pearson correlation) are rescaled to numbers between 0 and 25. The shorter the bar (distance between aspects),the closer the relationship becomes between the safety aspects. The Pearson correlation values for the overall data are presented in Appendix T – Table 1.

Based on Figure 11, two clusters of safety aspects were formed . The details of the clusters are as follows:

1. First cluster: risk awareness, competency level, job satisfaction and shore management support.

2. Second Cluster: reporting culture, importance of maritime regulations, health awareness, communication and language barrier, and working environment satisfaction.

In the first cluster, job satisfaction and shore management support are closely related (Pearson Correlation = 0.830) based on the perception of the seafarers. This shows that the shore management is giving nescessary supports to the seafarers the job satisfaction is also higher. These can be sufficient training, approriate working hours, employee welfare, communication,reward and holidays. The researcher believes the above mentioned supports are the basic rights for the employees, which can be the motivator to perform well and increase their job satisfaction. This finding is consistent with previous studies. For example, according to Newman *et al., (2014)*, the findings over the last decades suggest that there is a connection between organisational effectivess from the management perspetives and desired work outcome. Slišković and Penezić (2015a) who studied job satisfaction in a sample of Croatian seafarers, found that most seafarers listed good company management and equal treatment as a special source of satisfaction. A continuous support and appreciation from the management and the willingness to accept the opinions of the personnel would give a positive impact in work progress. The management role is therefore vital to motivate the seafarers to work efficiently.

According to the seafarers', risk awareness and competency level (Pearson Correlation = 0.500) are also closely related in the first cluster. This shows that when seafarers get sufficient training and skills, then this will enhances their risk awareness. Most of the respondents considered that they had an appropriate competency level to work safely on-board despite of all the risks and obstacles. Results from other studies show similar results. For example, studies have shown that risk perception may influence risk-taking behaviour at an individual level (Rundmo *et al.*, 2011). Based on the seafarer's perception, an appropriate competency level is therefore vital to ensure the adequate level of safety of navigation. This will enable them to stay alert always and be aware of risks, which may arise anytime.

A good working environment is described as an environment that enables personnel to perform effectively (Oswald, 2012). As such, in the second cluster, working environment satisfaction and communication and language barrier show a very close relationship (Pearson Correlation = 0.969). This confirms that most respondents have a good working environment based on the ranking they have given on the questionnaire; this enhances communications and relationships among other crew. The seafarers believe that good communication is essential for safe performance and effective team. This is also important in a daily working environment so that all the work tasks can be conveyed and performed safely.

In the second cluster, importance of maritime regulations and health awareness are also closely related (Pearson Correlation = 0.889) in the perception of safarers. This specifies that the seafarers' shipping companies complied with the maritime regulations by giving priority to their employees' health welfare. This is an indication showing that practicing maritime regulations could enhance safety among employees. Moreover, the European Marine Energy Centre (EMEC) (2008) has stated that health and safety is achieved with well established regulations. Previous studies have also highlighted the impact of lack of health awareness on work performances. For example, studies revealed that poor health awareness could increase the risk of fatigue or injuries and also will diminish work performance (Josten and Thierry, 2003). Studies have showed that the risk of developing deseases or health related issues among seafarers has increased by 50% upon boarding a ship (Rydstedt and Lundh, 2010). Therefore, the role of regulations is believed to be vital to emphasise the importance of health for productive performance and prevent casualties as this has been proven in other industries too such as the offshore oil and gas sector (Mearns *et al.*, 2003).

Based on the seafarers' perception, working environment satisfaction and health awareness aspects are also closely related (Pearson Correlation = 0.714) in the second cluster. This indicates that most seafarers that took part in the survey are working in a safe environment under the management that always particular about their employee's health which includes mental and physical. For example, the seafarers get proper health care awareness such as talks, safety buletin, safety month and appropriate working hours and rest time. A good working environment will enhance the seafarers's productivity and emotions as most of them are from different nationalities that work thousands of miles away from families and are very pontential to be affected by stress or isolation. This finding relates to the study by Knutsson (2003) where he has also identified an association between the work environment and health awareness. They have stated that poor work environment could lead to health disorders such as depression and mood disorders. Therefore, maintaining a good working environment should be a priority in all companies and on-board ships to promote safety and health awareness.

Reporting culture and competency level are not closely related in the seafarers' perception (Pearson Correlation = 0.436). Competency level, which is determined by sufficient training and skills, is crucial to emphasise the importance of reporting and to implement corrective actions appropriately. However, the result shows that the seafarers are not fully aware of the importance of the practice of reporting of incidents. In addition to that, reporting culture is also not closely related with shore management support based on the seafarers' perception. This is a reflection of insufficient management support and lack of awareness to update themselves (seafafers) with relevant knowledge and skills to be appropriate to work on a ship. Interestingly, the result is very contrasting. Apparently, a continuous management support should encourage the seafarers to report incidents. It can be speculated that these results indicate that the respondents distinguish between the reporting of incidents on board and the quality of management support they receive. The lack of connection could be considered as a potential safety problem because the poor reporting culture will prevent the shipping companies from learning from past incidents and implement changes. Therefore, the management should play the role effectively by providing sufficient support and trainings to their employees.

The aspect of communication and language barrier and importance of maritime regulation were not closely related (Pearson Correlation = 0.442) according to the seafarers' point of view. Such relationship may be formed due to the result of poor understanding and implementation of regulations. It may also suggest that in the mind of the seafarer's the international character of maritime regulation would have an effect even where there were communication problems on board. However, because the maritime regulations themselves require the establishment of good communication on board the latter assumption can not be supported. For example, the STWC (2010) convention states that the administrations should give priorities to communication and language skills in maintaining safety of life and property at sea and also in preventing pollution. Therefore, it is necessary for shipping companies to give more attention to issues related to communication by providing relevant traning and education to their employees'.

Based on the perception of the seafarers, importance of maritime regulations and risk awareness aspects were not closely (Pearson Correlation = -0.948) associated as they belong to different clusters. It is very interesting because in this case both variables would reasonably be expected to increase or decrease together as both the variables have influence on each other. This result indicates that the seafarers do not make the link between regulations and safety, perhaps viewing the first as a documentary exercise while safety being linked more with everyday activities onboard. The researcher believes that the seafarers did not get proper exposure towards better understanding of regulations and the requirements. In addition to that, the companies should reassess their proper implementation of the concerned regulations. The risk here is that if regulations are not understood as contributing to safety onboard they may be attended to as bureaucratic or legal tasks and thus not implemented in an efficient way.

Competency level and communication and language barrier aspects were also not closely connected(Pearson Correlation = 0.133) based on seafarers' opinion. This again may indicate that the perception of competency is a personal one and not one of the officers and the crew as a team or, reversely, that they do not perceive their ability to communicate as part of their competency. This may also indicate a safety risk as seafarers may consider themselves competent despite any communication problems onboard. Therefore, shipping companies should, perhaps place more emphasis in crew performance as a team in addition to the statutory requirements of relevant personal training.

Based on seafarers' perception, job satisfaction showed a weak relationship with working environment satisfaction (Pearson Correlation = -0.620). This indicates several possiblities such as poor condition of their work environment (for example the cleaniness or noise pollution), fellow co-workers, the level of safety at work and availability of management support. In theory, a good working environment that gives priority to safety and well being of the workers will always gives job satisfaction. However, the anticorrelation point out a complication either in the working environment or with the job. Various studies have revealed a positive connection between work environment and job satisfcation . This result indicates that the working environment of the respondents may not be safe or affected by other factors such as long working shifts, lack of sleep and noisy environment.

5.3.4.3 Multiple Linear Regression Analysis

This study examines whether, in the mind of the seafarers, the nine safety aspects (independent variables) are linearly correlated with safety practice. The level of significance (p-value) was set to $p < 0.05$. A low p-value (< 0.05) indicates that the null hypothesis can be rejected (Tranmer and Elliot, 2008). Therefore, the multiple regression enables the identification of independent variables that influencing safety practice.

A multiple regression model involving all the variables included. The model was rebuilt by an iterating process removing at each step a variable that was not statistically significant at the chosen level of p-value (<0.05).

Table 44 summarises the multiple regression analysis results. The table has five columns with aspects such as model (independent variables), unstandardised coefficients, standardised coefficients, t-value and significance. The unstandardised coefficient represents an average change in the dependent variable associated with a one-unit change in the dependent variable keeping the independent variables constant (Cohen *et al.*, 2013). A standardised coefficient compares the strength of the effect of each individual independent variable to the dependent variable (Cohen *et al.*, 2013). This means the higher the value of standardised coefficient (beta), the stronger the effect. The t-value is a standardised value that is calculated from sample data using t-test. T-test is a measure used to compare a sample mean to a hypothesised value during a hypothesis test (Cohen *et al.*, 2013). The significance value or know as p-value is used to determine statistical significance in a hypothesis.

Table 44 Multiple linear regression analysis results

Model	Unstandardised Coefficients		Standardised Coefficients	t	Significance
	B	Standard Error	Beta		
Constant	6.897	0.897		7.693	0.000
Communication and language barrier (H_3)	0.169	0.033	0.271	5.150	0.000*
Health awareness (H_6)	0.133	0.024	0.293	5.538	0.000*
Job Satisfaction (H_9)	0.270	0.062	0.243	4.364	0.000*
Dependent Variable: Safety culture Note: Significance level* $p < 0.05$					

Based on Table 44, three independent variables (communication and language barrier, health awareness and job satisfaction) are enough to describe the maximum amount of variance in safety culture. In addition to that, the positive beta coefficient (B) values of the three independent variables also show the degree of relationship to the dependent variable. The Beta coefficient (B) is an aspect that compares the strength of the effect of each individual independent variable to the dependent variable (Cohen *et al.*, 2013). It is also the degree of change (or rapidity or steepness) in the outcome for every 1-unit of change in the independent variable (Cohen *et al.*, 2013). In short, the higher the value of the beta coefficient, the stronger the effect of the variable.

These findings are supported by Ek *et al. (2014)*, who examined the relationships among safety culture aspects, particularly communication and reporting aspects where these aspects promote openness and insights about safety culture and performance among the crew. Slišković and Penezić (2015b) have claimed that work-related stressors such as demands of job, relationships at work and change management could increase the risk of health issues among seafarers, where it may affect the safety culture.

Table 45 present the final model of the analysis for safety practice aspects, built on the minimum number of safety practice parameters that can account for the perception of safety culture held by the seafarers. The table has five columns such as model, R-value, R-square, adjusted square and standard error of the estimate. The R-value represents the correlation coefficient and R-square is a statistical measure used to determine how close the data are to the fitted regression line (Cohen *et al.*, 2013). In other words, it is the percentage of the response variable variation that is explained by a linear model. The adjusted square is a modified version of R-square that has been adjusted for the number of independent variable in the model (Cohen *et al.*, 2013). The adjusted square will only increase if the removal of insignificant variables improves the model. The standard error of the estimate is a measure of the accuracy of predictions made with a regression line (Cohen *et al.*, 2013). In other words, the smaller the standard error of the estimate is, the more accurate the predictions are. In this study, the coefficient of multiple determination, R^2, gives the proportion of the variation in the safety culture explained by the independent variables in the model. R^2 is a statistical aspect that is used to measure how close the data are to the fitted regression line. The table shows that, when the five independent variables are fitted to the safety culture variable, the value of the adjusted R^2 is 0.445, suggesting the complete model was predictive for safety culture for safety practice in the UK shipping industry. This means that, close to 50% of the variation in safety culture data as perceived by the seafarers are explained by the independent variables listed in the table. This confirms that the independent variables have significant effect on safety culture.

Table 45 Final Model Summary

Model	R	R Square	Adjusted Square	Std. Error of the Estimate
1	0.667	0.445	0.439	1.860
Predictors: (Constant), communication and language barrier, health awareness and job satisfaction				

5.4 Comparison between Maritime Academy A and Shipping Company B – Hierarchical Cluster Analysis

5.4.1 Hierarchical Cluster Analysis

The analysis was performed in two subsets, one representing perception of seafarers from Maritime Academy A (Figure 12) and one for the seafarers from Shipping Company B Figure 13. The vertical axis represents the distance/similarity between any two variables.In SPSS the actual distances (Pearson correlation) are rescaled to numbers between 0 and 25. The Pearson correlation values for both Maritime Academy A and Shipping Company B are presented in Appendix T – Table 2 and Table 3 respectively.

Both the organisations have similarities and differences on their perception about safety culture based on the results of Hierarchical Cluster analysis. The two dendrograms have formed two clusters with each cluster containing almost similar variables. This indicates seafarers from both the organisations have similar perception about the safety culture in the maritime industry. However, they varied in the first cluster based on the number of variables.

The people in Maritime Academy A, have four variables in the first cluster namely competency level, shore management support, reporting culture and job satisfaction. For the people in Shipping Company B, the first cluster has only three variables namely shore management support, job satisfaction and risk awareness.

Based on the results, both the groups have similar perceptions about shore management support and job satisfaction; that is, they believe that these two variables are linked together. In other words, the shore management of their companies are providing sufficient support to them and other employees, which is believed to be a factor of their increased level of job satisfaction.

Figure 12 pertaining to Maritime Academy A, shows a close relationship between competency level and shore management support, which is contrast to Company B. This reflects a culture difference in both the organisations where in Maritime Academy A, the management provides sufficient training and awareness to their employees. They also know their responsibilities for their employees and it is important for them and their company to function productively and safely.

However, from the shipping company B data, shore management support and competency levels have not posed a close relationship. The researcher believes that the employees of this company are not getting sufficient support and awareness/exposure in acquiring the relevant competency level from the management. There can be several factors such as inadequate finance, lack of awareness, and poor communication between the management and the seafarers. Therefore, Shipping Company B should consider improving their shore management support service efficiently. These are the main similarities between the two organisations and the other relationships among the variables are similar to the main results (Figure 11).

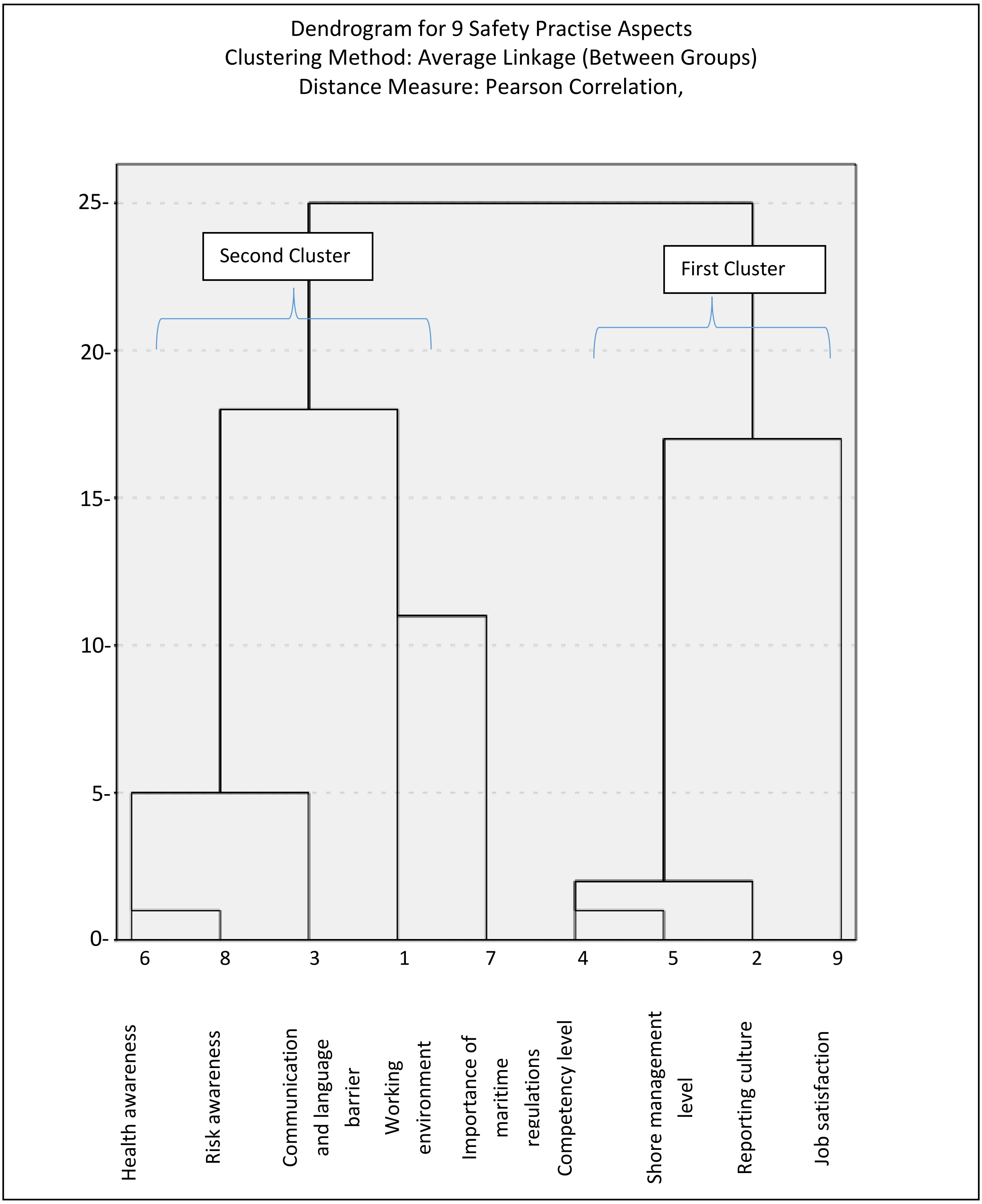

Figure 12 Relationships among nine safety practice aspects (Maritime Academy A)

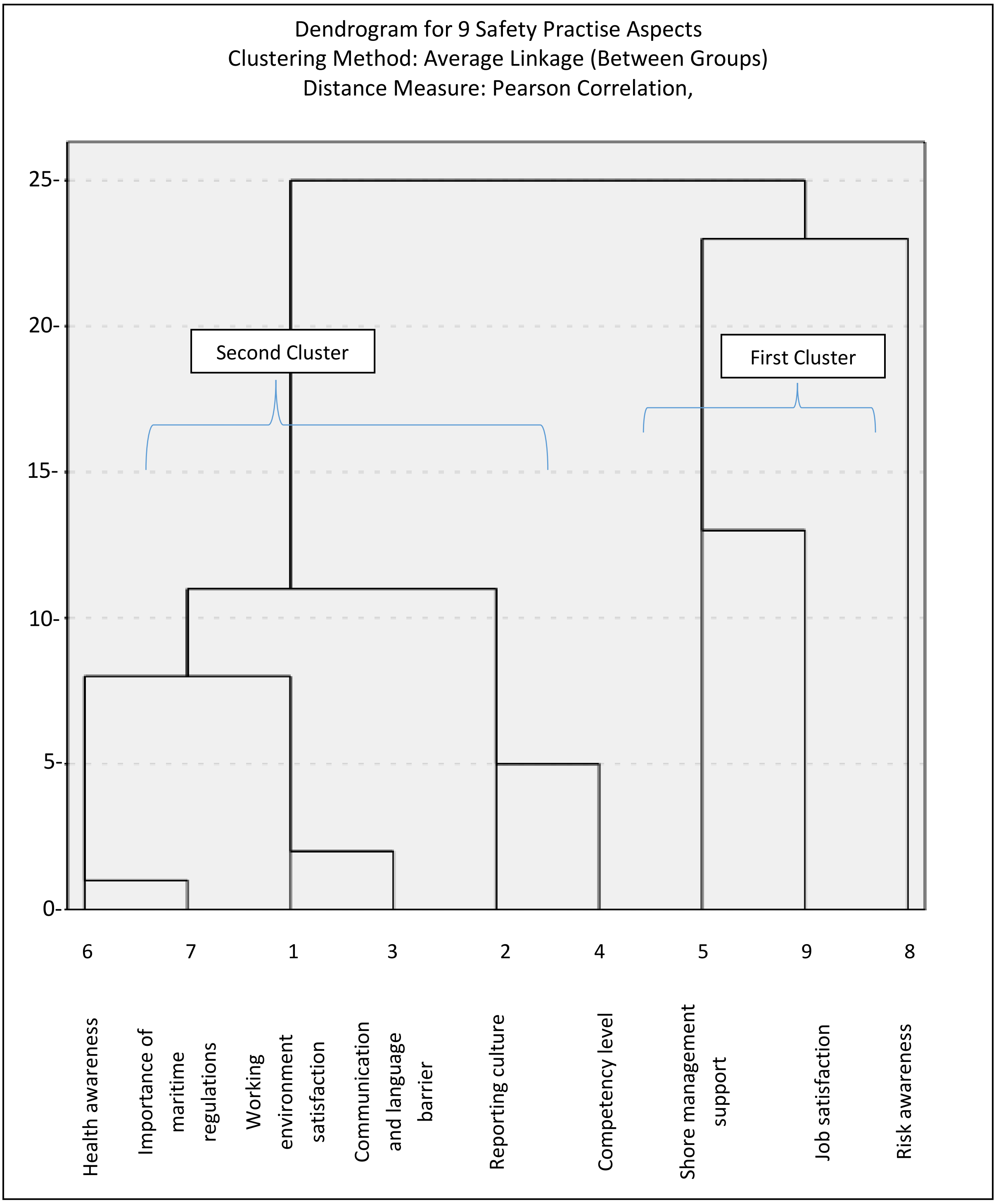

Figure 13 Relationships among nine safety practice aspects (Shipping Company B)

5.5 Comparison between the perception of seafarers with more than 10 years’ experience and less than 10 years’ experience

5.5.1 Hierarchical Cluster Analysis - Dendrogram

The analysis was also performed in two subsets, one representing the perception of seafarers with more than 10 years experience (Figure 14) and one for the seafarers with less than 10 years experience (Figure 15). The perception of seafarers with more than 10 years experience are different than the perception of seafarers with below 10 years experience. The main difference is that the perception of seafarers with above 10 years of experience has formed 3 clusters while those with less than 10 years experience has formed 2 clusters. Aspects such as working environment satisfaction, health awarenes and communication and language barrier are clustered together in both Figure 14 and Figure 15 dendrograms. This indicates that the both group of seafarers believes health awareness and communication and language barrier have influence on working environment satisfaction. Detailed comparison between the perception of these two groups is diccussed in section 7.2.2.1 (Chapter 7).

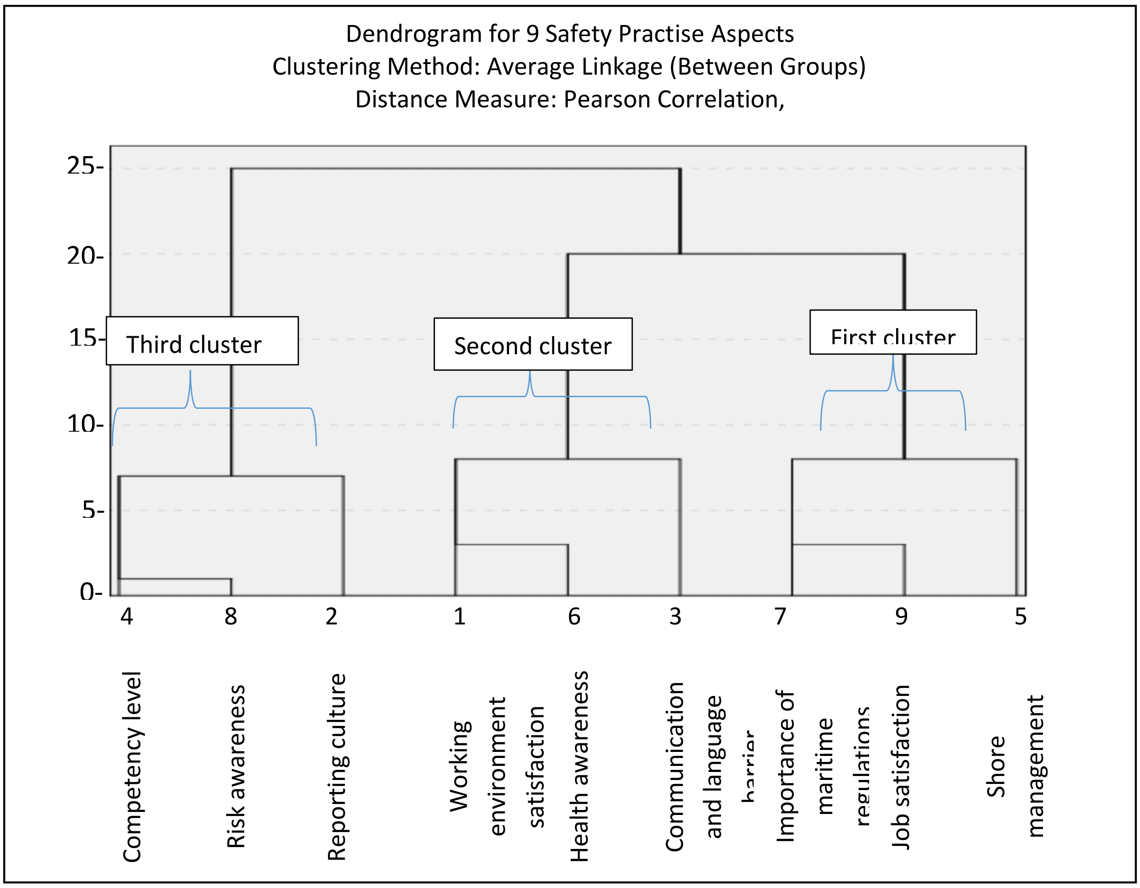

Figure 14 Perception of seafarers with above ten years of working experience

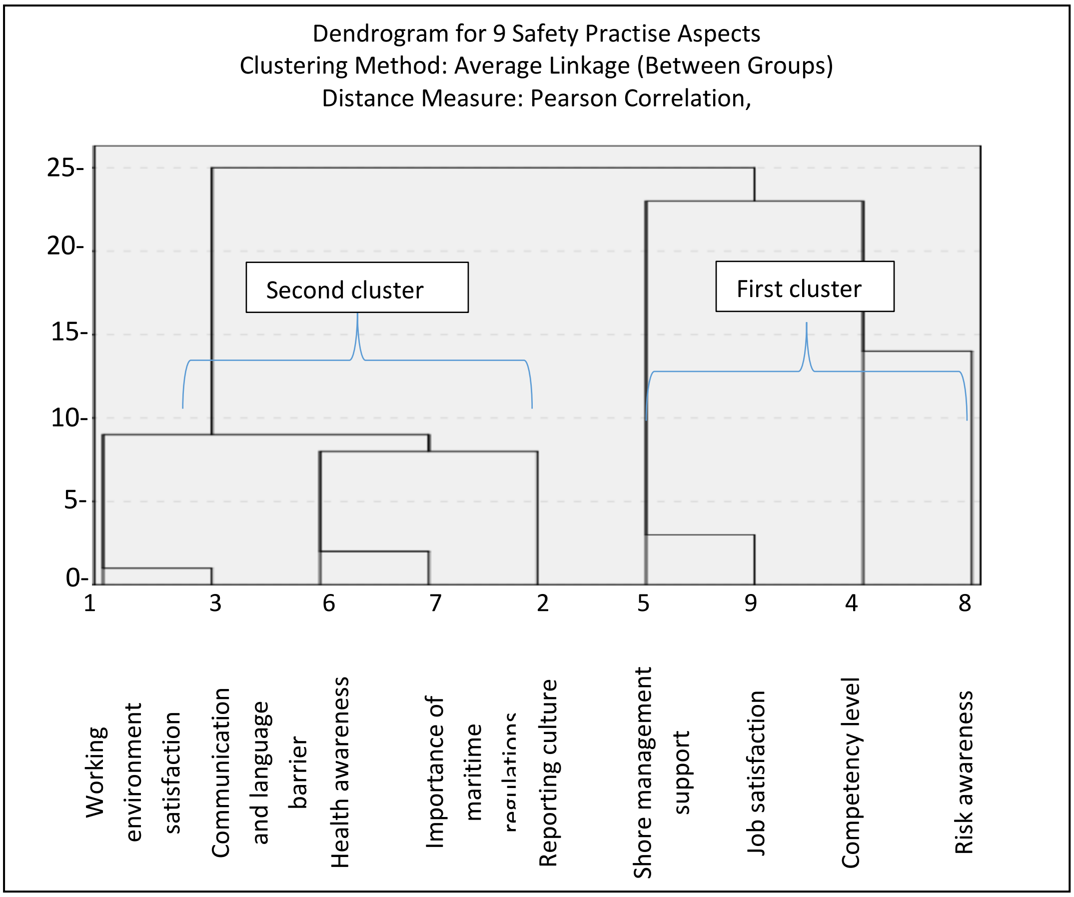

Figure 15 Perception of seafarers with below ten years of working experience

The results from Figure 11, Figure 14 and Figure 15 can be related to the findings of Ek *et al*. based on data collected from Swedish ships (Ek *et al.*, 2014). Ek *et al*. has used nine safety aspects and four of them namely work situation, reporting, communication and risk perception are similar to the aspects has used in this study. Though the name of the safety aspects used are not identical, they have the same description in the clustering. Ek *et al*. has found that work situation, communication and reporting belong to the same cluster similar to the findings on Figure 11 and Figure 15. Figure 14 also can be related to Ek's findings where, aspects such as work situation and communication have formed in the same cluster. This strongly supports the results that most seafarers have the same perception on the connection of these three factors and also gives confidence to the methodology followed and the analysis made. There is however, also, a difference between the results of Ek and this study because, all the three dendrograms from Ek's findings have two clusters whereas, in this study, only two dendrograms have formed two clusters and one formed three clusters. As our analysis indicates three clusters when the years of experience are taken into account and discrepancy could be due to the age of participants but also to other demographic differences (companies, nationalities, age and number of respondents) not explored on either of the two studies.

5.5.2 Multiple Linear Regression Analysis

Multiple linear regression analysis was applied to the data of both above and below 10 years of working experience. The aim of this analysis is to examine how the perception of the two groups of respondents varies. The results presented are in the Tables 46, 47, 48 and 49.

Based on the results, both group of respondents have different perception. This can clearly be the results of respondents with more than 10 years' experience (Table 46) have shown competency level aspect (independent variable) with p-value (<0.05) are closely related to safety culture (dependent variable) as it is enough to describe the maximum amount of variance in safety culture. However, the results of respondents with less than 10 years' experience (Table 47) have shown communication and language barrier and health awareness (independent variables) are closely related to safety culture (dependent variable) as it is enough to describe the maximum amount of variance in safety culture. Both the aspects are statistically significant with p-value (<0.05).

On the other hand, higher a standardised beta coefficient value, the stronger the effect (Freedman, 2009). As such, the beta value of the independent variable (competency level, beta = 0.660) in Table 46 is higher compared to the independent variables (communication and language barrier, beta = 0.376 and health awareness, beta = 0.359) in Table 47. This indicates that competency level has stronger effects towards safety culture or in other words, the respondents' with above 10 years' experience have statistically stronger perception. Although the beta values differ but all the three variables (competency level, communication and language barrier and health awareness), have an effect towards safety culture.

Table 48 and Table 49 present the final models of the analysis for safety practice aspects. Generally, the more the number of variables the higher the value of R-squared (Freedman, 2009). However, in this analysis, both model was analysed with same number of variables (nine independent variables). Whereas, the value of adjusted R^2 increases only when the new term improves the model fit more than expected by chance alone (Cohen *et al.*, 2013). Therefore, the difference in the results were not influenced by the number of variable in this study. The results of respondents above 10 years' experience (Table 48) shows that when the one independent variable (competency level) is fitted to the safety culture variable, the value of the adjusted R^2 is 0.424. This means that, close to 50% of the variation in safety culture data as perceived by the seafarers are explained by the independent variables listed in the table. This value is higher compared the values obtained by respondents with below 10 years experience (Table 49). The result in Table 49 shows that when the two independent variables (communication and language barrier and health awareness) is fitted to the safety culture variable, the value of the adjusted R^2

is 0.398. This means that, close to 40% of the variation in safety culture data as perceived by the seafarers are explained by the independent variables listed in the table.

Although the values of the adjusted R^2 are lower than 50%, all the three independent variables (competency level, communication and language barrier and health awareness) have significant effect on safety culture.

Table 46 Multiple linear regression analysis results (More than ten years working experience)

Model	Unstandardised Coefficients		Standardised Coefficients	t	Significance
	B	Standard Error	Beta		
Constant	8.328	2.070		4.023	0.000
Competency Level (H_4)	0.611	0.098	0.660	6.269	0.000*
Dependent Variable: Safety culture Note: Significance level* $p < 0.05$					

Table 47 Multiple linear regression analysis results (Less than ten years working experience)

Model	Unstandardised Coefficients		Standardised Coefficients	t	Significance
	B	Standard Error	Beta		
Constant	8.488	0.934		9.088	0.000
Communication and language barrier (H_4)	0.232	0.034	0.376	6.752	0.000*
Health awareness (H_6)	0.162	0.025	0.359	6.458	0.000*
Dependent Variable: Safety culture Note: Significance level* $p < 0.05$					

Table 48 Final Model Summary (More than ten years working experience)

Model	R	R Square	Adjusted Square	Std. Error of the Estimate
1	0.660	0.435	0.424	1.668
Predictors: (Constant), competency level				

Table 49 Final Model Summary (Less than ten years working experience)

Model	R	R Square	Adjusted Square	Std. Error of the Estimate
1	0.635	0.403	0.398	1.955
Predictors: (Constant), communication and language barrier and health awareness				

5.6 Conclusion

This chapter analysed a new dataset developed from questionnaires recording the perceptions of seafarers on safety culture and contributing parameters. Cluster analysis and multiple regression analysis were used to explore the links between safety culture with nine parameters describing aspects of the seafarer's work and reflecting training, regulatory and safety management aspects. The researcher has identified expected correlations in the perception of the safety culture and some aspects of safety on-board ship. However, the researcher has also identified lack of correlation between safety culture and some safety parameters, which were unexpected and indicate the areas where safety risks may arise from.

In shipping industry based on seafarer's perception. In a broad sense, this study enables the following contributions towards shipping safety: (1) it has highlighted the relationships among various aspects of safety practise distributed on dendrogram and (2) it has identified the major contributing causal factors of shipping accidents based on seafarer's point of view based on the correlation between independent and dependent parameters.

The results obtained are consistent with results obtained appear by *Ek et al.*in a different national setting. Both studies were based on seafarer's perception and have applied similar analysis. This confirms that the clustering of the safety aspects is reproducible across seafarers' samples. In the presence of previous studies, it has eased the researcher to highlight the similarities and differences to be applied for the betterment of safety in shipping industry. Based on the Hierarchical Cluster analysis the relationships among the nine safety aspects (independent variables) have been well portrayed based on their internal consistency. This analysis was useful to identify safety aspects that are closely related by the cluster formation to explore their connection to be related to the safety culture in shipping industry. Experience and additional training does change the perception seafarers have on safety aspects as the comparison between the perceptions of longer serving seafarers to those with less experience indicates. The only similarity was both groups shows a relationship between health awareness and communication and language barrier and working environment satisfaction.

The findings from multiple regression analysis have identified the variables that have close relationship with dependent variable (safety culture) based on seafarer's perception. For all seafarers; communication and language barrier, health awareness and job satisfaction aspects are the primary aspects that influence the safety culture. The results of multiple regression for both above 10 years and below 10 years of working experience have shown contrasting output. This proves that both the groups have different point of view on safety practices.

Measuring safety culture among seafarers from their point of view can provide the management of shipping companies and stakeholders to measure and view the problems and threats in the industry to improve the safety culture. Identifying areas where the perception does not reflect the expected linkage is indicative of inefficient training or understanding of the linkage between the various aspects of safety.

Chapter 6 Insights of Safety Practises In the Shipping Industry – A Qualitative Assessment

6.1 Introduction

In this and the following sections, the discussion presents the outcome of the safety culture interview. The main purpose of the interview is to explore more about the safety culture in shipping industry in the UK to achieve the third and fourth objectives of the study. The objectives are, third objective: to identify the safety aspects that shipping personnel believes contribute most towards an improved on-board safety culture, and fourth objective: to recommend methods to reduce the impact of human errors that could be used as a reference for decision makers in international shipping companies to augment their information on policy and management.

The interview was conducted among 10 shipping personnel from 3 different companies. Among the 10 shipping personnel, 5 were shipping company managers and another 5 were seafarers. The discussion will cover the profiles of respondents, safety practice facts and the respondent's perception on results from previous safety culture survey (questionnaire survey). The respondents were all around the UK and some of them were on sea sailing at the time of the interview. Therefore, none could be found in one place. Thus, telephone interviews were the only time saving option and economically reasonable method.

The respondents of the interview were from three companies. Company A has started as a shipping company in the late 1800s and has continued to operate successfully until present. It is based in Europe and extended their branch all around the world. Today, this company has become the centre for maritime expertise, providing commercial, ship management and technology services, along with assurance advice to internal and external customers. One of their strategies is safety and social responsibility that are fundamental to their business approach.

Company B is a marine classification society. They have started in 1760 and now they are one of the world's leading providers of professional services for engineering and technology. Their focus is on safety and increasing the performance of critical infrastructures for clients in over 75 countries.

Company C is a cruise line company based in Europe, which operates 10 ships. To ensure the proactive management of risk to ensure the safe operation of their fleet, they develop competent and motivated people, providing assets that are adequate for the purpose and delivering operational processes that meet the needs of the business. They also give priority to health, environment, safety and security and nautical and engineering expertise needed to safely deliver unforgettable holiday happiness to their guests.

6.2 Profiles of respondents

The first part of the interview was about the individual background facts that covers about their age, sailing experience, education background, years in the industry, number of employees or ships under their management and the challenges they deal in managing the employees or ships.

The interview was conducted between January to June 2018, which involved 10 respondents where, two of them had seafaring experience but currently, working in a classification society and shipping company respectively. The respondents consisted of five shipping company managers and five seafarers. All of them were aged between 35 - 63 years.

6.2.1 Shipping company managers

Among all the five managers, two have had sailing experience of 21 and 20 years respectively and have served as master before started to work on shore. All the managers have degrees in various engineering studies such as Naval Architect, Environmental Engineering and Civil Engineering. They are all well experienced personnel as they are in the industry between 12 to 43 years.

Next, when the interviewer asked, "how many employees are you responsible for?" two of them said that they are managing 'a large group' and '2 big teams' respectively. Another respondent has said that he is managing seven employees directly and 470 safety auditors working under the procedures. Whereas, the other two respondents have said that they are not managing any employees, but they are a part of the leadership team of their company.

Then, the interviewer asked, "can you explain about the challenges dealing with this number of employees?" all of them have given similar answers such as "it is challenging' and "very challenging" without explaining about the challenges. They are all have been asked "how many ships do you manage?" and none of them manage ships except one who manages 600 ships team.

6.2.2 Seafarers

Among all the five seafarers that took part in the interview, only two have stopped sailing and now working as a Technical Specialist and engineer on shore respectively. Even though, they stopped sailing but their experience being a seafarer would be relevant to this study. While, the other three respondents are still serving on sea where two of them are marine engineers and one ship nursing officer. They are all have sailing experiences between 5 to 10 years.

Two from the three respondents who are currently serving on sea are sailing on the same ship since 2009 and 2010 respectively while another respondent has just started on a new ship six months ago. In addition to that, four of the respondents have been working in the same company between 5 to 10 years and only one of them was newly joined the company six months ago.

6.3 Interview outcome based on safety practice themes

6.3.1 Introduction

To examine the conceptual understanding of safety practice in the UK shipping company, the study used interview survey. There were several questions developed related to safety culture, the main threat, human errors, human errors related incidents, safety management system (SMS) and safety training (refer to the questions in Appendix A and B). The questions were crucial to explore safety culture and how the respondent's deal with human error in their companies. Thus, their strategies can be adapted in the industry to improve safety.

The researcher has developed thematic areas using Nvivo software that was used to code the responses from all 10 respondents (shipping company managers and seafarers). Based on a thorough study on all their responses, the researcher has grouped them into six safety practice themes, which was previously used in questionnaire survey (refer to Chapter 5). Table 50 shows some of the responses with the relevant themes such as competency level, health awareness, shore management support, risk awareness, working environment satisfaction and importance of maritime regulations. Therefore, the interpretation of the results in this chapter will be based on the six themes.

Table 50 Responses and theme formation of interview survey

Responses to the conceptual understanding of safety practice	**Theme**
Dependent on technology and yes it causes accidents Competence and professionalism Inadequate training Lack of awareness and training can lead to disaster Accidents happened due to incompetency and tiredness	Competency level
Workload, employees not being given time to mitigate risks that they face Fatigue is a very real threat and the main one	Health awareness
Commercial pressures resulting in short cuts taken rather than taking time to work out how to eliminate or reduce a risk Continuous support from the management	Shore management support
Lack of understanding of hazards, clear line of sight to major accident, or foresee risks when situation changes for example wind or wave pick up Employees not following the safe and proper way of operating equipment	Risk awareness
The nature of the work	Working environment satisfaction
None but maritime regulations can prevent human errors	Importance of maritime regulations

6.3.1.1 Theme 1: Competency Level

All the respondents both shipping company managers and seafarers have an opinion that there are many aspects that affect safety practice in an UK shipping company. As such, competency level is among the aspects that should be improved and given more attention to improve current safety practice based on the respondent's view.

According to a respondent (manager), "competence and professionalism is the main threat to safety in shipping industry". This statement emphasised the importance of competence that would make a person fit to the designated job. In other words, an employee that lacks competence would be a threat to him/herself and the surrounding. Decision-making mistake due to insufficient training is also closely related to lack of competency level based on the respondents. This factor is merely human error as the employer/employee did not give priority in getting sufficient training to deal with unexpected or emergency situations. The respondents have also claimed that they train their employees on how to implement and comply with safety regulations and emphasised that all the trainings were effective to improve safety practice and to produce competent employees. For examples, the trainings provided in one of the respondent's company are safety induction, safety day, platform or ship specific training, video training programme and briefing before joining the ship. Based on the responses, all companies are concerned about safety and do provide trainings to their employees and it can be vary from company to company. On the other hand, another respondent (seafarer) has strongly stated that it is important to have competent employees for a ship to run safe.

Based on the respondents, human error is a threat to safety practice and it is unpredictable, as there is no standard situation or environment for it to take place, but it can happen anywhere and anytime. However, human error can be reduced through training, as it has been the top priorities produce competent employees and to make ship safer.

6.3.1.2 Theme 2: Health Awareness

Based on the respondent's perception, health awareness is also another important aspect for safety practice in shipping industry. Health is important because it determines the ability of a person to perform or take part in daily routine and it affects a company's productivity. Fatigue is often related to health awareness based on the respondent's perception. Fatigue is one of the main causes of accidents (Oluseye and Ogunseye, 2016). The main causes of fatigue are long shifts that prevent seafarers to perform effectively during watch keeping.

One of the respondents (manager) has stated that, "I also do not believe that IMO does enough to address it. There are new guidelines, which have been in development for sometimes, but they are only guidelines they are not regulations and there is unwillingness to recognise their failings of some watch keeping systems (six on six off) for extending periods, which is, comes to work again". The respondents also believe that increased paperwork as required by the regulations as another factor that causes fatigue. This is because the over flowing paperwork consumes most of the seafarer's time and energy that prevents them from performing their main task with full concentration.

In addition, wearing good quality of Personal Protective Equipment (PPE) all the time while on duty is important to avoid being injured and it is the responsibility of the company to provide them. For example, one of the respondents (seafarer) shared his experience about a crewmember who has crushed his finger in machinery. Therefore, regular machinery/equipment check, wearing PPE and strict health and safety policy are necessary to avoid casualties that could harm the employees' health.

6.3.1.3 Theme 3: Shore Management Support

Shore management support is crucial in improving and maintaining a good standard of safety practice in shipping industry. They play an important role mainly in providing sufficient support to the seafarers in every situation such as ship operations, in educating employees on Safety Management System (SMS), training, health and well-being. As such, one of the respondents (seafarer) has highlighted that his management are aware of their responsibilities in providing sufficient training to all their staffs. For example, they have started to provide video training, PPE, monthly training, regularly ensure all the safety policies are up-to-date, mandatory e-learning courses, tight security check upon arrival and departure, and continuous learning and improvements.

The respondents (seafarers) believe continuous support from the management could make a ship safer. They have also stated that, their company is always alert and has a close contact and communication with the staffs on board ship by monitoring and responding them quickly in all distress situation. They also have provided with sufficient supports, training and safety bulletin to keep their off-shore staffs updated with technical and safety related issues.

The above explanations illustrate how the seafarer's expectation from the shore management to work off shore with full confidence and motivation. It also emphasises the importance of shore management.

6.3.1.4 Theme 4: Risk Awareness

Risk awareness is an important aspect of safety practice. Risk or hazards can arise anytime and anywhere, therefore, being aware of the surrounding is essential.

"The features that makes it safe are we have risk-based approaches and everything risk assessed. There are no features that makes it unsafe."

The above statement was from a respondent (manager). The respondent has stated that when he was asked what features that make the company safe/sustain safety culture. Based on the response, regular risk assessment on everything that being carried out in a company or on a ship makes his company safe and it is vital to prevent casualties. The respondents have also shared their experience regarding risk awareness. As such, their crew members do get injured or slipped on-board because did not aware of their surroundings before carrying out their work. However, another respondent (seafarer) has mentioned that commercial pressures resulting in short cuts have been taken rather than taking time to work how to eliminate or reduce risk. They have also highlighted that, in most incidents, the employees often pose risk tolerance, lack of situational awareness or overlook risk. For example, they often use the statement, "it would not happen to me, why bother?" This should be treated a serious threat to safety practice as this attitude will not only harm the person but also could affect people around that person.

Above explanations have strengthen the importance of risk awareness where, everyone should be aware of the risk to work safely. Therefore, one should always learn and share especially from past incident documents as it is one of the best ways to mitigate the risk based on the respondent's perception.

6.3.1.5 Theme 5: Working Environment Satisfaction

Working environment satisfaction has been identified as one of the theme that closely related to safety practice. Studies show that working environment satisfaction is achieved when the work place is safe, supportive and understanding, and hence, enables personnel to perform effectively (Oswald, 2012).

In the interview, the respondents (managers and seafarers) have claimed that the culture and the work environment of their companies are very good. This is because their companies practice safety effectively by adapting great focus on life saving rules and zero accident goal. Other respondents (seafarers) have mentioned that their companies has good features such as proper operation procedures, behavioural based safety, learning and continuous improvement and sustainable, which, creates a safe environment to work with satisfaction.

"Forced culture is an unsafe feature because over emphasis will cause a bit of 'kick back' or demotivation. Forcing someone to follow the rules, I do not count it as culture. You should get people's heart rather than the procedure."

However, one respondent (manager) stated that he can feel a forced culture at work, which, he believes discourages most people at work to follow rules. In addition to that, peer pressure and commercial pressure often seen as a factor that decreases working environment satisfaction. With many distractions at work or poor working environment will be a threat to safety. This is because one can only perform safely and focused if the surroundings are favourable, and hence achieve satisfaction to perform better.

6.3.1.6 Theme 6: Importance of Maritime Regulations

Safety regulation and its implementation influences industrial performances of hazardous activities from health, safety and environmental considerations. In shipping industry, safety regulations can decrease the frequency of accidents and also motivate maritime organisations to take safety precautions more seriously (Størkersen, 2015). These statements strongly portrait that regulations are an important factor for better safety practice.

“Good and effective management of SMS will give positive impact on safety performance.”

“Following safety management system and routine training will make a ship safer.”

“Our company has strict health and safety policy, which, we all religiously follow it.”

Based on the above statements, the respondents (managers and seafarers) believe that regulations such as ISM Code and SMS are effective in enhancing safety. Making regulations for example SMS less prescriptive, could enhance its effectiveness. This emphasises that SMS can over prescriptive sometime, which can become a burden that could create hesitation to comply with it among the employees.

“There is so much regulation that trying to comply with all of the time is difficult to ship staff.”

However, based on the respondent’s perception, the attitude of disobeying the rules can be seen among the crews, which, often led to casualties. This is because they are not fully aware of the consequences of not complying. Hence, they practice taking short cuts while doing their task, which expose them to high risk of casualties. Several respondents (managers and seafarers) have an opinion that too many regulations could increase the workload, and this should be a threat to safety. This is because increased workload besides their main task can lead to fatigue and poor work performance.

Generally, presence and utilisation of regulations should prevent or reduce accidents; however, accidents are still occurring. The reason is maritime regulations are not being complied properly, hence, the increase of accidents.

Based on the respondent’s opinion, they believe, educating the crewmembers whom disobeying the rules is a best way compared to penalising them. In addition, regulations can only be utilised through effective training and inspections to obtain the possible outcome besides improving the standards of the requirement for the trainings and equipment.

6.4 Conclusion

This chapter has discussed about the insights of the safety practices in the shipping industry based on the semi-structured interview that was conducted among the shipping industry personnel. The researcher has explored the safety practice in the UK shipping through several questions that have been useful to obtain valuable information to improve the safety culture. The summary of the findings from the interview have been illustrated in the three figures below.

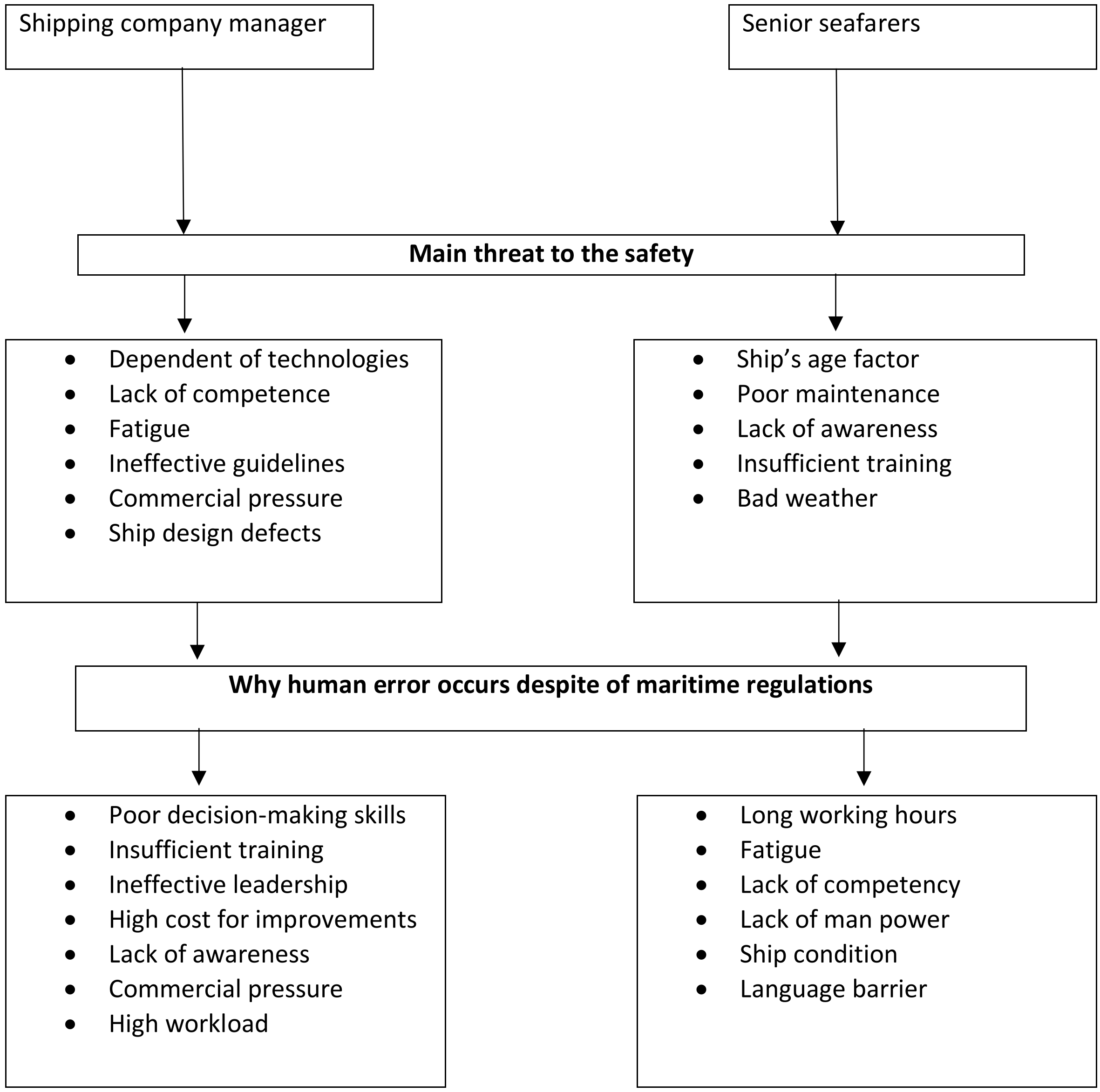

Figure 16 The threats and occurrence of human error in the shipping industry

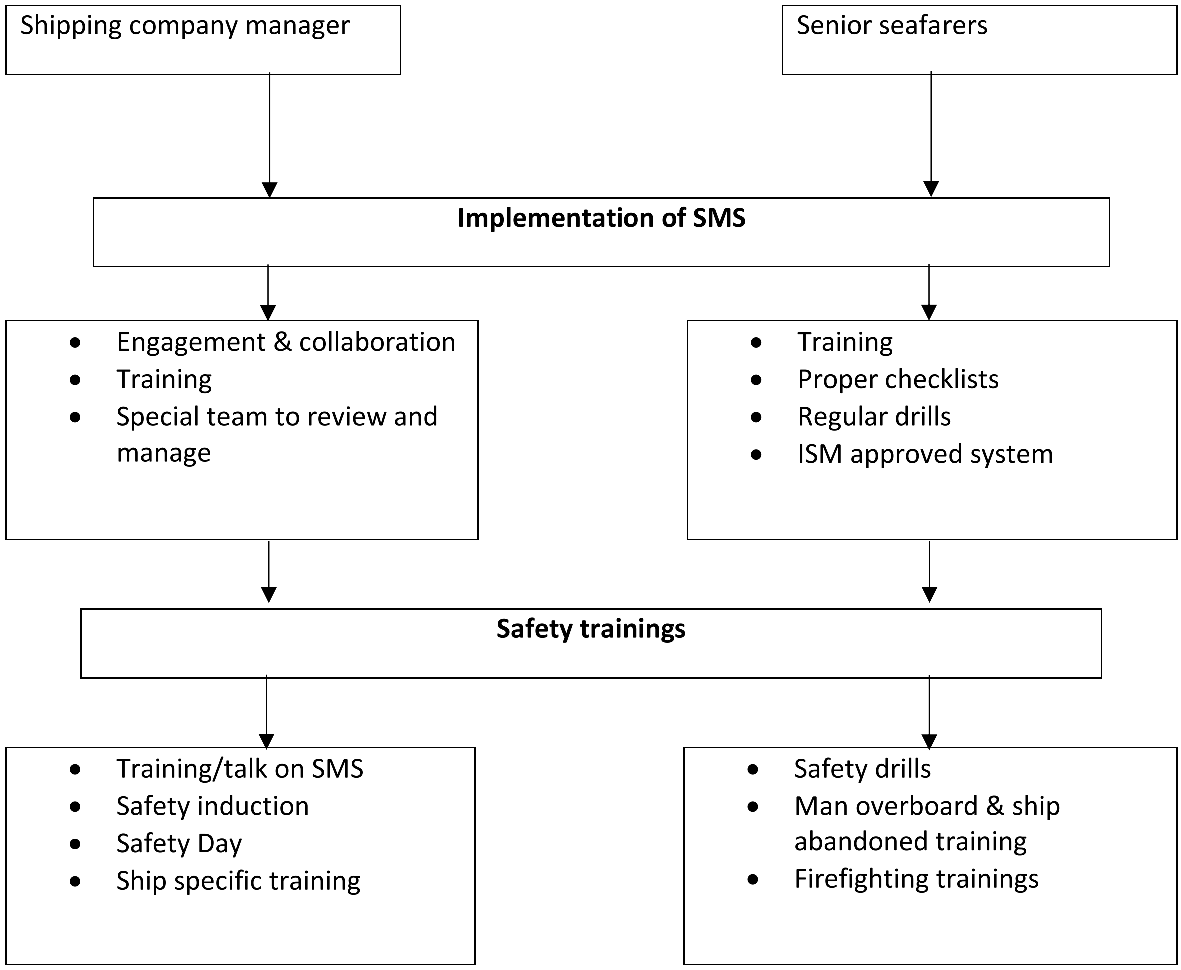

Figure 17 Implementation of SMS and safety trainings

Perception of shipping company managers & senior seafarers

How to utilise Maritime regulations?

- Effective training
- Regular inspection
- Simplifying the regulation
- Comply/practice the regulations

How to improve safety culture?

- Effective leadership
- High aims (aim for zero accidents)
- Financial assistance for safety improvements
- Practice learning from incidents
- Educate younger generations/employees from beginning

How to prevent and reduce the impact of human error?

- Human technology friendly
- Standardised requirements
- Employ competent individuals
- Rewards/appreciations

Figure 18 Perception of the respondents towards safer shipping industry

The researcher has illustrated the findings start from the threats and causes of human error followed by the proper implementation of SMS and safety trainings. Then, the last part was about the effective ways to utilise maritime regulation, ways to improve safety culture and the ways to prevent and reduce human error. Based on the findings, the researcher strongly believes that both groups (managers and seafarers) are not saying different things but seeing different aspects from various angle of the same issues. The difference occurred due to their different experiences and work environment. For example, they have seen different threats to safety and factors that causes human error despite of maritime regulation, which is shown in Figure 16. In Figure 17, they have suggested different ways of implementation of SMS and safety trainings. The fundamental fact here is the maritime safety, which can be improved by identifying the threats and practice proper implementation and training of safety regulations as suggested by the shipping personnel.

To conclude, Figure 16 has demonstrated the main threats and the causes of human error. Despite of the many factors, insufficient training, fatigue, lack of competency and lack awareness have been identified as the most potential threats to the safety based on the two groups of respondents (managers and senior seafarers).

Figure 17 has shown the effective ways of SMS implementation that have been proved to be a successful method in the respondent's companies. In general, both groups of the respondents have strongly suggested that the effectiveness of SMS can be achieved through effective training. Through training, the importance and the proper ways to utilise SMS, can be well conveyed to the personnel. Other than that, regular drills, safety talks and inductions are essential for better safety practices.

In addition to that, the respondents have also clarified the main concern about the occurrence of ship accidents in the presence of maritime regulations, which has been shown in Figure 18. Based on their perception, lack of training, understanding and commercial pressure are among the main causes of the ineffectiveness of the regulations. The respondents have recommended several ways to maximise the effectiveness of the regulation such as through effective training, regular inspection, simplifying the regulations and practicing the regulations without fail. Besides that, good leadership, high aim, financial assistance, learning culture and educating the younger employees could also help to enhance the safety culture. Reduced human error and its impact would will develop an ideal industry that would be safe to work. Therefore, by having developed human technology friendly, standardised requirements, competent individuals and rewards/appreciations, it is potential to reduce human error and its impact. This information will be useful to the policy makers to improve the regulations and shipping companies to practice safety and lead their employees effectively.

Additionally, the findings from this interview would be very useful to improve the safety aspects (competency level, communication and language barrier and health awareness) that have been identified through multiple regression analysis. This is because the identified aspects from the regression are consistent with the findings from interviews. Therefore, interview findings based on experienced shipping personnel can be used an additional evidence in support of the recommendations for safety improvement.

CHAPTER 7 DISCUSSION AND CONTRIBUTIONS

7.1 Introduction

This study has explored various elements related to safety practices in the shipping industry and in this chapter; the discussion of the findings is presented. The study has been pursued by applying qualitative and quantitative methods. In addition to that, a number of statistical analyses have been used to explore the data obtained.

The discussion will be based on the four objectives of the studies. The objectives are:

1. To analyse the causes of human error and the rates of maritime accidents.
2. To study and identify the relationships seafarers perceive to exist among various safety parameters on-board ships.
3. To identify the safety aspects the shipping personnel believes contribute the most towards an improved on-board safety culture.
4. To recommend methods to reduce the impact of human errors that could be used as a reference for decision makers in international shipping companies to augment their information on policy and management.

The discussion is divided into three sub-sections. In the first sub-section, the discussion will be based on the findings on human errors and its impact on safety that contributed to the first objective of the study. The second sub-section will be on the relationships among safety practice aspects based on seafarer’s perception that contributed to the second and third objectives. The last sub-section will be based on improved strategies and ways to reduce the impact of human error that contributed to the fourth objective.

7.2 Issues concerning the shipping safety

7.2.1 Human element on safety

One of the objectives of this thesis was to examine the cause of human error and the rates of maritime accidents using Human Factor Analysis and Classification System (HFACS). The purpose of using HFACS analysis was to identify the root causes of the accidents in order to create an awareness to reduce its impact and prevent the occurrence of similar causes.

The analysis was based on 30 shipping accident reports in the period 2000 – 2016, which is the period after the implementation of ISM Code. After a thorough analysis on the reports, 126 human related causal factors of accidents have been identified. In addition, all of the 126 causal factors have been classified into four level of the HFACS system to identify the most accident contributing levels of human error. Most of the accidents have been caused by level 1 human error such as decision errors, skill-based errors, perceptual errors, routine violations and exceptional violations. Specifically, there were more decision related errors involved in most of the accidents. According to Klein (1993), decision error is a decision made by a decision maker that is recognised to be erroneous and it can happen from insufficient decision maker experience, insufficient information or inadequate mental simulation. Lipshitz (1997) has defined decision error as a deviation from some standard decision process that increases the possibility of bad outcomes.

In this study, the common decision errors that have been found were wrong decision taken by the master or the crews during an emergency, in choosing a route or in planning. As mentioned by Klein (1993) insufficient experience and information and inadequate mental simulation are among the factors that lead to decision errors. Looking deeper into the context, the root cause of these factors is human error. In this perspective, the researcher had strongly believed that the human error was caused by lack of proper training. By acquiring proper training, which includes health and safety requirements, good communication skill for example standard language on board such as Maritime English is vital. This is because the message from a training is effectively delivered through good communication or an understandable language. Hence, with the sufficient knowledge obtained from the training could enable a person to think wisely to take the appropriate decision.

The second most accident contributing human error was from Level 2 set, comprising environmental factors. Here, it was the interesting to note that the occurrence of human error is more related to technology environment than to the natural physical environment. To be specific, technological environment is refers to design and automation issues which involve human issues;, the physical environment, on the other hand, refers to the operational setting (e.g., weather, altitude, terrain) and the ambient environment (e.g., heat, vibration, lighting, toxins) which are mainly unpredictable. Fundamentally, the introduction and development of technology and automation are believed to increase efficiency and safety (Ek *et al.*, 2014). However, in this case, technology does give negative results, as humans become very dependent on technology. Crew have been noted to have the confidence that the technology would handle everything. In addition, the development of technologies would cause confusion to operations, especially among the senior generation of seafarers. As a result, the dependency on technology could potentially lead to incompetent employees and that increases the likelihood of human error. To curb this issue, human friendly technologies that can be handled easily by all generation of seafarers should be developed, i.e.. systems which are not complicated and with easy instructions capable of being followed by seafarers from any generation. Training and safety talks are also essential to create awareness among seafarers about the unhealthy habit of being dependency on technologies.

The next most accident contribution human error was from Level 3 and followed by Level 4. The common human errors here, related to plan inappropriate operations (Level 3) and organisational process (Level 4). To be specific, plan inappropriate operation refers to operations that can be acceptable during emergencies, but unacceptable during normal operation such as risk management, crew pairing and operational tempo. The common aspect found in both type of errors was where significant decisions are essential in both operations and process. Based on the study, the researcher has found that lack of training, experience and ineffective implementation of standard safety regulations were the main reasons of the occurrence of human error from Level 3 and 4 respectively. This is because with proper training, experience or knowledge and implementation of regulations, an employee would be able to practice good risk assessment, adequate preparation for emergency, practice proper ship operation procedures and documentation and importantly, would understand and able to practice safety management system. Therefore, effective crew training should include tasks that require the employees to take relevant decisions in an emergency and any circumstances that would be essential to portray the real situation on a ship.

In general, the study on the maritime accidents based on HFACS classification system had been useful to achieve the first part of the first objective of the main study, which is to analyse the causes of human error.

As for the second part of the first objective, the rates of maritime accidents had been analysed based on ship accident statistics from 1999 to 2014 (Figure 9). Even though the statistics showed a decreasing trend, which was a positive progress, a sudden hike in the year between 2006 and 2007 has developed a question mark. According to European Maritime Safety Agency (EMSA, 2009), the reason for the hike in the number accidents was due to down in comparison to the market boom years of 2007/2008, although the number of accidents was still significantly higher in 2006. Another interesting fact from EMSA about the reason behind the significant fell of the number of accidents from late 2008 was due to global financial crisis and the associated slump in shipping requirements. This is because accident numbers often increase when the ships and seafarers are being worked harder particularly in the period from 2006 to 2007. Due to this, the ship activities have been reduced during the global financial crisis to avoid accidents and loss.

The identification of root causes of human error and the statistics of ship accident trend were crucial, as it has given an idea about the safety culture in the industry. Hence, it has boosted the researcher to study about the relationships of various safety practices that related to ship accidents. The discussion about the relationships among safety practice aspects are presented in the next sub-section.

7.2.2 Safety practice aspects and its influence on safety culture

7.2.2.1 Relationships among safety practice aspects

The discussion on this sub-section is on the second objective of the main study. As such, another significant finding of the main study is the identification of the relationships among nine safety practice aspects based on seafarer's perception. The relationships among the safety aspects were based on a dendrogram.In addition to the main analysis (Section 5.3.4), a comparison analysis was also performed separately for seafarers with above ten years of working experience (Figure 14) and below ten years of working experience (Figure 15).

Based on the findings, the pattern of relationships among the aspects are different between both the groups. However, the results of seafarers with working experience of less than 10 years are similar to the overall results (i.e. with both the groups – Section 5.3.4). This is because 82.9% of the respondents had less than 10 years of working experience. This shows that the perceptions of the seafarers with working experience of less than 10 years have influenced overall results. Therefore, in the remainder of this section, the discussion will be based on the perception of seafarers with more than 10 years of working experience to explore how a senior seafarer's perception varied from a junior's.

Based on the perception of the seafarers with more than 10 years of working experience, there is a close relationship between importance of maritime regulations and job satisfaction. To verify this result, the researcher has interviewed senior seafarers about the reason behind such result. Based on the interview, most of the seafarers believed that introduction and development of many regulations not only improved the safety but also deteriorate the safety. This is because, with the development of the regulations, the amount of paper work has increased which required the seafarers to spend more time and energy on paperwork. Perhaps, the increased workload can potentially diminish job satisfaction. The seafarers also highlighted that "*if your job is more challenging then you can achieve greater job satisfaction.*" Hence, this statement revealed the relationship between the two safety practice aspects that increased work or additional work would affect the work performance and develop boredom among the employees. Therefore, IMO should investigate the matter to come up with a solution or the companies should consider hiring a special task performer to handle all the paper work to ensure all the safety precautions were taken appropriately. This way can be efficient, as the employees do not have to perform multitask during a hectic schedule and this could prevent fatigue.

Seafarers with more than 10 years of working experience also believed that there is a close relationship between working environment satisfaction and health awareness. The seafarers claimed that in most cases, the employees work harder to meet target as result of commercial pressure or management pressure. The employees are also afraid that if they did not meet the target, it will affect their work promotion or reputation. Because of such working environment, the employees are often suffered from mental health issues such as stress, depression and fatigue. In a study by Messina (2018), the author has also found a similar responses from the seafarers that "*the biggest thing that causes stress is a poor working environment*." Besides commercial pressure or management pressure, other work environment factors such as conflicts with the management or colleagues (Spector *et al.*, 2007) and unfairness such as promotion or salary (Messina, 2018) could also affect the health. Apparently, such issues are the reflection of poor safety awareness in the industry. To develop a safer and healthier working environment, priorities and equalities should be given to employees rather than focusing on profit. The shipping companies should practice healthy discussion to clarify about any issues related to work and safety to enhance the safety and relationship between the employees and employers.

There is a close relationship between competency level and reporting culture based on the seafarer's perception. According to the seafarers, there is a lack of reporting culture on-board the ship although there is a requirement from the ISM Code to report every incident that takes place on-board (IMO, 2002). However, due to the lack of competency and because they are afraid of being penalised (i.e. blame culture), the seafarers often do not report any incidents. Hence, many of the underreported incidents were not investigated to identify the causes. Due to the incompetency's, the chances of occurrence of similar incidents increases leaving harmful consequences. One of the respondent has also mentioned that *"please report any incident that happen as only you can change the future of the next generation of seafarers."* This statement makes clear that accidents can be prevented by learning from past incidents as they can be used as a reference on what one should and should not do while on a voyage.

7.2.2.2 Safety practice aspects that associated with safety culture

The discussion in this sub-section is on the third objective of the main study. The researcher has identified aspects that associated with the occurrence of ship accidents. Out of the nine-safety practice aspects, three aspects have been to be statistically significant, which explain its influence on safety practice in the industry. The five safety practice aspects are reporting culture, communication and language barrier, health awareness and job satisfaction.

Communication and language barrier is found to have a significant connection with safety culture based on seafarer's perception. The seafarers highlighted that communication is a crucial tool for delivering a message appropriately to prevent any casualty or misunderstanding. According to one of the respondents, "*the greater the challenges in communication the greater the challenges in safety induction training and for intervening with colleagues who perhaps are seen to be exposed to risks in the work place".* In short, the better the communication the lesser the risk becomes. Communication problems often occur on-board a multinational crew ship due to the absence of a standard language. According to Evangelos (2002) who studied on language barriers and miscommunications as a cause of maritime accidents, has claimed that language and miscommunication is a serious threat. Evangelos has also stated that language barrier could lead to unwanted incidents such as problems on-board manoeuvring of the vessel under pilotage, external communication ship to ship and ship to shore, inability to read instructions, the cultural dimension and confusion during emergencies.

The critical part is safety is compromised when the involved personnel unable to communicate effectively with other colleagues or team. Communication has been recognised as critically important in the development and maintenance of high standards of safety on-board. In line with that, studies suggest that relevant steps should be taken for language development to lower the risks arise from communication. This includes having adequate levels of English prior to joining a vessel as English is one of the most widely spoken languages (Sampson and Zhao, 2003). Joe (2010) on the other hand, has argued that Maritime English is the only solution to the communication problems on-board even though some of the seafarers struggle to communicate in English. However, it can be overcome with only time and continuous commitment. In addition, shipping company's compliance with safety regulations by adopting the right method is one of the best ways to ensure less effect on safety by communication problems.

Health awareness is another important aspect of safety culture based on the seafarer's perception. The respondents have a perception that health awareness lacks among seafarers due to heavy workload, lack of enough sleep, alcohol intake, poor understanding of regulations and pressure from the management. They believe many health issues arise due to lack of health awareness and this problem should be a potential threat to safety. However, when looking deeper into the issue, the root causes of lack of health awareness is developed from ineffective implementation of safety regulations. When the researcher asked the respondents, what had causes the ineffective implementation of regulations and the answers was *"it is because the essence of the regulations was not delivered well during the training or possibly due to communication problem".* Based on the statement given by the respondents, it can be concluded that the ways of presenting and communicating are among the important ways towards effective implementation of safety regulation. Hence, with better understanding of regulations, one will be aware of the process, task and the risk associated with it.

In addition, self-awareness is important to be aware and caring about own health. Many seafarers undergoing psychological issues such as depression, anxiety, suicide and alcohol or drug dependence. This is not surprising as seafarers are among the occupational group at most risk for stress (Lipowski *et al.*, 2014) and adverse mental health issues (Jeżewska *et al.*, 2006). Therefore, every problems or issues at work must be treated seriously to curb health issues and improve work performance among seafarers.

Job satisfaction is viewed as an important factor of safety culture based on seafarer's perception. Many factors such as appreciation, rewards, pay increment, equal treatment and safe working environment have considerable impacts on job satisfaction. This is because the amount of stress associated with working on board a ship is worth to be rewarded and appreciated in relevant ways. The ability to motivate and retain seafarers is a critical manpower issue in view of the respondents. It is in the professionalism of the management to address this problem. An association between job satisfaction and turnover intentions of seafarers is empirically supported. For example, the respondents believed, they get motivated to work better whenever their work and effort are recognised. Every time they have been appreciated they feel less isolated and happier. Therefore, the welfare and well-being of seafarers must be well taken care for better safety culture.

7.2.2.3 Improved strategies to reduce the impact and the occurrence of human error

The discussion in this subsection is on the fourth objective. Human error and its consequences are one of the main concerns in the shipping sector. The occurrence of human error is constant regardless of development of maritime regulations or technologies. Based on the interview conducted among the shipping company managers and senior seafarers, the researcher has identified several important elements that can be used as a strategy to reduce or prevent the occurrence of human error and its impact. The identified elements are human technology friendly, standardised requirements, employ competent individuals and rewards/appreciation.

Based on the respondent's perception, technology is a powerful tool that eases the seafarer's workload and reduces human error only if it is utilised well. They have also claimed that the shipping companies should focus more from the technology perspective by developing efficient and human-technology friendly interference. The main aim of the technology usage should be to take the risk from the seafarers. This is because human can make mistake or unable to detect faults or danger ahead. However, technology can also be inefficient if it is not well maintained or structured in a way that it is difficult to operate. It will be ideal to develop technologies that easy to be operated by seafarers from all generation and importantly, regular monitoring by the management and maintenance are essential to increase the optimum usage of the technologies and lead to sustainable maritime transportation. According to Akyuz and Celik (2014), to develop a sustainable maritime transportation, established safe, secure and environmentally friendly organisations are required, where, advanced operational technologies and modern management styles are integrated in the relevant stakeholders. In addition to that, the IMO has developed a concept of a sustainable maritime transportation system which focuses on several issues includes safety culture (IMO, 2013a). Without any doubt, efficient technology is one of the important element of safety culture that is useful to reduce the impact and occurrence of human error. Therefore, future investments in human technology friendly ship will not be a waste as it can save the stakeholders from loss due to the impact of human error and thus, lead to an excellent mode of transportation.

Standardised requirement is another element that is potential to reduce or prevent the occurrence of human error based on the respondent's perception. The respondents believe that standardised requirement for example rules, language, training or equipment can prevent confusion among seafarers, as they do not stay in a ship constantly. Frequent change of work environment (ship) with unstandardized requirement, can take long time for the seafarers to adapt and learn all the things that are different from their previous work place. As such, having a standardised language for example Maritime English, especially on-board of multinational crew ship, could prevent miscommunications and ensure efficient communication at sea (Pritchard, 2001). In fact, in 2005, the IMO has reported that the major cause of accidents was human error and one of the main root causes is poor standards of Maritime English (Ziarati, 2006). Therefore, IMO and shipping companies should enforce mandatory standard requirement to all ships to improve safety and reduce human error.

Competency with compliance with the regulation is an important criterion for a seafarer to work on-board based on the respondents' perception. This ensure that the seafarer is seaworthy to work on-board a ship with all the required knowledge. The regulations on international training standards for officers has been introduced by the IMO through its International Convention on Standards of Training Certification and Watchkeeping (STCW) (2010). The convention required several issues related to competency such as improved measure to prevent fraudulent practices associated with certificates of competency, hours of work, prevention of drug and alcohol abuse, new requirement for trainings etc. (STCW, 2010). However, many problems arise due to incompetency issues among seafarers as some of the Maritime Education and Training Institutions (METS) fail to train the seafarers appropriately (Bloor *et al.*, 2014). As the demand of seafarers increases from the new labour supply countries, the incompetency issues have become the main concern led the IMO to require its member states to audit the quality of the training in their local METs through White List system in 2003 (IMO, 2003). After the audit, some institutions have been closed due to poor training but, overall, the quality of the trainings provided by the METs have been improved (Sampson, 2004). Even though, competency to work on-board a ship is necessary, it has always been neglected due to examiner corruptions, large number of examinees and limited resources of examiner (Bloor *et al.*, 2014). In fact, the White List system is a good start to abolish the problem and all the METs should provide trainings that complied with regulations. Moreover, companies should hire employees that have received trainings from METs in those member states of White List to get competent seafarers.

Recognition in a form of reward or appreciation is an element that can reduce human error based on the respondents. One of the respondents has said *"appropriate rewards are good to encourage employees to work safe and satisfied"*. They strongly believe that rewards or appreciation should be given upon any achievements or proper practice of regulations, as it will encourage the employees to perform better. The respondents have also emphasised that, if the employees are not recognised appropriately, they will get demotivated to perform well as there is no effect on their career. According to Manuel (2011) and Xhelilaj and Lapa (2010), unfair treatment which includes poor recognition, will potentially lead to fatigue which is one of the main factor of human error. Xhelilaj and Lapa (2010) have stressed that fatigue can reduces motivation at work leading to seafarer's poor performance at work. Based on their arguments, rewards or appreciation is vital and unfair treatment is one of the root causes of human error. If the relevant stakeholders identify the root causes and take initiative to sort the problem out, human error can be prevented or reduced.

7.3 Contribution of this research

7.3.1 Root causes of shipping accidents

One of the contributions of this study is the identification of the root causes of human error, which are the main causes of shipping accidents. Figures 19 and 20 visualise the different levels of human error and root causes of human error with percentage. These figures were tabulated based on shipping accidents reports from MAIB.

Based on Figure 19, human error from Level 1 was identified as the most accident contributing factor. The common root causes of human error from Level 1 are distributed on Figure 20. In general, the main root causes of human error from Level 1 are wrong decisions that were made during emergency, poor navigational practices, poor seamanship skills and lack of training. The results obtained here are consistent with the results obtained from the semi-structured interview.

In general, the officers or masters made most of the wrong decisions during emergency or distressed moments. The reasons for this are mainly due to insufficient action and information and commercial pressure. The respondents from the semi-structured interview (refer to Figure 16 in Chapter 6) have highlighted commercial pressure as one of the main causes of human error. The stakeholders/company should have more concern about the safety and health of their employees rather than profit. For example, the employees should be given sufficient time to complete their task without time pressure or an extension of time (with acceptable reasons). This will ensure the return of profit and the safety of the employees. The respondents have also highlighted poor navigational practices, poor seamanship skills and lack of training as among the main threats to safety and causes of human error. The basic reason of such results is lack of awareness towards acquiring sufficient knowledge or training upon going on-board a ship. This issue can be prevented from the beginning by the shipping companies by hiring competent employees and provides sufficient training.

Based on Figure 20, the root causes of human from Level 2 are mainly alcohol consumption, natural calamities, poor ship maintenance, inadequate rest/fatigue, lack of briefings or communication and poor planning. Identification of these root cause are important to reduce its impact or prevent its occurrence, as human error from Level is second highest most accident-contributed factors. Natural calamities or the weather are unpredictable. However, seafarer's readiness or preparedness towards dangerous climates are important. Seafarers therefore should always be alert and aware of their surrounding and climates to prevent any casualties. On the other side, the higher officers and management should be responsible to ensure that ship maintenance tasks are being carried out regularly. They also should ensure that their employees or the seafarers getting adequate resting and working hours as over working can be a threat to the safety according to the respondents in this study. Regular monitoring and training from the shipping companies could also enhance the communication and prepare the seafarers to develop strategic planning for any passage or task.

Besides that, based on Figure 20, the common root causes of human error from Level 3 are poor compliance of regulations, falsified documents/records of working and resting hours, and poor risk assessment practice. These root causes should be a serious threat for the stakeholders as regulations are the basic requirement to practice safety. One should be aware that falsifying documents and irregular or poor risk assessment are against the regulations as it could lead to serious consequences. The shipping companies should practice effective implementation of regulations to ensure the essence of the regulations are well delivered to the seafarers.

Based on Figure 20, the root causes of human error from Level 4 are management pressure, time pressure, lack of suitable facilities/equipment and poor design. In this matter related to management pressure and time pressure, the shipping companies should aware that safety is more important than profit. Pressure will only increase the risk of accidents and loses than profit. Sufficient amount of time and encouragements will increase the work quality and enhances the safety. Besides that, based on the accident reports, the common types of problems related to lack of facilities and poor design are poor design of engine room, poor storage for chemicals, and not equipped with a fixed fire-fighting system. These problems should be addressed appropriately from the initial stage of shipbuilding. This is clearly seen as human error as the design of the ship has been neglected and hence, led to unsafe or incompatible work environment.

The identification of the root causes of human error is an initiative to prevent its occurrences and to reduce its impact. This could help the stakeholders or researchers to find a solution to tackle the problems from the very beginning and the researcher strongly believes that the root causes found as one of the significant contributions of this study.

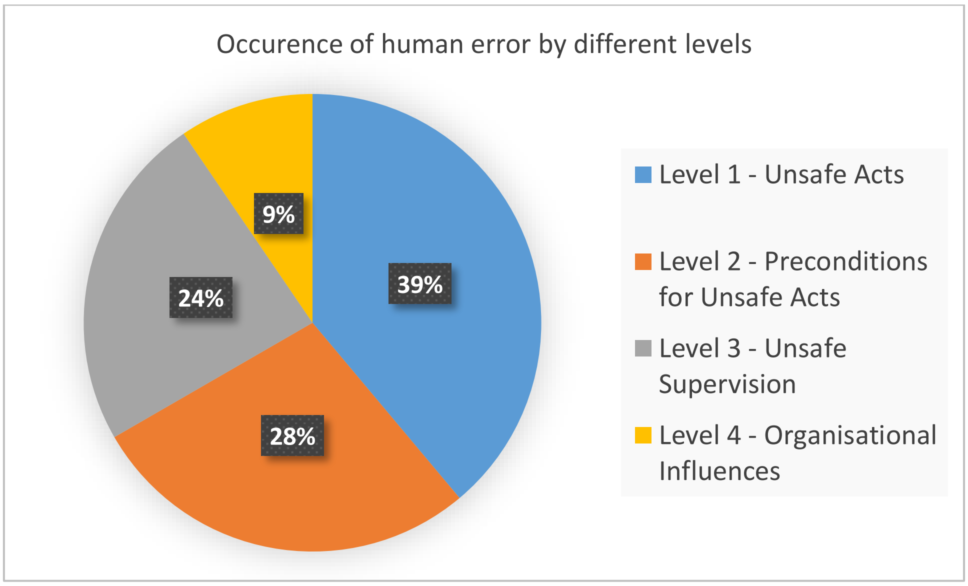

Figure 19 Occurrence of human error by different levels

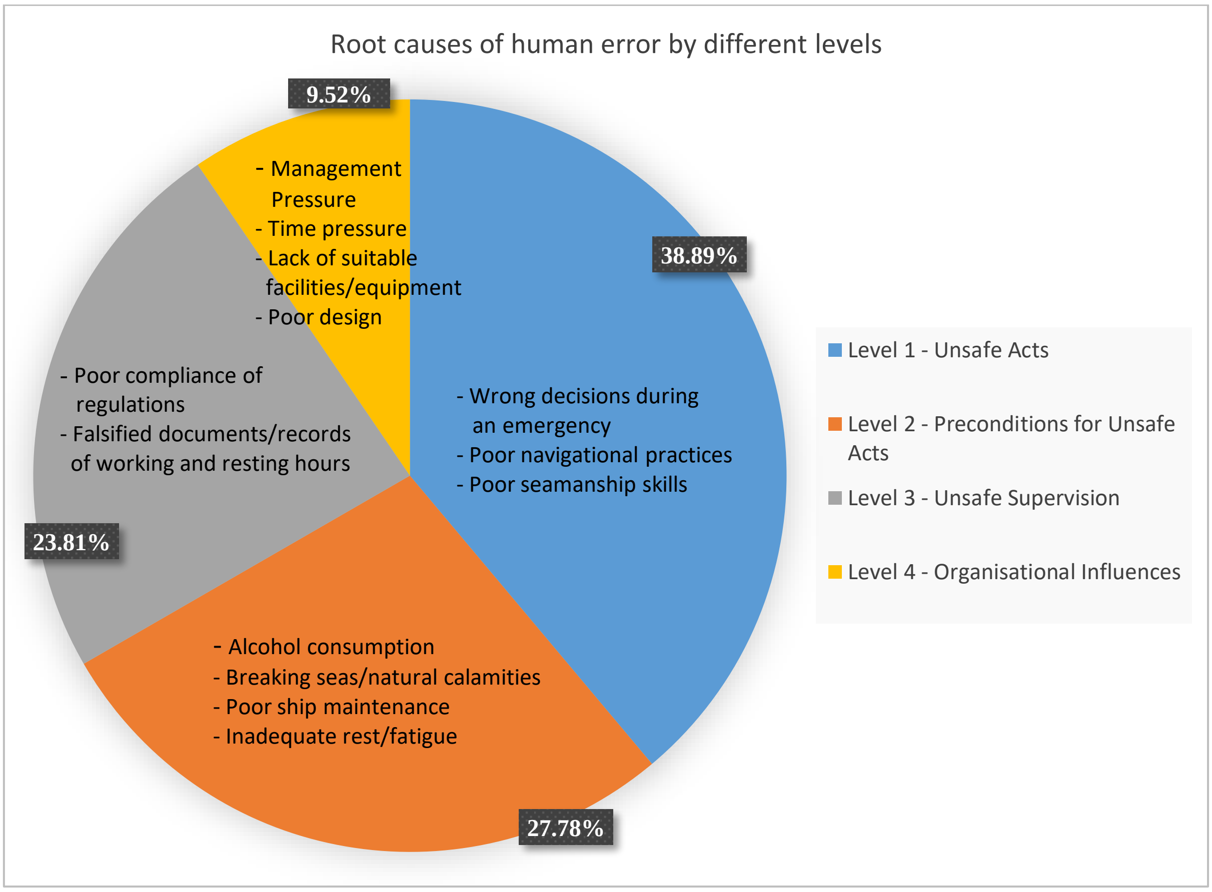

Figure 20 Root causes of human error by different levels

7.3.2 Important aspects of safety practices

Initially, nine safety practice aspects were used in this study to analyse its relationship with the safety culture aspect of the maritime industry. Based on the respondents (seafarers) perception and Multiple Linear Regression analysis, three safety aspects were identified to have close relationship with safety culture and they are presented on Figure 21. The three aspects are communication and language barrier, health awareness and job satisfaction (in the boxes). All the three safety practice aspects are equally important to enhance the safety culture. The identification of these three safety practice aspects is a significant contribution of this study. The researcher strongly believes, by highlighting the important aspects of safety practices, it will benefit the stakeholders to give priorities to these aspects. Besides that, it also will be crucial for other researchers to explore further into these aspects towards better safety culture.

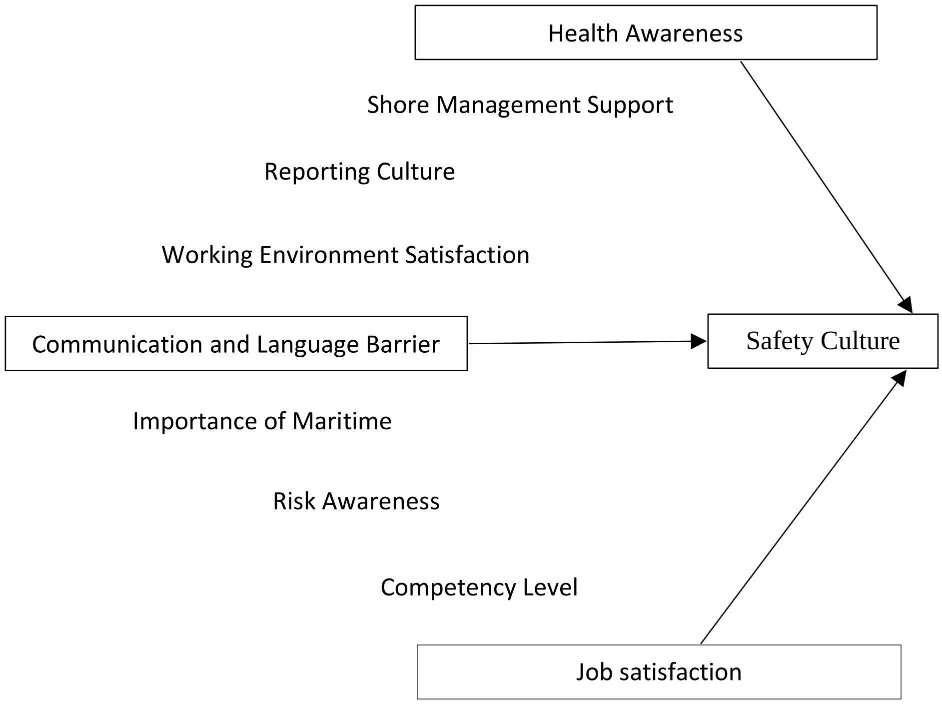

Figure 21 Important aspects of safety practices

7.3.3 Best practices towards safer shipping industry

A third significant contribution of this study is the identification of thirteen best practices aspects towards safer shipping industry. The thirteen best practice aspects are illustrated in Figure 22. These aspects were identified best based on the perception of the experienced shipping personnel as an outcome from the interview survey. These were the aspects that the shipping personnel believes would enhance the safety of the shipping industry if they were practiced right. All the aspects were discussed in Chapter 6 and chapter 7. The researcher strongly believes these aspects would potentially lead towards safer shipping industry if the stakeholders give priorities on these aspects appropriately.

Safer Shipping Industry

- Rewards/appreciation
- Effective training
- Regular inspection
- Simplifying the regulation
- Employ competent individuals
- Standardised requirements
- Human technology friendly
- Comply/practice the regulations
- Educate younger generations
- Practice learning from incidents
- Effective leadership
- High aims (Zero Accident)
- Financial assistance for safety improvements

Figure 22 Thirteen best practices towards safer shipping industry

CHAPTER 8 CONCLUSIONS

8.1 Introduction

This chapter highlights the novelty of the study towards improvising the safety practices in maritime industry. It has also acknowledged some of the limitations encountered through the research process. Finally, further research has also been suggested for a better understanding of the subject and for the benefits of the industry.

Many regulations have been introduced by the IMO to improve the safety and reduce the shipping accidents. However, the number of accidents that took place every year and the consequences has emerged the researcher to explore further into the subject through three research questions.

The first research question was “to what extent does the human element affect the safety of ship?” This question was addressed through the first objective of the study, which is “to analyse the causes of human error and the rates of maritime accidents”. This objective was achieved by applying statistics analysis by using shipping accident data from Global Integrated Shipping Information System (GISIS). The data was useful for the analysis to identify the accident trend. However, more detail information was required to identify the root causes of the accident. As a result, Human Factors Analysis and Classification System (HFACS) analysis has been applied using the data from Marine Accident Investigation Branch (MAIB). This analysis was effective to identify the root causes of the accidents to find a preventive measure to reduce human error.

The second research question was “what is the relationship among safety practice aspects in shipping industry”. This question was addressed through the second and third objectives of the study, which are “to study and identify the relationships seafarers perceive to exist among various safety parameters on-board ships” and “to identify the safety aspects the shipping personnel believes contribute most towards an improved-on board safety culture”. These objectives were achieved through several analyses using the data obtained from a questionnaire-based survey, which was conducted among shipping personnel. Factor analysis, Cluster analysis and Multiple Linear Regression analysis were used to analyse the data, as these analyses were appropriate to visualise the relationship among various safety aspects and to identify the aspects that contribute towards an improved safety culture.

The third research question was “how human errors and its impact can be prevented?” This question was addressed through the fourth or the last objective, which is “to recommend methods to reduce the impact of human errors that could be used as a reference for decision makers in international shipping companies to augment their information on policy and management". The objective was achieved by using the data collected from a semi-structured interview, which was conducted among senior shipping personnel. This method was beneficial to gain information to prevent human error from the perspective of the shipping personnel, as they are very informative and experienced. Based on their point of view, several methods have been drawn to prevent human error and its impact.

In general, all the methods and the analyses that have been used in this study were helpful and appropriate to achieve the objectives and thus, have generated several contributions to the maritime industry.

8.2 Novelty of the study

1. The combination of methodologies/analysis used.
    - I have used mixed mode methodology with various techniques.
    - For example: Hierarchical cluster analysis (questionnaire survey) has been implied and further explore the results with a qualitative analysis to identify safety aspect themes (semi-structured interview).

2. Identification of three best safety practice aspects that influences safety culture from quantitative analysis:
    - Communication and language barrier
    - Health awareness
    - Job satisfaction

3. Identification of six safety aspect themes (where the data has been analysed based on 10 safety aspects) that must be focused to improve safety culture from qualitative analysis.
    - Competency level
    - Health awareness
    - Shore management support
    - Risk awareness
    - Working environment satisfaction
    - Importance of maritime regulations

8.3 Limitations and further research

8.3.1 Limitations of this study

It is necessary to acknowledge that the study came across several limitations. The researcher has found that approaching a large number of respondents (327 includes both questionnaire survey and interview) is the main limitation of the study. The main respondents of the study are seafarers followed by shipping company managers. The researcher has conducted two surveys, which are question-based survey and interview-based survey. For the questionnaire-based survey, it took two months to reach the respondents, where, all of them were seafarers. Meanwhile, for the interview, it took six months to reach the respondents, where, they were a group of seafarers and managers. The delay was longer than what was expected. The main factor of the delay was the hectic work schedule of the respondents, especially the seafarers as they were at sea at the time. This issue was unavoidable as the availability of the respondents cannot be predicted or force them to take part in the survey. Therefore, all researchers should always start a survey earlier as possible to avoid very long delays that might affect their deadline or funding.

The next limitation of the study is the knowledge on the approach and tools used in the methodologies. In the case of limited knowledge about a tool, that will be used in the research, it is essential to take short courses to enhance the understanding. Besides that, the researcher can also start using the tools with a sample data to familiarise with the process and application. Pre-understanding about the method and its application prior to the research can be timesaving. In this case, the researcher has trained himself in designing and conducting questionnaires and interviews, undertaking quality controls, risk assessment, statistically analyse the large dataset, interpret and put them in a theoretical framework. The researcher has made all of these possible by acquiring the knowledge through reading, short courses and discussions with the experts in the related field.

Another limitation is the availability of the secondary data. In this study, the researcher has applied the ship accident statistics from the year 1999 to 2014 to identify the accident trend for that period. Then, the researcher has planned to study the accident reports based on HFACS analysis for the accidents that happened in the same period. However, due to unavailability of several accident reports, the researcher has used accident reports from the year 2000 to 2016. The reason for the unavailability of the reports was due to poor online system at the time or maybe it was not updated to the authority. Therefore, it is necessary to keep updated all the reports online for seafarers to learn from past incidents and researchers to study about the causes of the accidents for future research and improvisations.

8.3.2 Further research

The seafarers and the shipping company managers in this study voiced their concern over the implementation, daily workload and the consequences of the safety regulations. Meanwhile, this study examines the relationships among safety practice aspects and the root causes of human error. Therefore, in near future, further in-depth interview among the shipping personnel will be vital to examine the impacts and the implementation of safety regulations. Further research can also focus on attaining maximum advantage from safety regulations without increasing the workload. It also should examine how each company implement the safety regulations, so that, improvisation can be made if there is any problem.

It is also important to explore the reasons behind the IMO's intention to introduce such regulations that require the seafarers to do more paperwork. In addition to the in-depth interview, a special research task needs to be developed to identify the IMO's stance on this issue. This is because, identifying the root causes is always best to solve an issue. This research is potential to contribute further to improve the safety quality of maritime industry.

Appendix A Semi-structured interview questionnaire (Shipping company managers)

A. Background

1. Can you briefly give an introduction about yourself? For example your age, where you come from etc.

2. How long have you been in the industry?

3. What is the official title of your job and how long have you been working in this position?

4. Do you have sailing experience? If yes, how long and why did you left the job?

5. How many employees are you responsible for? Can you explain about the challenges dealing with this number of employees?

6. How many ships do you manage?

B. Company Safety Culture Facts

7. What do you think about safety culture in shipping sector? Do you think it is very good, improving or very poor? Can you give reason to your answer?

8. How would you rate the safety culture of your company? Do you think it is very good, improving or very poor?
   a. Why?
   b. Are there any features of your company that makes it safe?
   c. Are there any feature of your company that makes it unsafe?
9. What is the main threat to safety in the shipping sector? Do you think it causes shipping accidents?

10. How would you rate human errors in your company? I mean how often you encounter human error.

11. In the last one year, have you had any incidents related to human errors?
    a. What types were they?
    b. How did they happen?
    c. How could you prevent these in the future?

12. Why do you think human error is still occurring despite maritime regulations and Safety Management System (SMS)? This is because based on my reading, the number of accidents is huge and its impact is serious for example loss of life and properties and marine environment pollution.

13. How would you rate your company's SMS? I mean how well you are practising it in your company. Also,
    a. Do you well understand SMS?
    b. Do you think it is effective in enhancing safety?
    c. How is the company implementing SMS?

14. What safety training do you provide to sea staff?
    a. Is this effective? I mean is this effective to their awareness and responsibilities towards safety?

C. Opinions on results from safety culture survey

15. Among the following safety aspects, which factors are important to safety culture and why? So, these are the safety aspects that I have used in my survey.

Safety aspects		Rank (1-9)
a	Working environment satisfaction	
b	Communication and language barriers	
c	Health awareness	
d	Importance of maritime regulations	
e	Reporting culture	
f	Competency level	
g	Risk awareness	
h	Shore management support	
i	Job satisfaction	

16. How maritime regulations be utilised to improve safety culture and reduce human error?

17. Based on your experience, how can safety culture be improved and promoted? So, if you have given a chance, what strategy would you recommend?

18. Based on your experience, how can human error and its impact be reduced? So, if you have given a chance, what strategy would you recommend?

19. Finally, would you like to add anything more?

Thank you very much for your cooperation. It will definitely be useful for my research and I really appreciate that. Have a nice day!

Appendix B Semi-structured interview questionnaire (Seafarers)

A. Background

1. Can you briefly give an introduction about yourself? For example, your position, age, where you come from etc.

2. How long have you been at sea?

3. How long have you been employed by this company?

4. How long have you been employed by this company?

B. Company/Ship Safety Culture Facts:

5. Is this ship safe? If yes, why? And if no, why?

6. How would you rate the safety culture of your company? Do you think it is very good, improving or very poor?
   d. Why?
   e. Are there any features of your company that makes it safe?
   f. Are there any feature of your company that makes it unsafe?

7. What is the main threat to safety in your ship? Do you think it may cause lead to casualties?

8. How would you rate human errors in your company? I mean how often you encounter human error.

9. In the last one year, have you had any incidents related to human errors?
   d. What types were they?
   e. How did they happen?
   f. How could you prevent these in the future?

10. How could you make this ship safer? I mean is it by training, self-awareness, continuous support from the management etc.?

11. Why do you think human error is still occurring despite maritime regulations and Safety Management System (SMS)? This is because based on my reading, the number of accidents is huge and its impact is serious for example loss of life and properties and marine environment pollution.

12. How would you rate your company's SMS? I mean how well you are practicing it in your company. Also,

d. Do you well understand SMS?
e. Do you think it is effective in enhancing safety?
f. How is the company implementing SMS?

13. How well is the practice of SMS on this ship?
    a. Is this effective?

14. What safety training do you provide to sea staff?
    b. Is this effective? I mean is this effective to their awareness and responsibilities towards safety?

15. Does the management provide you with any assistance on safety matters?
    a. How?

16. Does the management give importance to safety problems raised by the ship personnel?

C. Opinions on results from safety culture survey

17. Among the following safety aspects, which factors are important to safety culture and why? So, these are the safety aspects that I have used in my survey.

	Safety aspects	**Rank (1-9)**
a	Working environment satisfaction	
b	Communication and language barriers	
c	Health awareness	
d	Importance of maritime regulations	
e	Reporting culture	
f	Competency level	
g	Risk awareness	
h	Shore management support	
i	Job satisfaction	

18. How maritime regulations be utilised to improve safety culture and reduce human error?

19. Based on your experience, how can safety culture be improved and promoted? So, if you have given a chance, what strategy would you recommend?

20. Based on your experience, how can human error and its impact be reduced? So, if you have given a chance, what strategy would you recommend?

21. Finally, would you like to add anything more?

Thank you very much for your cooperation. It will definitely be useful for my research and I really appreciate that. Have a nice day!

Appendix C Semi-structured interview script (Shipping company managers)

Introduction

Hello. I am Gobi, a final year PhD student. My research is in maritime safety, where I am looking into safety culture in the shipping sector and mainly focusing on human error. Previously, I have studied about the shipping accidents for example types and causes of accidents and prevention methods recommended by the maritime authorities. I have also conducted a safety culture survey via questionnaires to identify the relationships among various safety aspects and its impact towards safety culture. Therefore, now I am conducting this survey to follow up and explore further my findings based on your opinions and experiences. I am confident that your feedback will be very useful for my study in order to draw strategies to improve the safety and reduce the human error.

In this survey, there will be 19 questions split into three parts namely: individuals background facts, company safety culture facts and opinions on results from safety culture survey. The survey will require approximately 30 minutes. There is no compensation for responding to this nor is there any known risk. The information from this survey will be used for research purposes only and your identity will not be divulged.

Individual Background Facts:

We shall begin. The first question is:

1. Can you briefly give an introduction about yourself? For example your name, age, where you come from etc.

Second question:

2. How long have you been in the industry?

Third question:

3. What is the official title of your job and how long have you been working in this position?

Next:

4. Do you have sailing experience? If yes, how long and why did you left the job?

Next:

5. How many employees are you responsible for? Can you explain about the challenges dealing with this number of employees?

Next:

6. How many ships do you manage?

Thank you and now we will move on to the second part of the interview. In this part the questions will be about your company's safety culture and Safety Management System (SMS).

Company Safety Culture Facts:

The first question of this part is:

7. What do you think about safety culture in shipping sector? Do you think it is very good, improving or very poor? Can you give reason to your answer?

Next:

8. How would you rate the safety culture of your company? Do you think it is very good, improving or very poor?
   g. Why?
   h. Are there any features of your company that makes it safe?
   i. Are there any feature of your company that makes it unsafe?

Next:

9. What is the main threat to safety in the shipping sector? Do you think it causes shipping accidents?

Next:

10. How would you rate human errors in your company? I mean how often you encounter human error.

Next:

11. In the last one year, have you had any incidents related to human errors?
    g. What types were they?
    h. How did they happen?
    i. How could you prevent these in the future?

Next:

12. Why do you think human error is still occurring despite maritime regulations and Safety Management System (SMS)? This is because based on my reading, the number of accidents is huge and its impact is serious for example loss of life and properties and marine environment pollution.

Next:

13. How would you rate your company's SMS? I mean how well you are practising it in your company. Also,
    g. Do you well understand SMS?
    h. Do you think it is effective in enhancing safety?
    i. How is the company implementing SMS?

Next:

14. What safety training do you provide to sea staff?
    c. Is this effective? I mean is this effective to their awareness and responsibilities towards safety?

Thank you. Now we are in the last part of the interview. In this part the questions will be based on the findings of my safety culture survey via questionnaires. The main reason of this particular part is to verify and clear residual doubts on the findings.

Opinions on results from safety culture survey

The first question of this part is:

15. Among the following safety aspects, which factors are important to safety culture and why? So, these are the safety aspects that I have used in my survey.

Safety aspects	
a	Working environment satisfaction
b	Communication and language barriers
c	Health awareness
d	Importance of maritime regulations
e	Reporting culture
f	Competency level
g	Risk awareness
h	Shore management support
i	Job satisfaction

Next:

16. How maritime regulations be utilised to improve safety culture and reduce human error?

Next:

17. Based on your experience, how can safety culture be improved and promoted? So, if you have given a chance, what strategy would you recommend?

Next:

18. Based on your experience, how can human error and its impact be reduced? So, if you have given a chance, what strategy would you recommend?

And,

19. Finally, would you like to add anything more?

Well, that is the end of the interview session. Thank you very much for your cooperation and honest opinions. It will definitely be useful for my research and I really appreciate that. Have a nice day!

Appendix D Semi-structured interview script (Seafarers)

Introduction

Hello. I am Gobi, a final year PhD student. My research is in maritime safety, where I am looking into safety culture in the shipping sector and mainly focusing on human error. Previously, I have studied about the shipping accidents for example types and causes of accidents and prevention methods recommended by the maritime authorities. I have also conducted a safety culture survey via questionnaires to identify the relationships among various safety aspects and its impact towards safety culture. Therefore, now I am conducting this interview to follow up and verify my findings based on your opinions and experiences. I am confident that your feedback will be very useful for my study in order to draw strategies to improve the safety and reduce the human error.

In this interview, there will be 21 questions split into three parts namely: individuals background facts, company safety culture facts and opinions on results from safety culture survey. The interview will require approximately 30 minutes. There is no compensation for responding to this nor is there any known risk. I will be recording our conversation and will take notes during this interview. The information for this interview will be used for research purposes only and your identity will not be divulged.

Individual Background Facts:

We shall begin the interview. The first question is:

1. Can you briefly give an introduction about yourself? For example your name, age, where you come from etc.

Second question:

2. How long have you been at sea?

Third question:

3. For how long have you been sailing on this ship?

Next:

4. How long have you been employed by this company?

Thank you and now we will move on to the second part of the interview. In this part the questions will be about your company's safety culture and Safety Management System (SMS).

Company/Ship Safety Culture Facts:

The first question of this part is:

5. Is this ship safe? If yes, why? And if no, why?

Next:

6. How would you rate the safety culture of your company? Do you think it is very good, improving or very poor?
   j. Why?
   k. Are there any features of your company that makes it safe?
   l. Are there any feature of your company that makes it unsafe?

Next:

7. What is the main threat to safety in your ship? Do you think it may cause lead to casualties?

Next:

8. How would you rate human errors in your ship? I mean how often you encounter human error.

Next:

9. In the last one year, have you had any incidents related to human errors?
   j. What types were they?
   k. How did they happen?
   l. How could you prevent these in the future?

Next:

10. How could you make this ship safer? I mean is it by training, self-awareness, continuous support from the management etc.?

Next:

11. Why do you think human error is still occurring despite maritime regulations and Safety Management System (SMS)? This is because based on my reading, the number of accidents is huge and its impact is serious for example loss of life and properties and marine environment pollution.

Next:

12. How would you rate your company's SMS? I mean how well you are practising it in your company. Also,
    j. Do you well understand SMS?
    k. Do you think it is effective in enhancing safety?
    l. How is the company implementing SMS?

Next:

13. How well is the practice of SMS on this ship?
    a. Is this effective?

Next:

14. What safety training do you provide to sea staff?
    d. Is this effective? I mean is this effective to their awareness and responsibilities towards safety?

Next:

15. Does the management provide you with any assistance on safety matters?
    b. How?

Next:

16. Does the management give importance to safety problems raised by the ship personnel?

Thank you. Now we are in the last part of the interview. In this part the questions will be based on the findings of my safety culture survey via questionnaires. The main reason of this particular part is to verify and clear residual doubts on the findings.

Opinions on results from safety culture survey

The first question of this part is:

17. Among the following safety aspects, which factors are important to safety culture and why? Therefore, these are the safety aspects that I have used in my survey.

Safety aspects	
a	Working environment satisfaction
b	Communication and language barriers
c	Health awareness
d	Importance of maritime regulations
e	Reporting culture
f	Competency level
g	Risk awareness
h	Shore management support
i	Job satisfaction

Next:

18. How maritime regulations be utilised to improve safety culture and reduce human error?

Next:

19. Based on your experience, how can safety culture be improved and promoted? So, if you have given a chance, what strategy would you recommend?

Next:

20. Based on your experience, how can human error and its impact be reduced? So, if you have given a chance, what strategy would you recommend?

And,

21. Finally, would you like to add anything more?

Well, that is the end of the interview session. Thank you very much for your cooperation and honest opinions. It will definitely be useful for my research and I really appreciate that. Have a nice day!

Appendix E Consent letter (Interview)

To whom it may concern,

Subject: Permission to conduct interviews

Dear Sir,

I am a PhD student in the University of Southampton, undertaking research, on 'Decision making procedures on a vessel's shipboard management' with special reference to safety culture, shipping accidents and human error. My study requires the participation of shipping company managers and senior officers (seafarers). One element of my research involves a series of confidential interviews/written questionnaire survey focussed on the elements of safety culture.

Enclosed with this letter is a list questions that related to safety culture. The survey will require approximately 30 minutes. There is no compensation for responding to this nor is there any known risk. The information from this survey will be used for research purposes only and your identity will not be divulged.

I appreciate that you are extremely busy and I would be very grateful if you could spare some time for the survey. I eagerly await your kind response. Thank you.

Yours faithfully,

Gobikrishnan Veluplay
PhD Student
Faculty of Engineering and the Environment
University of Southampton

Email: gkv1m14@soton.ac.uk
Hp: +44 7835072414

Appendix F Participant Information Sheet (PIS) (Interview)

Participant Information Sheet

Study Title: Safety Culture Semi-Structured Interview

Researcher: Gobikrishnan Veluplay

ERGO number: 40018

Please read this information carefully before deciding to take part in this research. It is up to you to decide whether or not to take part. If you are happy to participate you will be asked to sign a consent form.

What is the research about?

This research is conducted for the purpose of fulfilment of my PhD. Through this study the researcher is intended to explore more about the approaches to improve safety and reduce human error. Moreover, this survey will be a great platform to verify the findings of a safety culture survey (questionnaire) that the researcher has conducted to identify the relationship among various safety aspects. This survey is funded by the Malaysia Government.

Aims: To understand and draw strategies to reduce the risk of human errors and enhance safety in the shipping sector. To verify the findings of a safety culture survey (questionnaire) that the researcher has conducted earlier.

Objective: To develop and implement effective strategies to overcome the risk of human errors.

Why have I been asked to participate?

The focus group for this survey is the individual within the shipping company such as managers and seafarers.

What will happen to me if I take part?

The researcher will conduct a survey based on several semi-structured questions/written questionnaire. During the survey, the researcher will take down notes and will record the interview (optional and only with the participant's consent). The survey will require approximately 30 minutes. Each participants will only take part once in this survey and there will no further follow up.

Are there any benefits in my taking part?

There is no compensation or any other benefits for responding. However, the knowledge that the respondent willing to share will help the researcher to explore the safety culture in the shipping industry and draw strategies to improve safety.

Are there any risks involved?

There are no risks involved.

Will my participation be confidential?

The participant's information will only be with the researcher and the data and findings from the survey will be used for research purposes only. Moreover, the data and findings will be completely confidential: names of personnel, companies and ships will not be identified in the thesis or in any future publication.

What should I do if I want to take part?

Reply to the researcher by email to confirm your participation.

What happens if I change my mind?

The participants can withdraw at any time.

What will happen to the results of the research?

The project will be written up in the researcher’s PhD thesis and will be published in relevant journal. The participants will not get a copy of the results; however, they may require for it or get access through the institutional repository. The research data will not be available for future projects and it’s entirely for my current PhD project. The research data will be stored for a minimum of 10 years, as per University of Southampton policy. After completing the PhD, the data will not be used anymore and will be disposed. Staff and postgraduate students should remember that publications and anonymised data relating to the research should be made available through the institutional repository.

Where can I get more information?

Project supervisor - Professor R Ajit Shenoi (02380592356, R.A.Shenoi@soton.ac.uk)

What happens if something goes wrong?

You may contact the following person if you have any problem regarding the survey. Research Governance Manager (02380 595058, rgoinfo@soton.ac.uk).

Thank you.

Thank you for taking your time to read the information and considering to take part in the research.

Appendix G Likert Scale Questionnaire (English)

Shipboard Safety Culture Questionnaire

The purpose of this survey is to identify the level of safety culture in shipping companies in order to improve the efficiency and safety levels. The findings of this survey will form one source of evidence from which to analyse and draw inferences.

This questionnaire asks about your experience on the safety culture in your company and the working environment. ***Do NOT*** *write your name or your company's name on this questionnaire. Your responses will be anonymous and will never be linked to you personally. If there are items you do not feel comfortable in answering then please skip them. Thank you for your cooperation.*

Completion of this questionnaire infers consent for participation in this study.

Please **tick (/)** in the box to indicate the extent to which you agree with the following statement regarding safety culture on-board.

1.	**Background Information**										
A	Gender	Female		Male							
B	Age	< 31		31 – 40		41 - 50		51 – 60		>60	
E	Working experience	0-2 years		3-5 years		6-10		11-20		>20	

2.	**Working Environment Satisfaction**						
	Only select one answer per question	Don't Know 0	Strongly disagree, 1	Disagree 2	Not sure 3	Agree 4	Strongly agree 5
A	The working environment on-board is very friendly.						
B	The working environment is organized.						
C	I feel safe working here.						
D	Working procedures are clear and well written.						
E	My work is appreciated by the company.						
Comments/suggestions:							

3.	**Reporting Culture**						
	Only select one answer per question	Don't Know 0	Strongly disagree, 1	Disagree 2	Not sure 3	Agree 4	Strongly agree 5
A	I report every incident.						
B	I report near miss incidents.						
C	I report if I get injured while doing job.						
D	Reports are always taken seriously.						
E	I report if I accidentally damage equipment on-board.						
F	Previous reports are useful for up-coming voyages.						
G	I learn much from past reports.						
Comments/suggestions:							
4.	**Communication and Language Barrier**						
	Only select one answer per question	Don't Know 0	Strongly disagree, 1	Disagree 2	Not sure 3	Agree 4	Strongly agree 5
A	All the instructions are easily understood.						
B	I have received sufficient training on how to communicate in emergency situations.						
C	It is easy to talk with team members.						
D	It is easy to talk with the Master and Officers.						
E	I can deliver any messages/ideas/instructions clearly.						
F	Language differences in multi-cultural crews are not a threat to safety.						

G	There is good communication on this ship about safety issues.						
Comments/suggestions:							

5.	**Competency Level**						
	Only select one answer per question	Don't Know 0	Strongly disagree, 1	Disagree 2	Not sure 3	Agree 4	Strongly agree 5
A	I have good knowledge about my job.						
B	I have received the appropriate education.						
C	I have received the training necessary to work safely on this ship.						
D	The training I have undertaken is relevant in practice.						
E	The training and education I have received are essential for me to work effectively.						
Comments/suggestions:							

6.	**Shore Management Support**						
	Only select one answer per question	Don't Know 0	Strongly disagree, 1	Disagree 2	Not sure 3	Agree 4	Strongly agree 5
A	The company management staff are friendly.						
B	Management support the employees to perform well.						
C	Management do not put pressure on the employees to achieve targets.						
D	I do not experience conflicts with my employers.						
E	Management staff regularly give importance to problems raised by employees.						

F	Management is working for good safety.						
G	Management never put schedule or cost above safety.						
Comments/suggestions:							

7.	**Health Awareness**						
	Only select one answer per question	Don't Know 0	Strongly disagree, 1	Disagree 2	Not sure 3	Agree 4	Strongly agree 5
A	I am getting enough sleep.						
B	I am getting enough rest hours.						
C	The company cares about my health and safety.						
D	Suggestions to improve health and safety are welcomed.						
E	I fully understand and am aware of my responsibilities for health and safety.						
F	Management encourages safe work.						
G	The crew is not encouraged to put health issues in second place to achieve a target.						
H	The crew is expected to follow the work/rest cycle.						
I	I have time to do my work.						
Comments/suggestions:							

8.	**Safety Awareness**						
	Only select one answer per question	Don't Know 0	Strongly disagree, 1	Disagree 2	Not sure 3	Agree 4	Strongly agree 5
A	I follow the safety procedures.						

B	The safety training on-board is sufficient.						
C	Fire drills are performed frequently.						
D	My co-workers do not pressure me to take shortcuts in my work.						
E	I am familiar with the on-board safety goals.						
F	Crews have adequate training in emergency procedures.						
Comments/suggestions:							

9.	**Importance of Maritime Regulations**						
	Only select one answer per question	Don't Know 0	Strongly disagree, 1	Disagree 2	Not sure 3	Agree 4	Strongly agree 5
A	I do not break any rules and regulations.						
B	This company follows all the regulations for the safety of the company and employees.						
C	This company follows the regulations effectively.						
D	I am aware the importance of maritime regulations.						
E	I understand the consequences in the absence of safety regulations.						
F	All the employees are well exposed to the regulations.						
Comments/suggestions							

10.	**Risk Awareness**						
	Only select one answer per question	Don't Know 0	Strongly disagree, 1	Disagree 2	Not sure 3	Agree 4	Strongly agree 5
A	I am aware of the risk of working on-board.						

B	I do work safely.						
C	I feel safe while working.						
D	The working environment is safe for all the crews while working.						
E	I am not at risk of injury while working.						
Comments/suggestions:							

11.	**Job Satisfaction**						
Only select one answer per question		Don't Know 0	Strongly disagree, 1	Disagree 2	Not sure 3	Agree 4	Strongly agree 5
A	I am comfortable asking for help when unsure how to do a task.						
B	I get proper instructions for any work I do.						
C	My suggestions to enhance safety are appreciated.						
D	I am comfortable to interact with everyone on-board.						
Comments/suggestions:							

Appendix H Likert Scale Questionnaire (Mandarin)

船舶安全文化调查问卷

本次调查的目的是确定船舶公司的安全文化水平，以提高当前航运业的效率和安全性。这项调查的结果将形成一个证据来源，从中可以分析和得出结论.

本调查问卷将询问您在公司的安全文化和工作环境方面的经验和经历。 不要在此问卷上写下您的姓名或公司名称。 您不需要提供您的姓名和公司名称，调查问卷信息也不会与您个人关联。 如果有您觉得不方便回答的问题，那么请跳过它们。 谢谢您的合作。

请在框中打勾（/）表示您同意以下关于船舶安全文化的声明的程度。

1.	**背景信息**										
A	性别	女		男							
B	年龄	< 31		31 – 40		41 - 50		51 – 60		>60	
C	工作经验	0-2 年份		3-5 年份		6-10 年份		11-20 年份		>20 年份	

2.	**工作环境满意度**						
	每个问题只选择一个答案	不知道 0	强烈反对 1	不同意 2	不确定 3	同意 4	非常同意 5
A	船上的工作环境非常友好。						
B	工作环境井然有序。						
C	我感觉在这里工作很安全。						
D	工作程序明确清晰。						
E	我的公司重视我的工作。						
评论 / 建议：							

3.	**报告文化**						
	每个问题只选择一个答案	不知道 0	强烈反对 1	不同意 2	不确定 3	同意 4	非常同意 5
A	我报告每一个事故。						
B	我报告几乎发生的事故。						

C	我报告如果我在工作时受伤。						
D	报告总是被认真对待。						
E	我报告如果我不小心损坏船上设备。						
F	以前的报告对于即将开始的航行很有用。						
G	我从过去的报告中学到了很多。						
H	报告将防止未来有害事件的发生。						
评论 / 建议：							

4.	**沟通和语言障碍**						
每个问题只选择一个答案		不知道 0	强烈反对 1	不同意 2	不确定 3	同意 4	非常同意 5
A	所有的说明都很容易理解。						
B	我已经接受了足够培训以在紧急状态下进行良好的沟通。						
C	很容易与团队成员交流。						
D	很容易与船员交流。						
E	我可以清楚地传递消息/想法/说明。						
F	多文化团队中的语言差异不会对安全构成威胁。						
G	在这艘船上有关于安全问题的良好沟通。						
评论 / 建议：							

5.	**能力水平**						
每个问题只选择一个答案		不知道 0	强烈反对 1	不同意 2	不确定 3	同意 4	非常同意 5
A	我对我的工作有很好的了解。						

B	我已经接受适当的教育。						
C	我已经接受了在这艘船上安全工作所需的培训。						
D	我所进行的培训是与实践相关的。						
E	我收到的培训和教育对我有效地工作至关重要。						
评论 / 建议：							

6.	**岸上管理支持**						
	每个问题只选择一个答案	不知道 0	强烈反对 1	不同意 2	不确定 3	同意 4	非常同意 5
A	公司管理人员很友好。						
B	公司管理支持员工的良好表现。						
C	管理层不对员工施加压力以实现目标。						
D	我没有遇到与雇主的冲突。						
E	管理人员重视员工提出的问题。						
F	管理层致力于良好的安全保障。						
G	管理从来不把时间或成本高于安全。						
评论 / 建议：							

7.	**健康意识**						
	每个问题只选择一个答案	不知道 0	强烈反对 1	不同意 2	不确定 3	同意 4	非常同意 5
A	我得到足够的睡眠。						
B	我得到足够的休息时间。						
C	公司关心我的健康和安全。						
D	公司鼓励提高健康和安全的建议。						

E	我完全理解并知道我对健康和安全的责任。						
F	管理人员鼓励安全工作。						
G	公司不鼓励船员为实现目标将健康问题放在第二位。						
H	船员遵循工作/休息周期。						
I	我有时间做我的工作。						
评论 / 建议：							

8.	**安全文化**						
	每个问题只选择一个答案	不知道 0	强烈反对 1	不同意 2	不确定 3	同意 4	非常同意 5
A	我遵循安全程序。						
B	船上的安全培训完善。						
C	经常进行防火演习。						
D	我的同事不要求我在工作中采取捷径。						
E	我熟悉船上的安全目标。						
F	船员在紧急程序方面有充分的培训。						
评论 / 建议：							

9.	**海事条例的重要性**						
	每个问题只选择一个答案	不知道 0	强烈反对 1	不同意 2	不确定 3	同意 4	非常同意 5
A	我不违反任何规则和条例。						
B	公司遵守公司和员工安全的所有规定。						
C	本公司有效遵守规定。						
D	我知道海事法规的重要性。						

E	我知道没有安全规定的情况下的后果。						
F	所有员工都了解并在法规下工作。						
评论 / 建议：							

10.	**风险意识**						
每个问题只选择一个答案		不知道 0	强烈反对 1	不同意 2	不确定 3	同意 4	非常同意 5
A	我知道在船上工作的风险。						
B	我保证工作安全进行。						
C	我在工作时感觉安全。						
D	工作环境对于所有船员都是安全的。						
E	我在工作时没有受伤的危险。						
评论 / 建议：							

11.	**工作满意度**						
每个问题只选择一个答案		不知道 0	强烈反对 1	不同意 2	不确定 3	同意 4	非常同意 5
A	我可以在不确定如何做任务时寻求帮助。						
B	我做任何工作前会得到指导。						
C	我的安全建议得到重视。						
D	我很乐意与船上的每个人进行互动。						
评论 / 建议：							

Appendix I Consent Letter (Questionnaire Survey)

10th February 2017

To who it may concern,

Subject: Permission for conducting questionnaire survey

My name is Gobikrishnan Veluplay and I am a PhD student in the University of Southampton. My survey title is ‘Safety culture in the shipping industry’. In order to fulfil one objective of my research, I am seeking to collect evidence on safety culture through a survey. The focus group for this survey are seafarers and shipping company personnel. It is for this reason that I am approaching you.

Enclosed with this letter is a brief questionnaire that asks a number of questions about safety culture. The questionnaire will require approximately ***20 minutes*** to complete. There is no compensation for responding nor is there any known risk. In order to ensure that all information will remain ***CONFIDENTIAL***, please ***Do NOT*** include your name or your company’s name. The information for this survey will be used for research purposes only. If you choose to participate in this survey, please answer all questions as fully as possible and return the completed questionnaires. Completion of this questionnaire infers consent for participation in this study.

Thank you for taking the time to assist me in my endeavours.

Yours faithfully,

Gobikrishnan Veluplay
PhD Student
Faculty of Engineering and the Environment
University of Southampton

Email: gkv1m14@soton.ac.uk
Hp: +44 7835072414

Appendix J Participant Information Sheet (PIS) (Questionnaire Survey)

Study Title: Shipboard Safety Culture Survey

Researcher: Gobikrishnan Veluplay **Ethics number**: 24667

Please read this information carefully before deciding to take part in this research. If you are happy to participate, you will be asked to sign a consent form.

What is the research about?

This survey will be carried out to identify the existing safety culture in the shipping industry. The output of the survey will be essential to draw conclusions about the safety culture in this industry. This study is relevant to the Ph.D. project, as the findings from this survey will fulfil one of the objectives of the project.

Why have I been chosen?

The focus group for this survey comprises seafarers and shipping company personnel.

What will happen to me if I take part?

The participants will be given a questionnaire to answer. The questionnaire will require approximately 20 minutes to complete. Each participants will only take part once in this survey and there will no further follow up. Completion of this questionnaire infers consent for participation in this study.

Are there any benefits in my taking part?

There is no compensation or any other benefits for responding. However, the knowledge that the respondent willing to share will help the researcher to identify the safety culture in the shipping industry.

Are there any risks involved?

There are no risks involved.

Will my participation be confidential?

In order to ensure that all information will remain confidential, the participants are advised to not include their names or company's name. The information for this survey will be used for research purposes only. All the answered questionnaires will be kept safely in the University.

What happens if I change my mind?

The participants can withdraw at any time.

What happens if something goes wrong?

You may contact the following person if you have any problem regarding the survey. Research Governance Manager, University of Southampton (Tel No: 02380 595058, Email Address: rgoinfo@soton.ac.uk).

Where can I get more information?

From my project supervisor - Professor R Ajit Shenoi, University of Southampton (Tel No: 02380592356, Email Address: R.A.Shenoi@soton.ac.uk)

Appendix K Research Proposal (Questionnaire Survey)

Proposal

Shipboard Safety Culture Survey

Student: Gobikrishnan Veluplay

Supervisors: Professor Ajit Shenoi & Professor Mikis Tsimplis

Research Group: FSI

11/2016

Background of the Safety Culture Survey

Many factors underpinning maritime accidents have been identified and regulations have been implemented to improve the safety of the maritime industry. However, the occurrence of accidents and their severity is unpredictable. Environmental conditions, technical failures, route conditions, ship-related factors, human errors and cargo related factors are among the main causes (Akten, 2006). Rothblum (2000) has underlined that most of the accidents occurred as a result of human errors and the manners in which organizational factors influenced the way people performed. Therefore, implementation and strict control of regulations will make major impacts on reducing the impacts of human error and organizational factors (Ganguly, 2011).

Improved or new safety regulations get developed after the occurrence of serious accidents that involve casualties, leaving a big impact on the maritime industry. These regulatory improvements have been imposed to prevent recurrence of the accidents (Ceyhun, 2014). The incident of the 'Herald of Free Enterprise' is the main reason for the establishment of the International Safety Management (ISM) Code (MAIB, 1989). ISM Code is an international standard for the safe management and operation of ships and pollution prevention, which was introduced by the International Maritime Organisation (IMO) in mid-1998 (IMO, 1998a).

Since the ISM Code was implemented there has been improvement in the safety of shipping (Tzannatos and Kokotos, 2009). However, maritime accidents are still happening on a daily basis around the globe. A total of 24545 accidents world-wide from 2005-2014 has been recorded (Allianz, 2015). This indicates that there must be lack of understanding and ineffective implementations of the ISM Code.

Additionally, a study on Greek-flagged vessels proved that, the problem is not in the code, but from the way the shipping companies implemented the code. This is because, when the ISM Code was implemented on Greek-Flagged vessels, it has shown a drop in the number of accidents (Tzannatos and Kokotos, 2009). Therefore, the safety culture in the shipping companies should be focused on the relationships of several factors such as learning, reporting, justness, flexibility, working situation, communication, behaviours, attitudes and risk perception (Ek *et al.*, 2014).

Hence, handling human errors with better understanding and implementation of safety regulations is important. In the next section, the ratification and purpose of the survey were highlighted.

Reasons for survey and fit-with PhD:

This study is relevant to the Ph.D. project, as the findings from this survey will fulfil one of the objectives of the project. Furthermore, the survey will be carried out to understand the existing safety culture in the shipping industry. The objectives of the PhD programme of study are as follows:

- To study and analyse the causes, patterns and rates of maritime accidents.
- To identify the roots of the human element that contribute towards shipping accidents.
- To develop and implement effective strategies to overcome the risk of human errors that could be used as a reference for decision makers in international shipping companies to augment their information in the field of safety policy and management.

Survey stages:

- Pilot study stage:

The survey is divided into two stages, the pilot study stage and the main study stage. Seafarers and shipping company personnel are the targeted respondents for both the studies. It is of utmost importance to carry out a pilot study before conducting the main survey as it is the chance to detect any flaws in the questions and to correct them. The pilot study also enables to perform a trial analysis on the pilot sample and test all the proposed analysis methodologies. The pilot study was conducted at Warsash Maritime Academy (WMA) with a total of 30 respondents.

- Main study stage

After changes are made to improve the quality of the questionnaire, the main study will be conducted with a larger scale of respondents. A total of 300 respondents are targeted and the survey will be carried out at the Cosco Shipping Company, WMA, Shetland School of Nautical Studies and etc.

Structure of the questionnaire:

A questionnaire form has been structured based on a Likert scale because this survey is aimed to identify the quality of the safety culture on board. The Likert scale is the most commonly used format, where, the questions will have several options of rankings, such as ‘don’t know’, ‘strongly disagree’, ‘disagree’, ‘not sure’, ‘agree’, and ‘strongly agree’ (Allen and Seaman, 2007). The respondents can only mark on one option for each question. The questionnaire form of this survey has 11 items, where, the first item is related to the demography and the rest are more focused on the objectives of the survey. The items are:

1. Demography (Background of the respondents: gender, age and working experience.)
2. Working environment satisfaction (Clear working procedures, recognitions and appreciations.)
3. Reporting culture (Habits of reporting every risky incidents that happens on board.)
4. Communication and language barrier (Capability of understanding the standard language on board to avoid misunderstandings.)

5. Competency level (Appropriate skills and trainings needed for seafarers.)
6. Shore management support (Support and assistance from shore management to the offshore personnel.)
7. Health awareness (Awareness among the offshore personnel about their rights to have enough rest and, health and safety at work.)
8. Safety awareness (Attitudes and responsibilities towards safety at work)
9. Importance of maritime regulations (Implementation and compliance with the regulations.)
10. Risk awareness (Conducting any task with full cautious.)
11. Job satisfaction (Accepting the opinions of all the personnel on board regarding the safety matters.)

Appendix L List of references of report analysis

Number	Vessel Name	Report Source
1	Petunia Seaways & Peggotty	https://assets.publishing.service.gov.uk/media/58a1840fe5274a040d000006/MAIBInvReport04_2017.pdf
2	Orakai & Margriet	https://assets.publishing.service.gov.uk/media/559d3c62ed915d1592000032/MAIBInvReport-16_2015.pdf
3	Lysblink Seaways	https://assets.publishing.service.gov.uk/media/564c571840f0b674d6000033/MAIBInvReport25_2015.pdf
4	Cemfjord	https://assets.publishing.service.gov.uk/media/571760fee5274a22d300001e/MAIBInvReport_8_2016.pdf
5	Dieppe Seaways	https://assets.publishing.service.gov.uk/media/5613d1c5ed915d0359000005/MAIBInvReport-20_2015.pdf
6	Danio	https://assets.publishing.service.gov.uk/media/547c6f38ed915d4c10000013/Danio.pdf
7	Ovit	https://assets.publishing.service.gov.uk/media/547c6f2640f0b60244000007/OvitReport.pdf
8	Beaumont	https://assets.publishing.service.gov.uk/media/547c6f42ed915d4c0d000021/Beaumont.pdf
9	Coastal Isle	https://assets.publishing.service.gov.uk/media/547c6f54ed915d4c10000019/CoastalIsle.pdf
10	Norcape	https://assets.publishing.service.gov.uk/media/547c6f72e5274a428d000027/Norcape.pdf
11	ACX Hibiscus & Hyundai Discovery	https://assets.publishing.service.gov.uk/media/547c6f6ce5274a4290000029/ACXHibiscus-HyundaiDiscovery_Report.pdf
12	CSL Thames	https://assets.publishing.service.gov.uk/media/547c6f8240f0b60244000021/CSLThames.pdf

13	Bulk Carrier (Yeoman Bontrup)	https://assets.publishing.service.gov.uk/media/547c6faced915d4c10000033/YeomanBontrupReport.pdf
14	Vallermosa, Navion Fennia &BW Orinoco	https://assets.publishing.service.gov.uk/media/547c6fdce5274a4290000057/VallermosaReport.pdf
15	Flying Phantom & Red Jasmine	https://assets.publishing.service.gov.uk/media/547c7010ed915d4c0d000073/FlyingPhantom.pdf
16	Antari	https://assets.publishing.service.gov.uk/media/547c6ffaed915d4c0d000067/AntariReport.pdf
17	Pride of Canterbury	https://assets.publishing.service.gov.uk/media/547c700ded915d4c0d000071/PrideofCanterburyReport.pdf
18	Sea Express 1 & Alaska Rainbow	https://assets.publishing.service.gov.uk/media/547c703440f0b60244000081/SeaExpress1AlaskaRainbowReport.pdf
19	Star Princess	https://assets.publishing.service.gov.uk/media/547c706ae5274a4290000097/Star_Princess.pdf
20	The Calypso	https://assets.publishing.service.gov.uk/media/547c7065ed915d4c0d000097/TheCalypsoReport.pdf
21	Ennerdale	https://assets.publishing.service.gov.uk/media/547c7049ed915d4c0d00008d/EnnerdaleReport.pdf
22	CP Valour	https://assets.publishing.service.gov.uk/media/547c707ded915d4c10000097/CP_Valour.pdf
23	FV Harvester & MV Strilmoy	https://assets.publishing.service.gov.uk/media/547c708140f0b602410000b1/Harvester_Strilmoy.pdf
24	Attilio Levoli	https://assets.publishing.service.gov.uk/media/547c70b9e5274a428d0000bf/Attilio_Ievoli.pdf
25	British Enterprise	https://assets.publishing.service.gov.uk/media/547c70a5e5274a42900000bd/British_Enterprise.pdf
26	Pride of Provence	https://assets.publishing.service.gov.uk/media/547c70d940f0b602410000e3/Pride_of_Provence_2003.pdf

27	Diamant & Northern Merchant	https://assets.publishing.service.gov.uk/media/547c710040f0b602410000f5/diamant-northern-merchant.pdf
28	Maria H	https://assets.publishing.service.gov.uk/media/547c70ede5274a42900000e7/maria-h.pdf
29	MV Ash & MV Dutch Aquamarine	https://assets.publishing.service.gov.uk/media/547c7108ed915d4c100000d1/ash-and-dutch-aquamarine.pdf
30	MV Coastal Bay	

Appendix M Very serious accidents

Year	Vessel types & Nature of accident	Causal factors	Consequences
2016	Ro-Ro Cargo (Petunia Seaways) & Motor Launch (Peggotty) - Collision	• Peggotty did not meet the requirements by SOLAS and the International regulations for Preventing Collisions at Sea (COLREGS). • The action taken by Petunia Seaways' master was insufficient and too late to avoid a collision. • The vessel traffic services officer (VTSO) did not monitor small vessels effectively.	• Damage to the Ro-Ro cargo vessel • Vessel (Motor Launch)
2015	General Cargo (Lysblink Seaways) - Grounding	• Alcohol consumption. • Failed to keep proper lookout for watch keeping. • Poor navigational practices. • Poor compliance with the SMS.	• 25 tonnes of marine gas oil spilled • Total damage to the vessel
2015	Cement Carrier (Cemfjord) – Capsizing & Sinking	• Breaking seas. • Limited time. • Master made wrong decision in choosing the route. • The crews of the vessel had not been adequately prepared to deal with emergency situations. • Poor maintenance. • 13 months before the accident, the vessel spent 54% of the time with shortcomings in safety related equipment and 40% of this time on defects related to the vessel's lifeboats. • Industrial and commercial pressures existed at all levels in the management.	• 8 fatalities • Vessel lost
2010	Bulk Carrier (Yeoman Bontrup) – Fire & Explosion	• Poor housekeeping. • Lack of suitable smoke detector. • There were no classification society rules or SOLAS regulations governing the cargo-handling areas and equipment on self-unloading bulk carriers. • Poor design of the engine room workshop/hydraulic pump space door prevented it from being easily closed and secured from both sides. • Poor storage of chemicals • The compartment was not equipped with a fixed fire-fighting system.	• Two cases of minor smoke inhalation and one suffered from bruising • Damage to the vessel
2008	Fire-fighting Tug (Flying Phantom) & Bulk Carrier (Red	• Thick fog. • There were no formal pre-towing checks to ensure the necessary preparations had been completed prior to towing.	• 3 fatalities • Constructive total loss

	Jasmine) - Capsize	• Ineffective procedure for operating in restricted visibility. • No effective system for assessing the risk of fog. • The port's risk assessment was immature. • Inconsistencies and conflicts within the port's SMS documentation.	
2006	Passenger Vessel (Star Princess) - Fire	• Poor compliance with regulations.	• 1 fatality and 13 passengers were treated for the effect smoke inhalation • Severe damage to the vessel
2006	Liquefied Gas Tanker (Ennerdale) – Gas Leakage	• Lack of guidance on cargo sampling in the industry. • There was no clear regulatory requirement for the emergency shutdown ESD valves to be regularly pressure tested or inspected to ensure the valve was function. • The sampling valve was able to be unscrews by hand and came apart after roughly a quarter of a turn. • The ESD valves on the discharge line were not tested to ensure they were closing. • The screw fitting of the sampling point was not secured as required in the ship's SMS.	• 1 minor cold burn • 66 tonnes of liquefied petroleum gas (LPG) leaked
2005	Container Vessel (CP Valour) - Grounding	• Poor seamanship skills. • Poor decision-making by the master. • No formal pre-operation briefing took place. • Poor teamwork. • Fatigue. • Not enough rest.	• Vessel total loss • Significant pollution
2005	Fishing Vessel (FV Harvester) & Supply and Standby Vessel (MV Strilmoy) - Collision	• Poor visibility due to fog. • Poor decision-making of the crews. • Insufficient number of lookouts kept on Strilmoy. • Late action by Harvester. • Poor navigational practices. • Strilmoy did not produced or made available on board the detailed instructions concerning actions in fog, calling the master, and the requirements for bridge watchkeepers.	• Harvested - abandoned/sank • Strilmoy – damage to the vessel
2001	General Cargo Vessel (MV Ash) & Chemical Tanker (MV Dutch Aquamarine) - Collision	• Did not keep a proper lookout. • Unaware of the developing risky situation. • Not fully adapt to the navigational equipment.	• 1 fatality (master of Ash) • Damage to the both vessels

Appendix N Serious Accidents

Year	Vessel types & Nature of accident	Causal factors	Consequences
2015	Chemical Tanker (Orakai) & Beam Trawler (Margriet) - Collision	• Fatigue. • Not enough rest. • Failed to keep proper lookout for watch keeping.	• Severe damage to the vessels
2013	General Cargo (Danio) - Grounding	• Fatigue. • Not enough rest. • Navigational aids were not used effectively. • Falsified records of hours of working and resting. • Poor risk assessment practices.	• Damage to the vessel
2012	Dry Cargo (Beaumont) - Grounding	• Fatigue. • Not enough rest. • None of the safeguard had been utilised. • Navigational aids were not used effectively. • Poor instructions from the master.	• Damage to the vessel
2012	Feeder Container Vessel (Coastal Isle) - Grounding	• Absence of personnel on the bridge to correct the vessel's heading • Absence of watchkeepers. • Watch alarms were switched off.	• Severe damage to the vessel
2011	Ro-Ro Cargo (Norcape) - Grounding	• Strong wind. • Poor risk assessment. • Poor consultation between the owner and the harbour authority relating to manoeuvring Norcape. • Absence of towage guidelines at the harbour (needs SMS review). • Not familiar with the operating limits of all manoeuvring equipment on the vessel.	• 1 person suffered heavy bruising on leg • Material damage to port windlass
2011	Container Vessel (ACX Hibiscus) & Container Vessel (Hyundai Discovery) - Collision	• Neither vessel's bridge teams fully complied with the applicable COLREGS for restricted visibility. • Fatigue.	• Damage to the vessels
2011	Bulk Carrier (CSL Thames) - Grounding	• Poor Navigational practices.	• Damage to the vessel

2009	Product Tanker (Vallermosa), Oil Tanker (Navion Fennia) & Oil Tanker (BW Orinoco) - Contact	• Vallermosa's approach to berth was unnecessarily aborted for administrative reasons. • Time pressure. • The pilot's effectiveness was reduced due to his overloaded workload, frustration and increasing stress. • The master had not gained sufficient information about the pilot's intention to ensure the safety of his vessel by monitoring the pilot's actions.	• Structural damage to the vessel • Minor pollution
2008	General Cargo Vessel (Antari) - Grounding	• Fatigue. • Not enough rest. • Absence of lookouts. • Lack of emphasis on STCW 95 and ISM Code.	• Damage to the vessel
2008	Ro-Ro Passenger Ferry (Pride of Canterbury) - Grounding	• Depended on electronic chart systems. • Lacking proper training to use navigational equipment. • There was no formal passage planning for the navigation. • The vessel's position was not systematically plotted on the paper chart.	• Damage to the vessel
2007	Ro-Ro Cargo (Sea Express 1) & Bulk Carrier (Alaska Rainbow) - Collision	• Poor communication by the pilot with Sea Express 1 and VTS. • The ground stabilised radar display was not used. • Pilot was not proactive in requiring support. • Master and officer of the watch (OOW) was not proactive in providing support to the pilot.	• Sea Express 1 – minor injuries to 13 passengers and damage to the vessel • Alaska Rainbow – minor damage
2006	Passenger Vessel (The Calypso) - Fire	• Poor maintenance. • Ineffective service engineer and ship's crew inspections. • Poor compliance with ISM Code. • Lack of information regarding rescue and safety equipment.	• Extensive fire damage to the vessel
2003	Ro-Ro Cargo/Passenger Ferry (Pride of Provence) - Contact	• The master's chosen approach to the harbour was not steady. • The ship personnel on bridge were unable to perform the monitoring task. • Ineffective command assessment procedures. • Not much frequent announcements were made to the passengers concerning the emergency response arrangement.	• 30 person injured • Damage to the vessel
2002	General Cargo (Maria H) - Contact	• A manoeuvring plan apparently not being successfully communicated to, understood, and agreed by all parties.	• 1 person injured • Damage to the vessel

		• Both the master and pilot were inexperienced in conducting unberthing operations. • Poor decisions made by the master.	

Appendix O Less serious accidents

Year	Vessel types & Nature of accident	Causal factors	Consequences
2014	Ro-Ro Passenger Ferry (Dieppe Seaways) - Fire	• Lack of detailed maintenance records. • Absence of a standard operating procedure for dealing with a fire on the thermal oil heating system installation. • Poor situational risk assessment. • Lack of shipboard fire-fighting training.	• Serious injuries to one firefighter and two crew members • Equipment damage to the ship
2013	Oil/chemical Tanker (Ovit) - Grounding	• An inexperienced and unsupervised junior officer prepared the passage plan. • The passage plan was not properly checked for navigational hazards using the ECDIS check-route function and the master did not check it. • Unfamiliar with the navigational equipment. • The master and deck officers did not implement the ship manager's policies for safe navigation and bridge watchkeeping.	• Damage to the vessel
2004	Chemical Tanker (Attilio Levoli) - Grounding	• Poor teamwork due to cultural differences. • Poor navigational practices. • The passage plan did not follow company instructions or IMO advice. • Did not comply with the company's SMS.	• Severe damage to the vessel
2004	Oil Tanker (British Enterprise) - Grounding	• Did not use navigational equipment properly. • Neither the VTS, not the port authority, issued a formal local or coastal navigation warning regarding the hazard. • Navigational charts were not updated. • Poor decision making by the master.	• Damage to the vessel
2002	Ro-Ro Cargo/Passenger Ferry (Diamant) & Ro-Ro Cargo/Passenger Ferry (Northern Merchant) - Collision	• Unsafe speed. • Did not use the navigational equipment efficiently. • Poor navigational practices. • Poor compliance with the rules. • Lack of company procedures and guidance.	• Damage to the vessels
2000	Container Feeder (MV Coastal Bay) - Grounding	• Fatigue • Not enough rest • The ship manager did not monitor the hours worked by the master or chief officer. • No additional lookout • The watch alarm was out of function. • Poor operating orders issued by the ship's manager.	• Damage to the vessel

		• The lack of written instructions regarding the watchkeeping arrangements by the MCA during the port state control inspection.	

Appendix P Level 1 – Unsafe acts and relevant safety actions

Sub - categories	**Safety actions recommended by MAIB**
Errors - Decision errors - Skill-based errors - Perceptual errors	• Refresher training for vessel traffic service officers (VTSO). • Check that intended courses are clear before altering. • The officer who in charge of a watchkeeping should not leave the bridge unless relieved by another qualified officer. • Verification of ECDIS training for officers. • Company should ensure that its masters and chief officers receive training related to newly installed equipment or tools. • Company should ensure that its personnel are familiar with the company's revised cargo loading and passage planning procedures.
Violations - Routine - Exceptional	• Companies should review and amend its internal auditing to ensure its auditors verify that its crew is following documented procedures. • Companies should emphasise on the fundamental principles of safe navigation. • Shipping companies should remind masters that deck work must be effectively managed to ensure watch personnel are adequately rested before sailing and all watch ratings are used equitably. • The International Chamber of Shipping is recommended to encourage its member shipping companies to ensure internal procedures are in place to verify compliance with company instructions.

Appendix Q Level 2 – Preconditions for unsafe acts and relevant safety actions

Sub - categories	Safety actions recommended by MAIB
Environmental factors - Physical environment - Technological environment	• Review the Bridge Resource Management in narrow navigational waters for vessels. • Companies should monitor the use and effectiveness of its upgraded accidents reporting and information sharing software system. • MCA should broadcast information regarding extreme local sea conditions and other maritime safety information to ships. • Companies should emphasise the appropriate use of watch alarms at sea. • MCA should forward a submission to the IMO Navigation, Communication and Search and Rescue Sub-committee, promoting the concept of carrying out annual performance checks on all ECDIS systems fitted to ships and in use as the primary means of navigation. • Shipping companies should emphasise on the use of bridge navigational watch alarm systems (BNWAS). • Officers should ensure that the BNWAS systems are linked with autopilots so that the watch keeping alarm is operational whenever the autopilot is in use. • Shipping companies should review the weather advice available for its ports of call, and provide guidance to its masters on the most appropriate sources to use. • Shipping companies should review the suitability of the design and structure their vessels with regards to watertight integrity and operational fire containment requirements. • The International Chamber of Shipping and The International Support Vessel Owners' Association are recommended to highlight to their national shipowner associations and member companies the importance of the functionality of radar and automatic radar plotting aid (ARPA) been fully utilised so that the risk of collision with detected objects could be established at an early stage. • The International Harbour Masters Association is recommended to remind its members of the importance of issuing appropriate and effective navigation warnings after new hazards to navigation have been reported.
Condition of operators - Adverse mental state - Adverse physiological state - Physical/mental limitations	• Companies should ensure that their crews are complying with hours of work and rest regulations. • Shipping companies should implement procedures to compare crew members' hours of rest, to ensure accuracy. • Department for Transport and MCA should approach for a review of the process and principles of safe manning at the IMO to reflect the critical safety issues of fatigue.

Personnel factors - Crew resource management - Personal readiness	• Verification of the company’s random alcohol testing regime. • Companies should monitor the effectiveness of the ECDIS familiarisation provided to their deck officers. • Shipping companies should remind its bridge teams of the value of using passage plan. • Shipping companies should introduce proper English language assessment for all deck, technical and fire-fighting personnel, supported by an on board English language improvement programme. • The International Federation of Shipmasters’ Association and The Nautical Institute are recommended to circulate or publish a reminder to their member to be aware of the importance of chart source data, its age, and accuracy when operating with limited under keel clearance or in shallow water.

Appendix R Level 3 – Unsafe supervision and relevant safety actions

Sub - categories	Safety actions recommended by MAIB
Inadequate supervision	• Issuing of instructions regarding the posting of lookouts. • Fire and rescue service should provide more specific shipboard fire-fighting training to exercise combined command and control. • Shipping companies should ensure that officers manoeuvring their vessels are able to retain full situational awareness. • MCA should issue guidance on how operators should determine a safe speed in restricted visibility.
Plan inappropriate operation	• Determine the risk of collision or any related emergency situations. • Vessel owners and managers should ensure that the training and supervision provided to its non-exclusive surveyors is effective. • Fire and rescue service should emphasise to its firefighters on the need to conduct a thorough situational risk assessment before developing an entry plan. • Enhance risk perception concerning ship construction and associated hazards. • Ports should conduct a review of their port risk assessment and safety management system to ensure conflicts within their SMS documentation are removed. • Ports also should conduct port risk assessment to ensure requirements; conditions, controls and operational limitations for the safe transit of large vessels are clearly defined. • British Tugowners Association should highlight to its members the importance of tug crews' emergency preparedness.
Fail correct known problem	• Fire and rescue service should emphasise to its fire fighters the available guidance provided in the Fire and Rescue Manual with regards to backdraught conditions. • Review the suitability of dry powder as a fixed fire-extinguishing medium for fire incidents caused by various factors. • Shipping companies should ensure their officers and crew to understand the need to properly evaluate routine operations after an accident to ensure that any new risks are identified and mitigated as appropriate. • Shipping companies are recommended to ensure their masters are given clear guidelines which details the importance of effective dialogue with pilots to be proactive in providing support to pilots and challenge decisions or actions taken by pilots, so that effective corrective action can be taken to prevent accidents. • Shipping companies should review and revise guidance provided to the industry on sampling arrangements, taking due account of any standard required by classification society.
Supervisory violation	• Issuing a general notice to pilots and crew that provides both general guidance and guidance in fog, with reference to Marine Guidance Note (MGN) 369 Navigation in Restricted Visibility and the COLREGS. • MCA should work closely with the European Commission and EU member states to make a proposal to the IMO that all vessels engaged

	in short sea trades be required to carry a minimum of two watchkeepers in addition to the master. • Improve the management of safety critical information in ECDIS system, in which, focusing on the protection of recorded positional data in accordance with IMO standards. • Classification society should ensure that during vessel audits and surveys, Voyage Data Recorders are functioning and certified in accordance with international regulations. • Shipping companies and the International Chamber of Shipping are recommended to encourage the ship owners/managers the MAIB Safety Flyer describing about previous accidents and the principal lessons to be learned from it.

Appendix S Level 4 – Organisational influences and relevant safety actions

Sub - categories	Safety actions recommended by MAIB
Resource management	• Should develop an in-house, accredited Maritime Resource Management training course to improve the standards of Bridge Resource Management of a vessel. • MCA in co-operation with shipping companies should plan to conduct a concentrated inspection campaign on ECDIS –fitted ships to establish the standards of system knowledge among navigators. • Paper charts should be used as the primary means of navigation. • Shipping companies should develop and adopt additional management controls designed to verify the authenticity of the certificates of competency held by seafarers employed by the company. • Shipping companies should ensure the availability of fire suits of various sizes on all their ships.
Organisational climate	• Revision of the management structure. • MCA should gather information that to be provided by vessels at any high-risk area, to be used by the coastguard. • MCA should identify the level of surveillance and monitoring required by vessels operating at a high-risk area. • MCA should establish operational routines for the use of Automatic Identification System (AIS) information and operator procedures to monitor AIS tracks and respond to loss of AIS contact. • Shipping companies should revise its SMS to require the use of lookouts during the hours of darkness and the use of radar and eco sounder alarm facilities. • Shipping companies should develop its Safety Management System, training and audit programme to enhance its masters' and watchkeeping officers' understanding of the precautions to be taken in restricted visibility, emergency manoeuvring actions and the obligation to offer assistance to any other vessels that their vessels might collide with. • Shipping companies should ensure their officers and crew understand the vessel's emergency procedures. • United Kingdom Major Ports Groups (UKMPG), British Ports Association (BPA) and United Kingdom Marine Pilot Association (UKMPA) should determine the training requirements necessary to ensure pilots can integrate effectively into bridge teams during the performance of their duties. • UKMPG, UKMPA and BPA should encourage their members to develop feedback mechanisms for pilots to report on substandard bridge team performance, and take appropriate action as necessary. • Shipping companies should review their SMS to improve external communications in the event of an emergency in terms of urgency and detail. • Port authority should tighten Port Control procedures for entry to prevent circumstances arising where vessels are committed to entry when the way is not yet clear for their intended manoeuvre.

Appendix T Pearson Correlation

Table 1 Proximity matrix (distance) among the nine safety culture aspects (Overall)

Safety practice aspects	1	2	3	4	5	6	7	8	9
1. Working environment satisfaction	1	0.571	0.969	0.352	-0.442	0.714	0.319	-0.585	-0.620
2. Reporting culture		1	0.413	0.436	-0.988	0.480	0.339	-0.380	-0.852
3. Communication and language barrier			1	0.133	-0.270	0.801	0.442	-0.702	-0.407
4. Competency level				1	-0.434	-0.342	-0.660	0.500	-0.836
5. Shore management support					1	-0.378	-0.290	0.289	0.830
6. Health awareness						1	0.889	-0.985	-0.150
7. Importance of maritime regulations							1	-0.948	0.149
8. Risk awareness								1	-0.007
9. Job satisfaction									1

Table 2 Proximity matrix (distance) among the nine safety culture aspects (Maritime Academy A)

Safety practice aspects	1	2	3	4	5	6	7	8	9
1. Working environment satisfaction	1	-0.094	0.806	-0.481	-0.005	0.091	0.260	0.219	-0.233
2. Reporting culture		1	-0.564	0.145	0.020	-0.441	-0.760	-0.002	0.597
3. Communication and language barrier			1	-0.341	-0.774	-.571	0.730	0.156	-0.698
4. Competency level				1	0.818	-0.298	-0.359	-0.100	0.541
5. Shore management support					1	-0.473	-0.284	-0.139	0.726
6. Health awareness						1	0.735	0.950	-0.314
7. Importance of maritime regulations							1	0.166	-0.373
8. Risk awareness								1	-0.816
9. Job satisfaction									1

Table 3 Proximity matrix (distance) among the nine safety culture aspects (Shipping Company B)

Safety practice aspects	1	2	3	4	5	6	7	8	9
1. Working environment satisfaction	1	0.755	0.925	0.900	-0.376	0.455	0.898	-0.427	-0.310

2. Reporting culture		1	0.902	0.585	-0.253	0.697	0.595	-0.722	-0.789
3. Communication and language barrier			1	0.041	-0.465	0.600	0.530	-0.566	-0.143
4. Competency level				1	-0.299	-0.011	-0.094	-0.122	-0.989
5. Shore management support					1	-0.472	-0.515	0.442	0.737
6. Health awareness						1	0.585	-0.990	-0.101
7. Importance of maritime regulations							1	-0.822	-0.189
8. Risk awareness								1	0.888
9. Job satisfaction									1

Appendix U Summaries of ten safety practice aspects

Table 1 Response Frequency for Working Environment Satisfaction

Statements	Don't know (%)	Strongly disagree (%)	Disagree (%)	Not sure (%)	Agree (%)	Strongly agree (%)	Agree + Strongly agree (%)	Mean , $\bar{x}$	Standard deviation, σ	Missing Values, (%)
W1. The working environment on-board is very friendly.	0.6	0.3	4.4	9.1	65.9	19.6	85.5	3.98	0.771	0
W4. The working environment is organized.	0	0	2.2	6.6	65.9	25.2	91.1	4.14	0.623	0
W5. I feel safe working here.	0	0	2.8	10.1	57.4	29.3	86.7	4.14	0.702	0
W6. Working procedures are clear and well written.	0.6	0.3	2.2	8.8	58.0	30.0	88.0	4.13	0.768	1(0.3%)
W7. My work is appreciated by the company.	1.9	2.5	9.1	21.5	45.7	18.9	64.6	3.64	1.085	1(0.3%)
Average	**0.6**	**0.6**	**4.2**	**11.2**	**58.6**	**24.6**	**83.2**	**4.00**		**2(0.6%)**

Table 2 Response Frequency for Reporting Culture

Statements	Don't know (%)	Strongly disagree (%)	Disagree (%)	Not sure (%)	Agree (%)	Strongly agree (%)	Agree + Strongly agree (%)	Mean, $\overline{x}$	Standard deviation, σ	Missing Values, (%)
R1. I report every incident.	0.3	1.6	11.0	10.4	55.2	21.5	76.7	3.83	0.963	0
R2. I report near miss incidents.	0.3	1.9	6.9	12.6	56.5	21.5	78.0	3.88	0.911	1(0.3%)
R3. I report if I get injured while doing job.	0.6	0.3	4.4	7.3	53.3	34.1	84.4	4.15	0.837	0
R5. Reports are always taken seriously.	1.6	0.9	3.2	18.0	49.5	26.8	76.3	3.93	0.954	0
R6. I report if I accidentally damage equipment on-board.	0.6	0.3	2.8	15.1	47.3	33.8	81.1	4.09	0.852	0
R8. Previous reports are useful for up-coming voyages.	1.3	0	2.2	8.8	51.7	35.6	87.3	4.17	0.842	1(0.3%)
R9. I learn much from past reports.	0.6	0.3	2.8	12.3	51.4	32.5	83.9	4.17	0.825	0
Average	**0.8**	**0.8**	**4.8**	**12.1**	**52.1**	**29.4**	**81.5**	**4.07**		**2(0.6%)**

Table 3 Response Frequency for Communication and Language Barrier

Statements	Don't know (%)	Strongly disagree (%)	Disagree (%)	Not sure (%)	Agree (%)	Strongly agree (%)	Agree + Strongly agree (%)	Mean, $\bar{x}$	Standard deviation, σ	Missing Values, (%)
Com2. All the instructions are easily understood.	0.6	1.3	11.1	15.8	51.4	19.6	71.0	3.75	0.977	1 (0.3%)
Com3. I have received sufficient training on how to communicate in emergency situations.	0.3	0.3	2.5	10.4	56.2	30	86.2	4.12	0.756	1 (0.3%)
Com4. It is easy to talk with team members.	0	0	6.3	6.6	59.9	26.5	86.4	4.07	0.764	2 (0.6%)
Com5. It is easy to talk with the Master and Officers.	0	0.3	4.4	6.6	56.2	31.9	88.1	4.16	0.756	2 (0.6%)
Com6. I can deliver any messages/ideas/instructions clearly.	0.6	0.3	2.5	8.2	58.4	29.3	87.7	4.13	0.772	2 (0.6%)
Com7. Language differences in multi-cultural crews are not a threat to safety.	1.9	9.8	17.0	21.8	35.0	13.9	48.9	3.21	1.269	2 (0.6%)
Com8. There is good communication on this ship about safety issues.	0.9	0.6	2.8	6.3	60.3	28.7	89.0	4.11	0.815	1 (0.3%)
Average	**0.6**	**1.8**	**6.7**	**10.8**	**53.4**	**25.7**	**79.1**	**3.90**		**11(3.3%)**

Table 4 Response Frequency for Competency Level

Statements	Don't know (%)	Strongly disagree (%)	Disagree (%)	Not sure (%)	Agree (%)	Strongly agree (%)	Agree + Strongly agree (%)	Mean, $\overline{x}$	Standard deviation, σ	Missing Values, (%)
Competency1. I have good knowledge about my job.	0.3	0.3	0.9	6.0	65.0	27.1	92.1	4.17	0.649	1 (0.3%)
Competency2. I have received the appropriate education.	0.3	0	0.6	5.0	63.7	30.0	93.7	4.22	0.615	1 (0.3%)
Competency3. I have received the training necessary to work safely on this ship.	0.3	0	0.9	7.6	58.0	32.8	90.8	4.22	0.668	1 (0.3%)
Competency4. The training I have undertaken is relevant in practice.	0.3	0.6	3.2	7.9	56.5	31.2	87.7	4.14	0.780	1 (0.3%)
Competency5. The training and education I have received are essential for me to work effectively.	0.6	0.3	0.6	9.5	52.1	36.6	88.7	4.22	0.754	1 (0.3%)
Average	**0.4**	**0.2**	**1.2**	**7.2**	**59.1**	**31.6**	**90.7**	**4.2**		**5(1.5 %)**

Table 5 Response Frequency for Shore Management Support

Statements	Don't know (%)	Strongly disagree (%)	Disagree (%)	Not sure (%)	Agree (%)	Strongly agree (%)	Agree + Strongly agree (%)	Mean, $\overline{x}$	Standard deviation, σ	Missing Values, (%)
Shore1. The company management staff are friendly.	1.6	0.9	6.9	18.6	50.5	21.1	71.6	3.79	0.988	1(0.3%)
Shore2. Management support the employees to perform well.	0.9	0.9	10.4	14.8	52.1	20.5	77.6	3.78	0.982	1(0.3%)
Shore3. Management do not put pressure on the employees to achieve targets.	2.5	6.3	20.2	19.9	36.0	14.5	50.5	3.25	1.255	2(0.6%)
Shore4. I do not experience conflicts with my employers.	3.5	3.2	7.6	12.3	52.1	20.5	77.6	3.69	1.181	3(0.9%)
Shore5. Management staff regularly give importance to problems raised by employees.	1.3	0	9.1	20.5	48.9	19.6	68.5	3.76	0.958	2(0.6%)
Shore6. Management is working for good safety.	0.6	0	3.5	8.8	57.4	28.4	85.8	4.10	0.782	4(1.2%)
Shore7. Management never put schedule or	3.8	5.0	11.7	19.6	38.8	20.2	59.0	3.46	1.289	3(0.9%)

cost above safety.										
Average	**2.0**	**2.3**	**9.9**	**16.4**	**48**	**20.7**	**68.7**	**3.69**		**16(4.8%)**

Table 6 Response Frequency for Health Awareness

Statements	Don't know (%)	Strongly disagree (%)	Disagree (%)	Not sure (%)	Agree (%)	Strongly agree (%)	Agree + Strongly agree (%)	Mean, $\overline{x}$	Standard deviation, σ	Missing Values, (%)
Health1. I am getting enough sleep.	0	4.7	11.0	17.0	50.8	16.1	76.9	3.63	1.033	1(0.3%)
Health2. I am getting enough rest hours.	0.3	3.2	9.8	14.5	50.8	21.1	71.9	3.76	1.016	1(0.3%)
Health3. The company cares about my health and safety.	0.6	1.6	5.7	16.7	50.5	24.6	75.1	3.89	0.937	1(0.3%)
Health4. Suggestions to improve health and safety are welcomed.	0.9	0	2.2	12.6	57.4	26.2	83.6	4.05	0.794	2(0.6%)
Health5. I fully understand and am aware of my responsibilities for health and safety.	0	0	0.3	6.6	57.7	34.7	92.4	4.28	0.594	2(0.6%)
Health6. Management encourages safe work.	0.3	0	0.9	6.0	55.8	36.3	92.1	4.27	0.664	2(0.6%)
Health7. The crew is not encouraged to put health issues in second place to achieve a target.	1.9	0.3	4.7	14.2	55.2	23.0	78.2	3.91	0.945	2(0.6%)
Health9. The crew is expected to follow the work/rest cycle.	0.6	2.2	4.7	12.3	49.5	29.7	79.2	3.99	0.959	3(0.9%)

Health10. I have time to do my work.	0.6	1.9	6.6	8.5	59.3	22.4	81.7	3.92	0.921	2(0.6%)
Average	**0.6**	**1.5**	**5.1**	**12**	**54**	**26**	**80.0**	**3.97**		**16(4.8%)**

Table 7 Response Frequency for Safety awareness

Statements	Don't know (%)	Strongly disagree (%)	Disagree (%)	Not sure (%)	Agree (%)	Strongly agree (%)	Agree + Strongly agree (%)	Mean, $\bar{x}$	Standard deviation, σ	Missing Values, (%)
Safety3. I follow the safety procedures.	0	0	0.9	4.4	64.0	30.0	94.0	4.24	0.573	2(0.6%)
Safety4. The safety training on-board is sufficient.	0.3	0.6	3.5	6.9	64.4	23.7	88.1	4.07	0.744	2(0.6%)
Safety5. Fire drills are performed frequently.	0.3	0	2.8	1.9	55.8	38.5	94.3	4.32	0.696	2(0.6%)
Safety6. My co-workers do not pressure me to take shortcuts in my work.	0.6	0.3	5.4	11.0	55.5	26.5	82.0	4.01	0.852	2(0.6%)
Safety7. I am familiar with the on-board safety goals.	0	0	0.3	2.2	65.9	31.2	97.1	4.28	0.518	1(0.3%)
Safety8. Crews have adequate training in emergency procedures.	0.3	0	4.7	7.3	64.4	22.7	87.1	4.05	0.736	2(0.6%)
Average	**0.3**	**0.2**	**2.9**	**5.6**	**61.6**	**28.8**	**90.4**	**4.16**		**11(3.3%)**

Table 8 Response Frequency for importance of Maritime Regulations

Statements	Don't know (%)	Strongly disagree (%)	Disagree (%)	Not sure (%)	Agree (%)	Strongly agree (%)	Agree + Strongly agree (%)	Mean, $\overline{x}$	Standard deviation, σ	Missing Values, (%)
Imp1. I do not break any rules and regulations.	0.9	0.3	3.8	8.2	56.5	29.7	86.2	4.09	0.841	2(0.6%)
Imp2. This company follows all the regulations for the safety of the company and employees.	0.3	0.6	4.4	12.9	53.3	27.8	81.1	4.03	0.835	2(0.6%)
Imp3. This company follows the regulations effectively.	0.3	0.3	4.1	14.2	51.7	28.4	80.1	4.20	2.986	2(0.6%)
Imp4. I am aware the importance of maritime regulations.	0	0	0	3.2	56.5	40.1	96.6	4.37	0.545	1(0.3%)
Imp5. I understand the consequences in the absence of safety regulations.	0	0	0	2.5	59.0	37.9	96.9	4.36	0.530	2(0.6%)
Imp6. All the employees are well exposed to the regulations.	2.2	0	3.8	15.1	51.1	27.1	78.2	3.96	0.967	2(0.6%)

Average	**0.6**	**0.2**	**2.7**	**9.4**	**54.7**	**31.8**	**86.5**	**4.17**		**11(3.3%)**

Table 9 Response Frequency for Risk Awareness

Statements	Don't know (%)	Strongly disagree (%)	Disagree (%)	Not sure (%)	Agree (%)	Strongly agree (%)	Agree + Strongly agree (%)	Mean, $\overline{x}$	Standard deviation, σ	Missing Values, (%)
Risk1. I am aware of the risk of working on-board.	0.3	0	0	0.6	55.8	42.6	98.4	4.41	0.565	2(0.6%)
Risk2. I do work safely.	0	0	0.6	6.6	54.9	37.5	92.4	4.30	0.617	1(0.3%)
Risk3. I feel safe while working.	0.3	0	3.2	12.6	53.9	29.3	83.2	4.09	0.770	2(0.6%)
Risk4. The working environment is safe for all the crews while working.	1.9	0.9	6.6	21.8	46.4	21.8	68.2	3.76	1.021	2(0.6%)
Risk5. I am not at risk of injury while working.	0.3	1.9	17.4	18.0	39.1	22.7	61.8	3.63	1.094	2(0.6%)
Average	**0.6**	**0.6**	**5.6**	**11.9**	**50**	**30.8**	**80.8**	**4.04**		**9(2.7%)**

Table 10 Response Frequency for Job Satisfaction

Questions	Don't know (%)	Strongly disagree (%)	Disagree (%)	Not sure (%)	Agree (%)	Strongly agree (%)	Agree + Strongly agree (%)	Mean, $\bar{x}$	Standard deviation, σ	Missing Values, (%)
Job2. I am comfortable asking for help when unsure how to do a task.	0.3	0	2.2	4.4	62.8	29.3	92.1	4.19	0.667	3(0.9%)
Job3. I get proper instructions for any work I do.	0	0	4.1	12.6	55.8	26.5	82.3	4.06	0.748	3(0.9%)
Job4. My suggestions to enhance safety are appreciated.	0.6	0.6	3.5	16.7	55.2	22.4	77.6	3.94	0.833	3(0.9%)
Job5. I am comfortable to interact with everyone on-board.	0.6	0.3	3.2	7.9	53.0	34.1	87.1	4.17	0.810	3(0.9%)
Average	**0.4**	**0.2**	**3.3**	**10.4**	**56.7**	**28.1**	**84.8**	**4.09**		**12(3.6%)**

Appendix V Reliabity test results for survey instrument (Factor Analysis)

Safety Practice Aspects	Obs	Sign	item-test correlation	item-rest correlation	average interitem correlation	alpha	Item lable
Working environment satisfaction							
W1	317	+	0.103	0.0765	0.4682	0.9794	The working environment on-board is very friendly.
W4	317	+	0.1086	0.0821	0.4681	0.9794	The working environment is organized.
W5	316	+	0.1029	0.0764	0.4682	0.9794	I feel safe working here.
W6	317	+	0.0921	0.0655	0.4685	0.9794	Working procedures are clear and well written.
W7	317	+	0.0404	0.0137	0.4698	0.9795	My work is appreciated by the company.
Reporting culture							
R5	317	+	0.0607	0.0341	0.4693	0.9795	Reports are always taken seriously.
R6	317	-	0.0146	-0.0121	0.4705	0.9796	I report if I accidentally damage equipment on-board.
R8	317	-	0.035	0.0083	0.47	0.9795	Previous reports are useful for up-coming voyages.
R9	317	-	0.0412	0.0145	0.4698	0.9795	I learn much from past reports.
Communication and language barrier							
com2	317	+	0.8967	0.8913	0.4474	0.9776	All the instructions are easily understood.
com3	317	+	0.8978	0.8924	0.4474	0.9776	I have received sufficient training on how to communicate in emergency situations.
com4	317	+	0.6525	0.6367	0.4538	0.9782	It is easy to talk with team members.
com5	317	+	0.6448	0.6287	0.454	0.9782	It is easy to talk with the Master and Officers.
com6	317	+	0.6444	0.6284	0.454	0.9782	I can deliver any messages/ideas/instructions clearly.

com7	317	+	0.7056	0.6918	0.4524	0.9781	Language differences in multi-cultural crews are not a threat to safety.
com8	317	+	0.8977	0.8923	0.4474	0.9776	There is good communication on this ship about safety issues.
Competency Level							
competency1	317	+	0.8986	0.8933	0.4474	0.9776	I have good knowledge about my job.
competency2	317	+	0.8982	0.8928	0.4474	0.9776	I have received the appropriate education.
competency3	317	+	0.8975	0.8921	0.4474	0.9776	I have received the training necessary to work safely on this ship.
competency4	317	+	0.897	0.8916	0.4474	0.9776	The training I have undertaken is relevant in practice.
competency5	317	+	0.8971	0.8917	0.4474	0.9776	The training and education I have received are essential for me to work effectively.
Shore management support							
shore1	317	+	0.8987	0.8934	0.4474	0.9776	The company management staff are friendly.
shore2	317	+	0.8987	0.8934	0.4474	0.9776	Management support the employees to perform well.
shore3	317	+	0.7093	0.6956	0.4523	0.9781	Management do not put pressure on the employees to achieve targets.
shore4	317	+	0.5896	0.5718	0.4555	0.9783	I do not experience conflicts with my employers.
shore5	317	+	0.7095	0.6959	0.4523	0.9781	Management staff regularly give importance to problems raised by employees.
shore6	317	+	0.5169	0.4969	0.4574	0.9785	Management is working for good safety.
shore7	317	+	0.5757	0.5574	0.4558	0.9784	Management never put schedule or cost above safety.
Health awareness							
health1	317	+	0.8886	0.8828	0.4477	0.9777	I am getting enough sleep.

health2	317	+	0.9	0.8948	0.4474	0.9776	I am getting enough rest hours.
health3	317	+	0.9005	0.8953	0.4473	0.9776	The company cares about my health and safety.
health4	317	+	0.9155	0.911	0.4469	0.9776	Suggestions to improve health and safety are welcomed.
health5	317	+	0.9147	0.9102	0.447	0.9776	I fully understand and am aware of my responsibilities for health and safety.
health6	317	+	0.9147	0.9102	0.447	0.9776	Management encourages safe work.
health7	317	+	0.9133	0.9087	0.447	0.9776	The crew is not encouraged to put health issues in second place to achieve a target.
health9	317	+	0.7553	0.7435	0.4511	0.978	The crew is expected to follow the work/rest cycle.
health10	317	+	0.9137	0.9091	0.447	0.9776	I have time to do my work.
Safety Culture							
safety4	317	+	0.9147	0.9101	0.447	0.9776	The safety training on-board is sufficient.
safety5	317	+	0.9109	0.9061	0.4471	0.9776	Fire drills are performed frequently.
safety6	317	+	0.9153	0.9108	0.447	0.9776	My co-workers do not pressure me to take shortcuts in my work.
safety7	317	+	0.3961	0.3732	0.4605	0.9788	I am familiar with the on-board safety goals.
safety8	317	+	0.9157	0.9112	0.4469	0.9776	Crews have adequate training in emergency procedures.
Importance of maritime regulations							
Imp2	317	+	0.9169	0.9125	0.4469	0.9776	This company follows all the regulations for the safety of the company and employees.
Imp3	317	+	0.8664	0.8595	0.4482	0.9777	This company follows the regulations effectively.
Imp4	317	+	0.3953	0.3724	0.4606	0.9788	I am aware the importance of maritime regulations.
Imp5	317	+	0.9151	0.9106	0.447	0.9776	I understand the consequences in the

							absence of safety regulations.
Imp6	317	+	0.913	0.9084	0.447	0.9776	All the employees are well exposed to the regulations.
Risk awareness							
Risk1	317	+	0.9142	0.9096	0.447	0.9776	I am aware of the risk of working on-board.
Risk3	317	+	0.9173	0.9129	0.4469	0.9776	I feel safe while working.
Risk4	317	+	0.9144	0.9099	0.447	0.9776	The working environment is safe for all the crews while working.
Risk5	317	+	0.9159	0.9114	0.4469	0.9776	I am not at risk of injury while working.
Job satisfaction							
Job2	317	+	0.5885	0.5706	0.4555	0.9783	I am comfortable asking for help when unsure how to do a task.
Job3	317	+	0.5911	0.5733	0.4554	0.9783	I get proper instructions for any work I do.
Job4	317	+	0.5919	0.5742	0.4554	0.9783	My suggestions to enhance safety are appreciated.
Job5	317	+	0.5901	0.5723	0.4555	0.9783	I am comfortable to interact with everyone on-board.
Test scale					0.4531	0.9785	

Appendix W – Semi-Structured Interview Data (Shipping company managers and seafarers)

Shipping company managers – Respondent 1

Background

1. Can you briefly give an introduction about yourself? For example, your age, where you come from etc.
I work as a project manager
2. How long have you been in the industry?
23 years
3. What is the official title of your job and how long have you been working in this position?
Project manager
4. Do you have sailing experience? If yes, how long and why did you left the job?
No
5. How many employees are you responsible for? Can you explain about the challenges dealing with this number of employees?
Very challenging
6. How many ships do you manage?
No

Company Safety Culture Facts

What do you think about safety culture in shipping sector? Do you think it is very good, improving or very poor? Can you give reason to your answer?
Good/impressing/much better than before.
How would you rate the safety culture of your company? Do you think it is very good, improving or very poor? Why? Are there any features of your company that makes it safe? Are there any feature of your company that makes it unsafe?
Safety policies/requirement/marine diciplines It is the culture/ follow maritime regulations You have to improve events and no such thing as unsafe/ how we put things together in the company/ have to fix all together
What is the main threat to safety in the shipping sector? Do you think it causes shipping accidents?
Dependent on technology

Yes Maintenance/training
How would you rate human errors in your company? I mean how often you encounter human error.
Not regular basis
In the last one year, have you had any incidents related to human errors? What types were they? How did they happen? How could you prevent these in the future?
No
Why do you think human error is still occurring despite maritime regulations and Safety Management System (SMS)? This is because based on my reading, the number of accidents is huge and its impact is serious for example loss of life and properties and marine environment pollution.
Human are human always/decision mistake.
How would you rate your company's SMS? I mean how well you are practising it in your company. Also, Do you well understand SMS? Do you think it is effective in enhancing safety? How is the company implementing SMS?
Not very detail Yes/but sometimes to burden if not careful/increase work load Don't know
What safety training do you provide to sea staff? Is this effective? I mean is this effective to their awareness and responsibilities towards safety?
Not related

Opinions on results from safety culture survey

Among the following safety aspects, which factors are important to safety culture and why? So, these are the safety aspects that I have used in my survey.

Safety aspects		Rank (1-9)
a	Working environment satisfaction	4
b	Communication and language barriers	3

c	Health awareness	8
d	Importance of maritime regulations	5
e	Reporting culture	9
f	Competency level	1
g	Risk awareness	7
h	Shore management support	6
i	Job satisfaction	2

The following pairs of safety aspects have shown very weak relationship (poor correlation).

In your opinion, what might be the possible reasons of such results?

Do they reflect poor safety practices in shipping sector and if so, why?

Safety aspect pairs		Opinions (short answers)
a	Working environment satisfaction – Competency level	
b	Working environment satisfaction – Shore management support	
c	Working environment satisfaction – Importance of maritime regulations	
d	Reporting culture – Communication and language barrier	
e	Reporting culture – Competency level	
f	Reporting culture – Health awareness	
g	Reporting culture – Importance of maritime regulations	
h	Reporting culture – Risk awareness	
i	Communication and language barrier – Competency level	
j	Communication and language barrier – Shore management support	No good relationship between shore management
k	Communication and language barrier – Importance of maritime regulations	
l	Communication and language barrier – Job satisfaction	
m	Competency level – Shore management support	

n	Competency level – Health awareness	
o	Shore management support – Health awareness	
p	Shore management support – Importance of maritime regulations	
q	Shore management support – Risk awareness	
r	Health awareness – Job satisfaction	
s	Risk awareness – Job satisfaction	

The following pairs of safety aspects have shown contrasting relationship (negative correlation). Negative correlation is a relationship between two variables (safety aspects) in which one increases as the other decreases, and vice versa (which is uncommon). Based on your experience what might be the possible reasons for such relationship?

Safety aspect pairs		Opinions (short answers)
a	Working environment satisfaction – Job satisfaction	That very strange. Not sure
b	Working environment satisfaction – Risk awareness	
c	Shore management support – Reporting culture	
d	Job satisfaction – Reporting culture	
e	Job satisfaction– Competency level	
f	Competency level – Importance of maritime regulations	
g	Risk awareness – Communication and language barrier	
h	Risk awareness– Health awareness	
i	Risk awareness – Importance of maritime regulations	

How maritime regulations be utilised to improve safety culture and reduce human error?

How they all cooperate to utilise the regulation.

Based on your experience, how can safety culture be improved and promoted? So, if you have given a chance, what strategy would you recommend?

Should develop in person.

Understand what safety is

How it affects you Why they are doing it/what are the risks
Based on your experience, how can human error and its impact be reduced? So, if you have given a chance, what strategy would you recommend?
From technology perspective Be more efficient Human-technology friendly interference Use technology to take risk from people
Finally, would you like to add anything more?
No

Thank you very much for your cooperation. It will be useful for my research and I really appreciate that. Have a nice day!

Shipping company managers – Respondent 2

Background

Can you briefly give an introduction about yourself? For example, your age, where you come from etc.
Callum, 63 years. I work in Shell for 35 years. 1982-2002: sea/master Shore/2003
How long have you been in the industry?
35 years.
What is the official title of your job and how long have you been working in this position?
Global maritime skill consultant.
Do you have sailing experience? If yes, how long and why did you left the job?
Yes, 21 years. Because benefit my skills in the maritime structure/apply sea skills in operations management/business.
How many employees are you responsible for? Can you explain about the challenges dealing with this number of employees?
2 direct/ part of a 2-big team.
How many ships do you manage?
None.

Company Safety Culture Facts

What do you think about safety culture in shipping sector? Do you think it is very good, improving or very poor? Can you give reason to your answer?
Improving – demonstrate the improvement TRCFS Regular check
How would you rate the safety culture of your company? Do you think it is very good, improving or very poor? Why? Are there any features of your company that makes it safe? Are there any feature of your company that makes it unsafe?
Very good Risk based approaches/everything risk assessed

What is the main threat to safety in the shipping sector? Do you think it causes shipping accidents?
Competence/professional human.
How would you rate human errors in your company? I mean how often you encounter human error.
In everyday life/managing human error very well.
In the last one year, have you had any incidents related to human errors? What types were they? How did they happen? How could you prevent these in the future?
None.
Why do you think human error is still occurring despite maritime regulations and Safety Management System (SMS)? This is because based on my reading, the number of accidents is huge, and its impact is serious for example loss of life and properties and marine environment pollution.
Inappropriate training/ leadership not effective High cost for improvements
How would you rate your company's SMS? I mean how well you are practising it in your company. Also, Do you well understand SMS? Do you think it is effective in enhancing safety? How is the company implementing SMS?
Very good uphold principles in the systems. No systems no shell Yes yes absolutely Engagement/collaboration
What safety training do you provide to sea staff? Is this effective? I mean is this effective to their awareness and responsibilities towards safety?
To understand the role

Opinions on results from safety culture survey

Among the following safety aspects, which factors are important to safety culture and why? So, these are the safety aspects that I have used in my survey.

Safety aspects	Rank (1-9)

	a	Working environment satisfaction	All competency and risk awareness are high	
	b	Communication and language barriers		
	c	Health awareness		
	d	Importance of maritime regulations		
	e	Reporting culture		
	f	Competency level		
	g	Risk awareness		
	h	Shore management support		
	i	Job satisfaction		

The following pairs of safety aspects have shown very weak relationship (poor correlation).

In your opinion, what might be the possible reasons of such results?

Do they reflect poor safety practices in shipping sector and if so, why?

Safety aspect pairs		Opinions (short answers)
a	Working environment satisfaction – Competency level	It's all about an individual's competency/perception/lack of support from management
b	Working environment satisfaction – Shore management support	
c	Working environment satisfaction – Importance of maritime regulations	
d	Reporting culture – Communication and language barrier	
e	Reporting culture – Competency level	
f	Reporting culture – Health awareness	
g	Reporting culture – Importance of maritime regulations	
h	Reporting culture – Risk awareness	
i	Communication and language barrier – Competency level	
j	Communication and language barrier – Shore management support	
k	Communication and language barrier – Importance of maritime regulations	

l	Communication and language barrier – Job satisfaction	
m	Competency level – Shore management support	
n	Competency level – Health awareness	
o	Shore management support – Health awareness	
p	Shore management support – Importance of maritime regulations	
q	Shore management support – Risk awareness	
r	Health awareness – Job satisfaction	
s	Risk awareness – Job satisfaction	

The following pairs of safety aspects have shown contrasting relationship (negative correlation). Negative correlation is a relationship between two variables (safety aspects) in which one increases as the other decreases, and vice versa (which is uncommon). Based on your experience what might be the possible reasons for such relationship?

Safety aspect pairs		Opinions (short answers)
a	Working environment satisfaction – Job satisfaction	Being isolated/no concentration/afraid to report getting caught
b	Working environment satisfaction – Risk awareness	
c	Shore management support – Reporting culture	
d	Job satisfaction – Reporting culture	
e	Job satisfaction– Competency level	
f	Competency level – Importance of maritime regulations	
g	Risk awareness – Communication and language barrier	
h	Risk awareness– Health awareness	
i	Risk awareness – Importance of maritime regulations	

How maritime regulations be utilised to improve safety culture and reduce human error?

2 things

To avoid negative incidents

To preserve life Learning from incidents
Based on your experience, how can safety culture be improved and promoted? So, if you have given a chance, what strategy would you recommend?
Open engagement/good communication Transparency/incident reporting Implementation of better system/SMS
Based on your experience, how can human error and its impact be reduced? So, if you have given a chance, what strategy would you recommend?
Employ competent individuals whom willing to develop/practise safety Effective monitoring Suitable/appropriate rewards to encourage employees to work safe and satisfied
Finally, would you like to add anything more?
None

Thank you very much for your cooperation. It will be useful for my research and I really appreciate that. Have a nice day!

Shipping company managers – Respondent 3

Background

Can you briefly give an introduction about yourself? For example, your age, where you come from etc.
Aged 50, British. Graduated as Naval Architect 1988, then carried out Dept of Transport sponsored Research / MPhil on survivability of Ro-Ro vessels in collision, graduating 1990. Subsequently worked as ship surveyor for Class Society (LR) for 10 years mainly for new building in Korea and repair ships in China, then worked as Senior Ship Surveyor for Red Ensign Group Flag for a couple of years, currently working as Naval Architect for Shell.
How long have you been in the industry?
30 years.
What is the official title of your job and how long have you been working in this position?
Naval Architect at Shell – 7 years.
Do you have sailing experience? If yes, how long and why did you left the job?
No ship sailing experience.
How many employees are you responsible for? Can you explain about the challenges dealing with this number of employees?
None.
How many ships do you manage?
None.

B. Company Safety Culture Facts

What do you think about safety culture in shipping sector? Do you think it is very good, improving or very poor? Can you give reason to your answer?
Improving. Increased safety awareness at shipyards and on-board ships / offshore production platforms– safety campaigns, training and learning from incidents.
How would you rate the safety culture of your company? Do you think it is very good, improving or very poor? Why? Are there any features of your company that makes it safe? Are there any feature of your company that makes it unsafe?
Very good. Great focus on Life Saving Rules, on "Goal Zero" (recordable incidents), on carrying out Journey Management Plans and Travel Risk Assessments wherever appropriate for business travel, safety day once per year for the whole company, globally, meetings commence with safety moments.
What is the main threat to safety in the shipping sector? Do you think it causes shipping accidents?

Commercial pressures resulting in short cuts being taken rather than taking time to work out how to eliminate or reduce a risk.
How would you rate human errors in your company? I mean how often you encounter human error.
Infrequently – where they have occurred, then Learning from Incidents document is produced, highlighting the risk to others and advising how best to mitigate the risk.
In the last one year, have you had any incidents related to human errors? What types were they? How did they happen? How could you prevent these in the future?
No.
Why do you think human error is still occurring despite maritime regulations and Safety Management System (SMS)? This is because based on my reading, the number of accidents is huge, and its impact is serious for example loss of life and properties and marine environment pollution.
Commercial pressures: overwork, employees not being given time to mitigate risks that they face, inadequate training.
How would you rate your company's SMS? I mean how well you are practising it in your company. Also, Do you well understand SMS? Do you think it is effective in enhancing safety? How is the company implementing SMS?
I believe that it is effective in enhancing safety, but I have little to do with SMS so do not have detailed knowledge of the system and how it is implemented.
What safety training do you provide to sea staff? Is this effective? I mean is this effective to their awareness and responsibilities towards safety? Personally, none as I do not manage staff… but with respect to the department as a whole we have safety induction on joining the company where we are taught about Life Saving Rules and Goal Zero. We have "safety day" discussions on safety. Bespoke offshore platform or ship specific training is provided if visiting an offshore platform or ship. Ditto for a shipyard visit.

Opinions on results from safety culture survey

Among the following safety aspects, which factors are important to safety culture and why? So, these are the safety aspects that I have used in my survey.

Safety aspects	Rank (1-9)

a	Working environment satisfaction	8
b	Communication and language barriers	5
c	Health awareness	7
d	Importance of maritime regulations	4
e	Reporting culture	3
f	Competency level	6
g	Risk awareness	1
h	Shore management support	2
i	Job satisfaction	9

The following pairs of safety aspects have shown very weak relationship (poor correlation).

In your opinion, what might be the possible reasons of such results?

Do they reflect poor safety practices in shipping sector and if so, why?

Safety aspect pairs		Opinions (short answers)
a	Working environment satisfaction – Competency level	I think that it is in human nature to become acclimatised to a certain risk level at work if you see everyone around you in the same environment taking the same risks as you are, therefore competency level, shore management support and maritime regs can become ineffective in affecting one's satisfaction. Yes, they reflect poor safety practices - need safety induction training, safety campaigns to raise risk awareness.
b	Working environment satisfaction – Shore management support	
c	Working environment satisfaction – Importance of maritime regulations	
d	Reporting culture – Communication and language barrier	Reporting culture needs to be instilled from above, by management. The five pairs all have different answers and I do not see why they should have such great correlation other than (h), e.g. (d) perhaps is a good thing that reporting culture is
e	Reporting culture – Competency level	
f	Reporting culture – Health awareness	

g	Reporting culture – Importance of maritime regulations	unaffected by communication and language barriers. Surprised that (h) risk awareness and reporting culture are not related – to me this indicates that the information obtained from the incident reports are not being analysed and shared back to those on the front line and of the 5 (d to h) this one stands out as reflecting poor safety practices.
h	Reporting culture – Risk awareness	
i	Communication and language barrier – Competency level	Although communication and language barriers should led to safety concerns, I do not see why the parings listed should correlate …so the apparent independence of the two items in each pairing do not in my opinion indicate poor safety practices.
j	Communication and language barrier – Shore management support	
k	Communication and language barrier – Importance of maritime regulations	
l	Communication and language barrier – Job satisfaction	
m	Competency level – Shore management support	Little correlation between the items in the parings come as no surprise. I do not think that they reflect poor safety practices. They are independent.
n	Competency level – Health awareness	
o	Shore management support – Health awareness	Little correlation between the items in the parings come as no surprise. I do not think that they reflect poor safety practices. They are independent.
p	Shore management support – Importance of maritime regulations	
q	Shore management support – Risk awareness	
r	Health awareness – Job satisfaction	Similar answer to a / b / c
s	Risk awareness – Job satisfaction	Similar answer to a / b / c

The following pairs of safety aspects have shown contrasting relationship (negative correlation). Negative correlation is a relationship between two variables (safety aspects) in which one increases as the other decreases, and vice versa (which is uncommon). Based on your experience what might be the possible reasons for such relationship?

<table>
<tr><th colspan="2">Safety aspect pairs</th><th>Opinions (short answers)</th></tr>
<tr><td>a</td><td>Working environment satisfaction – Job satisfaction</td><td rowspan="2">No idea on (a).

(b) seems obvious… if you are aware of risks then you should be less satisfied with the work environment.</td></tr>
<tr><td>b</td><td>Working environment satisfaction – Risk awareness</td></tr>
<tr><td>c</td><td>Shore management support – Reporting culture</td><td>No idea.</td></tr>
<tr><td>d</td><td>Job satisfaction – Reporting culture</td><td rowspan="2">(d) too much paperwork and form filling perhaps can diminish job satisfaction. (e) perhaps indicates that if your job is more challenging for you then you achieve greater job satisfaction.</td></tr>
<tr><td>e</td><td>Job satisfaction– Competency level</td></tr>
<tr><td>f</td><td>Competency level – Importance of maritime regulations</td><td>Relying on maritime regulations and applying them by rote, perhaps diminishes the necessity to risk assess for oneself and therefore less competency required with respect to risk awareness.</td></tr>
<tr><td>g</td><td>Risk awareness – Communication and language barrier</td><td rowspan="3">(g) the greater the challenges in communication the greater the challenges in safety induction training and for intervening with colleagues who perhaps are seen to be exposed to risks in the work place.

(h) no idea.

For (i) see answer to (f).</td></tr>
<tr><td>h</td><td>Risk awareness– Health awareness</td></tr>
<tr><td>i</td><td>Risk awareness – Importance of maritime regulations</td></tr>
</table>

How maritime regulations be utilised to improve safety culture and reduce human error?

Training and Learning from Incidents that have arisen because of maritime regulations not being complied with.

Based on your experience, how can safety culture be improved and promoted? So, if you have given a chance, what strategy would you recommend?

Leadership commitment to supporting safety culture needs to be visible to all their reports. Should be led by example.

Based on your experience, how can human error and its impact be reduced? So, if you have given a chance, what strategy would you recommend?

Compliance with Life Saving Rules, Training, instilling a Safety Culture in the company that encourages you to not do something if you think that it is hazardous, that is, awareness that management will always support you if there is an identified safety concern and that safety is the top priority.

Finally, would you like to add anything more?

No.

Thank you very much for your cooperation. It will be useful for my research and I really appreciate that. Have a nice day!

Shipping company managers – Respondent 4

Background

Company Safety Culture Facts

Can you briefly give an introduction about yourself? For example, your age, where you come from etc.
I'm Alvin Ho (36-yr) from Malaysia and has been with Shell for about 12 years. Joined Shell Upstream based in Miri, Sarawak after my study in MSc. Environmental Eng. and Civil Eng. from Universiti Sains Malaysia. I started as a graduate HSE Engineer specializing in projects (seismic, exploration drillings, front end & development) for Environmental discipline (3-yr) and regional reporting role for Upstream Asia (1-yr). Successful in leading numerous Environmental Impact Assessments, Environmental Management Plans and successful for permits to Install and Operated by relevant Government authorities for new development projects. Then, I took up the role of Technical Safety Engineer (4-yr) focussing on Brownfield modifications (i.e. life extension assessments for Enhanced Oil Recovery, living quarter removal & utilities upgrades), Operational HSE Case review and operation assurance for acceptance of new projects (Gumusut Kakap FPS & Malikai TLP) on behalf of operator. Also, involved in critical assurance and verification activities such as Pre-sail away, Pre-commissioning and Final Acceptance Audits for projects (i.e. subsea & fixed jackets). Spent about a year leading the inaugural Tier 3 cross country oil spill exercise between Shell Malaysia Upstream, Brunei Shell Petroleum, Malaysia and Brunei Government. I've been in the UK with Shell International Trading & Shipping Co. Ltd. for the past 4 years as Technical and Process Safety Advisor focussing on projects (i.e. liquid hydrogen carrier, regasification, LNG bunkering, ship-shore interface, LNG carrier efficiency improvement opportunities) and general Process Safety improvements for shipping and maritime.
How long have you been in the industry?
I've been with oil and gas industry for 12-year. 8-year in Upstream activities and 4-year in shipping and maritime industry.
What is the official title of your job and how long have you been working in this position?
Technical & Process Safety Advisor for 2-year Previously, Technical Safety Engineer for 2-year.
Do you have sailing experience? If yes, how long and why did you left the job?
No sailing experiences.
How many employees are you responsible for? Can you explain about the challenges dealing with this number of employees?
I don't have any staff report directly to me but I'm part of the leadership team for Shipping Maritime Technology and Innovation department.
How many ships do you manage?
None.

What do you think about safety culture in shipping sector? Do you think it is very good, improving or very poor? Can you give reason to your answer?
Generally, there are thousands on safety incidents for shipping industry and it's not improving. Shipping incident records showed there were lots of repetitive incidents and the industry has yet to learn from it. Not to say improve further.
How would you rate the safety culture of your company? Do you think it is very good, improving or very poor? Why? Are there any features of your company that makes it safe? Are there any feature of your company that makes it unsafe?
In Shell, we've tried utmost best to improve safety within our operations as well as working with partners in shipping industry. I would rate it as good. There are still opportunities to raise the bar by pushing for greater improvement. All Shell staff understand safety is top priority in all our decision and actions.
What is the main threat to safety in the shipping sector? Do you think it causes shipping accidents?
Residual risk in design, lack of understanding and management of safety critical equipment and sharing of incident learnings as a group.
How would you rate human errors in your company? I mean how often you encounter human error.
Human error is the easiest way out in most incident investigation and personally it's the weakest findings. There must be some underlying causes in the system or organization that put a person to commit mistake or not complying to procedures.
In the last one year, have you had any incidents related to human errors? What types were they? How did they happen? How could you prevent these in the future?
I was involved in a Causal Learning investigation for mooring incidents from one of our partner. Some of the lessons learnt are gaps in culture and knowledge (i.e. situational awareness, culture, knowledge & experience, autocratic & management style), lack of maintenance strategy (competency, commercial pressure and common in industry), crew unable to respond on changing conditions (i.e. perceived commercial pressure, situational awareness, relying on authority, risk tolerance & culture), cargo operations (situational awareness, risk tolerance, oversight missing, changing from stable to unstable situation, competency) and equipment in poor conditions (i.e. culture, peer pressure, commercial pressure, risk tolerance, it wouldn't happen to me, why bother?).
Why do you think human error is still occurring despite maritime regulations and Safety Management System (SMS)? This is because based on my reading, the number of accidents is huge, and its impact is serious for example loss of life and properties and marine environment pollution.
Lack of understanding of hazards, clear line of sight to major accident, or foresee risks when situation changes (i.e. wind or wave pick up).

Company culture which lead to systemic issue which might jeopardise safety performance. Office staff that make certain decisions which impacted crew activities (i.e. cost cutting initiatives).
How would you rate your company's SMS? I mean how well you are practising it in your company. Also, Do you well understand SMS? Do you think it is effective in enhancing safety? How is the company implementing SMS?
I would rate Shell Integrated Management System (SMS) as good. There is dedicated team managing and reviewing the requirements for conventional ships (ie. LNG carrier, crude carrier). Good and effective management of IMS/SMS will give positive impact to safety performance. Potential lacking is managing risk related to ships with step out against conventional shipping activities (ie. LNG bunkering, liquid hydrogen carrier).
What safety training do you provide to sea staff? Is this effective? I mean is this effective to their awareness and responsibilities towards safety?
Unable to comment.

Opinions on results from safety culture survey

Among the following safety aspects, which factors are important to safety culture and why? So, these are the safety aspects that I have used in my survey.

Safety aspects		Rank (1-9)
a	Working environment satisfaction	4
b	Communication and language barriers	5
c	Health awareness	8
d	Importance of maritime regulations	9
e	Reporting culture	7

f	Competency level	3
g	Risk awareness	2
h	Shore management support	6
i	Job satisfaction	1

The following pairs of safety aspects have shown very weak relationship (poor correlation).

In your opinion, what might be the possible reasons of such results?

Do they reflect poor safety practices in shipping sector and if so, why?

Safety aspect pairs		Opinions (short answers)
a	Working environment satisfaction – Competency level	
b	Working environment satisfaction – Shore management support	
c	Working environment satisfaction – Importance of maritime regulations	
d	Reporting culture – Communication and language barrier	
e	Reporting culture – Competency level	
f	Reporting culture – Health awareness	
g	Reporting culture – Importance of maritime regulations	
h	Reporting culture – Risk awareness	
i	Communication and language barrier – Competency level	
j	Communication and language barrier – Shore management support	
k	Communication and language barrier – Importance of maritime regulations	
l	Communication and language barrier – Job satisfaction	
m	Competency level – Shore management support	

n	Competency level – Health awareness	
o	Shore management support – Health awareness	
p	Shore management support – Importance of maritime regulations	
q	Shore management support – Risk awareness	
r	Health awareness – Job satisfaction	
s	Risk awareness – Job satisfaction	

The following pairs of safety aspects have shown contrasting relationship (negative correlation). Negative correlation is a relationship between two variables (safety aspects) in which one increases as the other decreases, and vice versa (which is uncommon). Based on your experience what might be the possible reasons for such relationship?

Safety aspect pairs		Opinions (short answers)
a	Working environment satisfaction – Job satisfaction	
b	Working environment satisfaction – Risk awareness	
c	Shore management support – Reporting culture	
d	Job satisfaction – Reporting culture	
e	Job satisfaction– Competency level	
f	Competency level – Importance of maritime regulations	
g	Risk awareness – Communication and language barrier	
h	Risk awareness– Health awareness	
i	Risk awareness – Importance of maritime regulations	

How maritime regulations be utilised to improve safety culture and reduce human error?

Safety culture is a reflective of the company leadership.

Human error will be reduced with inherent safe design of ship (i.e. system or equipment) & increase of risk or hazards awareness among crew (include office staff).

Maritime regulations can reduce human error if the requirements are specific and detail.

Based on your experience, how can safety culture be improved and promoted? So, if you have given a chance, what strategy would you recommend?
Safety culture is a reflective of the company leadership. Frequent leaders visit to ship and frontlines, walk the talk, have strong ambitions to improve safety (i.e. aim for zero incident), provide allocation for safety improvement initiatives and share incident learning with the industry.
Based on your experience, how can human error and its impact be reduced? So, if you have given a chance, what strategy would you recommend?
Human error will be reduced with inherent safe design of ship (i.e. system or equipment) & increase of risk or hazards awareness among crew (include office staff).
Finally, would you like to add anything more?
Thank you for the survey. I've difficulties to provide answer for question 16 & 17.

Thank you very much for your cooperation. It will be useful for my research and I really appreciate that. Have a nice day!

Shipping Company managers – Respondent 5

Individual Background
Can you briefly give an introduction about yourself?
Marine management system manager (LR) Dealing with ISM Code, Maritime Labour Convention
How long have you been in the industry?
Been in the industry for 43 years 20 years sailing experience at sea, mostly in Asia
Official title of your job?
Refer Q1
4. Sailing experience/why left the job.
Yes, disagreements with the company allowing me joining the ship with my wife.
How many employees are you responsible for? / challenges
Seven people directly report to me/ 470 safety auditors working under the procedures. Challenges: when the ISM Code was introduced, the IMO trying to drive a change the safety culture quickly, I mean within a few years. I do not believe see a massive change in the industry culture. We are seeing improvements in safety management within industry but not quickly. Every increasing number of regulations/requirements are placed on ship staffs and they are finding increasingly hard not to address the requirement but to understand what they are in the first place. It is quite a burden for them. The ships are usually complied with regulations but the factors like ports authorities (not address the requirements) for example when we talk about security. The Flag State administration is easier to put the responsibility for changing compliance directly onto the sea staff because they used to be the head for all the regulations. But it's becoming quite difficult to deal with because I don't believe take an example when in sea in 1974, I don't believe from a safety management point of view that the ship that I worked on then was any less safe than the ships people are working on now, not from a management point of view. There is been some changes in technology, so your equipment maybe designed to move things safer that has its own disadvantages because technologies goes the other way. But I think in terms of company attitudes things haven't changed much. I not convinced with all the new regulations coming in for last 30-40 years to make things safer. Seafarers not following the new regulations effectively following increasing workloads. If you see there is a very small reference within the ISPS code saying that the company and the flag of administration should consider, the extra burden being placed on the sea staff when looking at the safe manning level of the ship.

We saw ZERO change in safe manning even though ship staffs will be required to do more. We do see occasional conflicts between safety and security and which is always error in the side of safety of code, but they don't. For example: because there is no increase in the manning level of the ship you have an AB on board whose job it is to stay at the gangway and do security checks on everybody who comes on board, but he may also be responsibility to making sure the ship mooring lines are tight. If he moves out to check the mooring line and leaves the gangway unattended the ship get retained. That's wrong. But what should have happened was the Flag State to be more responsibility for safe. This will be an increase manning level to deal with this, but they didn't. it always leaves to the company. Like I said earlier it is easier to put the regulations and the requirements on the company and ship staffs. You got always have extra work to do, it is up to you to make sure you properly meant to do it. Rather than the administration saying we think the manning level should be increased.
How many ships do you manage?
Team manages 6000 ships
Company Safety Culture Issues
Safety culture in shipping sector
There is a percentage of the industry, which is actively embracing any opportunity to improve its safety awareness and safety culture. Those companies will engage much more with the seafarers because it needs two sided it need shore-based operations to support what is going on board the ship. Probably, about 20% of the industry is getting benefits doing that. I still think that most of the shipping sector is only doing what it need to do to achieve compliance with the prescriptive regulations. When you look at safety management, it is not prescriptive, it is the safety management code the ISM Code, which is basics, is what to be achieved but it is up to the company to decide how it does it. But many of them see it as prescriptive so we have the procedures for this. So, we will have a piece of paper and this is what we do. We must fill in a form to sat we have done it. They do not really get any benefit from it. I still think that the large percentage of the industry either openly falsify information to say that they done things even though they haven't because they are more concern about the cost of providing safety than the cost of dealing with safety. Based on my experience, the shipping industry is 100% behind safe management affairs. What seafarers is facing now is they already hearing about autonomous ships. They seeing their potential future threatens. People at sea or going to go to sea are bothered about this because they think I am going to be replaced by an autonomous ship. But I think you never going to get that on ship in term of safety culture. Quite negative but... Good, improving or very poor? I think if the company wanted something then "Yes". Overall, cultural improvement "No". You must look at accident statistics to see the pattern whether safety in the industry is good or poor.
How would you rate the safety culture of your company?
The culture in my company is interesting. Very definitely driven from the top and with specific agenda requirements. But I do feel it's a kind of forced culture. We have an element sort of enforcement for so many things as well. So, people they are not necessarily by into it but they are doing things because if they do not there is a disciplinary case. So that I don't count as culture and I think everybody want to be safe.

This is because people are being told. I give one example: few years ago, we brought I a requirement for anybody who going climb a vertical ladder of two meters or more would have to wear a full safety harness with two-point attachments to climb two meters. So that would mean that every time I was walking around the ship even to from the main deck upon to the mass house I have to wear full safety harness which is ridiculous. So, our practical people, people who actually doing this sort of kick back at that and we got that changed to four meters which is reasonable. If you are climbing a vertical ladder of four meters height, then you wear safety harness that is fine! You should wear it when you think it is necessary and you believe you should. That is the type approach is enforcement of the safety culture. You should get people's heart rather than the procedures. That is the one example. They are very safety focus so that is our business. Are there any features of your company that makes it safe? Yes! So, we have a guideline not only for us but for the industry. It is highly focused on making things safe. In term of shipping industry, we are more involved in setting up, applying and creating regulations for safety rather than being on the other side and having comply with them. Are there any feature of your company that makes it unsafe? The forced culture. The over emphasis also will cause a bit of kick back. So, indirectly that could be unsafe.
What is the main threat to safety in the shipping sector?
Overall, it takes all aspects of ship safe run. Fatigue is very real threat and the main one. I also don't believe that IMO does enough to address it. There are new guidelines which have been in development for sometimes but there are only guidelines they are not regulations and there is a unwillingness to recognise their failings of some watch keeping systems (6 on 6 off) for extending periods which is comes to work again. Even though analysis of various watch keeping patterns show this 6 on 6 off does not really work. The IMO is reluctant to bring in a regulation preventing that and because it all related to increasing manning which is the 'cough' of the industry.
How would you rate human errors in your company?
Well, in our training courses we were always had 80% of the incidents caused by human error which is an industry sort of figure. But you could argue that there is an element of human error in every sector. Even if it is an equipment failure it could the equipment design which is the human fault. There are well known cases of human errors occurring because of the inappropriateness of the equipment. A very quick example: on a wheelhouse control panel the seafarers might face with a line of three xxx one to the bow thrust one might be for the helms. And in one case it's got to push the switch this way to move the ship to the port and then in the control below he has to do it complete opposite to move the switch the other way. The understanding of the complexity of the equipment is something that the seafarers might struggle with. Particularly modern equipment is that the matter of training and experience that they go from one ship to another they go for every five or six months with different equipment. Then start using it with very little briefing. We had many incidents due to this modern equipment such as radar/ARPA even though it was designed for safety. Over reliance on it or failure to understand to use it properly is actually causing accidents. The human error, which is brought about because of the failing to understand. In another case we can talk about actual "national culture" it could even be ethics in some cases without mentioning any I do know in some areas the seafarers attitude.

I'm working on the behalf of the government, so I don't have to, and they have very lackadaisical attitude towards safety as I am here only for few months and I am not coming back to the ship so why should I care whether we properly maintain the equipment or not, which lead to an accident. Human errors due to different nationality which lead to problems in communications. It causes accidents too.
In the last one year, have you had any incidents related to human errors? What types were they? How did they happen? How could you prevent these in the future?
Yes. Slipped on board. They should be more aware about their surrounding before they carry out the work. We have guidance on safety, if you followed that you would be always safe. But the problem they have is that I will always be safe, but I may not be able to complete the job. Lots of error is comes from this conflict between one thing to keep the customer happy if you like and protecting your own safety or safe the others even.
Why do you think human error is still occurring despite maritime regulations and Safety Management System (SMS)?
It is perhaps, there is so much regulations that trying to comply with all with all of the time is difficult to the ship staff. At a certain level staff particularly, junior staff are not made fully aware of the consequences of not complying. Taking short cuts, walking through a water tight door while it's closing because it saves time or failing to open it fully before you start is classic. They are not fully aware of what could happen if we don't comply with the requirement. So, I think that is one reason. You should penalise them to make sure they do it or better way is to educate them, and I don't think they are properly educated despite all the facilities, many seafarers are not sufficiently educated in convinced of the need to do it in certain way.
How would you rate your company's SMS? Do you think it is effective in enhancing safety? How is the company implementing SMS?
I think it is very good (company), it changed recently because of the feedback. It was overly prescribed before and we are trying to make it less prescriptive. Our system is improving. Yes, I understand SMS of my company. Everybody has to take test on it so you should know. Yes, it is effective enhancing safety. If you look at our safety report, surveyors working in dangerous environments they must board ship or anchor and boat-to-boat transfer which is a dangerous activity, they have work in closed spaces. We have got good procedures and those surveyors who doing it are aware of the all precautions taken and the reasons why. In our company all are aware of the consequences of not doing it. It is well implemented. Everybody is well educated on it and everybody is given the equipment that they need to conduct their safety activities.
What safety training do you provide to sea staff? Is this effective?
In my company, both sea-based staffs and shore-based staffs coming for training in safety management systems, so if you like we train our clients on how to implement and comply safety management or ISM Code. We do trainings across the board.

From the industry point of view, I would say that generally the industry will rely on the statutory point. So, anything that you have to do to get your seafarers certificates in term safety trainings that is a must so all that must be done. At the basic level it is effective.
Opinions on results from safety culture survey
Among the following safety aspects, which factors are important to safety culture and why?
Most important aspects: They are all important, but some are more important than others. 1. Working environment satisfaction 2. Communication is vital 3. Importance of maritime regulations 4. Reporting culture/ near miss 5. Competency/attitude 6. risk awareness 7. Shore management support 8. Job satisfaction 9. Health awareness
The following pairs of safety aspects have shown very weak relationship (poor correlation). a. In your opinion, what might be the possible reasons for such results? Do they reflect poor safety practices in shipping sector and if so, why?
In term of working environment satisfaction: I don't think competency level/regulations has much impact on WES but shore management support is important.
The following pairs of safety aspects have shown a contrasting relationship (negative correlation). Based on your experience what might be the possible reasons for such relationships?
It does not make any sense. Maybe due to some anomalies in the size of the study. Maybe the second one – wes/ra: if you are happy with your working environment you are less likely to be thinking about the potential risks. I think that kind of things make sense. If you are feeling safe you don't think much about the risks. Shore ms/rc: this is contrasting as you need both. Maybe it could be they are getting support in certain things but not stressing enough on reporting. If you change shore management response to reporting maybe you could see more correlation. Js/cl: I can't see. Js/rc: but this again. If change reporting to form filling, and it is the less form filling they have to do then the happier they will be. That's why I might get the contrasting result. Cl/iomr: this is again to attitude. Ra/communication: it is hard to believe this. The better your communication the less your risk awareness becomes. I think it is due to anomalies. Maybe they don't understand the question because it is very hard to see.
How maritime regulations be utilised to improve safety culture and reduce human error?

Simplify them. So that it is easy to understand and practice. Safe manning. For example: this boat carrier which is trading from China to South America before and the safe manning let’s say on the at the Hong Kong Flag is sixteen, I failed to understand just because the flag on the back of the ship is changes from Hong Kong to xxx Islands to fourteen. So, the flag does not make any differences. So, different administrations are applying certain guidelines in a different way. So, it should be standardised at the IMO level rather than allowing a flag to make its own interpretation. Standardisation and simplification.
Based on your experience, how can safety culture be improved and promoted?
Focusing on the young people coming in the industry. It’s better to focus from the beginning. I think you got lot of these salty sea dogs who do not think in a certain way so long, they still have reasons to change. I do not think that many people now go to sea as a lifetime career anymore it is stepping stone to something else. This people think that I am coming here just for a short while and I don't really need to do anything to improve things. So, we need to get a better pool of intake and educate them in why it is not required but more in why it is required from early stage. That is how to improve the culture. Convincing people on the reason why rather than hitting the with what should do. Strategy to improve: Maybe this should be at the IMO level. It could be done by taking steps to better educate the younger/less experience side of the industry. It is a kind of trying to promote the culture in the very early stage, so the people are exposed/understand and getting ideas. I do not think this will be done by the IMO, but the industry or groups could bring in if they really wanted to. Many companies are struggling to find what they could do to seafarers now.
Based on your experience, how can human error and its impact be reduced?
Better standardisation requirement. So, it does not change too much from one ship to another. Uniform/standardised equipment.
Finally, would you like to add anything more?
Xxx. It was based on my experienced but more on generalised view.

Seafarers – Respondent 1

Background

Can you briefly give an introduction about yourself? For example, your position, age, where you come from etc.
Sailed as Marine Engineer on Pakistan National Shipping Corporation (PNSC), age 38, from Pakistan.
How long have you been at sea?
Approximately 5 years.
How long have you been employed by this company?
Approximately 5 years.
How long have you been employed by this company?
Same as above.

Company/Ship Safety Culture Facts:

Is this ship safe? If yes, why? And if no, why?
Ship is safe; however, some aspects may make it not so safe Spare parts not available when required Ship is, and machinery is very old, a lot of repairs required for hull and machinery Some Auto/control functions not working properly
How would you rate the safety culture of your company? Do you think it is very good, improving or very poor? Why? Are there any features of your company that makes it safe? Are there any feature of your company that makes it unsafe?
It is improving, The crew is well trained and experienced which make it safe The unexpected behaviour of the machinery and lack of spare parts when required
What is the main threat to safety in your ship? Do you think it may cause lead to casualties?

Not well maintained due to ship being old and always require maintenance of some kind either related to hull (plating etc.) or main and auxiliary machinery
How would you rate human errors in your company? I mean how often you encounter human error.
Very rare.
In the last one year, have you had any incidents related to human errors? What types were they? How did they happen? How could you prevent these in the future?
Yes, Transferring lube oil into Main Engine Sump The engineer who started the operation were asked to do another task and he handed over this operation to another engineer who was already busy in another task. The 2nd engineer forgot that the oil was being transferred and only realised when the complete lube oil tank was drained into main engine lube oil sump. It would have been prevented if the remote handling of the valves was possible and engineer who started the operation would have completed the task instead of transferring to someone else.
How could you make this ship safer? I mean is it by training, self-awareness, continuous support from the management etc.?
Training and continuous support from the management.
Why do you think human error is still occurring despite maritime regulations and Safety Management System (SMS)? This is because based on my reading, the number of accidents is huge, and its impact is serious for example loss of life and properties and marine environment pollution.
Long working hours and the nature of the work i.e. hostile working conditions.
How would you rate your company's SMS? I mean how well you are practising it in your company. Also, Do you well understand SMS? Do you think it is effective in enhancing safety? How is the company implementing SMS?
Yes Yes Through training and auditing of the crew
How well is the practice of SMS on this ship? Is this effective?
Yes, very effective.

What safety training do you provide to sea staff? Is this effective? I mean is this effective to their awareness and responsibilities towards safety?
Yes, crew understands that what effects their actions could have in saving the life and property at sea.
Does the management provide you with any assistance on safety matters? How?
Yes, through monitoring the ship operations and responding quickly in case any issue on ship and keeping a good communication.
Does the management give importance to safety problems raised by the ship personnel?
Yes.

Opinions on results from safety culture survey

Among the following safety aspects, which factors are important to safety culture and why? So, these are the safety aspects that I have used in my survey.

Safety aspects		Rank (1-9)
a	Working environment satisfaction	8
b	Communication and language barriers	9
c	Health awareness	6
d	Importance of maritime regulations	8
e	Reporting culture	9
f	Competency level	9
g	Risk awareness	9
h	Shore management support	8
i	Job satisfaction	7

The following pairs of safety aspects have shown very weak relationship (poor correlation).

In your opinion, what might be the possible reasons of such results?

Do they reflect poor safety practices in shipping sector and if so, why?

Safety aspect pairs	Opinions (short answers)

a	Working environment satisfaction – Competency level	a-This shows poor correlation because there could be other reasons for a competent person not being satisfied like
b	Working environment satisfaction – Shore management support	b- shore support is important , however sometime it can be too demanding for crew
c	Working environment satisfaction – Importance of maritime regulations	c- too many forms to fill can also put the crew away
d	Reporting culture – Communication and language barrier	d-if no action is taken after reporting then reporting culture subsides
e	Reporting culture – Competency level	e-I don’t think its related, so poor correlation exists
f	Reporting culture – Health awareness	f- related but very weak
g	Reporting culture – Importance of maritime regulations	g- related but very weak correlation
i	Communication and language barrier – Competency level	i-even a less competent person can have good communication skills
j	Communication and language barrier – Shore management support	J-very important, however it may put too much pressure on the crew.
k	Communication and language barrier – Importance of maritime regulations	k-weak correlation
l	Communication and language barrier – Job satisfaction	L-weak correlation
m	Competency level – Shore management support	m-it is important to be able to get support from shore when required
n	Competency level – Health awareness	n-strong correlation
o	Shore management support – Health awareness	o-shore management wants the smooth operation of ship
p	Shore management support – Importance of maritime regulations	p-high correlation
q	Shore management support – Risk awareness	q-high correlation
r	Health awareness – Job satisfaction	r- not related I think
s	Risk awareness – Job satisfaction	s- weak correlation

The following pairs of safety aspects have shown contrasting relationship (negative correlation). Negative correlation is a relationship between two variables (safety aspects) in which one increases as the other decreases, and vice versa (which is uncommon). Based on your experience what might be the possible reasons for such relationship?

Safety aspect pairs		Opinions (short answers)
a	Working environment satisfaction – Job satisfaction	a- Lack of communication and training not provided
b	Working environment satisfaction – Risk awareness	
c	Shore management support – Reporting culture	b-too much pressure and not good relations between shore and crew
d	Job satisfaction – Reporting culture	d-I think this should not have a negative correlation
e	Job satisfaction– Competency level	
f	Competency level – Importance of maritime regulations	f- I believe these doesn't have negative correlation
g	Risk awareness – Communication and language barrier	g- strong correlation
h	Risk awareness– Health awareness	h-this could be due to poor safety and just culture
i	Risk awareness – Importance of maritime regulations	i-this also indicates poor safety culture

How maritime regulations be utilised to improve safety culture and reduce human error?
Implementing through training and auditing/inspection.
Based on your experience, how can safety culture be improved and promoted? So, if you have given a chance, what strategy would you recommend?
Improving Training and awareness of the consequences of crew actions
Based on your experience, how can human error and its impact be reduced? So, if you have given a chance, what strategy would you recommend?
Training and promoting just culture, also good working practices are promoted and celebrated
Finally, would you like to add anything more?
Just culture amongst the crew is very important, where they free to report knowing that it can make a positive change.

Seafarers – Respondent 2

Background

Company/Ship Safety Culture Facts:

Can you briefly give an introduction about yourself? For example, your position, age, where you come from etc.
Imran Ibrahim, age 43, Technical Specialist in Technical Performance and Investigation Department, Lloyd’s Register, British Citizen, living in Britain since 2003, born and brought up in Pakistan, Karachi.
How long have you been at sea?
Nearly 10 years
How long have you been employed by this company?
Since 2009
How long have you been employed by this company?
years
Is this ship safe? If yes, why? And if no, why?
Our company has strict policy about health and safety, we all religiously follow s company’s health safety policy.
How would you rate the safety culture of your company? Do you think it is very good, improving or very poor? Why? Are there any features of your company that makes it safe? Are there any feature of your company that makes it unsafe?
I rate my Company’s safety culture 10/10, because we amend or update our safety policies from time to time to improve our safety culture, company introduce several mandatory e-learning courses to keep aware their employees about safety related issues and regulations. Currently working on zero harm policy, already training started.
What is the main threat to safety in your ship? Do you think it may cause lead to casualties?
When I was working on board the ship as a marine office, my main concern was to provide training and awareness to seafarers about safety and action take in emergency through several drills. Lack of awareness and training can lead to disaster.
How would you rate human errors in your company? I mean how often you encounter human error.
Human error cannot be eliminated but can reduce the error through proper training.
In the last one year, have you had any incidents related to human errors?

What types were they? How did they happen? How could you prevent these in the future?
a. Car accident, involving two cars in front of me on motorway, b. In competency, tiredness c. Awareness, proper training
How could you make this ship safer? I mean is it by training, self-awareness, continuous support from the management etc.?
Training, proper rest, awareness, development of safety culture.
Why do you think human error is still occurring despite maritime regulations and Safety Management System (SMS)? This is because based on my reading, the number of accidents is huge, and its impact is serious for example loss of life and properties and marine environment pollution.
I think it's because of tiredness, in competency and lack of employee.
How would you rate your company's SMS? I mean how well you are practising it in your company. Also, Do you well understand SMS? Do you think it is effective in enhancing safety? How is the company implementing SMS?
I will rate my company's SMS 10/10, because we all practice regularly A- Yes B- Yes C- Well effective in enhancing safety
How well is the practice of SMS on this ship? Is this effective?
Yes, it is effective if all seafarers have proper rest and training.
What safety training do you provide to sea staff? Is this effective? I mean is this effective to their awareness and responsibilities towards safety?
Yes.
Does the management provide you with any assistance on safety matters? How?
Yes, they provide full support and arrange drills and courses.

Does the management give importance to safety problems raised by the ship personnel?
Yes.

Opinions on results from safety culture survey

Among the following safety aspects, which factors are important to safety culture and why? So, these are the safety aspects that I have used in my survey.

Safety aspects		Rank (1-9)
a	Working environment satisfaction	7
b	Communication and language barriers	9
c	Health awareness	8
d	Importance of maritime regulations	7
e	Reporting culture	8
f	Competency level	8
g	Risk awareness	8
h	Shore management support	7
i	Job satisfaction	7

The following pairs of safety aspects have shown very weak relationship (poor correlation).

In your opinion, what might be the possible reasons of such results?

Do they reflect poor safety practices in shipping sector and if so, why?

Safety aspect pairs		Opinions (short answers)
a	Working environment satisfaction – Competency level	For greener world
b	Working environment satisfaction – Shore management support	For implementation
c	Working environment satisfaction – Importance of maritime regulations	For awareness

d	Reporting culture – Communication and language barrier	Cultural awareness and better understanding
e	Reporting culture – Competency level	High
f	Reporting culture – Health awareness	Very important
g	Reporting culture – Importance of maritime regulations	For investigation to avoid further risk
i	Communication and language barrier – Competency level	Reduce gape between management and seafarers
j	Communication and language barrier – Shore management support	To reduce gape and better understanding
k	Communication and language barrier – Importance of maritime regulations	
l	Communication and language barrier – Job satisfaction	
m	Competency level – Shore management support	8
n	Competency level – Health awareness	
o	Shore management support – Health awareness	8
p	Shore management support – Importance of maritime regulations	
q	Shore management support – Risk awareness	To keep up to date and safe
r	Health awareness – Job satisfaction	Safety first
s	Risk awareness – Job satisfaction	important

The following pairs of safety aspects have shown contrasting relationship (negative correlation). Negative correlation is a relationship between two variables (safety aspects) in which one increases as the other decreases, and vice versa (which is uncommon). Based on your experience what might be the possible reasons for such relationship?

Safety aspect pairs		Opinions (short answers)
a	Working environment satisfaction – Job satisfaction	To make seafarers comfortable
b	Working environment satisfaction – Risk awareness	required
c	Shore management support – Reporting culture	bonding
d	Job satisfaction – Reporting culture	Better communication

e	Job satisfaction– Competency level	Very high
f	Competency level – Importance of maritime regulations	
g	Risk awareness – Communication and language barrier	To develop safety culture
h	Risk awareness– Health awareness	
i	Risk awareness – Importance of maritime regulations	

How maritime regulations be utilised to improve safety culture and reduce human error?
Proper rest and training.
Based on your experience, how can safety culture be improved and promoted? So, if you have given a chance, what strategy would you recommend?
Meetings, drills, communication.
Based on your experience, how can human error and its impact be reduced? So, if you have given a chance, what strategy would you recommend?
Training and competency level.
Finally, would you like to add anything more?
Seafarers need proper rest and need entertainment to reduce the stress which lead to the human error.

Seafarers – Respondent 3

Background

Can you briefly give an introduction about yourself? For example, your position, age, where you come from etc.
I work in a cruise ship as a nursing officer
How long have you been at sea?
5 years
For how long have been sailing on this ship?
6 months
How long have you been employed by this company?
6 months

Company/Ship Safety Culture Facts:

Is this ship safe? If yes, why? And if no, why?
Yes, the company has focus in safety measures to ensure all crew and passenger are safe.
How would you rate the safety culture of your company? Do you think it is very good, improving or very poor? Why? Are there any features of your company that makes it safe? Are there any feature of your company that makes it unsafe?
Very good They investigate every options/possibility of ensuring safety always Luggage check before/after entry to ship none
What is the main threat to safety in your ship? Do you think it may cause lead to casualties?
Main threat: Fire which many lead to most casualty if not prevented
How would you rate human errors in your company? I mean how often you encounter human error.

Very minimally on the company/ship is highly digitalised.
In the last one year, have you had any incidents related to human errors? What types were they? How did they happen? How could you prevent these in the future?
Only been in the company for 6 months Injury of crew whilst doing their job Crushed finger in machinery Machinery/equipment has to be checked regularly PPE’s needs to be used all the time whilst performing duty.
How could you make this ship safer? I mean is it by training, self-awareness, continuous support from the management etc.?
Training Providing safety equipment
Why do you think human error is still occurring despite maritime regulations and Safety Management System (SMS)? This is because based on my reading, the number of accidents is huge, and its impact is serious for example loss of life and properties and marine environment pollution.
Because of employees not following the safe and proper way of operating equipment
How would you rate your company’s SMS? I mean how well you are practising it in your company. Also, Do you well understand SMS? Do you think it is effective in enhancing safety? How is the company implementing SMS?
Yes Very effective on the company do drills regularly Training, drills, handouts
How well is the practice of SMS on this ship? Is this effective?
Very effective.
What safety training do you provide to sea staff? Is this effective? I mean is this effective to their awareness and responsibilities towards safety?
Staffs now are provided specific safety training depending on where they work in the ship on top of other trainings in care of fire, man over board, abandoned ship

Does the management provide you with any assistance on safety matters? How?
- through training/drill - Through safety equipment
Does the management give importance to safety problems raised by the ship personnel?
Yes, a data log is allocated/filled in to every incident that occur on board, which is being identified/investigated regularly-so preventive measure can be implemented.

Opinions on results from safety culture survey

Among the following safety aspects, which factors are important to safety culture and why? So, these are the safety aspects that I have used in my survey.

Safety aspects		Rank (1-9)
a	Working environment satisfaction	8
b	Communication and language barriers	2
c	Health awareness	4
d	Importance of maritime regulations	1
e	Reporting culture	7
f	Competency level	6
g	Risk awareness	3
h	Shore management support	9
i	Job satisfaction	5

The following pairs of safety aspects have shown very weak relationship (poor correlation).

In your opinion, what might be the possible reasons of such results?

Do they reflect poor safety practices in shipping sector and if so, why?

Safety aspect pairs		Opinions (short answers)
a	Working environment satisfaction – Competency level	Depends sometimes on level of understanding of crew/staff
b	Working environment satisfaction – Shore management support	

c	Working environment satisfaction – Importance of maritime regulations	Various talk/strategy provided to crew is difficult to groups Different culture/confronting culture Education level and crew not trained maybe can be a factor.
d	Reporting culture – Communication and language barrier	
e	Reporting culture – Competency level	
f	Reporting culture – Health awareness	
g	Reporting culture – Importance of maritime regulations	
i	Communication and language barrier – Competency level	
j	Communication and language barrier – Shore management support	
k	Communication and language barrier – Importance of maritime regulations	
l	Communication and language barrier – Job satisfaction	
m	Competency level – Shore management support	
n	Competency level – Health awareness	
o	Shore management support – Health awareness	
p	Shore management support – Importance of maritime regulations	
q	Shore management support – Risk awareness	
r	Health awareness – Job satisfaction	
s	Risk awareness – Job satisfaction	

The following pairs of safety aspects have shown contrasting relationship (negative correlation). Negative correlation is a relationship between two variables (safety aspects) in which one increases as the other decreases, and vice versa (which is uncommon). Based on your experience what might be the possible reasons for such relationship?

Safety aspect pairs		Opinions (short answers)
a	Working environment satisfaction – Job satisfaction	Crew works harder to meet satisfaction level Crew work hard to meet target not thinking about risk
b	Working environment satisfaction – Risk awareness	

c	Shore management support – Reporting culture	Crew gets penalised for every negative report
d	Job satisfaction – Reporting culture	More job for crew, afraid of the consequences
e	Job satisfaction– Competency level	
f	Competency level – Importance of maritime regulations	Additional job for crew in top of the workload
g	Risk awareness – Communication and language barrier	Crew came from all over the world Some regulations do not apply to everything that happen on board
h	Risk awareness– Health awareness	
i	Risk awareness – Importance of maritime regulations	

How maritime regulations be utilised to improve safety culture and reduce human error?
Regulations should be implemented in line to existing regulations already put in place.
Based on your experience, how can safety culture be improved and promoted? So, if you have given a chance, what strategy would you recommend?
Training survey
Based on your experience, how can human error and its impact be reduced? So, if you have given a chance, what strategy would you recommend?
Training Questionnaire/survey
Finally, would you like to add anything more?
None.

Seafarers – Respondent 4

Background

Can you briefly give an introduction about yourself? For example, your position, age, where you come from etc.
Eighteen years ears as a cadet- marine engineer/ Chief engineer/Shell Tankers.
How long have you been at sea?
Ten years
How long have you been sailing on this ship?
No more
How long have you been employed by this company?
23 years

Company/Ship Safety Culture Facts:

Is this ship safe? If yes, why? And if no, why?
Yes/SMS: Learning: industry/company Generative Procedures/pp Behavioural based safety
How would you rate the safety culture of your company? Do you think it is very good, improving or very poor? Why? Are there any features of your company that makes it safe? Are there any feature of your company that makes it unsafe?
Very good Procedures/pp Behavioural based safety C) always can learn: learning/continuous improvement

sustainable
What is the main threat to safety in your ship? Do you think it may cause lead to casualties?
Process safety: High impact increases
How would you rate human errors in your company? I mean how often you encounter human error.
Regularly/ change the behaviour
In the last one year, have you had any incidents related to human errors? What types were they? How did they happen? How could you prevent these in the future?
A) yes Maritime regulations B) none
How could you make this ship safer? I mean is it by training, self-awareness, continuous support from the management etc.?
Training less than behaviour
Why do you think human error is still occurring despite maritime regulations and Safety Management System (SMS)? This is because based on my reading, the number of accidents is huge and its impact is serious for example loss of life and properties and marine environment pollution.
Because we are human.
How would you rate your company's SMS? I mean how well you are practising it in your company. Also, Do you well understand SMS? Do you think it is effective in enhancing safety? How is the company implementing SMS?
Very good/ all over the time Yes, very well Yes 100% System: ism approved/available to all
How well is the practice of SMS on this ship? Is this effective?
Very good. Regularly accessed

What safety training do you provide to sea staff? Is this effective? I mean is this effective to their awareness and responsibilities towards safety?
Ccw/isps/ism On board safety trainings/rota Safety drills/ man over board/security Learning modules
Does the management provide you with any assistance on safety matters? How?
Yes Equipment to be safer Share learning Visit ship Share vision
Does the management give importance to safety problems raised by the ship personnel?
Yes Top importance

Opinions on results from safety culture survey

Among the following safety aspects, which factors are important to safety culture and why? So, these are the safety aspects that I have used in my survey.

Safety aspects		Rank (1-9)
a	Working environment satisfaction	All equally
b	Communication and language barriers	
c	Health awareness	
d	Importance of maritime regulations	
e	Reporting culture	
f	Competency level	
g	Risk awareness	
h	Shore management support	

	i	Job satisfaction		

The following pairs of safety aspects have shown very weak relationship (poor correlation).

In your opinion, what might be the possible reasons of such results?

Do they reflect poor safety practices in shipping sector and if so, why?

Safety aspect pairs		Opinions (short answers)
a	Working environment satisfaction – Competency level	B=im not agreed to this result/strange Not appreciated W.e Rules not matter to use Doesn't make any difference
b	Working environment satisfaction – Shore management support	
c	Working environment satisfaction – Importance of maritime regulations	
d	Reporting culture – Communication and language barrier	
e	Reporting culture – Competency level	
f	Reporting culture – Health awareness	
g	Reporting culture – Importance of maritime regulations	
i	Communication and language barrier – Competency level	
j	Communication and language barrier – Shore management support	
k	Communication and language barrier – Importance of maritime regulations	
l	Communication and language barrier – Job satisfaction	
m	Competency level – Shore management support	
n	Competency level – Health awareness	
o	Shore management support – Health awareness	
p	Shore management support – Importance of maritime regulations	
q	Shore management support – Risk awareness	
r	Health awareness – Job satisfaction	

s	Risk awareness – Job satisfaction		

The following pairs of safety aspects have shown contrasting relationship (negative correlation). Negative correlation is a relationship between two variables (safety aspects) in which one increases as the other decreases, and vice versa (which is uncommon). Based on your experience what might be the possible reasons for such relationship?

Safety aspect pairs		Opinions (short answers)
a	Working environment satisfaction – Job satisfaction	Working environment (w.e) includes personalities
b	Working environment satisfaction – Risk awareness	
c	Shore management support – Reporting culture	
d	Job satisfaction – Reporting culture	Frustrated with people
e	Job satisfaction– Competency level	
f	Competency level – Importance of maritime regulations	
g	Risk awareness – Communication and language barrier	Maybe due to communication
h	Risk awareness– Health awareness	
i	Risk awareness – Importance of maritime regulations	

How maritime regulations be utilised to improve safety culture and reduce human error?

Maintain safety standard: equipment standard

Improve standard

Equipment up to standard to reliable

It comes from industry/low human error

Based on your experience, how can safety culture be improved and promoted? So, if you have given a chance, what strategy would you recommend?

Not good enough introduction

Sustainable change/leaning report

Based on your experience, how can human error and its impact be reduced? So, if you have given a chance, what strategy would you recommend?

Sustainable change: eliminate the issues/ will not happen again
Finally, would you like to add anything more?
None.

Seafarers – Respondent 5

Can you briefly give an introduction about yourself? For example, your position, age, where you come from etc.
My name is “Rana Ali Raza” 37-year-old from Pakistan working as 2nd engineer in pacific international line Singapore.
How long have you been at sea?
Since 2003
How long have you been employed by this company?
Since 2010.
How long have you been employed by this company?

Background

Company/Ship Safety Culture Facts:

Is this ship safe? If yes, why? And if no, why?
Yes, all machinery and safety equipment/machinery working well, staff is competent, following SMS and routine training and drill etc. Since I joined this vessel I didn’t see any major injury and accident onboard.
How would you rate the safety culture of your company? Do you think it is very good, improving or very poor? Why? Are there any features of your company that makes it safe? Are there any feature of your company that makes it unsafe?
-It is improving by time. `- now company has started video training programme, providing good quality PPE (personal protective equipment), each officer getting to brief before joining the vessel Monthly training, safety meeting, etc

Not providing welder on board even ship is more than 20-year-old, engineer must do all welding and cutting job, which is not safe, as they are not well specialized trained for this job.
What is the main threat to safety in your ship? Do you think it may cause lead to casualties?
Severe bad weather is always big threat at sea you always have.
How would you rate human errors in your company? I mean how often you encounter human error.
Most of the accident happened due to human error, oil spill, burn, injury etc. Company providing fleet injury report after every 3 months to alert all engineer after investigation the case. Almost 50 % accident found due to human error and negligence.
In the last one year, have you had any incidents related to human errors? What types were they? How did they happen? How could you prevent these in the future?
Yes, Oil spillage 4th engineer transferring sludge from BSO tank to waste oil tank, after starting went to attend some alarm, the ship was quite old, high level alarm was out of order, tank top side manhole door was opened for checking oil level. 4th engineer forget that he has started the transfer pump, oil overflow from manhole door and spread all that floor, luckily not splashed to main engine turbocharger side, otherwise could lead to severe fire. To avoid like these incident, informed electrical engineer to check alarm switch. Given training to all engineer regarding risk assessment, safety precaution before any transferring, should be performed in day time as per SMS.
How could you make this ship safer? I mean is it by training, self-awareness, continuous support from the management etc.?
Most important part is training, by sharing your knowledge and experiences, every seafarer has some weak points, but they are shy to discuss each other especially in mix nationalities. I am conducting regular training and safety, tool box meeting. sharing my experiences and giving my all staff freedom to speak regarding share their experience. We are doing all planned maintenance as per schedule. Checking all machinery safeties and all working well. Regularly conducting all types of drill.
Why do you think human error is still occurring despite maritime regulations and Safety Management System (SMS)? This is because based on my reading, the number of accidents is huge, and its impact is serious for example loss of life and properties and marine environment pollution.

Due to work overload, old ships work load is more and total ship staff is very less. Before Performing the jobs if we follow all ISM and SMS checklist properly, then can't finish job timely. By the time paper job load has been increase significantly and must perform all Maintenance job. vessel crew don't have social life on board, and the periodic routine is hectic they don't have holidays until they will be signed off ... Due to multinational crew there is language barrier also. In these conditions most of the time they couldn't concentrate well on their jobs leading to accident. The management should increase the man power on board.
How would you rate your company's SMS? I mean how well you are practising it in your company. Also, Do you well understand SMS? Do you think it is effective in enhancing safety? How is the company implementing SMS?
Yes, I well understand SMS Yes Through several checklists, senior officers should have proper knowledge of SMS
How well is the practice of SMS on this ship? Is this effective?
Yes
What safety training do you provide to sea staff? Is this effective? I mean is this effective to their awareness and responsibilities towards safety?
Yes, much effective, training on various topics as per yearly schedule given by company.
Does the management provide you with any assistance on safety matters? How?
Through technical circular and safety bulletin
Does the management give importance to safety problems raised by the ship personnel?
If it is very severed only

Opinions on results from safety culture survey

Among the following safety aspects, which factors are important to safety culture and why? So, these are the safety aspects that I have used in my survey.

Safety aspects		Rank (1-9)
a	Working environment satisfaction	8
b	Communication and language barriers	6
c	Health awareness	7
d	Importance of maritime regulations	8
e	Reporting culture	6
f	Competency level	7
g	Risk awareness	7
h	Shore management support	7
i	Job satisfaction	6

The following pairs of safety aspects have shown very weak relationship (poor correlation).

In your opinion, what might be the possible reasons of such results?

Do they reflect poor safety practices in shipping sector and if so, why?

Safety aspect pairs		Opinions (short answers)
a	Working environment satisfaction – Competency level	
b	Working environment satisfaction – Shore management support	
c	Working environment satisfaction – Importance of maritime regulations	
d	Reporting culture – Communication and language barrier	
e	Reporting culture – Competency level	
f	Reporting culture – Health awareness	
g	Reporting culture – Importance of maritime regulations	

i	Communication and language barrier – Competency level	
j	Communication and language barrier – Shore management support	
k	Communication and language barrier – Importance of maritime regulations	
l	Communication and language barrier – Job satisfaction	
m	Competency level – Shore management support	
n	Competency level – Health awareness	
o	Shore management support – Health awareness	
p	Shore management support – Importance of maritime regulations	
q	Shore management support – Risk awareness	
r	Health awareness – Job satisfaction	
s	Risk awareness – Job satisfaction	

The following pairs of safety aspects have shown contrasting relationship (negative correlation). Negative correlation is a relationship between two variables (safety aspects) in which one increases as the other decreases, and vice versa (which is uncommon). Based on your experience what might be the possible reasons for such relationship?

Safety aspect pairs		Opinions (short answers)
a	Working environment satisfaction – Job satisfaction	
b	Working environment satisfaction – Risk awareness	
c	Shore management support – Reporting culture	
d	Job satisfaction – Reporting culture	
e	Job satisfaction– Competency level	

f	Competency level – Importance of maritime regulations	
g	Risk awareness – Communication and language barrier	
h	Risk awareness– Health awareness	
i	Risk awareness – Importance of maritime regulations	

How maritime regulations be utilised to improve safety culture and reduce human error?
By raising competency level
Based on your experience, how can safety culture be improved and promoted? So, if you have given a chance, what strategy would you recommend?
The management should organise briefing and training for officer and engineer before joining the vessel to discuss safety issues and after signing off their experiences. Conduct training once a week on board.
Based on your experience, how can human error and its impact be reduced? So, if you have given a chance, what strategy would you recommend?
By proper planning before performing any jobs, risk assessment, conduct training and by well concentrating during the job.
Finally, would you like to add anything more?
Once I read one article in ITF magazine, they conduct research regarding life on ship, they conduct interviewed and visits hundreds of ships. Later they suggested the working life at sea can be improved By increasing the man power Minimize the language barrier, by effective communication By improving social life

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