Safety culture and safety management within the Norwegian-controlled shipping industry

State of art, interrelationships, and influencing factors

By

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Preface

My interest in the shipping industry started while working on a project in which I calculated the risk for ships making contact with high-rise constructions located shore side. When searching for background information, I realized that very little research concerning safety related to human factors and seafarers' welfare existed. I found evidence of seafarers working under unacceptable working conditions, sailing on "rust buckets," jeopardizing their own safety as well as that of the vessels—in some cases afraid to come forward out of fear of losing their jobs. At the same time, working at sea was ranked as one of the most dangerous occupations in the world. This situation triggered my interest in the field and the research presented in this thesis.

I need to thank several people for their contribution during the process of completing this PhD. First of all, I would like to thank my supervisor Ole A. Engen for his encouragement, help, and support throughout this process. I would also like to thank my colleague Doctor David McArthur for helping me with statistical problems as well as useful comments and suggestions while writing the articles. Dean A. Rune Johansen has also been a great support during my research. Thanks to his engagement in the maritime industry, I was able to receive funding for five more years of research—something that I appreciate tremendously. I would like to mention Captain Vigleik Storesund, who has been a great help in enabling me to understand the maritime industry and life at sea. Last, but not least, Chief Officer Johanne Marie Trovåg, Professor Knud Knudsen, and Professor Preben Hempel Lindøe all made tremendous efforts in reading through my final work.

Furthermore, I would like to thank the Norwegian Shipowners' Association for helping me get in touch with their members. Although they cannot all be mentioned by name, I wish to thank the shipping companies who volunteered to participate and all the seafarers who—despite a hectic working situation—found time to contribute with their views. In addition several companies have enabled me to sail on their vessels and in other ways participate in their daily operations.

I would also like to thank Dr. Nick Bailey and Professor Helen Sampson at the Seafarers International Research Centre (SIRC) in Cardiff, Wales, for making my research stay there possible.

My apologies to all of you who have not been mentioned. I cannot mention you all, but no one has been forgotten. During my research, I have gained valuable and useful contributions from many people of different nationalities, including academics, practitioners, seafarers, and shore personnel working in all parts of the shipping industry.

Finally, I would like to thank my family for their encouragement and support. I also want to apologize to my two young children who have had a mum preoccupied with research for such a long time. I have spent long periods away from home and, when staying at home, I have been mentally absent. I hope I can now make up for the lost time. It would not have been possible to complete this thesis without the support of my incredibly patient and supportive husband Mikal. Thus, I dedicate this thesis to them—Mikal and our two exceptional and wonderful children, Jørgen and Elene.

Haugesund, April 2011, Helle A. Oltedal

Summary

This research focuses attention on safety challenges within the Norwegian shipping industry. A status picture of the shipboard safety culture and the interrelationships with safety management and organizational factors is given. Three research questions are explored: (1) What characterizes safety culture and safety management within the shipping industry? (2) What is the relationship between safety culture and safety performance within the shipping industry? (3) What characterizes shipping companies' application of the safety management concept? In order to explore these research questions, four aims were defined to guide this work: (1) to outline and discuss the application of safety culture and safety management within merchant shipping; (2) to outline and discuss relevant theories of safety culture and safety management and analyze the relationship between safety culture and safety management; (3) to support the use of a methodological framework for the assessment of safety culture in relation to safety management; and (4) to assess safety culture within merchant shipping and analyze the relationship with safety management and actual performance. The research questions are further examined and specified in six journal articles.

The thesis is divided into two main parts. Part I includes the overall framework in relation to research aims. Part II presents the six journal articles. In part I, chapter 1, a general introduction and a status picture of risk, safety management, and safety culture within the shipping industry are presented, which gives reason for the research aims and questions introduced in the chapter. Chapter 2 outlines the safety responsibilities within the industry at the international, national, and company levels. Emphasis is placed on the

International Safety Management (ISM) Code, which provides the minimum standards and guidelines for operational safety management. Chapter 3 provides theoretical clarification and framing with regard to safety culture and safety management. This chapter also introduces a general working model used in the studies of safety culture and safety management in this thesis. Chapter 4 presents the methodological approach. The thesis builds upon a mixed method approach where both qualitative and quantitative techniques are used. The main results are briefly summarized in Chapter 5, followed by a discussion in Chapter 6 and concluding remarks in Chapter 7. The concluding remarks concern study limitations, implications, and suggestions for future research.

The thesis draws upon theory from both the socio-anthropological and organizational psychological directions. In accordance with the organizational psychological perspective, a survey was carried out. A safety culture questionnaire developed by Studio Apertura, a constituent centre of The Norwegian University of Science and Technology (NTNU), in collaboration with the Norwegian DNV and the research institution SINTEF was used. In total, 1,574 questionnaires were distributed to 83 tanker and bulk/dry cargo carriers, with 1,262 being returned from 76 of the vessels. The vessels were initially randomly selected from the Norwegian Shipowners' Association member list, but as participation was voluntary, some withdrawal occurred. Statistical analysis involves descriptive statistics, factor analysis, regression analysis, and structural equation modeling. The statistical survey results were complemented by qualitative data obtained through document studies, case studies including two tanker companies and two bulk/dry cargo companies,

interviews, participating observations and field studies at sea, and participation in other maritime forums.

The study results indicate several deficiencies in all parts of a traditional safety management system defined as: (1) the reporting and collection of experience data from the vessel; (2) data processing, summarizing, and analysis; (3) the development of safety measures; and (4) implementation. The underreporting of experience data is found to be a problem, resulting in limitations related to the data-processing process. Regarding the development of safety measures, it is found that the industry emphasizes the development of standardized safety measures in the form of procedures and checklists. Organizational root causes related to company policies (e.g., crewing policy) is to a lesser degree identified and addressed.

The most prominently identified organizational influential factors are the shipping companies crewing policy, which includes rotation systems, crew stability, and contract conditions, and shipboard management. The companies' orientation toward local management, which includes leadership training, educational, and other managerial support, are also essential. The shore part of the organization is identified as the driving force for development and change in the shipboard safety culture. Thus, safety campaigns should to a larger degree include and be directed toward shore personnel.

List of articles in thesis:

Article 1

Oltedal, H. A., & Engen, O. A. (2009). Local management and its impact on safety culture and safety within Norwegian shipping. In S. Martorell, C. Guedes Soares & J. Barnett (Eds.), *Safety, Reliability and Risk Analysis: Theory, Methods and Applications* (pp. 1423-1430). London: Taylor & Francis Group.

Article 2

Oltedal, H. & Wadsworth, E. (2010). Risk perception in the Norwegian shipping industry and identification of influencing factors. *Maritime Policy & Management, 37*(6), 601-623.

Article 3

Oltedal, H. A. (2010). The use of safety management systems within the Norwegian tanker industry—Do they really improve safety? In R. Bris, C. Guedes Soares, & S. Martorell (Eds.), *Reliability, Risk and Safety: Theory and Applications* (pp. 2355-2362). London: Taylor & Francis Group.

Article 4

Oltedal, H. A., & Engen, O. A. (2010). Tanker versus dry cargo—The use of safety management systems within Norwegian dry cargo shipping. In J.M. Ale, I.A. Papazoglou, & E. Zio (Eds.), *Reliability, Risk and Safety* (pp. 2118-2125). London: Taylor & Francis Group.

Article 5

Oltedal, H. & McArthur, D. (2010). Reporting practices in merchant shipping, and the identification of influencing factors. *Safety Science, 49*(2), 331-338.

Article 6

Oltedal, H. A., & Engen, O. A. (2010). Safety Management in Shipping—Making Sense of limited Success. *Safety Science Monitor,* submitted.

Contents

Part I

1 General background and introduction

"Never before have so few done so much for so many." When opening the Year of the Seafarer in 2010, these brave words—a quotation paraphrased from one of Winston Churchill's most famous speeches—were similarly strikingly declared by Efthimios E. Mitropoulos, Secretary General of the International Maritime Organization (IMO). Few people seem to understand the importance of seafarers and shipping in our society. The worldwide population of seafarers serving in international trade is estimated to be approximately 1,187,000 people from virtually every nationality. Worldwide, about 50,000 ships carry about 90% of the world's trade; thus, these more than one million seafarers are transporting goods for the benefit for the world's population of almost 7 billion. The seafarers' and shipping industry's global importance is commonly highlighted by the phrase "without shipping, half the world would starve and the other half would freeze."

The current research is conducted in light of safety challenges within merchant shipping. During the first five years of the previous decade (i.e., 2000 to 2005), an average of 18 ships collided, grounded, or caught fire every single day, and two vessels were sinking every day (Gregory & Shanahan, 2010). Merchant shipping and seafaring are traditionally perceived as a risky industry—a risk partly induced by its situational characteristics. Work at sea is demanding as both work and leisure time happens within a small group, at the same place, for a long period of time and with few possibilities to interact with the surrounding world. The seafarer's only alternative whereabouts when

at sea is the sea itself, where harsh conditions prevail. Seafarers and their vessels are constantly exposed to forces beyond their control, such as storms, freak waves, and strong currents. Being far from port most of the time, the seafarer must handle critical situations with little or no support from others, with only their own competence and expertise to rely on.

1.1 Safety culture and safety management within shipping

Human error is associated with the vast majority of accidents and incidents within shipping. An estimated 75% to 96% of marine casualties are caused—at least in part—by some form of human error (Anderson, 2003; Rothblum, 2000; Wagenaar & Groeneweg, 1987). However, within recent safety management theories, human error is not seen as a cause of accidents and incidents, but rather as something shaped and provoked by upstream organizational factors. Thus, human error is not an explanation per se, but something that needs further explaining (Hollnagel, 2004; Reason, 2001). Possible explanatory factors may be related to seafarers' cognitive system (e.g., human information processing, training, motivation, and fear), social system (e.g., social pressure, role, and life stress), and situational system (e.g., physical stress, environmental stress, and ergonomic aspects), which are all assumed to be mutually interdependent (Wagenaar & Groeneweg, 1987). It is also widely accepted that individual factors are inextricably linked to organizational factors and decisions (Hollnagel, 2004; Reason, 2001; Schager, 2008).

Safety at sea is regulated by the UN's agency for maritime affairs, the International Maritime Organization (IMO). From the IMO perspective, safety management and human error are closely intertwined with the industry's definition and application of the safety culture concept, regulated through the International Safety Management (ISM) Code (IMO, 2010a; Lappalainen, 2008; Mitroussi, 2003). The ISM Code, which became mandatory for all merchant vessels from July 1998 to July 2002, formally introduced the idea of safety culture in shipping:

> The application of the ISM Code should support and encourage the development of a safety culture in shipping. Success factors for the development of a safety culture are, inter alia, commitment, values and beliefs (IMO, 2010a, p. 35).

However, despite the implementation of the ISM Code, recent statistics indicate that losses are continuing to increase, resulting in a heavy loss of life and serious damage to the environment (Soma, 2010). The statistics in Figure 1 illustrate the frequency of navigational accidents (collisions, contacts, and wrecked/stranded vessels) from 1993 to 2009.

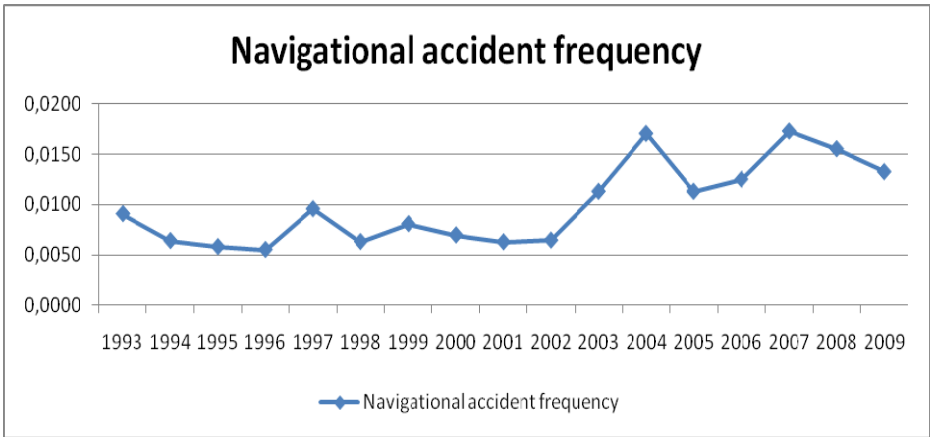

***Figure 1*: Navigational accident frequency in relation to the world fleet size, 1993-2009 (Source: Lloyds' Fairplay, 2010) Fleet size in number of crude oil tankers over 100,000 dwt, chemical tankers over 10,000 dwt, containers over 20,000 dwt, RoRo cargo over 10,000 dwt, bulk over 50,000 dwt.**

As shown in Figure 1, the frequency of serious navigational accidents has increased significantly since 2002. It is also interesting to note that, since the first introduction of the code in 1998, none of the subsequent years show lower accident frequency than before the code was introduced. This statistical trend raises a fundamental question: Why do we have such an increase in the accident rates despite the introduction of the ISM Code, emphasis on safety culture, and lower tolerance for non-conformities? Three possible explanations have been put forth:

1. Shipping companies' implementation of the ISM Code and understanding of safety management are inadequate. The IMO assessment of the effectiveness of the ISM Code (IMO, 2005) indicates that implementation has resulted in more administrative

work, procedures, checklists, and other means in order to control human behavior. However, is safety best ensured by controlling and restricting human behavior?

2. The ISM Code's underlying theoretical rationale of linear causality is inadequate. Is it possible to prevent future accidents by learning from past events? Are there any causal links between near misses, minor incidents, and major accidents? When dealing with future events evolving in an unforeseen and complex pattern, are other rationalities more adequate?

3. The ISM Code's assumption of a relationship between safety culture and actual safety performance and outcome is inadequate. What is organizational safety culture and what determines its relations to safety management, organizational practices, and safety performance?

This thesis provides an account of these three possible explanations. Empirical data are collected from the Norwegian controlled liquid and dry cargo shipping industry for this purpose. The data are analyzed and discussed in light of theory on safety management and safety culture. The seafarers' perspective and their operative experiences are emphasized. The analyses and discussion will be consistent with the scope of the research aims and questions, as formulated in the following sections.

1.2 Research aims and research questions

Although shipping is known to be a risky industry, surprisingly little research has been done within this area. In recent years, a few articles and doctoral

theses on maritime safety culture and climate have been published (e.g., Antonsen & Norges teknisk-naturvitenskapelige universitet. Institutt for sosiologi og statsvitenskap, 2009; Christophersen, 2009; Ek, 2006; Håvold & Norges teknisk-naturvitenskapelige universitet. Institutt for industriell økonomi og teknologiledelse, 2007; Lamvik, 2002; Østreng, 2007). In light of the discussed situation, it is important to get a better understanding of what characterizes safety culture within shipping and how shipboard safety culture relates to safety management and human error. Thus, the following four research aims have been developed in order to provide direction for this thesis:

1. To outline and discuss the application of safety culture and safety management within merchant shipping.
2. To outline and discuss relevant theories of safety culture and safety management and analyze the relationship between safety culture and safety management.
3. To give reason for a methodological framework for assessment of safety culture in relation to safety management.
4. To assess safety culture within merchant shipping and analyze the relationship with safety management and actual performance.

In order to pursue these aims, a questionnaire survey was carried out within merchant shipping along with field studies, case studies, interviews, and other qualitative methods. The population is defined within the Norwegian controlled shipping industry as liquid tankers and dry cargo carriers above 500 gross ton. *Norwegian controlled* is defined as vessels owned by

Norwegian parties where the owners' safety management department is located in Norway. In the study, the seafarers' perspective is emphasized.

Based on the four research aims previously described, three research questions were developed for the purpose of the thesis:

1. What characterizes safety culture and safety management within the shipping industry?
2. What is the relationship between safety culture and safety performance within the shipping industry?
3. What characterizes shipping companies' application of the safety management concept?

1.3 Aims of articles

The thesis includes six separate studies with their own main aims. All aims for each study are discussed in this section.

1. Local management and its impact on safety culture and safety within Norwegian shipping:

The first study uses survey data collected in 2006. The data cover all sailing personnel on 76 Norwegian controlled liquid tankers and dry cargo carriers. The aims of the study are to:

- ✓ Explore and analyze the shipboard characteristics of safety culture;
- ✓ Identify which factors affect the shipboard safety culture; and
- ✓ Get results in order to set direction for further studies.

2. Risk perception in the Norwegian shipping industry and identification of influencing factors:

This second article makes use of the same survey data. In this study, the catering personnel and captains are excluded. Risk perception is used as an indicator for shipboard safety. The aims of the study are to:

- ✓ Assess the relationship between risk perception and dimensions of safety culture; and
- ✓ Explore the influence of organizational structural variables.

3. The use of safety management systems within the Norwegian tanker industry and whether they really improve safety:

The third study involves both quantitative survey data and qualitative data. The sub-sample dry cargo carriers are excluded. The data and analyses are organized in accordance with the sub-components and information flow of a traditional safety management system. The aims of the study are to:

- ✓ Describe the status of safety management within the liquid tanker sector; and
- ✓ Identify organizational structural factors that influence the safety management performance.

4. Tanker versus dry cargo regarding the use of safety management systems within Norwegian dry cargo shipping:

The fourth study is a follow-up of the third, and follows a similar structure related to the sub-components and information flow of a traditional safety management system. The study includes both quantitative survey data and qualitative data. The sub-sample liquid cargo carriers are excluded. The aims of the study are to:

- ✓ Describe the status of safety management within the dry cargo sector;
- ✓ Identify organizational structural factors that influence the safety management performance; and
- ✓ Compare current situations between the two sectors—namely, dry and liquid cargo carriers.

5. Reporting practices in merchant shipping and the identification of influencing factors:

The fifth study involves quantitative survey data. Both the third and fourth study identified underreporting of experience data as a substantial problem. The reporting of experience data is regarded as a main cornerstone in a safety management system. Thus, the aims of the article are to:

- ✓ Assess the relationship between reporting practices and the dimensions of safety culture;
- ✓ Explore the influence of local management; and

- ✓ Further explore differences between the dry and liquid cargo carrier sectors.

6. Safety management in shipping and making sense of limited success:

The sixth study involves both quantitative survey data and qualitative data. As the previous studies (i.e., three through five) point to a substantial weakness in current safety management practices, the aim of this study is to:

- ✓ Explore and identify reasons for the gaps between safety ambitions inherent in traditional safety management systems and operational practices.

2 Safety responsibilities in maritime industry

This section is, in accordance with specified research aim 1, formulated as follows:

1. To outline and discuss the application of safety culture and safety management within merchant shipping.

The development of international trade and shipping in today's globalized market has to a large degree determined the regulative structure of the industry. The international regulative system is of high importance for the safety of ships and crew sailing the seven seas, as every shipping company is required to relate to this during daily operations. In order to gain proper understanding of safety management within shipping, knowledge of the most important laws and the international regulative framework is necessary. Thus, some of the historical mainlines and the present situation related to safety management and the regulatory system will be further presented. An overview of the international regulatory system, maritime administration, and conventions (conventions in bold) related to safety management are shown in Figure 2 (next page).

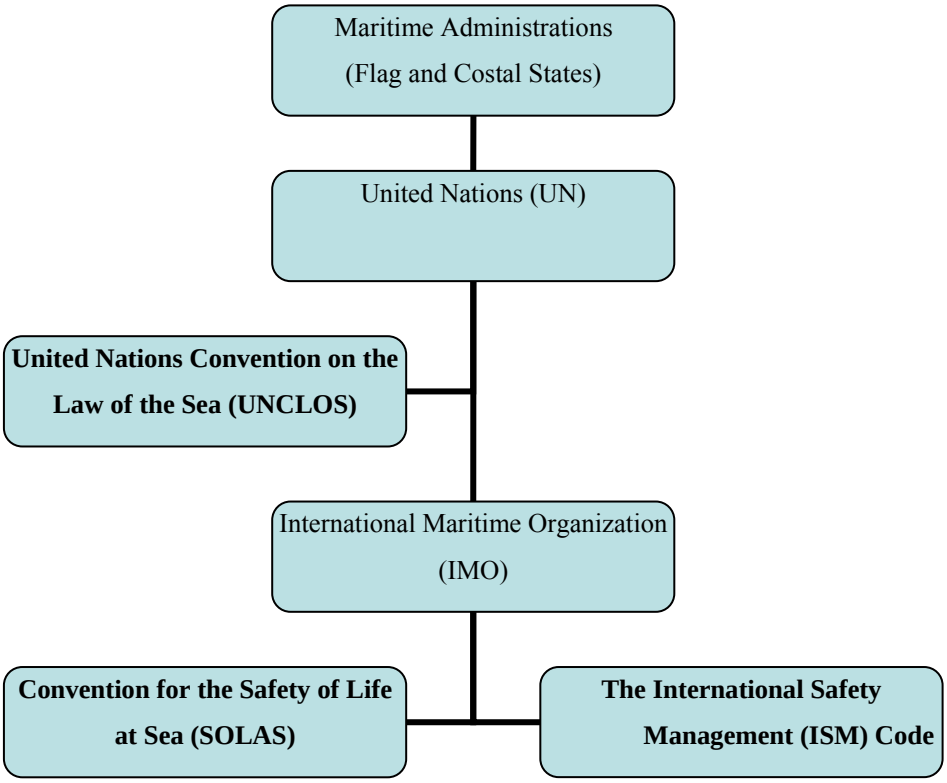

Figure 2: The maritime international regulatory system related to safety management

As shown in Figure 2, the maritime administrations' (flag and coastal states) safety responsibilities are determined by the UN through the Convention on the Law of the Seas (UNCLOS). Although UNCLOS sets the broad regulative framework, the task of developing and maintaining workable regulations on ship safety within this framework is delegated to the UN agency the IMO, which is now responsible for 35 international conventions and agreements. For the purpose of this thesis, the most relevant is the Convention for the Safety of Life at Sea (SOLAS) chapter IX, management for the safe operation of ships, and the guidelines for SOLAS IX—namely, the ISM Code.

2.1 The International Safety Management (ISM) Code

The ISM Code became mandatory for all merchant vessels above 500 gross tons in two waves, depending upon type of vessel—namely, July 1, 1998, and July 1, 2002. Until the adoption of the ISM Code, IMO had attempted to improve shipping safety largely by improving the hardware of shipping (e.g., the construction of ships and their equipment). By comparison, the ISM Code focuses on the way shipping companies are managed. The ISM Code is the first to provide regulations and guidelines to promote the development of sound management and operating practices in order to ensure crew safety and avoid damage to the environment. The shipping industry is known to have a reactive approach toward safety as the process of regulating the activity has evolved primarily as a response to maritime disasters. Development of the ISM Code was also based upon a growing recognition that loss of life at sea and environmental pollution are influenced by the way in which companies manage their fleets. Table 1 (next page) summarizes some of the accidents' precursory to the ISM Code (Anderson, 2003).

Table 1.

Accidents Precursory to the ISM Code

1987	*Herald of Free Enterprise* capsized off Zeebrugge; 190 people lost their lives.
1987	*Donna Paz* ferry collided with a tanker in the Philippines; an estimated 4,386 people were killed.
1989	*Exxon Valdes* ran aground off the coast of Alaska, spilling 37,000 tons of oil and causing extensive environmental damage.
1990	*Scandinavian Star* caught fire; 158 people lost their lives.
1991	*Agip Abruzzo,* with 80,000 tonnes of light crude on board, was in a collision with the ro-ro ferry *Moby Prince* off Livorno, Italy. Fire and pollution occurred, and 143 people died.
1991	*Have* experienced fire and explosion off Genova, spilling 50,000 tons of crude oil; 6 people were killed.
1991	The Egyptian ferry *Salem Express* struck a reef and sank; 470 people were killed.
1991	*Aegean Sea* broke in two off La Coruna, Spain, spilling about 74,000 tons of crude oil; extensive pollution occurred.
1993	*Braer* driven onto the Shetland Island, carrying about 84,700 light crude oil; extensive pollution occurred.
1994	*Estonia* ro-ro passenger ferry sank after the bow door fell off during heavy weather at sea; 852 people lost their lives.

A common factor appearing in these accidents was human error, which could be traced back to poor safety management and organizational practice. By introducing the ISM Code, IMO intended to adopt a proactive approach

toward safety, where future accidents should be prevented by learning from and reflecting upon previous mistakes and experiences.

The ISM Code requires shipping companies to develop, implement, and maintain a safety management system, which includes the following functional requirements: (1) a safety policy; (2) instructions and procedures to ensure safe operations of ships in compliance with relevant international and flag state legislation; (3) defined levels of authority and lines of communication between and amongst shore and shipboard personnel; (4) procedures for reporting accidents and non-conformities with the provision of the ISM Code; (5) procedures to prepare for and respond to emergency situations; and (6) procedures for internal audits and management reviews. In the code's guidelines, emphasis is placed on near-miss reporting and how to create an organizational atmosphere in which people are willing to report accidents and non-conformities by developing a just culture. The concept of a just culture is also known to be a fundamental element in James Reason's theory of safety culture and safety management (Reason, 2001). Moreover, in order to achieve the development of an organizational safety culture, IMO identifies three key elements: (1) recognizing that accidents are preventable by following correct procedures and establishing best practices; (2) constantly thinking about safety; and (3) seeking continuous improvement. IMO's approach and perspective to safety culture is apparently instrumental, where safety culture is seen as something that may be engineered by an organization's structures and control systems in order to produce desired behavioral norms and accompanying safety outcomes.

Safety management, as described in the ISM Code, is founded on a linear causality, in which future events are attempted, predicted, and prevented by

analyzing past operational experiences. Thus, a critical system requirement is reliability and accuracy of input data—the experience, near miss, and accident reports ; as long as the input is reliable, the overall system presupposes the possibility of developing efficient standardized measures in order to control operational safety (Kjellen, 2000). One underlying assumption is that serious injuries and accidents may be prevented by learning from and reflecting upon incidents with no injury or damage. This idea is frequently illustrated as a near miss-accident pyramid. However, previous research does not support this theory (Anderson, 2003). Moreover, IMO recognized that near misses are underreported (IMO, 2007c), and the input system requirement is not met. This also provides a reason to question the underlying theory of linear causality, especially if near misses, small-scale accidents, and more serious events have the same causal chain (Rundmo, 1996).

In 2005, IMO provided a report assessing the impact and effectiveness of implementation of the ISM Code (IMO, 2005). Based on the data collected, IMO concluded that—when the ISM Code and safety cultural development is embraced as a positive step—tangible positive benefits are evident. It was also recognized that ISM Code compliance could be made easier through a reduction in the administrative processes by, inter alia, the reduction of paperwork, increased reporting of operational experience data, and greater involvement of seafarers in the development of ISM manuals, the procedural system, and checklists. In the industry, it seems to be a common misconception that the ISM Code requires large quantities of paperwork and administration to function and that ticking boxes and checklists would replace good training and seamanship (Anderson, 2003).

Although the national maritime government is responsible for implementation of the ISM Code, the coastal state is responsible for enforcement of the code, and each shipping company has the primary responsibility for safe operations. However, these responsibilities are challenging as shipping today has become—more than ever before—a globalized industry. For example, a vessel may have owners in one state, be registered in a second state, be chartered by a company from a third state, and be transporting goods whose owners belong to a fourth state. To make it even more complicated, the vessel is sailing between ports in different states and is manned with a multinational and culturally diverse crew, who are managed by a company in yet another state. These sector-related circumstances have resulted in specific challenges with regard to the administration and enforcement of international regulations, as outlined in the following section.

2.2 Maritime administrations and responsibilities

A maritime administration may have two different roles: a flag state and a coastal state. The coastal states' responsibility for the enforcement of international regulations is done through inspections and Port State Control (PSC) of vessels entering their own coastal territorial waters, regardless of which flag the vessel is flying (Stopford, 2009). The coastal state may be the same as the flag state, but this is far from always the rule. Any ship owner is free to register a vessel in any of the world's flag states.[1] The term *flag state*

[1] The definition of a flag state is not straightforward. A myriad of descriptions of flag states have evolved, including traditional maritime nation, embedded maritime nation, national flag, classis register, open register, opportunist register, international open register, international register, closed register, second register, dependent territory register, offshore register, and flag of convenience (Mansell & SpringerLink,

(or administration) is used to refer to a country that maintains a vessel's registry. The flag state has the overall responsibility for ensuring compliance with international regulations. This responsibility encompasses the operation of the ship, the physical status of the ship, the activities of the ship owners, and the working conditions of the seafarers. The flag administration, in the first instance, underwrites the safe operation of those ships under its flag.

The flag state

Each flag state may have a national register, second register, and/or open register. A national register is reserved to vessels with national ownership. Second registers, which are additional to national registers, are mostly open registers. In an open register, ships owned by foreign entities may register. The creation of second registers is a response to intensified competition in the market for ship registration. In the early 1980s, the shipping market experienced a severe depression. Since the late 1980s, a number of states have created second registers in addition to their first national register in order to provide some or all of the advantages of an open register as a result of the economic crisis. A common motivation for establishing such second registers are to attract shipowners or prevent shipowners from flagging out by providing other or more relaxed application of the international IMO regulations (Alderton, 2004). Income in the form of tonnage taxation fee is also a motivation for some nations to establish a register when they do not necessarily have the means, will, or competence to meet their responsibilities as a flag state. According to Alderton (2004), low barriers to entry into the

2009). In this thesis, flag state refers to an open international register where any shipping owner is free to register a merchant vessel.

flag market exist, with minimal start-up cost or time being required. This situation has led to competition among some maritime administrations, which—in order to encourage registration of vessels under their flag—permits less bureaucratic control along with relaxed requirements.

International regulations adopted by IMO intend to provide a harmonized set of rules for the industry. The previously described situation has resulted in variations among maritime administrations in performance and application of the international regulations (Alderton, 2004). Alderton (2004) distinguishes between three types of administrations:

(1) Regulatory efficient states in which the state seeks to regulate the full extent of maritime operations.

(2) Regulatory inefficient states; the main distinction between this category and the first lies in the treatment of labor issues.

(3) Unregulated states, in which the regulatory environment within these registers is almost non-existent.

Many of today's safety-related criticisms are related to ship registration and to which flag the vessels fly. Although substandard shipping is mostly associated with regulatory inefficient and unregulated states, even administrations regarded as being regulatory efficient may have defective performance. An audit of the Norwegian Maritime Directorate, which is regarded as being regulatory efficient, revealed that the administration does not have, inter alia, adequate operational control with its own working procedures and that the administrated regulations are not comprehended in unison, which may result in misinterpretations and erroneous decisions (Riksrevisjonen, 2010).

As long as the flag states benefit from running open registries and shipowners can benefit from it, the situation will most likely never change. Moreover, the lack of flag state control, as evident in several countries, has made PSC even more important.

The Port State Control

In the wake of some major maritime disasters in the European area (e.g., accidents with the *Erika* in 2000 and *Prestige* in 2002, which both occurred after the implementation of the ISM Code), it was realized that the PSC and ParisMOU[2] could and should take a more determined stance against substandard shipping in order to ensure better enforcement of the international regulations.

The *Prestige* was a Greek-operated oil tanker, officially registered in the Bahamas, but with a Liberian corporation registered as the owner. The

[2] The ParisMOU (Memorandum of Understanding) on Port State Control is the official document in which the 27 participating maritime authorities agree to implement a harmonized system of PSC. The MOU consists of a the main body in which the authorities agree on: 1) their commitments and the relevant international conventions, 2) the inspection procedures and the investigation of operational procedures, 3) the exchange of information, and 4) the structure of the organization and amendment procedures. The current member states of the ParisMOU region are, in alphabetical order, Belgium, Bulgaria, Canada, Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Latvia, Lithuania, Malta, Netherlands, Norway, Poland, Portugal, Romania, Russian Federation, Slovenia, Spain, Sweden and The United Kingdom. Following the foundation built by the ParisMOU, several other regional MOUs have been signed, including the Tokyo MOU (Pacific Ocean), Acuerdo Latino or Acuerdo de Viña del Mar (South and Central America), the Caribbean MOU, the Mediterranean MOU, the Indian Ocean MOU, the Abuja MOU (West and Central Atlantic Africa), the Black Sea MOU, and the Riyadh MOU (Persian Gulf). In this thesis, due to its geographic area, references will be made to the ParisMOU (http://www.parismou.org/).

ownership of the *Prestige* was unclear, and it was difficult to establish responsibility for the accident, which resulted in the spill of more than 60,000 tons of heavy fuel oil. Prior to the accident, the *Prestige* set sail without being properly inspected, although a previous captain had complained about numerous structural deficiencies.

The oil tanker *Erika* also experienced structural failure. Although the structural failures were visible, the vessel was found to be seaworthy by the classification society. The *Erika* was sailing under a Maltese flag and chartered by a shipping company registered in the Bahamas on behalf of a French oil company. With regard to the *Erika*, it was also difficult to establish responsibilities (CPEM, 1999). The *Erika* accident resulted in a spill of about 19,800 tons of heavy fuel oil.

Although both accidents involved structural failures, they can also be characterized as stemming from a non-functional ISM system. In a functional safety management system, such structural failures should have been detected and handled appropriately by the shipping company. In the case of *Prestige*, the captain had even notified the company about structural deficiencies that had not been handled properly. In the aftermath of these accidents, the response from ParisMOU came in form of developing a harmonized vessel detention policy, guidelines for operational PSC, and others (ParisMOU, 2007). One of the strategies was naming and shaming. Today, all inspection results and detentions, with detailed information about the company, vessel, and flag, are registered in a public database (at parismou.org). Information about banned vessels and "rust buckets" are also made public. A more recent initiative includes a list for the performance of flag states (MARISEC, 2008; MARISEC, 2006; Winchester, Alderton, & Seafarers International Research Centre, 2003). On this list, each flag state is evaluated and ranked based on

their performance on certain aspects, as PSC records ships flying their flags along with the implementation and enforcement of important international treaties, such as the ISM Code. Flag state performance is then ranked and placed on a black list (poor performance), grey list (mediocre performance), and white list (good performance). The black, grey, and white lists for 2009 included a total number of 82 flags, 24 on the black list, 19 on the grey list, and 39 on the white list (ParisMOU. 2010).

Despite ParisMOU's intention to make shipping safer, the current inspection system has inherent weaknesses. ParisMOU's target is to inspect 25% of all vessels calling port. The ships are selected based on criteria as previous inspections reports from the MOU region. A vessel flying a poor performance black-listed flag is more likely to be selected for an inspection than others. These criteria for the selection of vessels are understandable; however, they disregard the fact the some of the ships flying a poor performance flag are owned by companies that take their responsibilities for the safe operation and crew welfare seriously. As a result, PSC resources may be used inefficiently. It is widely known that vessels in bad shape continue to be operational, without getting caught by the inspection net (Corbett, 2009; Tradewinds, 2007). In order to improve the current system, the ParisMOU introduced a new inspection system in January 2011, whereby each ship is ranked as high, standard, or low risk; this will determine the frequency of inspections. These changes intend to prevent low-risk vessels from being overly inspected in order to release resources for more frequent inspections of high-risk vessels. With the implementation of this new system, it remains to be seen if it will capture those vessels that deliberately avoid inspections.

The company and crew management

Although the overall responsibility for ensuring compliance with international regulations belongs to the flag state, each shipping company has the primary responsibility for the safety of their ships and crews. The ISM Code requires shipping companies to develop, implement, and maintain a safety management system for this purpose. However, safety management is not only a system property; system efficiency is determined by its human interrelationships. On board the vessels, the crew is the ultimate asset to ensure safety at sea, which is dependent on their experience and competence.

The recession of the 1980s brought about several structural changes apart from flagging out—namely, the establishment of manning and crewing agencies. Crew management normally involves finding, organizing, paying, and training crews. In order to survive financially, some companies turned to managing ships for other owners as a means of utilizing spare management capacity. Others found it necessary to turn to crew managers in order to hire cheaper crew in other and unfamiliar parts of the world. This has resulted in ships being crewed by mixed nationalities working under different contracts and employment terms. The sudden switch to employing seafarers from nations without maritime traditions is claimed to result in a reduction in standards of competence, except from those relatively unusual cases where the shipowners invest in training.

In addition, within crew management, there is variability in performance. At one end are those who have become seriously involved in training, some with their own training facilities and with established systems of testing crew competence (Alderton, 2004). On the other end are those who do not—nor intend to—perform such control over crew competence, which is quite a

problem, as fraudulent certificates of competence are an issue within the industry (IMO STW 41/4, 3, 2009). As pointed out by Anderson (2003), one might question if crew from manning agents takes the companies' (safety) goals and objectives to heart due to a lack of ownership and short employment. When crew management is carried out by an external party, the shipowner will lose control over assessing and ensuring qualifications, training, and competence. The shipowner then depends on third-party qualifications, thoroughness, and follow-up when providing crew.

2.3 When the regulatory framework and safety management fails

Major accidents are valuable sources of information about the regulatory framework, organizational practices, and cultures and in which way these impact safety. In order to illustrate how the regulatory system may fail, the explosion and sinking of the chemical tanker *Bow Mariner* is further outlined. The *Bow Mariner* was one out of four[3] chemical tankers that exploded during a six-month period between December 2003 and June 2004. The *Bow Mariner* case is interesting for several reasons. First, the accident occurred after the introduction of the ISM Code. Second, the accident investigation of *Bow Mariner* indicated that safety culture and poor safety management are explanatory factors of the accidents. Finally, what happened aboard the *Bow Mariner* is a driving force for further amendments of the international regulations, concerning shipboard leadership and managerial skills (IMO, 2007a; IMO, 2007b). Based on this situation, the *Bow Mariner* is seen as a

[3] The other three were the tankers *Sun Venus, Panama Serena*, and *NCC Mekka*.

case suitable for the purpose of understanding and exemplification. All factual information derives from the official accident investigation report (United States Coast Guard, 2005).

On February 28, 2004, the chemical tanker *Bow Mariner* exploded and sank in the seas outside Virginia, United States, causing the death of 21 crewmembers. The *Bow Mariner,* owned by the Norwegian company Odfjell Tankers, was flying a Singaporean flag, was operated by the Greek company Ceres, and was manned by Greek officers and Filipino crew. The vessel had a valid Safety Management Certificate (SMC). As part of the investigation, the vessel's inspection history for a five-year period before the explosion were reviewed and found to be unremarkable. However, during an internal audit in June 2003, 25 observations were recorded, including one pertaining to the failure to complete an enclosed space entry permit and another for failure to record training. These latter non-conformities were also present during the accident and pointed to as possible influencing factors to what happened. The accident investigators point to numerous indications that the ISM Code requirements were not fully implemented or functional aboard the vessel, despite apparent documentation of full compliance with the code. These ISM non-conformities were found to contribute to the accident. Amongst others, no crew familiarization with the vessel was conducted.

It is also explicitly stated that the shipboard social culture and safety culture contributed to the occurrence of the accident. This included poor shipboard management. Aboard the *Bow Mariner*, the Greek captain had—in accordance with the company policy—full authority over all personnel. Such full authority is not unusual aboard a seagoing vessel. However, at the *Bow Mariner* the distinctions between Greek and Filipino nationality were

remarkable. Filipino officers did not take their meals in the officers' mess, and the Filipino crew were given almost no responsibility and were closely supervised in every task. The Filipino crew were simply doing what they were ordered to do. As a result, they gained little knowledge about important aspects of their jobs. The lack of technical knowledge and fear of the Greek senior officers provide an explanation as to why the Filipino crew did not question the masters' unsafe order to open all the empty tanks, which was a significant breach of normal safe practices for such ships. If the tanks had remained closed, the explosions would not have occurred. However, as stated in the company policy, the captain's orders should never be questioned, and the failure to obey orders was a reason for disciplinary actions. Investigations of the accident leave no question that such fear of the ship management or senior officers can lead to a shipboard culture where safety takes a backseat to preserving one's employment. Interviews with crew from another Ceres vessel indicate that this poor culture was the general rule in the entire Ceres company.

With the case of *Bow Mariner*, it is evident that the ISM Code did not generate the intended outcome—namely, safe operations and a good safety culture—as a result of reasons not necessarily related to shortcomings in the ISM Code itself. This situation can also be related to the lack of ability to reveal the onboard conditions, which are related to coastal administration and inspections. Despite documentation and certification confirming full compliance with the code, the accident investigators pointed to numerous indicators that the code was neither fully implemented nor functional aboard the vessel. The onboard situation is created by organizational factors (e.g., crewing and shipboard management policies). The accident investigators also regarded commercial pressure as a contributory factor to what happened.

2.4 Safety responsibilities in the maritime industry—a summary

Thus far, the safety responsibilities in the maritime industry have been shortly outlined and analyzed. The situation is summarized in the following:

- ✓ With the UN delegation of authority, IMO is responsible for developing and maintaining workable safety regulations and laws regulating ship safety.
- ✓ The maritime administrations encompass flag state and coastal state. The coastal state is responsible for enforcing maritime regulations while the flag state is responsible for ensuring compliance with international regulations.
- ✓ The shipping companies have the primary responsibility for the safe operations of ships and crew safety. Safety management is regulated through the ISM Code, which is developed by IMO.
- ✓ The crew is the ultimate asset for ensuring safety at sea. Shipping companies may ensure safe operations by investing in crew training and competence and ensuring that crew experience is made use of in the company safety management system.

When ensuring operational safety, the crew relates to and is influenced by all these actors and levels of authority. National and international legislations represent minimum standards. Beyond the minimum standards, each shipping company determines the crew's working conditions. On each vessel, the framework given by the shipping company is moderated by the ship's

management. Safety culture and safety management in theory and practice are further elaborated in the following chapter.

3 Safety culture and safety management in theory and practice

This section focused on specified research aims 2 and 3, formulated as follows:

2. To outline and discuss relevant theories of safety culture and safety management and analyze the relationship between safety culture and safety management.

3. To give reason for a methodological framework for assessment of safety culture in relation to safety management.

The concept of safety culture as a term and an explanatory factor in an accident investigation was first used by the International Atomic Energy Agency (IAEA) International Nuclear Safety Advisory Group (INSAG) following the Chernobyl accident that occurred on April 26, 1986 (IAEA, 1991). The Chernobyl accident occurred while a test was being performed on a turbine generator during a normal, scheduled shutdown of one of the reactors. At the time, written test procedures were unsatisfactory from a safety point of view. In addition, serious violations of basic operating safety rules were present, as the operators deliberately withdrew most control rods from the core and switched off important safety systems (The United Nations Scientific Committee on the Effects of Atomic Radiation, 1988). Both safety management and the interrelationship with the human factors and human error were brought into the safety culture concept and safe operations. Safety culture was defined as both attitudinal as well as structural, relating to both the organizational framework and structures along with the attitude of

employees at all levels in responding to and benefitting from the framework (IAEA, 1991).

More recently, several diverse definitions of the safety culture concept have abounded in the safety research and organizational literature (Guldenmund, 2000; Sorensen, 2002; Wiegmann, Zang, von Thaden, Sharma, & Mitchell, 2002a). In general, all the conceptual definitions can be placed in two broad categories: the socio-anthropological and the organizational psychology perspective (Wiegmann et al., 2002b). One difference between these perspectives concerns the conceptual definition, which is also reflected in methodology. From the socio-anthropological perspective, it is argued that a superficial research model of culture should be avoided in order to build cultural research on a deeper, more complex anthropological model. From an anthropological perspective, the practice of ethnography and fieldwork, qualitative in-depth studies with data deriving from interviews, observations, and/or participation is commonly accepted as appropriate research methods. Within this scientific direction, culture is described in text with an emphasis on the organizational member's subjective interpretation and sense making. From the organizational psychology perspective, it is argued that culture can be described with a limited number of dimensions, usually sought through large organization-wide questionnaire surveys. From this latter perspective, the culture concept is assumed to express itself through an organizational climate—a set of perceptually based psychological attributes (Guldenmund, 2000).

Another important difference between the two directions concerns their view toward cultural change. The socio-anthropological direction considers organizational culture to be an "evolved construct" deeply rooted in history,

collectively held, and sufficiently complex to resist any attempt at direct manipulation (Mearns & Flin, 1999; Wiegmann et al., 2002b). In contrast, the organizational psychologists regard culture as changeable and tend to focus on its functional significance and the means by which it may be manipulated to improve productivity and safety (Wiegmann et al., 2002b). The organizational psychology perspective provides a conceptual bridge between safety culture, safety behavior, and organizational safety management systems, with the aim of controlling, guiding, or directing first-line operators' attitude and behavior toward safe operations.

The concept of safety culture—and climate—has over time been a theme of heated discussion, with little theoretical consensus emerging on the ontological, epistemological, and methodological questions relating to the subject. The main differences in these questions seem to be: (1) What is the scope of safety culture and the relationship between culture and climate? (2) How does the concept relate to other organizational aspects and outcome? (3) Which methods are most suitable for measurement? (Peterson, Ashkanasy, & Wilderom, 2000). These fundamental questions have already been elaborated upon by many researchers (e.g., Antonsen & Norges teknisk-naturvitenskapelige universitet. Institutt for sosiologi og statsvitenskap, 2009; Cooper, 2000; Glendon & Stanton, 2000; Guldenmund, 2000; Håvold & Nesset, 2009; Olsen, 2009; Sorensen, 2002; Tharaldsen, 2011; Wiegmann et al., 2002a; Wiegmann et al., 2002c; Zhang, Wiegmann, von Thaden, Sharma, & Mitchell, 2002). Based on his review, Guldenmund (2000) pointed out that most of the characteristics given to culture equally apply to climate, and within recent research it is more commonly accepted that climate is a reflection of an underlying culture. Hale (2000) even proposed that one should stop talking about safety culture completely and instead talk about

(organizational) cultural influences on safety (Hale, 2000). In order to grasp as many facets as possible of the safety culture concept, a multi-method approach is needed. As the safety culture-climate debate seems to be settling down and has already been thoroughly discussed by many, the concept will in this thesis only be touched upon in brief.

A general working model used in the studies of safety culture and safety management in this thesis is shown in Figure 3.

***Figure 3*: The general working model used in the studies of safety culture and safety management**

With reference to Figure 3, organizational culture/climate is seen as an integrated concept subject to change by organizational management practices and structures. It is assumed that both organizational cultural and managerial features influence safety, which is defined as safety culture. As such, organizational safety culture is perceived as a concept with integrated parts from organizational management system practices and organizational culture/climate. The organizational safety culture is assumed to reflect the status of safety in the organization. Organizational safety, or safety culture, is assessed using two measurement outcome variables: risk perception and the

state of the safety management system (SMS). The various concepts and relationships shown in Figure 3 are further elaborated upon in the following three sub-chapters.

3.1 Safety culture as an organizational integrated concept

Within the field of organizational safety, the climate concept was first introduced by Zohar in 1980 (Zohar, 1980). In more recent publications, Zohar relates safety climate to an overall organizational climate made of shared perceptions among employees concerning the procedures, practices, and kinds of behavior that are rewarded and supported with regard to a specific strategic focus. When the strategic focus involves the performance of high-risk operations, the resultant shared perceptions define safety climate (Zohar, 2010). Although climate and the underlying culture may have a particular referent as safety, they embrace and are influenced by more than a single unit or function in the organization. An organization has multiple goals and multiple policies that are all manifested in organizational behavior and practices. The different goals are often in competing conflict, like profit and safety (Hollnagel, 2004; Hollnagel, 2009). For example, the crew may be expected to cut corners and work faster without getting crossing prevailing rules and regulations or jeopardizing safety. The safety climate concept integrates perceptions toward the organization's total contexts as a regulatory framework and competitors as well as internal matters as finance, marketing, human resources, control systems, safety management systems, and so on. Consequently, when measuring climate with a particular reference, it is important to embrace the organization in a wider sense in order to reveal conflicting areas and the priority of importance. True priorities at work (e.g.,

efficiency versus safety) have been shown to provide the strongest prediction of actual behavior (Zohar, 2008).

The theoretical roots of the safety culture discussion can be traced back to Barry Turner and the introduction of the manmade disaster model (Pidgeon & O'Leary, 2000; Turner, 1978). In the manmade disaster model, an accident is defined not by its physical impact, but in sociological terms, as a significant disruption or collapse of the existing cultural beliefs and norms regarding hazard. These cultural beliefs and norms are assumed to be formally laid down in rules and procedures or more tacitly taken for granted and embedded within working practices. This is also related to managerial and organizational practices.

Andrew Pettigrew (1979), whose background is in anthropology and sociology, relates the cultural concept to the everyday tasks and objectives in organizations as a product of social processes connecting the past, present, and future. In many ways, Pettigrew's definition encompasses Turner's definition. According to Pettigrew (1979), culture is related to the less rational and instrumental tasks in an organization as well as the more expressive social tissue that give those tasks meaning, such as the meaning of having a safety policy, if procedures should be followed only when safety inspectors are present, or if efficiency is the real area of priority and the safety-first policy only serves as a function for external stakeholders. It is argued that, in order for people to function within any given setting, they must have a continuing sense of what reality is all about in order to be acted upon. In this setting, culture is the system of such public and collectively accepted meanings with regard to safety, operating for a given group at the time (Pettigrew, 1979).

One of the most influential anthropologists of modern time, Clifford Geertz, regards culture as "webs of significance" spun by man and in which man are suspended. According to Geertz (1973), cultural scientists should try to interpret those webs in search of meaning and explanation. Geertz (1973) concluded that culture is most effectively treated as a symbolic system. By isolating the elements of the symbolic system, specifying the internal relationship, the whole system may be characterized in general. Symbols are the surface expression of the underlying cultural structure. Pettigrew (1979) also emphasized symbols, languages, ideologies, beliefs, rituals, and myths as an important part in the codification of meaning and emergence of normative patterns. For example, in accordance with requirements of the ISM Code, shipping companies have safety policies. From a cultural perspective, policies such as safety first are not important in themselves. The importance stems from how such policies, as a symbol, make sense for the organizational members. A safety-first policy may be perceived as a statement aimed to attract customers or directed toward other external stakeholders. In the case of the *Bow Mariner*, it is likely that the company safety policy would be given meaning as a façade maintained toward external stakeholders, which can explain the actual safety-degrading behavior on board. The vessel did hold a valid ISM certificate and documentation, but during normal operations they were not acted upon and complied with. This understanding of culture also establishes a relation between culture and climate—namely, that cultural beliefs and meaning given to organizational factors are reflected in actual behavior. In this particular case, the symbolic system is explained by the gap among safety policy, guidelines, and actual behavior.

One of the most widely used organizational culture frameworks is probably that of Edgar Schein (1992, 2004), a framework that built upon Pettigrew's

cultural theory. This framework explains culture at three levels: (1) artifacts—visible organizational structures and processes that are difficult to measure but are felt and heard by individuals who enter a new culture; (2) espoused values—norms, standards, and moral principles usually measured through questionnaire surveys; and (3) basic underlying assumptions—unconscious taken-for-granted beliefs, perceptions, thoughts, and feelings, which may be understood by ongoing observations and participation. Schein (1992, p. 12) formally defined culture as:

> a pattern of shared basic assumptions that the group learned as it solved its problems of external adaption and internal integration that has worked well enough to be considered valid and, therefore, to be thought to new members as the correct way to perceive, think, and feel in relation to those problems.

Schein regards culture as shared assumptions expressing consistent, clear, and organization-wide consensus. However, in looking for organization-wide consensus, important areas of conflict will be disregarded and lost. What is regarded and learned as valid patterns of shared assumptions depends upon how the group is defined, which in turn opens up for the existence of various groups and subcultures within an organization.

Regarding the *Bow Mariner*, it is natural to assume that the group of Greek officers and the group of Filipino crew differ with regard to what is shared, which also brings about the notion of subcultures. In general, it is assumed that subcultures are found within the shipboard departments' deck, engine, and galley. Analyses of other levels in the organization may give different results, as the group may be defined as the whole fleet or as all shipping

companies. A cultural trait identified at the industry level may be related to manning policies and the extended use of manning agencies and contract employment, which most regard as the only possible solution to manning—a solution that is taken for granted and not questioned by insiders, thereby determining national subcultures. When distinguishing climate from culture, climate is often suggested to arise from individuals whereas culture is suggested to arise from group or interpersonal processes (Dansereasu & Alutto, 1990)

Safety culture is assumed to be influenced by and seen as an integrated part of an organizational culture and a product of equal processes. Organizational culture is a relatively stable, multidimensional, holistic construct shared by groups of organizational members that supply a frame of reference. It gives meaning to and/or is typically revealed in certain practices manifested as organizational climate. In the same way, Mearns and Flin (1999) described safety climate as employees' perceptions, attitudes, and beliefs about risk and safety whereas safety culture is a more complex and enduring trait reflecting fundamental values, norms, assumptions, and expectations. These cultural elements can be seen through safety management practices, which again are reflected in the safety climate and in actual behavior (Mearns & Flin, 1999). In conclusion, most of what is true for safety culture is also considered true for safety climate (Guldenmund, 2000).

3.2 Organizations, management and cultural change

Safety management and safety culture are all about change—a change toward enhanced operational safety. Both Pettigrew (1979) and Schein (2004) regarded individuals, including entrepreneurs and leaders, as important in the process of creating and managing an organizational culture. According to

Schein, one of the most decisive functions of leadership is the creation, management, and sometimes even the destruction of culture. Although Schein regarded leaders as important in these processes, leaders are not regarded as the only determiner of culture. Schein also stated that culture is a result of complex group of learning processes only partially influenced by leaders. Groups (e.g., departments or vessels that operate within similar situations) may behave very differently from one another as the group dynamics differ. Schein (2004) referred to culture as those elements of a group or an organization that are most stable and least malleable. However, according to Schein (2004), the group itself needs a certain degree of stability. Any group with a stable membership and a history of shared learning will have developed some level of culture, but a group having either a great deal of member turnover and/or a history without any challenging events may lack shared assumptions. Zohar (1980) identified a stable workforce with less turnover and older workers as an organizational characteristic when determining safety climate. A stable workforce is then vital for both climate and culture. Within the segments of shipping that have large turnover and less group stability, it might be questioned if they have developed any shared basic assumptions (culture) or working practices (climate).

According to Schein (2004), some barriers to the development of an integrated shared culture exist, including the insufficient stability of group membership and the insufficient shared history of practice or the presence of many subgroups with different kinds of shared experience. This may lead to a situation of ambiguity and conflict. Joanne Martin (Martin, 1992) distinguished three perspectives: (1) integration, (2) differentiation, and (3) fragmentation. Martin's (1992) recommendation is that an organization be viewed from all three perspectives, as one perspective's strengths are

another's weaknesses. As a result, a greater understanding of an organization's culture and how to approach cultural change may be obtained. From each perspective, different aspects of culture and cultural change are captured. This view was also supported by Alvesson (1993).

From the integration perspective, culture is described as patterns of manifestations shared by all members of the organization, and the organization's manager/leader is regarded as the primary source of cultural change. One of the most renowned representatives within the integration perspective is probably Edgar Schein (Frost, 1991; Richter & Koch, 2004; Schein 2004). According to Schein's theory, the organization's leader is regarded as being able to create and manage the culture in pre-given directions. The development of subcultures is regarded as undesirable side effects appearing when the organizations grow and mature. In such a situation, Schein argued that the leader's effort should focus on integrating the variety of subcultures.

From the differentiation perspective, cultural manifestations are described as sometimes inconsistent when consensus occurs only within the boundaries of subcultures, which often is regarded as being in conflict with each other. With regard to influence and change, greater importance is assigned to the environment, and teams of leaders are ascribed to have secondary influence to cultural change. Nick Pidgeon (1998) considered the importance of subcultures, questioning whether a unified culture may be designed within a large organization and arguing that existing subcultures should be given attention regarding how they differ in (safety-related) priorities, perceptions, and interpretations of emerging safety problems. How these aspects interact with each other, existing power relations, and the like is of equally great importance (Pidgeon, 1998).

While both the integration and differentiation perspectives focus on what is shared and accounts of planned and directed goals change, the fragmentation perspective regards ambiguity as the essence of culture. In this perspective, culture is something that is constantly fluctuating, and no stable organization-wide or subcultural consensus is supposed to exist. Cultural change is seen as being in a constant flux, where the power of change is usually seen as being diffused broadly in the environment and among organizational members. The ambiguity is supposed to emerge from the complexity and unpredictability in the organization and society; the fragmentation perspective does not assume that the organizational members have similar reactions to these ambiguities. Karl Weick and the theories of high reliability organizations (HRO) are well known within this field (Weick & Sutcliffe, 2007).

Within shipping, subcultures, conflicts, ambiguity, stress, and misunderstandings are likely to be present due not only to the lack of stability of membership, but also to an insufficient shared history of practice. This relates to both the specific work situation, but also, amongst others, to nationality. National cultures are known to differ in aspects such as power distance and the degree of human inequality, uncertainty avoidance, and how they adapt to unstructured situations as well as how they integrate into a group with regard to individualism versus collectivism (Hofstede, 2001). In addition, value of life, safety standards, and risk perception are known to differ between nationalities. Geert Hofstede perceived culture as mental programming—a pattern of thinking, feeling, potential acting, and unwritten rules of the social game that distinguishes the members of one group of people from others. A certain culture is learned through the lifetime. What is acquired in early childhood and once established is difficult to change (Hofstede & Hofstede, 2005). Hofstede argued that layers of culture (e.g.,

organizational culture) acquired later in life tend to be more changeable. Organizational acquirements and practices—the visible part of culture—are regarded as faster and easier to change.

Based on the previous discussion, it is concluded that organizational safety culture and behavior are subject to change by organizational practices and structures, which includes safety management systems. Furthermore, individuals in the organization (e.g., their leaders) do have a mediating effect upon the formation of an organizational safety culture.

3.3 Organizational culture and safety management

Safety management systems have two interrelated main functions: to avoid accidents and improve safety. Theories of accident causation and safety management have progressed over time (Borys, Dennis & Legget, 2009). H. W. Heinrich is considered to be a pioneer within safety management and accident causation (Heinrich, Roos & Petersen, 1980) from the first age of safety—namely, the technical age. With reference to the shipping industry, the first development of SOLAS belonged to a technical age; the introduction of the ISM Code represented a transition to the age of management systems and culture. The age of human factors occurred in between, in which the view of human error considered the interaction of human and technical factors when exploring the causes of errors and accidents (Borys et al., 2009).

As previously highlighted, traditional safety management systems (SMS) described in the ISM Code fall along a linear causality where attempts are made to predict and prevent future incidents by reflecting upon previous experience related to empirical safety control. The traditional SMS contains several subsystems. First, a system for reporting and collecting experience data from the vessel itself is required, followed by a system of data processing

(i.e., summarization and analysis) in order to reveal causal factors and perform trend analyses, which form the basis for the development of safety measures. Both identification of causes and remedial actions are closely intertwined with how the organization addresses technological, organizational, and individual factors. Irrespective of this, one critical system requirement is the reliability and accuracy of input data (i.e., near miss and accidents reports). As long as the input is reliable, the overall system presupposes the possibility of revealing a root cause and develops efficient measures in order to control operational safety (Kjellén, 2000). Although the fundamental rationale of safety management has changed little over the years, the rationale for the understanding of human error and causal factors, root causes, and adequate safety measures has changed. However, quite surprisingly, recent research also points to insufficient scientific evidence on the effectiveness of systematic safety management to make recommendations either in favor of or against them (Robson et al., 2007). Thus, the obvious question is why: Is the reason found within the theoretical rationale of safety management or within organizational understanding and applications of the systems or is the reason found elsewhere?

The application of traditional safety management is questioned with a distinction between small-scale accidents and larger more infrequent accidents (Rundmo, 1996). According to Rundmo (1996), the empirical safety control, in which measures are developed through the analysis of past events, is only applicable for frequent and small-scale accidents such as ordinary work accidents. When it comes to medium-size and more infrequent accidents (e.g., groundings and collisions) and large-scale accidents with very low probabilities (e.g., the capsize of the *Herald of Free Enterprise* and the fire at the *Scandinavian Star;* see Table 1), traditional safety management is not

considered to be applicable. Such accidents are often too unique and complex to grasp, and it will not be possible to single out some isolated underlying causes or develop measures that cover all involved risk—a risk that in the first place is considered too complex to understand. Others, such as Scott Sagan (1993) and Charles Perrow (1999), questioned the possibility of foresight and preventions of accidents through empirical safety management.

Within the age of human factors, human error is regarded as primary cause of accidents. In more recent theories and subsequent ages of safety, human error is seen as a consequence of faults deriving from other parts in the organization or environment, complexity, interactions, and/or organizational culture. A big difference between human error as a cause and human error as a consequence is seen in the characteristics of remedial actions. With human error cited as the cause of failure, the tendency for safety measures is to seek to control human behavior with inter alia procedures and checklists. Then, when the real cause is found to lie elsewhere in the organization, such measures may not clearly be the answer to the underlying problem and incidence of failure, and accidents will continue to occur. The following sections shed light on these issues from the theoretical perspective of accident causation and prevention.

The Man Made Disaster model

Barry Turner is presumably among the first to regard latent conditions as a primary cause in accident causation. With the development and introduction of the Man Made Disaster model, accidents and disasters are proposed to develop through a long change of events leading back to root causes like lack of information and misperception among individuals (SINTEF, 2003). Turner argued that this is a result of an organizational culture where information and interpretations of hazard signals fail. Thus, a typical accident can be traced

back to initial beliefs and norms—culture and climate—that do not comply with existing operational reality. From this perspective, accident development is viewed as a process, often over years, developing from an interaction between human and the organizational arrangements of the socio-technical system (SINTEF, 2003). With reference to accidents such as the capsize of *Herald of Free Enterprise*, a common understanding of the crew—given by the management of the organization—was a general understanding that the vessel should leave some minutes ahead of schedule, even if it involved putting pressure on those who did not move fast enough. The inherent risks of such a practice were not questioned. From the Man Made Disaster perspective, systematic safety management should deal with these breakdowns in the interpretation of information. For example, are some danger signals or causes systematically disregarded or misunderstood? As with the *Bow Mariner*, why did none of the involved stakeholders (e.g., charterers, vetters, inspectors, and flag state) manage to reveal the degrading shipboard safety situation?

As such, existing cultural beliefs and norms are the essence of the Man Made Disaster theory. According to Turner, such cultural beliefs and norms might be formally laid down in rules and procedures or more tacitly taken for granted and embedded within working practices. An accident is then assumed to occur because of inaccuracy or inadequacy in the accepted norms and beliefs and of a discrepancy between the way the world is thought to operate and the way it really operates (Pidgeon & O'Leary, 2000). When acknowledging the weaknesses in traditional safety management and failure of foresight, these institutional barriers to effective learning should, according to Pidgeon and O'Leary (2000), be addressed. The aim for efficient safety management should be to let all organizational members develop a safety

imagination that breaks the pattern of becoming overly fixated with prescribed patterns, simplification, and ignorance. Pidgeon and O'Leary (2000) presented seven guidelines for fostering a safety imagination: (1) attempt to fear the worst, (2) use good management techniques to elicit varied viewpoints; (3) play the "what if" game with potential hazard; (4) allow no worst case situation to go unmentioned; (5) suspend assumptions about how the safety task was completed in the past; (6) approach the edge of a safety issue with a tolerance of ambiguity, as newly emerging safety issues will never be clear; and (7) force oneself to visualize "near miss" situations developing into accidents. It is argued that such safety imagination is a critical facet of organizational learning and an effective safety culture.

Normal Accident Theory

The Man Made Disaster theory also highlights how system vulnerability arises from unintended and complex interactions between contributory preconditions (Pidgeon, 2000), which may be linked to Charles Perrow's theory of normal accidents (NAT). However, in contrast to Barry Turner, Perrow regards some systems to be to complex and interactive to avoid organizational accidents completely. In such systems, safety management is regarded as futile as accidents are doomed to happen due to the system characteristics.

The development of NAT started with Perrow's exploration of the 1979 accident at the Three Mile Island nuclear plant. During this investigation, Perrow was struck by the fact that the present accident literature overwhelmingly blamed the operators (Perrow, 1999). Perrow then looked into accident reports from various industries, such as mining, aircraft, and marine accidents, and evolved the alternative theory that risk is a result of two

dimensions—interactions and complexity—rather than human error. It is argued that the operator is free from blame as the overall system, interactions, and interdependencies of events are incomprehensible for a critical period of time. Like Rundmo (1996), Perrow distinguishes between small-scale, frequent personal accidents and other medium-sized accidents and larger-scale accidents. Risk is, according to Perrow (1999), regarded as something designed into organizations in the form of complex systems with tight couplings. The paradox is, when barriers and other safety measures are built into the system to increase safety, often it is the complexity that is increased at the cost of safety. Perrow (1999) regards such error-prone organizations as impossible to manage safely in the long run, thereby resulting in the notion of normal accident. In the maritime setting, Perrow (1999, p. 230) described the risk-inducing complexity as follows:

> The ship itself, with its power plant explosive mixture, steering apparatus, and draft in shallow channels is important, but so are other ships, the insurance industry, the fragmented shipping industry, attempts are regulation, rules of the road, dangerous cargoes, national jealousies and interests, and, of course the horrendous environmental problems of fog, ice, and storms.

In his analysis, Perrow also pointed to conflicting organizational goals, production pressure, and organizational pressure related to risk taking, authoritarian structure on board, and inappropriate leadership. One of Perrow's (1999) main points was to regard all human constructions (e.g., vetting, class, regulatory bodies, flag state, insurance, manning companies) as systems and not as collections of individuals or representatives of ideologies. Dangerous accidents lie in these systems based on how the different parts fit

together and how they interact. From this point of view, safety management is about reducing the system complexity and/or loosening the couplings to reduce interactivity. From the perspective of NAT, Turner's notion of "safety imagination" is a dead end for organizational safety as long as complexity, incomprehensible interdependencies, and tight couplings are present.

High Reliability Organizations Theory

The High Reliability Organizations Theory (HRO) developed as a result or a continuance of Perrow's rather pessimistic message—namely, that accidents are inevitable in some systems or organizations due to their characteristics (Roberts, 1990). The concept of *safety culture* constitutes a central difference between NAT and HRO. Whereas NAT argues that in some systems accidents are inevitable, HRO argues that even in the most vulnerable and error-prone systems, safety culture has characteristics that can counteract the inherent system risk.

In many ways, HRO is in line with the arguments given by Turner, Pidgeon, and Perrow. HRO recognized that everything that may fail during operations has not yet been experienced; therefore, a system based on experience feedback (as the ISM code) is doomed to fail on its own premises. HRO also recognizes that not all incidents may be deduced to detect all possible failure or error modes. Recognizing that the world is complex, unstable, unknowable, and unpredictable, the HRO perspective maintains reluctance to the simplification inherent in traditional risk assessment. Both procedures and checklists may represent simplification of measures when a complex, unstable, unknowable, and unpredictable working situation is attempted to be controlled by preplanned prescriptions. This view is shared by Perrow, and

both NAT and HRO are skeptical towards those who heavily rely on risk assessment.

In HRO, more attention is given to the real work going on in frontline operations. By empowering those doing the actual work, operators have the possibility to solve the situations themselves, based on their own experience and knowledge. This is a contrast to traditional safety management from the era of human factors with a focus on the control of human behavior. Within the HRO paradigm of HRO, frontline personnel operate by using pre-planned descriptions, but it is accepted that in real situations deviations will occur. One of the HRO's key points is mindfulness, which is related to the concept of safety culture and similar principles such as Turner's safety imagination. *Mindfulness* is understood as a combination of alertness, sensibility, flexibility, and adaptability. This perspective argues that unexpected events should be handled by creating a mindful infrastructure by following five main principles: (1) continuously tracking small failures, (2) resisting oversimplification, (3) being sensitive to operations, (4) maintaining capability for resilience, and (5) monitoring the shifting locations of expertise. The violation of these principles is regarded as a setback toward the more traditional approach, where simple diagnoses are accepted, frontline expertise is overridden by faith in risk analysis, and safety measures are developed detached from operations. The HRO view implies that the operators gain more responsibility, so other parts of the organization have to give them the possibility to act. In other words, control is taken from the upper levels of the organization in favor of lower levels.

Within HRO, safety culture is seen as essential in managing risk. All of Johanne Martin's three perspectives of safety are adopted: "Each form of culture handles ambiguity differently: Integration denies it, differentiation

selectively clarifies it, and fragmentation accepts it. In a mindful culture, all three forms of culture are present" (Weick & Sutcliffe, 2007, p. 112). HRO does not reject the fact that organizational members have shared values and beliefs. However, with regard to safety these shared patterns are not regarded as vital for the outcome. The shared orientations are accommodated differently in all situations, and the chain of events and patterns of interactions between people fall under the influence of situational conditions as stress, misunderstandings, interpretation, and others conditions specific to each chain of event. From an HRO perspective, more weight is placed on fragmentation than on differentiation and more on differentiation than on integration.

Managing risk and safety culture

James Reason (Reason, 2001) developed a widely used practical definition and approach to safety culture. Barry Turner and the Man Made Disaster model provided much of the conceptual foundation for Reason's work (Pidgeon & O'Leary, 2000). Reason's approach to safety management and safety culture is also to a large degree adopted by the HRO perspective (Weick & Sutcliffe, 2007). Based on the organizational culture literature, Reason (2001) differs between two theoretical stands: those who regard culture as something an organization *has* and those who regard culture as something the organization *is*. Reason favors the former approach and thus regards culture as something changeable and manageable by organizational practices.

Like Turner, NAT, and HRO, Reason is also concerned about the organizational factors that trigger an accident. According to Reason (2001), accidents by their nature are not directly controllable, as many of the causal influencing factors lay outside organizational control and influence. As such,

rather than struggling vainly to exercise direct control over behavior, accidents, and incidents, organizational managers should measure and improve the processes of underlying factors, such as training, procedures, planning, budgeting, goal conflicts, and others. Thus, an efficient SMS system should help identify those conditions most needing correction and not be limited to non-compliance of global rules. Attention should also be directed toward the quality of these global rules (e.g., accuracy, relevance, availability, and workability of procedures). The information reported into the system should embrace organizational factors as well as local workplace factors and unsafe acts. The cultural factor is linked to commitment, competence, and cognizance within the organization as a whole.

Reason (2001) regards safety culture as a cornerstone in efficient safety management in order to get the needed operational information. He identifies safety culture using four critical subcomponents: (1) a reporting culture, (2) a just culture, (3) a flexible culture, and (4) a learning culture. Together, these interact to create an informed culture. According to Reason, an informed culture is one that collects operational experience data that are characterized by an organization's climate in which members feel free to report without experiencing negative, unfair, or in other ways meaningless consequences. Attention is also given to how the interpretation of information and outcome is influenced by the overall company policy. Reason is more preoccupied with organizations' internal organizing than how safety is influenced by other organizations and macroeconomics than by national and international conditions such as politics, laws and regulations.

The theory of Practical Drift – why organizations fails

Safety culture in shipping is often depicted side by side with compliance to prevailing procedures and other safety measures. However, if compliance is to be a valid key performance indicator, it is presupposed that these safety measures are appropriate for the actual action. The development of standardized measures fitting all real-life situations are a challenging if not an impossible task considering the complexity and unpredictability of most situations. This is also pointed out by NAT and HRO. The Practical Drift Model (PDM) provides an explanation for how and why organizations experience such gaps among standardized measures, real situations, and actions, referred to as practical drift (Snook, 2000). PDM combines HRO and NAT in two ways, emphasizing how different degrees of mindfulness will depend on different situations and contexts. During their lifetime, organizational systems develop both tight and loose couplings, which they shift in between—tight to loose couplings and back again—as the various sub-units within the operative part of the organization alternate between a low and high degree of interdependence. The model also captures both contextual and temporal factors when explaining why incidents and accidents occur, along with practical drift from the global rules, such as standards, procedures, and checklists.

Standardized rules are often designed according to organizational lifecycle, where the governance structure is top-down oriented. Using organizational safety management systems, organizational managers put large effort into developing extensive routines and procedures in order to make the organization robust and resilient against future unforeseen events. When designed, tight couplings and rule-based action of logic is assumed to

characterize the organization. This, in contrast to an operational situation, is assumed to be loosely coupled, and the real world does not act in accordance with the organizational design. When organizations experience that unforeseen events do not occur as expected, the attention toward the limitations and inadequacy in routines and procedures become a part of everyday life and practice and are therefore more relaxed. Others (e.g., Hollnagel, 2004) point to real-life work processes that are irregular and unpredictable in contrast to work regulations—either explicitly by procedures and instructions or implicitly by rules, standards, or good practice. Another issue arises when these rules are developed detached from the operational situations (e.g., in shipping by shore personnel); consequently, accuracy, relevance, availability, and workability of the rules may be low. Moreover, company policy may favor efficiency over safety.

As a result, the sharp end operators—when aware of this situation—will be able to break the strict rules without fear of sanctions or punishment. On a local basis, breaking strict rules may actually get the job done quicker and more efficiently. The operator may be "rewarded" for achieving additional goals in the organization. During such a process of de-coupling, the organization will become increasingly free from global rationality. Subcultures with their own logic of action based on experiences and tacit knowledge develop, and the operators accordingly drift further away from a rule-based system to a more task-based system.

According to PDM, accidents and incidents occur when the system suddenly and stochastically becomes tightly coupled, as with the *Bow Mariner, Scandinavian Star*, and *Herald of Free Enterprise*. In such situations, the involved operators are forced to act on the assumption that all others act in accordance with the original rules and procedures initially designed. The

operators become trapped in a game in which trusting their own logic of actions is the only solution while they must simultaneously base their decision on the assumption that others are following the general rules.

After an unwanted event, the outcome is often even more tightly designed control criteria. James Reason describes such an approach to safety management as a person-oriented approach, which may also be perceived as belonging to a blame culture, implying crew shortcomings as the cause of error. With human error cited as the cause of failure, the tendency is for safety measures to seek to control human behavior by developing more procedures and checklists. When the real cause is found to lie elsewhere in the organization, such measures may clearly not be the answer to the underlying problem and incidence of failure, and unwanted events will continue to occur. Global rules may be perceived as less and less meaningful; thus, constantly relying on them will further undermine the safety system as more procedures are violated and the local units drift even further apart from global rationality. Less reporting of experience data could also be a consequence in the longer run.

3.4 Safety culture and measurable outcome variables

The IAEA has built its concept of safety culture upon Edgar H. Schein's three-level model and regards safety culture as both attitudinal as well as structural relating to both the organizations and the individuals (IAEA, 1991). Based on this conceptual definition, INSAG and IAEA regard systematic safety management, which belongs to the first layer in Schein's model (i.e., artifacts), as a tool for promoting a strong safety culture and achieving a good safety performance. This may be measured in the second layer, espoused

values, using a questionnaire survey. The third layer, basic assumptions, may be captured by observation.

Using previous research within the oil industry, Rundmo (1996) demonstrated that risk perception and risk behavior are significantly correlated, but also relatively independent from each other. The association between risk perception and risk behavior is then caused by the fact that the same predictor affects both variables. Crew risk perception and other subjective assessments are suggested as good indicators of the safety level, but not as predictors for risk behavior. It is further suggested that employees' behavior to a great extent is constrained by the conditions under which they work. When the working conditions are not perceived to be satisfactory, employees know that the occupational risk is higher; they feel more unsafe, which will affect their risk perception (Rundmo, 1996). Risk perception as a measurement variable is supported by Zohar (1980), who used climate research to assume that an individual's perception focuses on the organizational environment, organizational control system, and safety management system.

Drawing from the Man Made Disaster theory, safety culture is the product of cultural beliefs and behavioral norms regarding hazards, which are laid down in the organizational control system and thus reflected in procedures and guidelines. This is in accordance with Schein (1992, 2004), who regards organizational control systems (e.g., safety management systems) as a manifestation of basic underlying cultural assumptions. In this respect, companies approach to safety management is a manifestation of the underlying beliefs and thoughts on how safety management should be performed. Pettigrew (1979) relates the cultural concept to how everyday tasks and objectives in the organization are expressed as well as their meaning, including how the organizational members comprehend the

importance of the organizational control system and derived safety measures in relation to other directions given by the company. This approach aligns with Geertz's (1973) work referring to the social processes where meaning and sense making arise. Social processes are influenced by crew composition and human resource policies. Personal beliefs and values are also antecedents to behavioral norms. Traditional cultural researchers also regard beliefs and values as less changeable as they are acquired through a lifetime and therefore deeply rooted within the individual. However, Hofstede and Hofstede (2005) argue that beliefs and values learned through an organizational context are more changeable as they are acquired at a later stage of life. The organizational context and organizational control system are assumed to directly impact behavioral norms.

When managing behavioral norms by means of an organizational control system, Kjellen (2000) defined the system as one that provides the information needed for safety and signaling related to health and safety matters. In this regard, Reason (2001) regarded safety culture as the cornerstone for ensuring the information flows as needed. Reason also addressed the safety management system as a whole, with regard to how the incoming experience data are analyzed and processed into safety measures. From this, the state of the safety management system is regarded as a measurement outcome variable.

4 Research methodology

This chapter describes the research methods applied in this thesis. Based on the discussion in Chapter 3, climate will not be separated from culture, but in theory and research methodology the recommendation from both perspectives will be taken into consideration. This synthesis of qualitative and quantitative methods is regarded as important in order to understand how culture is created through social processes while quantitative methods simultaneously say something about how widespread certain patterns of behavior and perceptions are within the industry and statistical associations. The application of a multi-method approach is also supported by others. According to Cooper (2000), the triangulation of different methods allows the researcher to take a multifaceted view of safety culture, so that the interrelationships among psychological, behavioral, and situational factors can be examined with a view to establish antecedents, behaviors, and outcomes within the specific contexts. Triangulation allows the employment of each method's strengths in order to overcome the others' weaknesses. Both Rousseau (1990) and Schein (1992, 2004) identified that different layers of culture are amenable to different research methods. For example, the fundamental content of culture is assumed to be unconscious and highly subjective. The organizational members' basic assumptions, values (what is important), and beliefs (how things work) as well as culture's social construction are difficult to assess without interactive probing. Moreover, the organizational members' fears and defenses are difficult to elicit without interaction, which gives reason for an ethnographic methodology. On the other hand, the organizational members' patterns of behavioral norms (how things are done) are far more accessible to observation from outsiders and respond to structured instruments and quantitative methods.

According to Geertz (1973), cultural analysis is (or should be) guessing at meanings, assessing guesses, and drawing explanatory conclusions from better guesses. However, the previously described examples illustrate how such guesses might be wrong if not related to individuals' own experiences and national, situational, and/or historical context. *Street Corner Society* is a method of participant observation where becoming native, without being too attached, is a part of the research strategy (Whyte, 1991). In accordance with *Street Corner Society*, the researcher lives with the community in order to understand the nature of the field, learn to understand the group, and build trust and credibility. Whyte also demonstrated how such qualitative studies may be expressed and presented in a more quantitative format. Whyte has become a major spokesman for the advantages of integrating research methods, including those typically associated with quantitative research (Bryman, 1991). As such, there is no adversative relationship between cultural field studies from an anthropological perspective representing qualitative methods and the quantitative methods typically from the psychological perspective.

From the author's own experience, the ethnographic approach has been valuable not only to understand, but to correct misunderstandings. For example, when conducting the first field studies, one Philippine mate discussed her former Norwegian captain, who refused any crew members to whistle on the bridge. Both the Philippine mate and I interpreted this as an indication of authoritarian leadership. However, months later, after getting a better understanding of seamanship in a national historical context, I found that this interpretation was wrong and in fact related to superstition, which is quite common among the older generation of seafarers. In the days of sails, the seafarers needed wind, and they whistled to call for the wind. Nowadays,

with engine propulsion, wind is no longer wanted as wind causes waves. Thus, whistling is not allowed as it calls for the wind. In other situations, misinformation may be a result of deliberately withholding information as the group being researched does not trust the researcher. In another field study, I observed that all engine crew wore helmets in the engine room, as required. However, after one week at sea, once I had become familiar with the group, I learned that usually no one wore their helmets. They only applied the rules when they had a third party on board—an outsider.

Apart from this, also favoring an integrated use of methods, cultural interpretation, and theoretical development is suggested to follow its own unplanned course in the search of grasping and analyzing "the web of significance" and structure of symbols and meaning, plunging more deeply into the same ideas. These theoretical formulations do not make much sense or hold much interest apart from the context of interpretation. Indeed, a safety culture study carried out within the anthropological tradition alone could have brought descriptions, interpretations, and understanding of how safety is interwoven with symbols and cultural elements on a single vessel or in one department. However, the developed theories would not make any sense outside that unit. Thus, within the organizational aim of enhancing safe operations in general, this approach would not be very useful.

4.1 Quantitative research and questionnaire survey

A quantitative design incorporating a questionnaire is used to develop an understanding of the manifestation of culture and to give direction for the subsequent qualitative studies. In order to grasp the underlying dimension of safety culture through the use of questionnaire, a high level of instrument quality—namely, reliability and validity—is required.

The starting point of every questionnaire is item generation, concerning which questions and themes should be included. This stage is also related to content validity. Although Hinkin (1995) suggests a strong theoretical framework as a starting point, followed by a sorting process allowing for the deletion of conceptually inconsistent items, Guldenmund (2007) suggests two different approaches for questionnaire development. First, a descriptive model of the construct can be used as a starting point—namely, a normative or theoretical approach. Second, theories and results of previous research can be used in combination to construct a new questionnaire, which is a more pragmatic approach.

However, some inherent difficulties exist in both of these frameworks. First, if starting with a theoretical approach, a lack of theoretical consensus may result in different themes, scales, and items depending upon the researchers' theoretical stand. Second, as a result of the first point, previous research may be difficult to use due to, inter alia, the variety of themes, scales, and items used. Moreover, when established theory is derived from empirical research, the theory itself may be misleading due to the vast amount of far-from-validated measurements in use. Hale (2000) perceived part of the problem as being induced by the tendency for each researcher to start from scratch by developing his or her own instrument. Hardly any scales have been reused in the same form in more than one study, and they can therefore not be systematically refined and improved by combined research efforts across several research groups. It is important to keep in mind that the cultural disagreements and differences related to epistemology, ontology, and methodology, to a great extent, may explain the many different measurements in use.

Theory plays a key role in how measurement is conceptualized, and the lack of theoretical consensus poses a clear challenge to researchers. Under such circumstances, it is especially important to be mindful of measurement procedures and development. In addition, it is considered impossible to reach theoretical progress without adequate measurement (Hinkin, 1995). As described here, the situation within the field is complicated, and some important questions are raised regarding whether the methodological disagreements derive from a lack of theoretical consensus or if theoretical consensus is lacking due to methodological differences and the use of flawed measures. In order to overcome some of these problems, a previously developed instrument was used in this thesis

Questionnaire development

In order to examine safety culture, a questionnaire developed by Studio Apertura, a constituent centre of The Norwegian University of Science and Technology (NTNU), in collaboration with the Norwegian DNV and the research institution SINTEF, was used. Their development was based on a theoretical review and an evaluation of eight preexisting questionnaires—four developed in Norway, two in Denmark, and two in the United Kingdom. The evaluation was carried out according to five criteria: (1) foundation (theoretical foundation, documentation, and premises for application), (2) thematic width, (3) practical experience of use, (4) the ability to describe and measure safety culture, and (5) the ability to be used at multiple levels (individual, group, team, company). A more thorough description of the development is available (Antonsen & Norges teknisk-naturvitenskapelige universitet. Institutt for sosiologi og statsvitenskap, 2009; SINTEF, 2003; Studio Apertura, 2004). The questionnaire was previously used to survey

safety culture on board supply vessels and found to be acceptable for use within merchant shipping. The full questionnaire and letter of introduction are included in Appendix 1.

Survey sample and respondents' demographics

The research population is Norwegian-controlled dry cargo and liquid carriers above 500 gross tons. A total of 150 target group vessels were randomly selected from the 953 vessels within the Norwegian Shipowners' Association's list of members for 2005. The target group of 150 vessels represented approximately 15% of the overall population, which was considered to be large enough to be representative of the population as a whole (Neuman, 2000). A sample of 10% is recommended, but some withdrawals were expected; thus, a 5% margin was included in the original sample. The sample was stratified with regard to status of the vessel's flag register (white, grey, or black listed flag) and type of vessel (general cargo, bulk carrier, oil tanker, gas tanker, or chemical tanker).

Following the initial selection, telephone calls were made to each company to ask for their participation. Thirty-one companies, with a total of 83, vessels agreed to participate while 45 companies with 67 vessels in total declined. Reasons for not participating included:

- ✓ Being unable to contact the company despite repeated efforts (23 vessels, 16 companies).
- ✓ The vessel was not owned by a Norwegian party and therefore was not defined as Norwegian controlled (15 vessels, 8 companies).

- ✓ Ship management was outsourced to a non-Norwegian country and therefore was not defined as Norwegian controlled (14 vessels, 8 companies).
- ✓ The company refused to participate (12 vessels, 10 companies).
- ✓ The remaining vessels were sold (3 vessels, 3 companies).

The population was later redefined, and vessels managed from a non-Norwegian country were not considered to be Norwegian controlled.

In total, 1,574 questionnaires were distributed to 83 tankers and bulk/dry cargo carriers; 76 vessels from 29 companies returned a total of 1,262 forms, resulting in an individual response rate of 80.2%, a vessel response rate of 91.5%, and a company response rate of 93.5%. The questionnaires were returned from 40 liquid bulk carriers (liquid tanker) and 36 dry bulk carriers (dry cargo); 63% of the respondents were employed on a liquid tanker and 37% on a dry cargo vessel. Twenty-two nationalities were represented, with the majority from the Philippines (65.5%), followed by Norway (9.2%), Poland (8.1%) and Russia (5.5%). Unfortunately, no company with vessels flying a black-listed flag was willing to participate.

The further validation process (results are included in the articles in part II) is based on the following premises and methodological guidelines.

Validity and reliability through theoretical conceptualization

The starting point when developing a questionnaire and scales is conceptual definition, which specifies the theoretical basis. A questionnaire is normally comprised of several dimensions or constructs represented by several partly overlapping items, called multidimensional scales. When generating the item

pool, each item making up a construct should reflect the latent variables underlying the theme (i.e., the different features or dimensions of the safety culture concept). In order to truly reflect the underlying feature, the items in each dimension should ideally have a common cause (i.e., local management) or consequence (i.e., work practices). Thus, an underlying assumption is that the items reflecting one single construct are unidimensional. In other words, within each measured dimension, items are strongly associated with each other while simultaneously representing a single dimension of the concept. Three reasons for using a multi-item measure instead of a single-item measure are noted. First, an individual item is not reliable due to a considerable random measurement error. Second, an individual item lacks precision and can only categorize people into a relatively small number of groups. Third, an individual item lacks scope, and it is very unlikely that a single item may represent a complex theoretical concept (DeVillis, 2003; Gliem & Gliem, 2003; Hair, 1998; Shevlin, Miles & Bunting, 1997; Spector, 1992). Summing up, single items are considered to be less valid, less accurate, and less reliable than multi-item constructions. It is also suggested that a scale should consist of a minimum of three items in order to be robust (Pett, Lackey & Sullivan, 2003). However, due to collinearity, the use of multiple items could represent a problem in regression models and when independent variables are created by summing items in a scale. Such an additional method represents a procedure that does not control for the effect of measurement error. Regression parameter estimates may be attenuated or increased (Shevlin et al., 1997).

When ensuring the conceptual definition, the primary concern is content validity, which is a requirement for construct validity (Hinkin, 1995). Content validity is the degree to which elements of the measurement are relevant to

and representative of the underlying safety culture concept. Determining whether the scale or item-set has good content validity can be done from a number of sources of relevant theory, empirical literature, and expert judgment. Construct validity concerns the degree to which inferences can legitimately be made from the operationalized constructs in the questionnaire to the theoretical concepts on which those operationalizations were based. When using multidimensional scales, both the convergent validity of the respective subscales (i.e., the degree to which the items within a particular subscale measure the same unidimensional construct) and their discriminant validity (i.e., the degree to which the items in different subscales measure different rather than the same construct) need to be considered. Both content and construct validity are concerned with how the measurement fits with the theoretical foundation and power of generalization—namely, external validity. When the objective of a study is to establish a causal relationship (i.e., using regression analysis), internal validity is of particular consideration, referring to the confidence placed on the assessed cause-effect relationship. The internal validity of the conclusions reached depends on the reliability and validity of the questionnaire or scales used (Neuman, 2000; Raubenheimer, 2004).

Other aspects that should be taken into consideration are whether the items are measuring a perception or an attitude. Perceptions are considered more volatile and mostly oriented toward the current workplace conditions, whereas attitudes are considered to be less open to change, more durable, and developed through experiences both inside and outside the workplace. Cooper (2000) cautions against the use of measurements that include attitude scales due to the risk of muddying the construct. Previous research has shown that attitudinal questions have more positively skewed responses than the

perceptional questions and may therefore influence the analytical results. Moreover, Cooper (2000) indicated that the mix of attitudinal-perceptual questions is one explanatory reason that different factor structures emerge across research groups.

Measurement errors threaten the validity of the conclusion about the relationship between the constructs. Method bias has both a systematic and a random component, with the systematic error in particular being considered a major problem. One source of method bias is apparent when the same measurement is used for all constructs, making it difficult to assess the strength of the bias. The direction also varies, and the observed relationships may be either inflated or deflated. Potential sources of common method biases are produced by a common source or evaluator (e.g., social desirability, consistency motive acquiescence, or positive and negative affectivity) whereas method effects are caused by an item's characteristics (i.e., complexity, ambiguity, scale format, and negatively worded items). Method effects are caused by item context produced by the measurement context (Podsakoff et al., 2003). Podsakoff et al. (2003) presented several approaches to addressing this problem. However, others regard the common method biases as an urban legend, claiming that the supposed effect on correlations is overstated (Spector, 2006). Spector (2006) further pointed to the fact that, as long as there is uncertainty related to the presence and size of a possible bias, applying methods, inter alia statistical methods, in order to control the bias effect might produce biases itself, as one might control for something that does not exist. However, being aware of the possible problems makes it easier to consider them during the process of developing a valid measurement.

Validity and reliability through factor analysis

When data are collected, factor analysis is a common method for validation of the questionnaire's conceptual definition. Factor analysis defines the underlying structure of the interrelationship (correlation) between the variables in the questionnaire data by defining a set of common underlying dimensions known as factors. However, not only do the constructs share that they are facets of the same concept, but correlations could also be—due to similarities in measurement—common source and/or common method (DeVillis, 2003; Podsakoff et al., 2003). If the data are not biased, the extracted factors comprise internally consistent and correlated items that externally differ from the other factors. Thus, the extracted factors are assumed to have discriminant and convergent validity. The convergent validity is further assessed by the means of scale analysis and inter-item statistics.

For the method of factor analysis to be appropriate, a certain sample size is required. Preferably, the sample size should be 100 or larger. As a general rule, it is suggested to have at least five times as many observations as there are variables to be analyzed. Some even propose 20 cases for each variable. Small sample sizes or low variable-case ratio lead to higher chances of "overfitted" data (i.e., deriving factors that are sample specific with little generalizability) (Hair, 1998). Hair (1998) also pointed out that correlations in small samples could be deemed significant and appear in the factor analysis just by chance. In addition, if no items are substantially correlated, factor analysis is not applicable. The method's applicability is commonly tested by Barlett's test of sphericity, which should be significant, and Kaiser-Mayer-Olkin (KMO), which should exceed 0.60 (Hair, 1998).

Factor analyses can be done from an exploratory or confirmatory perspective. Exploratory techniques are often more useful early in the validation process, while confirmatory techniques are far more common when the instrument in question has been previously validated. The most common method for extracting factors is Principal Component Analysis (PCA), which is considered suitable when the research purpose is data reduction or exploration, but should not be used in causal modeling. When the research purpose is theory confirmation and causal modeling, Common Factor Analysis (CFA) (e.g., Principal Axis Factoring [PAF]) is most suitable (Hair, 1998). An important tool for interpreting factors is factor rotation (Hair, 1998). Varimax rotation is the most common method for interpretation. However, the varimax rotation method, which belongs to the group of orthogonal rotation techniques, may be problematic to use. Orthogonal techniques assume that the underlying factors are independent, but from the theoretical perspective dimensions of, for example, safety culture, they are not regarded as independent but as an integration of various sub-facets. To validate a questionnaire, CFA is recommended with an oblique rotation technique. Oblique techniques allow for correlation between factors and are preferable when the researcher's aim is to obtain several theoretically meaningful factors or constructs (Field, 2005; Hair, 1998; Pett et al., 2003). Moreover, confirmatory analysis is recommended when the final objective is structural equation modeling (SEM) analysis (Hoyle, 1995).

Each item's, or variable's, "fit" with the underlying dimension is represented by factor loading. Factor loadings range from 1 to -1; the closer to ±1, the better the representation of the underlying dimension. The definition of a significant loading depends upon the sample size. A small sample size requires higher loading than a large sample. In addition, variables'

communalities should be assessed. Communality refers to the total amount of variance an original variable shares with all other variables included in the factor analyses. Variables with low loadings and low communalities should be considered for deletion (Hair, 1998). By one rule of thumb in CFA, loadings should be 0.7 or higher to confirm that independent variables identified a priori are represented by a particular factor. However, such high loadings (≥ 0.70) are not typical, and real-life data may not meet this criterion. Thus, some researchers—particularly for exploratory purposes—use a lower level such as 0.4 for the central factor and 0.25 for other factors (Raubenheimer, 2004). On the other hand, factor loadings must be interpreted in light of theory and their practical significance, not by arbitrary cutoff levels alone. In addition, items with multiple significant loadings at various factors should be deleted, as this is a sign of multidimensionality (Hair, 1998) and, thus, not discriminant valid. In a multidimensional scale, it is recommended that a minimum of three items load significantly in each factor. The more items there are per factor, the more likely is it that the factor will replicate as originally constructed (Pett et al., 2003; Raubenheimer, 2004). When using a validated questionnaire, the extracted factors should be similar to the theoretical construct as operationalized.

Factor correlation analysis is often done in order to check construct validity, which is viewed as the extent to which an operational measure truly reflects the underlying safety culture concept as well as whether it operates in a consistent manner.

Validity and reliability through scale analysis

Various statistics can be selected in order to estimate the reliability of scale and items, including alpha models, split-half models, Guttman models, and

parallel and strict parallel models. Cronbach's alpha is extensively reported as the most commonly accepted measure for internally consistency reliability (Hinkin, 1995; Shevlin, Miles, Davies, & Walker, 2000). Internal consistency (convergent validity) is statistically tested by Cronbach's alpha coefficient and inter-item statistics. Although no consensus exists with regard to the Cronbach's alpha coefficient, usually a value above 0.7 is considered acceptable, although some advocate for a level of 0.8 or better, especially when a new scale is being evaluated (Netemeyer, Sharma & Bearden, 2003; Raubenheimer, 2004). Others suggest that when dealing with psychological constructs, values below even 0.7 can, realistically, be expected because of the diversity of constructs being measured (Field, 2005).

Although high reliability is generally cited as evidence of good psychometric properties of a scale, it is noted that Cronbach's alpha value on its own should be used with caution (Shevlin et al., 2000). The value depends upon the number of items in the scale and is a function of, inter alia, the inter-item correlation and the item-total correlation. Thus, the inter-item statistics should also be examined. Inter-item statistics, or convergent validity, are related to the extent to which different scale items assumed to represent a construct converge on the same construct. Convergent validity is the degree to which multiple attempts to measure the same concepts agree, which may be tested by the item-total correlations. Rules of thumb suggest that the item-total correlation should exceed 0.5 (Hair, 1998) or 0.4 (Field, 2005) and the inter-item correlation should exceed 0.3 (Hair, 1998), but not 0.8. An inter-item correlation exceeding 0.8 suggests that items are duplicates of one another (Pett et al., 2003). Moreover, Shevlin et al. (2000) argued that a high estimate of Cronbach's alpha may indicate the presence of systematic error, such as scales deviating from unidimensionality. In such cases, extraneous variables

can make a substantial contribution to inflating the Cronbach's alpha value rather than the actual dimension being measured. Indeed, when the factor loadings of the dimension being measured are low, the presence of systematic errors can greatly inflate the estimate of Cronbach's alpha, especially with large sample sizes (Shevlin et al., 2000). These findings substantiate the importance of reporting item statistics so that the presence of unidimensionality can be evaluated, along with factor loadings and cross loadings.

Causal relationship through structural equation modeling

Structural equation modeling (SEM) is applied to test the causal relationship between the components deriving from factor analysis. Through SEM analysis, it is possible to estimate multiple and interrelated dependence relationships. SEM is focused on testing causal processes inherent in theory. Moreover, this method has the ability to represent unobserved concepts, as safety culture, in these relationships and account for measurement error in the estimation process (Hair, 1998). The structural relations between tested variables are specified with both a theoretical and empirical foundation.

SEM is an extension of both factor analysis and regression analysis. The method serves purposes similar to multiple regressions, but in a way that takes into account the modeling of interactions, nonlinearities, measurement error, and correlated error terms. SEM also considers when the independent variable(s) as well as the dependent variable are measured with multiple indicators, such as when extracted using factor analysis. Hence, the advantages of SEM compared to multiple regressions include more flexible assumptions. SEM analysis also opens up the possibility to explore multiple relationships simultaneously, where regression analysis only examines a

single relationship at the time, holding all other variables constant (Hair, 1998).

The final model is evaluated with goodness-of-fit criteria assessing the overall model. Assessing the goodness-of-fit is not as straightforward as with other multivariate dependence techniques (e.g., multiple regressions) as no single test best describes the "strength" of the SEM model. Instead, a number of goodness-of-fit measures have been developed; when used in combination, the results are assessed from three perspectives: overall fit, comparative fit to a base model, and model parsimony. However, there is no consensus of what accurate levels of fit are, as none of the measures (except the chi-square statistics) have an associated statistical test. According to Hair (1998), several guidelines have been suggested, but ultimately each researcher must decide whether the model fit is acceptable (Hair, 1998).

4.2 Qualitative research design

The term *qualitative research* refers to any kind of research that produces findings not arrived at by means of statistical procedures or other means of quantification. Although some of the qualitative data may be quantified, as with census data, the analysis itself is a qualitative one (Strauss & Corbin, 1990). The most prominent qualitative research techniques employed in this study are: (1) document study, (2) case studies, (3) interviews, (4) participatory observation, and (5) participation in maritime forums.

Document study

Document study is an indirect method of data collection that does not require participation of the subjects involved. Official maritime accident investigation

reports (CPEM, 1999; Danish Maritime Authority, 2009; Justis-og politidepartementet 1991; National Transportation Safety Board, 1990; United States Coast Guard, 2005) are studied in order to understand how safety culture, safety management, and context interact and influence the course of events.

In addition, administrative safety management documentation has been studied in the four different companies selected for the case study (further information about these cases follows). This includes safety meeting minutes, reported events, root cause analyses, procedural manuals and checklists, and other available relevant documentation. Analyses were performed with the intention of understanding the companies' approaches to safety management and priority areas. Of particular interest were safety information data analyses—namely, how the experience information was categorized and their approach to identifying causes in cases of near-miss, incidents, and accidents. Such analyses occurred with reference to the previous mentioned ages of safety and to which degree technical, personal, and underlying organizational causes were identified. The analyses were also seen in relation to safety measures and changes done upon the processed information—namely, if changes aimed at introducing more control in the form of procedures and checklists or if changes were done in other levels of the organizational structures and policies (e.g., manning policies). This part of the document analysis was complemented with interviews.

The document studies have given valuable insights into understanding how safety culture, safety management, and context interact and influence accidents. These studies also provided a better understanding of shipping companies' approach to safety management. They have enabled the study of

past events and issues to identify changes over time; however, some limitations exist. The documents are not representative; therefore, findings cannot be generalized. Which documents were made available depended upon each company; thus, a full comparative study between cases could not be performed. In addition, all documentation should be considered as biased as it represents the view of its authors (Sarantakos, 1998)

Case studies

Case study research involves studying individual cases—in this case shipping companies—in their natural environment for a long(er) period of time, employing a number of methods of data collections and analyses. Four case studies were carried out in two tanker companies and two dry cargo companies. The statistical results from survey data analyses were used as criteria for selecting cases and focus area—namely, mixed crew nationality and ship management. Thus, a better understanding of the structure, processes, and complexities underlying the statistical results were achieved. Administrative document studies (as previously described), interviews, and participatory observation were performed along with seminar participation. The information gathered is used to illustrate, explain, and expand the quantitative findings. However, some of the drawbacks with case study as a method are poor representativeness and poor replicability (Sarantakos, 1998).

Interviews

In contrast to document studies, interviewing requires direct interaction with the respondents and heavily relies on their involvement, participation, and contribution. Both formal and informal interviews were performed. Open formal interviews were carried out with shore-side personnel working in

selected case companies within the department of safety management and/or manning. When available, top-level management was also interviewed. The interview process had to be adapted to the subjects' availability; thus, individual interviews were conducted in some cases and group interviews in others. The scope of the interviews also changed over time as a better understanding of the industry was acquired. Therefore, the first interviews are more superficial in character then the last. All interviews were recorded.

When interviewing the sailing personnel, a more informal and ethnographic approach was selected. Safety issues, behavioral norms, violation of standards, and the like are sensitive issues. Most crews are not Norwegian and do not enjoy fixed employment; thus, many fear losing their job from being open about the situation. Most interviews conducted in the field studies were done as a part of daily conversations after a trusting relationship had been established. None of these interviews were recorded.

Participatory observation

Participatory observation at sea was also carried out. During the study, vessels from various companies sailed for different periods of time, ranging from one to two weeks.[4] During the field studies, I participated in daily work activities such as ballast tank cleaning, mooring operation, loading, and acting as watch keeper at night. However, in a 24-hour society, leisure time is also of great importance. During my spare time, I participated in leisure activities and games. I experienced that spending time with the crew was essential to

[4] The shipping industry is known to be a highly transparent industry. Thus, to ensure that all participants remained unidentifiable, the number of vessels sailed is not included.

gaining their trust, and the first days no questions of a more sensible character were asked. When interacting with the crew, informal interviews were carried out as part of the daily conversation. Both interviews and observations aimed to understand how the ship management influenced the work on board and to understand team and group processes from within the group. Although the crew knew about my research area in more general terms, research questions were never explained in detail to avoid biases.

Participatory observation has the advantage that group processes and management practices may be observed in their natural environment. In addition, it is possible to retrieve firsthand information that respondents are unable or unwilling to offer during formal interviews (e.g., deliberate violations of safety standards). However, one limitation is that participatory observation can only be employed with smaller groups; thus, findings cannot be generalized. Although behavior is directly observed, the method does not offer frequency of behavior. The method is also exposed to observer bias, selective perception, and memory and offers no control measure regarding bias, attitude, and opinion of the observer. In particular, the latter were experienced during the field study, especially when working with lower-paid crew from the third world originating from poor conditions. I had much empathy for this group. Being aware of my own bias gave me some control over the situation in order to remain objective.

Participation in maritime forums

Participation in maritime forums and seminars as a method was used for two reasons: (1) to gain an understanding of the maritime context and interrelationships and (2) to ensure quality assurance of results. Inspired by William Foote Whyte and the Street Corner Society, an ethnographic

approach was adopted to gain an understanding of the research area and build up credibility and trustworthiness. As a part of this, the maritime aspects became integrated into my own social life as well as my research. Early in the study, I reallocated myself from my institute's economical and administrative department, where I was originally employed, to the department of nautical sciences. Along the road, I also became chairman of the Nautical Institute Norway Branch, an international organization working to improve the safety and efficiency of shipping. I then became an official member of the Norwegian delegation participating in IMO meetings. Thus, by carrying out research at the maritime industry, I became a part of the industry itself.

Several presentations of my results have been given at national and international conferences, both for governmental and non-governmental industrial stakeholders and company conferences. Feedback from the audience has been used to interpret statistical results and define critical areas for further investigation. As with participatory observation, going native was—and still is—an area of concern.

4.3 Applied methods and statistics in articles

An overview of methods for data collection and statistics applied in the different papers is presented in Table 2. Although not explicitly stated in all articles, all quantitative results are interpreted in a qualitative framework.

Table 2.

Overview of Methods for Data Collection and Statistics

	Article Id.					
Data collection	**1**	**2**	**3**	**4**	**5**	**6**
Maritime document study	x	x	x	x	x	x
Field study at sea	---	---	x	x	---	x
Shore interviews	---	---	x	x	---	x
Maritime/safety related conference attendance	---	---	---	x	---	x
IMO attendance	---	---	---	---	---	x
Survey comments	x	---	x	---	---	x
Survey quantitative data	x	x	x	x	x	x
Analysis						
Exploratory factor analysis (EFA)	x	x	x	x	x	x
Confirmatory factor analysis (CFA)	x	---	---	---	---	---
Cronbach's alpha	x	x	---	---	x	---
Correlation (Pearson's *r*)	x	x	---	---	x	---
Inter-item, item-total statistics	x	x	---	---	x	---
Analysis of variance (ANOVA)	---	x	---	---	---	---
Linear regression analysis	---	x	---	---	---	---
Logistic ordered regression analysis	---	---	---	---	x	---
Development of factors used in analysis						
Summarized items from extracted factor structure	x	x	---	---	---	---
Transformed standardized factor scores	---	---	---	---	x	---
Summarized items based on theoretical relationship	---	---	x	x	---	x

5 Research results

This section summarizes each article, including the objective, applied method, main results, conclusions, and interrelationships. All articles are related to the three research questions developed for the purpose of this thesis:

- What characterizes safety culture and safety management within the shipping industry?
- What is the relationship between safety culture and safety performance within the shipping industry?
- What characterizes shipping companies' application of the safety management concept?

Finally, a structural model testing the causal relationship among the latent dimensions of safety culture is presented.

5.1 Summary and results of article 1

Oltedal, H. A., & Engen, O. A. (2009). Local management and its impact on safety culture and safety within Norwegian shipping. In S. Martorell, C. Guedes Soares & J. Barnett (Eds.), *Safety, Reliability and Risk Analysis: Theory, Methods and Applications* (pp. 1423-1430). London: Taylor & Francis Group.

The objective of this article was threefold: (1) explore and analyze the shipboard characteristics of safety culture; (2) elaborate upon which factors affect the shipboard safety culture; and (3) use the results to set the direction for future studies. The first two objectives are stated in the article.

The article first states the theoretical approach to safety culture, along with the methodological framework. Safety culture is perceived as a reciprocal interrelated fusion of three main elements. The first element is internal psychological factors, including each individual's attitude and perception toward safety, work situation, and organization. This element was measured using a questionnaire. In addition, formal and informal interviews were performed to get a more comprehensive understanding of what is happening inside people's heads. The second element is observable safety-related behavior, or what individuals are actually doing on board. Safety-related behavior, which is perceived to be partly determined by the first element (i.e., psychological factors), was also measured by a questionnaire, in which individuals reported their own behavior in working situations. In addition, participatory field studies were conducted to observe actual behaviors. Behavioral patterns are regarded as a manifestation of shipboard culture and of a culture existing on a higher level in the organization (i.e., organizational factors). Finally, the third element is organizational factors (e.g., employment policy, safety management policy, approach towards efficiency versus safety), which were measured by case studies and interviews. However, the questionnaire also comprised questions related to organizational factors. In this approach, the contextual influence is also important. Distinctive characteristics of the shipping context are, inter alia, life and work on board as a total institution and a 24-hour society.

A mixed method approach was applied, where retrieved data were integrated into the interpretation, although this was not explicitly stated in the article. Consequently, psychological measures traditionally referred to as safety climate and safety culture traditionally explored by qualitative methods were not distinguished. In this article (and the others), statistical data were all

interpreted in a qualitative framework. It was recommended that the questionnaire not be used as a single method; thus, it was referred to as a safety culture questionnaire.

The statistical approach was based on a combination of exploratory and confirmatory factor analyses, using the method of principal component. The exploratory factor analyses were carried out with orthogonal varimax rotation. In the confirmatory factor analysis a one-factor solution on each construct was performed. Based on a comparison of the exploratory and confirmatory factor analyses, five factors were found to be valid: (1) crew interaction, (2) reporting practices, (3) competence, (4) local management, and (5) working situation (proactive work practices).

The qualitative data indicated that the shipping companies' crewing strategy, which includes employment terms, rotation systems, and policy toward shipboard management, are interrelated with how safety culture is manifested on board. Considering seafaring as a 24-hour society and the geographical distance between the on-shore organization and the vessel may affect both the quality of those systems and plans developed on shore and their implementation on the vessels. Thus, ship management was identified as a key factor to a sound safety culture along with the on-shore crewing strategy.

5.2 Summary and results of article 2

Oltedal, H., & Wadsworth, E. (2010). Risk perception in the Norwegian shipping industry and identification of influencing factors. *Maritime Policy & Management, 37*(6), 601-623.

Based on the findings from the first article, the second paper aimed to assess the relationship among shipboard safety, safety culture, and shore-based

organizational factors, using risk perception as a proxy variable for the general safety level on board. The objective of this article was to assess the relationship between risk perception and the dimensions of safety culture.

With regard to assessing the relationship between risk perception and safety culture, the article introduced risk perception as a dependent variable, thereby expanding the trinity methodological framework presented in the first article (i.e., person, behavior, and situation) with a measurable dependent variable. Risk perception has been found to be adequate as a dependent variable, as previous research indicates that risk perception and risk behavior are strongly correlated. It is suggested that risk perception is a good indicator for safety level in general, which is constrained by the situation and context.

Explorative principal component analysis with varimax rotation was applied in order to explore the latent dimensions of safety culture. Eight factors were identified, providing a good representation of the concept of shipboard safety culture: (1) competence, (2) interpersonal relationship (crew interaction), (3) shore orientation, (4) ship management (local management), (5) proactive work practices, (6) feedback, (7) demand for efficiency, and (8) reporting practices. Furthermore, a one-way analysis of variance (ANOVA) was carried out to explore any associations between the demographic (nationality, age, department, and vessel type) and organizational (work description) variables as well as both dependent variables (i.e., risk perception and the independent safety culture dimensions). A linear regression analysis (OLS) was subsequently conducted to assess the associations between risk perception and the dimensions of safety culture, controlling for any potentially influential demographic and organizational factors.

Based on the results, the overall safety in respondents' working situations was perceived to be very high, which may indicate a relatively good safety standard. The ANOVA analysis showed significant differences between age groups in the dimensions of interpersonal relationship and shore orientation. The type of vessel indicated significant differences on the dimensions of competence, local management, and feedback. Those working on dry cargo vessels perceived the feedback on reported experience data to be better than those working on liquid tankers. However, those working on liquid tankers had a better perception of their own level of competence and their local management than those working on dry cargo vessels. Finally, work description (i.e., teamwork versus individual) showed significant differences on all dimensions of safety culture. Crews working on a team perceived the dimensions of competence, interpersonal relationship, local management, feedback, and reporting practices to be better than those working on an individual basis. Crews working on a team also felt less demand for efficiency and perceived the shore side of the company to be more safety orientated.

The regression analysis indicated that local management, working practices, and reporting practices have a positive association with risk perception while demand for efficiency has a negative association with risk perception. The working situation has a positive association when work is performed on a team in contrast to when work is performed on an individual basis. None of the demographic data were significantly associated with risk perception.

For future research, it was suggested to further examine the characteristics of teamwork along with the concept of group identity. It would also be of interest for future research to examine risk perception both in general and in

relation to potential differences among nationalities, along with differences among white, grey and black listed flags of registration.

Given that the overall research topic in the current thesis concerns safety management on dry cargo vessels and liquid tankers, the remaining articles address safety management within dry cargo vessels and liquid tankers in greater detail, starting with liquid tankers. The third article also suggests differences with regard to safety management within the two sectors.

5.3 Summary and results of article 3

Oltedal, H. A. (2010). The use of safety management systems within the Norwegian tanker industry—Do they really improve safety? In R. Bris, C. Guedes Soares, & S. Martorell (Eds.), *Reliability, Risk and Safety: Theory and Applications* (pp. 2355-2362). London: Taylor & Francis Group.

The aim of this article is twofold: (1) describe safety management within the liquid tanker sector and (2) identify factors that influence safety management performance.

The theoretical rationale of traditional safety management systems was introduced for the first time in this article. Traditional safety management was presented as a system containing four sub-systems: (1) reporting and collection of experience data from the vessel; (2) data processing, summarizing, and analysis; (3) development of safety measures; and (4) implementation. The topic of focus was presented in a situational context where safety concerns need balance to ensure profits and economical concerns. Safety management as such is related to the International Safety Management (ISM) code. This article was the first to explicitly state that it

adopted a multi-method approach combining surveys, case studies, field studies, interviews and other qualitative information, although all the concerned articles are based on a multi-method approach.

With regard to the statistics and factor analysis, the survey items were grouped as they relate to the information flow in a safety management systems—more precisely: (1) crew's reporting practices, (2) analysis and follow up by shore side, (3) procedures and checklists, and (4) perceived balance between commercial pressure and safety concerns. Explorative principal component analysis was carried out in each group in order to examine the items' interrelationships. Shore-side development of safety measures was also analyzed, although most findings stemmed from the qualitative data.

The results indicated a situation with substantial underreporting of experience data from the vessels. Such underreporting may be explained by the crew's fear of negative consequences, a complicated reporting system, and a lack of understanding of the overall safety management system. The development of measures tends to focus on controlling human actions, often in the form of excess use of procedures and checklists. This situation was traced back to a person-oriented approach in safety management. Moreover, procedures and checklists are often perceived as being problematic to use in daily shipboard operations. In order to turn such a situation around, it was suggested that the seafarers' experience be taken seriously, with regard to both reasons for underreporting and their experience with new measures. On board, the ship management was identified as a factor strongly influencing the shipboard situation, and it is suggested that the shore side pay more attention to that

element. Other organizational factors that were suggested to influence the situation included employment conditions and crew stability.

5.4 Summary and results of article 4

Oltedal, H. A., & Engen, O. A. (2010). Tanker versus dry cargo—The use of safety management systems within Norwegian dry cargo shipping. In J.M. Ale, I.A. Papazoglou, & E. Zio (Eds.), *Reliability, Risk and Safety* (pp. 2118-2125). London: Taylor & Francis Group.

As the overall research topic in the current thesis concerns safety management on both dry cargo vessels and liquid tankers, this article focused on safety management within the dry cargo sector in order to compare the findings with the liquid tank sector. The aim of this article was to (1) describe safety management within the dry cargo industry, (2) identify factors that may influence safety management performance, and (3) compare the current situation within the dry cargo to the liquid tanker industry. This was the first article to provide a description of the two sectors (i.e., liquid and dry cargo) with the purpose of conducting comparative exploration and analysis. The two sectors were introduced in order to make each sector's major safety challenges visible.

This article served as a follow-up to the third article and, thus, followed a similar structure related to the information flow of a traditional safety management system. Although a multi-method approach was applied, only areas in which statistical data were available for both sectors were presented and analyzed—namely, (1) crew's reporting practices, (2) procedures and checklists, and (3) perceived balance between commercial pressure and safety

concerns. An explorative principal component analysis was carried out at each group in order to examine the items' interrelationships.

This article pointed to a central custom-related difference between the two sectors. Although customers of dry cargo shipping have fewer safety-related requirements, the tanker sector is extensively embedded in the Norwegian oil industry, which explains the extended focus on safety in general, safety management, attitudes, etc., within the tanker industry compared to dry cargo. Underreporting of minor incidents and near misses are more present within the dry cargo industry. In both sectors, reporting frequency is correlated with feedback given upon reported events. Although both sectors have substantial underreporting, our data indicated that the safety campaigns, which are typical for the oil industry, have some positive effects on reporting practices. However, within the dry cargo industry, such feedback is perceived as better than within the tanker sector. The analysis suggested that the shore tanker organization is not prepared to manage the growing workload that increased reporting brings about. The organization fails to obtain feedback's motivating effect, which again may counteract the effect of safety campaigns. However, it was suggested that the dry cargo industry could benefit from such campaigns when it comes to increasing crews' awareness and recognition of a near miss, along with a better understanding of reporting's importance in safety-management systems. It was recommended that the shore side provide resources for the potential increase in number of reports placed and proper follow-up. When following up the reports, the development of new measures should also be considered carefully, and alternatives to the development of new procedures should be developed. The experiences from the tanker industry suggested that the development of a constantly increasing, detailed, and extensive procedural system may undermine safety. Moreover, the

analysis suggested that safety measures be initiated by internal and industrial need, not external demands from the customer. When externally initiated, safety management may be less integrated into the operational part of the organization. It was also suggested that this external demand is related to the existence of a poor procedural system.

Both the third and the fourth articles pointed to a situation with substantial underreporting of experience data. Reporting is regarded as a critical cornerstone in formal safety management. Some influencing factors were suggested, and the fifth article further assessed the relations among reporting practices, safety culture, and organizational factors.

5.5 Summary and results of article 5

Oltedal, H., & McArthur, D. (2010). Reporting practices in merchant shipping, and the identification of influencing factors. *Safety Science, 49*(2), 331-338.

This article pursued three aims: (1) assess the relationship between reporting practices and safety culture, (2) explore the influence of familiarity with local managers, and (3) further explore differences between vessel type (i.e., liquid and dry cargo).

Reporting practices are regarded as a cornerstone when working with systematic safety management, and this article was the first to statistically explore factors affecting reporting practices. A review of safety research within the maritime sector indicated that—although underreporting of experience data is regarded as a major problem within the industry—little research has been done. With a foundation in both theory and results derived

from research within other high-risk sectors, barriers to experience data reporting were summarized in the following categories: (1) fear of disciplinary action or of other people's reactions; (2) risk acceptance, where incidents are regarded as a part of the job or unpreventable; (3) useless, as reporting does not lead to any changes; and (4) practical reasons like time pressure or a complicated reporting system.

In the statistical analysis, explorative principal component analysis with varimax rotation was carried out, followed by a scale reliability analysis. Seven factors were extracted and found to be valid, reflecting crews' perceptions of (1) their own competence, (2) interpersonal relationships among the crew, (3) shipboard management, (4) work practices, (5) feedback on reported safety information, (6) shore orientation to safety, and (7) perceived demand for efficiency. An ordered logistic regression was then carried out in order to explore the relationships between extracted factors and reporting practices. In the analysis, the dependent variable reporting practices were measured with four possible outcomes: (1) never/seldom, (2) sometimes, (3) often, and (4) always.

The results indicated that high competence, a good and open interpersonal relationship among the crew, safety-oriented management, execution of proactive work practices, and feedback on reported events all increase the odds of being in a higher category of the reporting frequency measure. On the other hand, shore orientation downgrading safety and prioritizing efficiency increase the odds of being in a lower category of the reporting frequency measure. With regard to feedback, vessel type, and management, the effect of these variables is dependent on the category of the dependant variable. The effect of both vessel and feedback is larger when moving between the higher

categories. Crews who have been working with their closest manager for more than one year tend to report more often. However, the effect of being familiar with one's superior is larger when moving between the lower categories.

None of the identified factors should be addressed in isolation from each other. As followed from the discussion, they are all important and mutually dependent. Thus, the internal relationship between the identified dimensions of safety culture should be further explored using, for example, structural equation modeling and/or path-analysis, as performed in this thesis.

5.6 Summary and results of article 6

Oltedal, H., & Engen, O. A. (2011). Safety Management in Shipping—Making sense of limited success. *Safety Science Monitor*, submitted

This article sought to (1) explore the gaps between the safety ambitions (in the form of, e.g., rules and procedures) and operational practice on board and (2) identify possible pitfalls when relying on safety through a system perspective (as described in articles three through five), without focusing on its human interrelationships.

A multi-method approach combining surveys and case studies, including field studies and interviews, was applied. Previous articles (i.e., three through five: Oltedal, 2010; Oltedal & Engen, 2010; Oltedal & McArthur, 2010) all pointed to substantial weaknesses in current safety management; thus, this article explored the theoretical rationale behind traditional safety management. Normal Accident Theory (NAT) and High Reliability Organization Theory (HRO) were outlined, with an emphasis on how they explain and make sense of safety, risks, and accidents. The conceptual framework of the Practical

Drift Model (PDM), which seeks to combine NAT and HRO and explain why seemingly well-regulated organizations (e.g., within shipping), develop traits that may evolve into big accidents and disasters, was applied. The PDM model allows us to look for possible new explanations of the success and failure of safety strategies. In an effort to question what the scientific safety literature has offered to make sense of the gaps between safety ambitions and the practical outcome, some examples of gaps from our own data were examined more closely.

The structure of the article followed the four stages of the PDM model, with each stage being supported by qualitative and quantitative data. (1) *Design* refers the stage in which organizational managers or designers develop extensive routines and procedures in order to make the organization robust and resilient against attacks and unforeseen events. (2) *Engineered* refers to an operational situation in which the routines and procedures are first applied and experienced to not always match the real situations. (3) *Applied* refers to situations in which the designed control measures are substituted with a logic of action based on individuals' experiences and tacit knowledge. (4) *Fails* refers to a situation of change (e.g., major unforeseen event such as ship collisions), when individual units are forced to act on the assumption that all others are acting in accordance with the original rules and procedures as they were initially designed. The actors are then trapped in a game where trusting their own logic of actions is the only solution while they must simultaneously base their decision on the assumption that others are following the general rules.

The article concluded that the industry could gain from abandoning the person-oriented approach, where control measures are designed to control human actions, often in the form of the excess use of procedures and

checklists. These measures developed through a traditional safety management system are standardized to fit all—whether in a fleet of 5 vessels or 100 vessels. This creates a paradox when confronting actual work situations, where operations are never the same. The vessels are different, the people, constellations of people, power figurations, weather and so on. A standardized measurement will therefore never align with reality. Yet human actions and deviations are compared to the standard and found to be erroneous. In an attempt to gain control, new and even more detailed measurements may be developed, thereby creating a vicious cycle resulting from the anxiety of not being in control. Organizations should abandon such person-oriented approaches in their search for causal and influencing factors.

5.7 Causal relationships between components of safety culture

In order to test the multidimensionality of the theoretical safety culture construct, a first-order confirmatory factor analysis (CFA) was carried out, resulting in six dimensions that were found to be a reliable reflection of the safety culture concept: (1) company orientation, (2) local management, (3) crew interaction, (4) competence, (5) proactive working practices, and (6) risk perception. All dimensions and their interrelationships were further discussed in articles number 1 (Oltedal & Engen, 2009), number 2 (Oltedal & Wadsworth, 2010) and number 5 (Oltedal & McArthur, 2010) and are briefly presented below.

Company orientation reflects the crew's perception of the shore organization. A high score indicates that the company has a reactive approach and statistics are a major concern, whereupon the crew perceives the safety work to be a façade. A low score indicates that the company is proactive and cares about

the human consequences of hazardous situations, whereupon the crew perceives the company's safety work to be a real priority area.

Competence reflects the crew's perception of their own training and ability to work safely and handle critical and hazardous situations. A high score indicates that crews see themselves as having a high level of competence in these areas; a low score indicates a low competence level.

Local management reflects crew's perception of their closest manager as a role model as well as the manager's engagement and interest in ensuring safety in work operations. A high score indicates good safety management; a low score indicates poor safety management.

Proactive work practices reflect performance of proactive activities, such as safe job analysis and hazard identification, as well as how safety is prioritized in daily operations. A high score indicates that proactive work practices are performed on a regular basis, whereas a low score indicates the infrequent performance of proactive work practices.

Group interaction reflects the relationship amongst the crew, including their problem-solving abilities, form of communication, and sharing of safety information. A high score indicates the presence of a good interpersonal relationship amongst the crew, whereas a low score indicates that the on-board group interaction is poor.

Risk perception is an indicator related to the onboard safety and the crew's own assessment of the probability that they or any other crewmembers will have an accident on board the vessel during the next 12 months. A high score indicates a low probability of an accident to occur; a low score indicates a high probability that an accident will occur.

In the SEM structural model (see Figure 4) the latent dimensions of safety culture are tested for causal relationships. Postulated causal relationships are grounded in both theory and empirical results. The hypothesis is that the shipping company's orientations toward safety at the shore side of the organization influence the safety culture on board the vessel; thus, *company orientation* towards safety is set as an exogenous variable. The outcome measurement variable is represented by the crew's overall *risk perception*. Each path was analyzed and evaluated; paths with no significant effect were removed from the model.

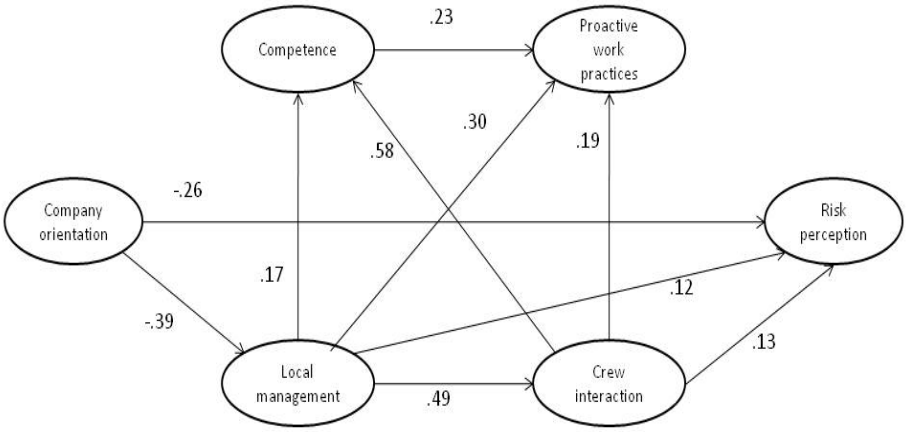

***Figure 4*: Structural model testing for validity of causal structure**

All paths in Figure 4 are reasonable and consistent with the theoretical construct. The model shows a good fit (RMR=0.044, CFI=0.957, and RMSEA=0.052). The root mean square residual (RMR) represents the average residual value derived from the fitting of the variance-covariance matrix for the tested hypothesized model. In a well-fitting model, this value will be small (0.5 or less). The Comparative Fit Index (CFI) is a measure of

complete covariation in the data. CFI ranges from zero to 1.00, with values close to 0.95 being advised. The root mean square error of approximation (RMSEA) takes the error of approximation in the population into account. RMSEA values of less than 0.05 are indicative of a good fit between the hypothesized model and the observed data. RMSEA values as high as 0.08 represent reasonable errors of approximation (Byrne, 2010). The standardized regressions weighted (Stand. Reg.) together with significance value (P) are presented in Table 3.

Table 3.

Standardized Regression Weights and Significance Value of Structural Model

Dimension of safety culture		**Stand. Reg.**	**P**
Local management.	<--- Company orientation	-.390	***
Crew interaction.	<--- Local management.	.494	***
Competence	<--- Local management	.169	***
Competence.	<--- Crew interaction.	.575	***
Proactive work	<--- Local management	.300	***
Risk perception	<--- Company orientation	-.256	***
Risk perception	<--- Crew interaction.	.131	***
Risk perception	<--- Local management	.122	.002
Proactive work	<--- Competence	.233	***
Proactive work	<--- Crew interaction.	.194	***

Standardized total effect of each latent variable is further presented in Table 4. Standardized total effect is the sum of each latent dimension's direct and mediated effect.

Table 4.

Standardized Total Effects

	Company orient.	Local management	Crew interaction	Competence	Risk perception	Proactive work practices	Squared Multiple Correlations
Local management	-.390	.000	.000	.000	.000	.000	.152
Crew interaction	-.193	.494	.000	.000	.000	.000	.244
Competence	-.177	.453	.575	.000	.000	.000	.456
Risk perception	-.329	.187	.131	.000	.000	.000	.151
Proactive work practices	-.195	.501	.328	.233	.000	.000	.362

The results from the SEM analyses indicate that company orientation has a direct effect upon the performance of local management on board the vessel (-.390) as well as a direct effect on the general risk perception (-.256). When safety work in the company is not perceived as a genuine effort, local management is perceived as being less safety oriented while the risk level on the vessel is generally perceived to be higher. Management/leadership style, commitment, and visibility are also among the most commonly measured

dimensions in safety research in general (Flin, Mearns, O'Connor, & Bryden, 2000). Within the maritime sector, research initiated by the Maritime and Coastguard Agency in the United Kingdom identified various core leadership qualities necessary for effective safety leadership (Maritime and Coastguard Agency, 2004). On board, these qualities were primarily geared toward the captain as a key leader of safety, but also toward lower ranks with leadership responsibilities.

Local management demonstrated a direct effect upon the competence dimension (.169), proactive work practices (.300), risk perception (.122), and crew interaction (.494), suggesting that local management plays a major role in the development of safety culture on board. Proactive work practices increase the chances of revealing potentially dangerous situations; thus, preventive measures should be introduced in advance of operations. Error detection and correction are also assumed to be stimulated by teamwork (Kontogiannis & Malakis, 2009). The relationship between local management and company orientation (-.390) indicates that the company is the driving force for how management is performed. The relationship between company orientation and local management is one directional, indicating that experiences from shipboard management do not influence the overall company policy. Likewise, management-relationships are one directional, indicating that the management is not adapted to the shipboard situation—an individual is either a good manager or he/she is not. Traditionally, no requirements concerning formal management competence or training have been established within shipping. Such requirements were recently adopted by amendments of the STCW convention, which will put into force on January 1, 2012.

Furthermore, competence has a direct effect on proactive work practices (.233), indicating that well-informed crews trained to handle risk are better in performing proactive work practices. However, quite surprisingly, proactive work practices have no direct effect on the general level of risk perception. Competence includes both training acquired on board the vessel and training acquired on shore. Also included are the orientation new crew members receive when joining the vessel, which is often referred to as familiarization and safety-related drills carried out on board. Within safety research, competence is among the top five most commonly measured themes (Flin et al., 2000). Minimum training requirements are covered by international conventions and regulations developed by IMO, with parts are required to be performed onboard. For example, every crew member must participate in at least one abandon ship and one fire drill every month. These drills should, as far as practicable, be conducted as if there were an actual emergency (International Convention for the Safety of Life as Sea, 1974, International Maritime Organization, 2009). On board, the captain and the ship management are ultimately responsible for how such drills—as well as other onboard training arrangements—are carried out.

Finally, crew interaction has a direct effect upon the competence dimension (.575), proactive work practices (.194), and risk perception (.131). This relationship is also one-directional; thus, crew interaction is suggested to be a driving force when it comes to how onboard competence-increasing activities are performed as well as proactive work practices. The relationship between local management and crew interaction is one directional, suggesting that management plays a major role in how crewmembers interact, but management does not adjust its style to the crew's characteristics and dynamics. A trusting relationship is regarded as a key factor in forming a

safety culture (Reason, 2001). The importance of group interaction and teamwork has also been suggested as influencing accidents to a greater extent than individual unsafe acts (Barnett, Gatfield & Habberley, 2010; Mitropoulos & Cupido, 2009).

5.8 Summing up and presentations of main conclusions

The main conclusions drawn from the research indicate that the shore side of the company is the driving force for onboard safety culture. Thus, undesirable onboard working practices may be traced back to shore-side organizational decisions. The onboard conditions are influenced by the shore side in three ways: (1) the organization's manning policy (e.g., contract arrangements, mix of nationalities, and rotation systems), which establish the premises for the cultural development; (2) the approach to safety management, which lay the foundation for the reporting culture and system efficiency; the industry to a large degree is person oriented, with excessive use of standardized measures; and (3) shipboard management has a major mediating influence as the shore-side organization's contribution as a support function sets the stage for shipboard management performance. All three areas are further discussed in the following chapter.

6 Discussion

This chapter presents a discussion of the overall results from all articles included in this thesis. The discussion is related to the research questions given in the introduction:

1. What characterizes safety culture and safety management within the shipping industry?
2. What is the relationship between safety culture and safety performance within the shipping industry?
3. What characterizes shipping companies' application of the safety management concept?

At the international level, safety management within shipping is carried out through the delegation of authority from the UN to IMO, delegating responsibility for developing and maintaining workable safety regulations. Each coastal state is responsible for the enforcement of maritime regulations, while each flag state is responsible for ensuring compliance with international regulations. The results of this study indicate that the structure of the administrative authorities has some deficiencies as some maritime administrations may be involved in shipping activities without fulfilling their safety responsibilities. In many instances, they are unable to detect real safety threats on board when performing inspections. However, the shipping companies have the primary responsibility for the safe operations of ships and the welfare of the crew. Safety management is regulated through the ISM Code, which was developed by the IMO. One of the intentions behind the ISM Code has been to develop a safety culture within shipping. Study results indicate several deficiencies related to both the industry's application of safety

management and the underlying theoretical rationale. It is important to emphasize that there are variations within companies.

Articles 3 and 4 indicated that the application of safety management in relation to culture is associated with two areas. First, safety culture is associated with a reporting culture. A vessel with a high reporting frequency is regarded as having a good safety culture. Reporting emphasizes what has or could have gone wrong, while experience data and suggestions for improvement are less emphasized. This restricts the crew's ability to learn and improve. The qualitative results point to several situations where less serious episodes (e.g., a misallocated knife) has been reported while more serious episodes (e.g., gas on deck) have not. Reasons for not reporting include fear of being blamed by the ship management or shore organization. The review of investigation reports shows that human error is still identified as the major cause of maritime accidents, which impedes the possibility of revealing underlying organizational causes. An inherent intention of the ISM Code was to move the shipping industry application of safety management from the age of human factors to the age of organizational factors. This study indicates that the application of the code still operates within the era of human errors, resulting in safety measures aiming to control human performance through procedures and checklists. Second, a safety culture is associated with compliance with the developed safety measures, but without questioning whether or not the given safety measures are adequate for the situation. Depending upon the type of operation, the crew is expected to relate to safety directives given not only by their own company, but also by the operator, charterer, and customer. In many instances, these directives are not applicable, are incompatible, or do not reflect the onboard operation. Better integration of operating personnel's experience and expertise could improve this situation as

safety measures in some cases are developed by people with no seagoing experience. The overall study results indicate that such weaknesses are related to the shore side of the organization. The SEM analyses support the relationship between shore-side and shipboard practices. In his thesis, Soma (2005) found that safety is a quality of the ship owner rather than the vessel.

Within the industry—especially within the liquid tanker sector—reporting and compliance are attempted by safety campaigns aimed at altering the crew's attitudes. However, according to the theoretical discussion, personal attitudes are less amendable by such means. Despite the campaigns, the results indicate that a substantial underreporting of experience data occurs. It could be time to focus attention on shore-side personnel. Launching safety campaigns aimed at shore-side personnel would enable them to gain a better understanding of their own roles as a support function and how their practice affects operational practice—not only with regard to safety management per se, but also concerning the influence of other parts of the organization (e.g., commercial pressure and crew resource management).

Another drawback is standardization. Measures are generally standardized to fit all vessels within a company fleet. The shore personnel fail to understand the diversity created by situational circumstances in operations, crew constellations, the vessel's technical condition, and so on. Accordingly, the crew bypasses the problem with standardization and develops their own deviating working practice. In particular, article 6 dealt with this subject. These processes may be seen in relation to Snook's theory of practical drift (Snook, 2000). Formal instructions given by the company are complied with on paper, but onboard the vessels working practices are adapted to the situation. However, as the crew at this point uses their experience and tactical

knowledge to ensure safe operations, deviations from standardized procedures should not uncritically be put on par with unsafe operations.

The standardization of safety measures is necessary in relation to crew organization and lack of crew stability. Life and work on board are known to be a highly formalized, hierarchical, and authoritarian organization, with a clear chain of command, clear communication lines, levels of authority, and clearly defined tasks and activities that are more or less the same on all vessel. Such organization makes it possible to handle crew as changeable components. Indeed, within the industry, such an organizational structure is necessary in order to handle the lack of crew stability. However, the lack of both crew stability and standardization may be problematic for other safety reasons as well. A lack of crew stability may be a barrier to change, and safety management is all about change—changes of work practices and attitudes and others; thus, crew may not see the benefit of their efforts. By the time necessary changes are highlighted, crew have most likely signed onto another vessel, where they might experience the same problems. Shipboard management may be problematic as the ship's management is not familiar with each crewmember's capabilities and limitations; by the time they finally get to know them, the crewmember changes vessel. Finally, crewmembers lack familiarity with the specific ship, the rest of the crew, and the management. The influence and importance of crew stability is discussed in articles 1, 3, 5, and 6. Crew stability also relates to team dynamics; article 2 indicates that the onboard safety level is perceived as better when work is performed as a team.

The overall study results further identified the onboard management as a driving force. Management and leadership as mediating factors have support in climate research from Zohar (1980), who found management's attitude to

be of major importance in fostering a safe work environment. This is also supported by cultural research done by Pettigrew (1979) and Schein (1992, 2004), who both regard individuals (entrepreneurs and leaders, respectively) as important in the processes of creating and managing an organizational culture. In articles 2 and 5, ship management was statistically associated with risk perception and reporting practices. The shipboard management is responsible for implementing prevailing regulations and company policies. The SEM analyses demonstrated that local management has a direct effect upon all shipboard dimensions of safety culture and that the quality of the shipboard management is influenced by the shore side of the company. Evidence indicates that the ship officers are getting dual instructions regarding safety performance as well as demand for efficiency from other parts of the organizations. Thus, safety and efficiency are balanced in daily operations, where efficiency and corner-cutting activities are rewarded in absence of accidents, but are simultaneously identified as causal factors when accidents occur. Ambiguous instructions from shore should be counteracted by a strong shipboard management. However, according to the results, few ship managers have formal management and leadership education. In addition, shipboard management is not evaluated by crewmembers on a regular basis. By recognizing the importance of ship management, the company should provide support in order to ensure adequate onboard management and leadership—for both the crew and the shore side.

Shipping companies' understanding of safety management has also resulted in more administrative work, which makes less time available for attention to operations. The constant development of new procedures increases the system's complexity as defined by Perrow (1999), resulting in the industry becoming increasingly prone to accidents. The work situation is less easy to

understand when the procedural framework does not fit the situation and when each procedure is not internally coordinated with the overall framework. With reference to Perrow (1999), fewer procedures may simplify the system characteristics and increase resilience. To this end, an understanding of when standardized measures and procedures are appropriate should be reached. This is not to suggest that standardized measures and procedures should be completely abandoned. However, the crew should be able to trust their relevance and applicability, which relates to the casual rationality inherent in safety management systems along with limitations of foresight.

Safety management as described by the ISM code is based upon causal rationality, where attempts are made to prevent future events by reflecting upon previous experiences. However, insufficient scientific evidence exists on the effectiveness of systematic safety management to make recommendations either in favor of or against them (Robson et al., 2007), which may be related to their application. As pointed out by Rundmo (1996), the application of traditional safety management is questioned with a distinction between small-scale accidents and larger and more infrequent accidents (Rundmo, 1996). Measures developed through the analysis of past events are in theory only applicable for frequent and small-scale accidents, such as ordinary work accidents. When it comes to medium-size and larger and more infrequent accidents, traditional safety management is not considered to be applicable. Such accidents are often too unique and complex to grasp or to single out some isolated underlying causes. When the course of event is unclear, it is difficult to develop measures that cover all involved risk as the risk in the first place is considered too complex to be fully understood. This highlights the second point: the limitation of the foresight of future events. The study results

indicated that the shipping industry does not differ sufficiently between these types of events and, thus, applies the same logic independent of type of event.

The results from the study point to a situation in which serious accidents are on the rise, despite the introduction of the ISM Code and systematic safety management. This can also be seen in relation to the different ages of safety and the recent development of an adaptive age. The adaptive age of safety is characterized by a shift from reliance on systems supported by safety culture to operations. The focus on operations is also in accordance with the theories of HRO and mindfulness. When recognizing the limitations of safety management systems and safety rules, which attempt to control human behavior, it is proposed that adaptive cultures should be embraced (Borys et al., 2009). Consequently, resilience engineering requires a change in perspective from human variability as a liability and in need of control to human variability as an asset in a situation getting out of control, thereby making it important for safe operations. Embracing variability as an asset challenges the comfort of management and, thus, may meet resistance from the industry. However, with reference to the standardization and development of global rules, the industry could ask whether they are made for comfort and to simplify the work for shore personnel or to support safety in daily operations. A consequence of safety management is to shift the focus to how crew is coping in daily operations under constantly shifting circumstances as well as learn from their adaption processes. This should also be seen in relation to the fact that most of the time, when crewmembers adapt, the operations are still performed in accordance with the super-eminent objectives (Hollnagel, 2009). In order to follow such an approach, the crew should be able to trust in the applicability of procedures and the safety measures that ought to be in place. Second, crewmembers should have the possibility to

develop skills, competences, and tactical knowledge in order to handle any unexpected, infrequent situations that cannot be prevented through traditional safety management and standardized measures. Third, when things do go wrong, organizations should remove themselves from a person-orientated approach in which operators are blamed.

Safety culture encompasses not only what is done at the operational level, but also at all levels in the company. In order to improve safety, companies should look for influencing factors derived from organizational structures and policies. The shipping industry is known to employ crewmembers from various nationalities through manning agents located in each country, without giving the crewmembers a fixed company employment, thereby resulting in instability. With this in mind, one might question if some of the vessels do have a (safety) culture at all as they lack stability in the group. Without structural stability, they have not been given the possibility to develop the deeper and less conscious levels of cultural patterns and sense making; nor do they have the possibility to develop the experience and tactical skills necessary to handle new and emerging unexpected situations as their efforts are orientated toward making sense of what is unfamiliar—namely, new crew, new power relations, new social constructions, and the like. The study results indicate that loose conditions of employment affect the overall safety management system (e.g., in the form of more underreporting of experience data due to fear of negative consequences and a lack of trust). By changing such a manning strategy, the company could have better possibilities to create a positive safety culture and build competence so that the crewmembers have better premises for handling unsafe situations.

7 Concluding remarks

This chapter includes a discussion of the major limitations for the thesis with regard to methods and measurements. Suggestions for future research and implications are also addressed.

7.1 Methodological limitations

The major methodological limitations concern the validity of the questionnaire and sample characteristics. The questionnaire did not show the ability to cover all aspects of the safety culture concept, which is a limitation affecting the overall validity of the study. Due to low reliability, several items and constructs were excluded from the further statistical analysis. One explanation is poor representative reliability across subpopulations or groups of people (Hair, 1998; Neuman, 2000). It may be fair to assume that some groups (e.g., Norwegian employees or senior officers) are better informed about their company's strategic and tactical management and operations and, therefore, are better placed to answer some of the questions related to the company. A second issue concerns the constructs itself. DeVillis (2003) focused on the fact that the items constituting a construct or dimension should share a common cause or consequence. Some of the questionnaire constructs did not meet this latter requirement.

Biases could also be produced by national differences, languages, and response style. In a cross-national study, Harzing (2005) found that English language survey versions tended to be more homogenized, potentially obscuring cross-national differences. McCrae (2001), who studied Norwegians and Filipinos, did not find such differences. Given that questionnaire language could potentially bias the results, the questionnaire was also made available in Norwegian, Polish, and Tagalog. Taking this into

consideration, cross-cultural comparisons of results are not performed in the current study. In addition, indicated differences at the organizational level (e.g., between type of vessel and employment terms) should not be overestimated.

The survey data are representative of vessels flying a white and grey flag only, as those registered under a black listed flag did not want to participate. As participation was voluntary on behalf of the company, it is assumed that those participating do, in general, emphasize safety in their operations; thus, the results are biased in a positive direction. Moreover, the survey data are only representative of members of the Norwegian Shipowners' Association.

The possibility exists that the results are subject to the common method bias (Podsakoff et al., 2003) due to the data deriving from a common source (e.g., a common scale for different questions). Potential statistical remedies have been suggested. Spector (2006) is skeptical of the merits of such approaches. He argued that—given that it is not possible to know the existence or extent of any possible bias—treating it could in fact introduce more bias than what existed in the first place. He recommended using a multi-method strategy so that results do not rely exclusively on the results of one questionnaire. In the current research, case studies, interviews, participatory, and field studies were used to validate the data.

As with the survey data, a question of validity arises to the qualitative data. In order to be certain that the elements of culture identified by qualitative methods, Hopkins (2006) recommended consulting the members of the culture. If the members of the culture fail to recognize the description of their culture, the description must be called into question. Accordingly, all results in this thesis were also presented to several people working within the

industry; they expressed that they believe the results to be giving an accurate representation of the situation.

7.2 Theoretical limitations

The principal objective of this thesis has been to examine the role of safety culture for safety management and vice versa. Limitations also follow from the theoretical stand and research perspective. By focusing on cultural influences on safety management, other areas of equal importance give way. Research with other perspectives (e.g., professional culture, national culture, or a sociotechnical approach) would bring about different results. For example, technological changes have unquestionably left their mark on both operational safety and the organizational structure of the industry. The shipping industry has, since the early 1960s, steadily adopted the automation and integration of new technology (Alderton, 2004). Yet despite the introduction of new technology partly intended to increase safety by, for example, reducing human error, new technology may also be the cause of new and emerging risk (Schager, 2008). This could be a mismatch between ergonomic aspects and the human information processing system, overreliance in technology that may fail, loss of operational skills and experience necessary for handle critical and unexpected situations, or changes in the social and organizational system.

7.3 Future research

With estimation that 75% to 96% of marine casualties are caused by some form of human error (Anderson, 2003; Rothblum, 2000; Wagenaar & Groeneweg, 1987), human error is possibly overemphasized as a causal explanation for accidents at sea. Research on organizational and structural factors in shipping accidents indicates that the human element is identified as

a causal factor without addressing the relationship to underlying organizational and structural factors. Still, the need exists to trace the human factors to conditions resulting from decisions taken at higher organizational levels (IMO, 2010b). A new investigation into accident reports can possibly identify other organizational and structural factors related to shipping accidents. If reviewed and analyzed according to, for example, the accident model developed by James Reason (2001), latent organizational influences, local workplace factors, preconditions for unsafe acts, and unsafe acts can be identified. With new findings discussed in light of theories developed by Snook (2000) and Hollnagel (2009), among others, alternative explanations can be put forward, such as how frontline personnel make sense of organizational safety communications and adapt their work practices through social relations and psychological mechanisms, thereby moving safety management and research into the new era of the adaptive age (Borys et al., 2009; Hollnagel, 2009; Snook, 2000). The adaptive age embraces adaptive cultures and resilience engineering and requires a change in perspective from human variability as a liability and in need of control to human variability as an asset and important for safety. Efforts could also be made to better identify and measure the social processes among workers, along with further exploration of the relationship among management, leadership, and safety-related matters Thus, better insights into how behavioral norms interact with and are formed by the social life on board could be achieved.

7.4 Final remarks

This thesis has explored the safety culture and safety management within shipping in relation to current theories of safety management and safety culture. The major limitations of the research along with implications for

safety practitioners and researchers—previously addressed in this thesis—can be summarized as follows.

Survey: Parts of the applied questionnaire showed several deficiencies, and results may be biased due to common method, psychometric properties, language, and characteristic with the sample, which may affect the validity of the conclusions. Future research should strive to develop an instrument in order to reduce such biases.

Research model: The strengths and limitations of both qualitative and quantitative research should be acknowledged, and future research should be open to a multi-method approach.

Safety researcher: As the theories of safety management are developing over time, safety researchers should strive to develop a better understanding of the limitations of current safety management systems and be open to research within the prevailing adaptive age.

Safety practitioners: In practical applications of safety management, one should rely less on safety through standardized measures and experience data. This includes understanding the difference between events where such measures are applicable and unexpected events where it is adequate to support competence-promoting activities so that the operators have the ability to adapt their behavior to new situations. The human inferential capacity in handling unexpected situations should not be underestimated in relation to technology.

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Part II

Article 1

Oltedal, H. A., & Engen, O. A. (2009). Local management and its impact on safety culture and safety within Norwegian shipping. In S. Martorell, C. Guedes Soares & J. Barnett (Eds.), *Safety, Reliability and Risk Analysis: Theory, Methods and Applications* (pp. 1423-1430). London: Taylor & Francis Group.

Article 2

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Article 3

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Article 4

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Article 5

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Article 6

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Article 1

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Local Management and its impact on Safety Culture and Safety within Norwegian Shipping

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ABSTRACT: This paper addresses safety culture on tankers and bulk carriers and which factors affect the safety culture onboard vessels. The empirical setting for the study is the Norwegian shipping industry. Safety management is a challenging issue within shipping for several reasons. First of all, life and work onboard a vessel is a 24 hour activity and the crew has few possibilities of interacting with the surrounding society. Secondly the geographical distance between the on-shore organization and the vessel may affect both the quality of those systems and plans developed on shore and their implementation on the vessels. The ship management is thus identified as a key factor to a sound safety culture along with the on shore crewing strategy.

1 INTRODUCTION

In this paper we will discuss the safety culture within the Norwegian shipping industry with tankers and bulk carriers, and identify which organizational factors may affect this particular safety culture.

In Norway, shipping has for several centuries been the principal trade, and Norway as a maritime nation has roots way back in the Viking age. Today Norway is one of the five largest shipping nations in the world, after Greece, Japan, Germany and China. In the third quarter of 2007 the Norwegian foreign-going fleet comprised 1,795 ships, the highest number ever in Norwegian history, of which about 49 percent are flying under the Norwegian flag (Nærings- og handelsdepartementet 2007). The remaining 51 percent may register in any of the world's more than 150 flag states. Norwegian shipping companies employ some 57,000 seamen from more than 60 different nationalities and of which about 30 percent are Norwegian Nationals(Norwegian Shipowners' Association) The crew may be recruited and managed by the shipping company itself, or by one of the world's many professional crew hiring companies. Within the Norwegian fleet, most sailors are contract-employees working on different vessels during each enrolment, which results in continually shifting working groups. The situation today is a result of a structural change dating back to the 60s and 70s when technical development allowed for bigger vessels with more automation and monitoring, along with the need for reorganization to improve efficiency. This resulted in a cut in the crewing level. Later in the 80s a global recession caused further structural changes; flagging-out, use of external crewing agencies and signing on crew from developing countries and lower wages (Bakka, Sjøfartsdirektoratet 2004). However, the shipping industry is today facing new manning related challenges as there is a global shortage of manpower, this is due to three main challenges: First, it is less attractive nowadays to work in the shipping industry. Second, the recruitment for ship crews has been slow. This has resulted in the third situation where the liquefied natural gas (LNG) shipping sector is drawing crew from the tanker industry, and the tanker industry in turn is drawing people from the dry bulk sector.

In 1894 the British Board of trade carried out a study which showed that seafaring was one of the world's most dangerous occupations, and it still is (Li, Shiping 2002). Regulations in order to reduce the risk at sea were introduced about 150 years ago. These regulations initially encompassed measures to rescue shipwrecked sailors, and further requirements for life-saving equipment, seaworthiness and human working conditions. Traditionally the safety work has focused on technical regulations and solutions even though experience and accident statistics indicate that most of the accidents at sea somehow were related to human performance (Bakka, Sjøfartsdirektoratet 2004). However, a few very serious accidents at sea that occurred in the late 80's resulted in a change towards how safety was organised, and more focus was given to the human barriers and how the seafarers' working conditions

were affected by organisational and managerial factors – both on shore and at sea. Along with this the term safety culture started to gain a foothold also within shipping. The idea of safety culture within shipping was officially introduced on the 4th November 1993 by the adoption of a new resolution, the present SOLAS Convention 1974 Chapter IX, entitled "Management for the Safe Operation of Ships and for Pollution Prevention", also known as the International Safety Management Code (ISM Code) (Le Meur 2003).

Hence, the main purpose of this paper is to elaborate the following questions:

- What characterises safety culture on tankers and bulk carriers?
- Which factors affect the safety culture on board vessels?

With reference to shipping, this article will more concretely analyse crewing strategies such as outsourcing of crewing management and the extended use of contract employment instead of permanent employment. Our hypothesis is that these conditions may contribute to an unfavourable and error-inducing working environment, i.e. poor communication between shore management and the ship management and the remaining crew, unworkable procedures, lack of loyalty to the organisation, dysfunctional interaction, fear of reprisals, which again counteract the development of a safety culture.

2 APPROACH TOWARDS SAFETY CULTURE

There seems to be no clear consensus concerning the ontological, epistemological, and methodological questions related to the topic of safety culture. The main differences seem to be

(1) Definition of the scope of safety culture and the relationship between culture and climate.
(2) Which methods are regarded as most suitable for measurement.
(3) The relationship to other organisational (safety-related) aspects (Cooper 2000, Guldenmund 2000, Neal, Griffin & Hart 2000, Peterson, Ashkanasy & Wilderom 2000, Sorensen 2002, Yule 2003).

However, it is not the scope of this paper to problematise the concept of safety culture. As a point of departure we will apply Schein's definition of organisational culture:
"*A pattern of shared basic assumptions that the group learned as it solved its problems of external adoption and internal integration, that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think and feel in relation to those problems*"(Schein 2004).

Further we have decided to use a methodological framework presented by Cooper (2000), and the application of this framework will be discussed below. Cooper (2000) introduces a reciprocal model of safety culture that allows the multi-faceted and holistic nature of the concept to be fully examined by using a triangular methodology approach, depicted in figure 1.

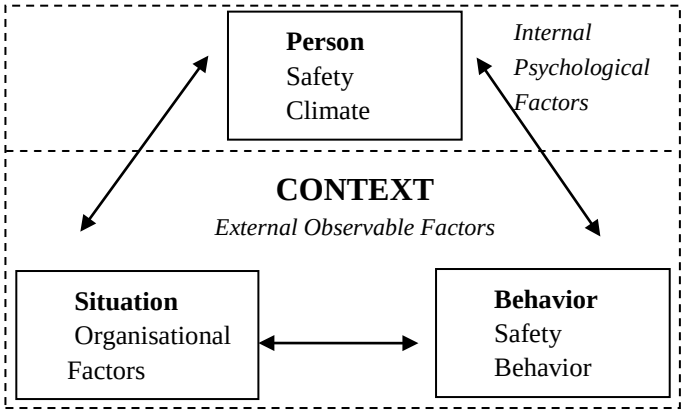

Figure 1. Reciprocal safety culture model (adopted from Cooper, 2000)

Cooper's (2000) model contains three elements:

(1) The subjective internal psychological factors i.e. attitude and perceptions.
(2) Observable on-going safety related behaviour.
(3) The organisational situational features.

According to Cooper (2000) these elements reflect those accident causation relationships found by a number of researchers, such as John Adams, Herbert William Heinrich and James Reason. The investigation of several serious shipping accidents such as Herold Free Enterprize (Department of Transport 1987), Exxon Valdes (National Transportation Safety Board 1990) and Scandinavian Star (Justis- og politidepartementet 1991)is also congruent with their findings. The Herold Free Enterprize accident was partly caused by members of the crew not following best practice, but was also due to managerial pressure from the organization's upper level to sail as early as possible, along with other mistakes made by the on-shore management. Two years later when the US tanker "Exxon Valdes" grounded, the accident investigation determined several probable causes linked to human errors induced by managerial faults

in the upper levels of the organisation. At the vessel, the third mate failed to properly manoeuvre the vessel, possibly due to fatigue and excessive workload. The master failed to provide a proper navigation watch, possibly due to impairment from alcohol. At the onshore part of the organisation, the shipping company fails to supervise the master and provide a rested and sufficient crew for the “Exxon Valdez”. In addition to this effective pilot and escort services were lacking. The following year, in 1990, there was a fire on the passenger liner "Scandinavian Star". In the aftermath of this accident the investigation brought into focus organisational and managerial faults with regard to a lack of competence and training, but also weaknesses in the wider social-technical system. These weaknesses consisted of ownership separated from management, unsatisfactory control routines by the flag state and, in general, an overall maritime system with a lack of transparency. Further, Cooper’s (2000) three elements will be outlined more in detail, starting with safety related behaviour.

2.1 *The importance of safety related behaviour*

Herbert William Heinrich work (published in 1931 Industrial Accident Prevention) is the basis for the theory of Behaviour-Based Safety (BBS), which holds that as many as 80-90 percent of all workplace accidents are caused by human error and unsafe acts (Tinmannsvik, 2008). Schein’s (2004) definition of culture does not clearly address observable behaviour patterns, but behaviour is regarded to be partly determined by a person’s perceptions, feelings and thoughts. However, Schein (2004) regards behavioural patterns as a manifestation of a culture existing at a higher level in the organisation, and not as culture itself. When it comes to BBS, the current theories posit that safety culture, and a reduction of accidents may be achieved through continuous attention to three domains:

(1) Environmental factors such as equipment, tools, physical layout procedures, standards, and temperature.
(2) Person factors such as people’s attitudes, beliefs, and personalities.
(3) Behaviour factors, such as safe and at-risk work practices, referred to as the Safety Triad (Geller 2001).

When adopting this approach humans are seen as a cause of accidents, whereupon interventions to enhance safety are aimed at changing attitude or behavior (i.e. poster campaigns, training, procedures and so on, or changing the technology they operate). This orientation towards risk and safety management has traditionally been and still is adopted from the majority of the shipping companies. The BBS-approach has been criticised for placing too much responsibility on the people operating the systems, assuming that they are responsible for the outcome of their actions (Dekker & Dekker 2006). An alternative view is to recognise human error not as a cause of accidents, but as a consequence or symptom of organisational trouble deeper within the organisation, arising from strategic or other top level decisions. This includes resource allocation, crewing strategy and contracting (Dekker, Dekker 2006, Reason 2001, Reason, Hobbs 2003). An organisation is a complex system balancing different, and often also conflicting, goals towards safety and production in an aggressive and competitive environment (Rasmussen 1997), a situation that to a large extent is current within shipping. The BBS approach towards safety often implies that more automation and tighter procedures should be added in order to control the human actions. However, the result may be that more complexity is added to the system. This in combination with the organisation's struggle to survive in the competitive environment, leads to the system becoming even more prone to accidents (Perrow 1999) (Dekker & Dekker 2006, Reason 2001, Reason & Hobbs 2003) However, the concept of focusing on the human side of safety is not wrong. After all, the technology and production systems are operated, maintained and managed by humans, and as the final barrier towards accidents and incidents they are most of the time directly involved. The proponents of the BBS approach argue that behaviour control and modification may bring a shift in an organisation's safety culture, also at the upper level, but this is most likely if the focus is not exclusively addressing observed deficiencies at the organisation's lower levels (DeJoy 2005). DeJoy (2005) calls attention to three apparent weaknesses related to the BBS approach:
(1) By focusing on human error it can lead to victim-blaming.
(2) It minimises the effect of the organisational environment in which a person acts.
(3) Focusing on immediate causes hinders unveiling the basic causes, which often reside in the organisational environment.
Due to this, we will also include the organisational environment in the safety culture concept, as proposed by Cooper (2000).

2.2 *The relation to organisational factors*

When human error is not seen only as a cause of accidents, but as a symptom and consequence of problems deeper inside the organisation, or what Reason (2001,2003) refers to as latent organisational factors, emphasis is placed on weaknesses in strategic decisions made at the top level in the organisation. These strategic decisions may reflect an underlying assumption about the best way to adapt to external factors and to achieve internal integration, and if they are common for most shipping companies an organisational culture may also be revealed.(Schein 2004). Schein (2004) also stresses the importance of leadership. The top management influences the culture as only they have the possibility of creating groups and organisations through their strategic decisions. And when a group is formed, they set the criteria for leadership and how the organisation will support and follow up their leaders. The leaders, at all levels on shore and at the vessel, are also key figures in the development of a safety culture. It is their task to detect the functional and dysfunctional elements of the existing culture, and to channel this to the upper levels of the organisation. In return, the upper levels of the organisation should give their leaders the support necessary in order to develop the desired culture.

3 METHODOLOGICAL IMPLICATIONS

Cooper's (2000) framework put forward the importance of methodological triangulation in order to grasp all facets of the cultural concept. The internal psychological factors are most often assessed via safety climate questionnaires. Our approach is to start with such a survey in order to gain insight into the seafarer's perceptions and attitudes related to safety, along with self-reported work behaviour related to risk taking, rule violation and accident reporting. The survey also includes questions related to crewing strategy, which opens up the possibility of assessing the relationship between the organisational situation and actual behaviour. The survey results are used to determine which organisational factors are most likely affect the safety culture, and to define research areas for a further qualitative study.

3.1 *Development of questionnaire items*

The survey instrument was developed by Studio Apertura in collaboration with DNV and SINTEF. The development was based on an evaluation of seven already existing questionnaires in comparison with various theoretical views of the safety culture concept (Studio Apertura 2004). Minor adjustments were made after a pilot for use within the tanker and bulk carrier sector. This resulted in a questionnaire with constructs and accompanying number of items as presented in table 1. All items were measured on a 5 point likert scale ranging from *strongly disagree* to *strongly agree*, or *very seldom/never* to *very often/always.*

Table 1. Questionnaire constructs and number of items

Construct	Number of items
Top management's safety priorities	3
Local management	7
Procedures & guidelines	7
Interaction	18
Work situation	8
Competence	5
Responsibility & sanctions	7
Working environment	9
Reporting practices	10

3.2 *Questionnaire sample*

A total of 1574 questionnaires were distributed to 83 randomly selected Norwegian controlled tankers and bulk carriers. All vessels were flying a flag on the Paris MOU white or grey list. 76 vessels returned a total of 1262 completed forms, which gives an individual response rate of 80% and a vessel response rate of 91.5 %. The survey was carried out in 2006.

3.3 *Statistical analysis*

The Statistical Package for the Social Sciences (SPSS) v.15.0 was used to perform all of the analysis, which included descriptive statistics, exploratory factor analysis (EFA), confirmatory factor analysis (CFA) and bivariate correlation analysis.

With regard to the EFA, the principal component analysis with Varimax rotation was carried out. The factors were extracted based on the three following analytical criteria: (1) Pairwise deletion, (2) Eigen value more than 1, and (3) factor loading more than 0.50. Of the extracted factors, all factors with 2 or fewer items were removed, based on the notion that a factor should be comprised of at least three items to be robust (Pett, Lackey & Sullivan 2003). A confirmatory factor analysis (CFA), using a one-factor solution for each construct, has also been performed. The advantage of the CFA is that it allows for more precision in evaluating the measurement model (Hinkin 1995), and the results were compared with the EFA for providing validity evidence based on the hypothesis that a valid instrument should produce similar results.

Each factor was then evaluated using the Kaiser-Meyerto-Olkin (KMO) parameter, and only factors

with KMO value at 0.60 or above were included in the further analysis (Hair 1998).

This was followed by a scale-reliability test. For that purpose, the Cronbach's Alpha coefficient of internal consistency was calculated, and evaluated along with inter-item statistics. Cronbach's Alpha is a measure of scale reliability concerned with the proportion of a scale's total variance that is attributable to a common source, presumed to be the true score of the latent construct being measured. In our case that will be the safety culture. Usually a value above 0.7 is considered acceptable, although some advocate an alpha level of 0.8 or better (Netemeyer, Sharma & Bearden 2003). As the alpha value is a function of, inter alia, the average inter-item correlation; the inter-item correlation and item-total statistics have also been evaluated. Rules of thumb suggest that the item-total correlation should exceed .50, and the inter-item correlation should exceed .30 (Hair 1998), but it should *not* exceed .80. An inter-item correlation exceeding .80 suggests that items are duplicates of one another (Pett, Lackey & Sullivan 2003). Then the remaining items went through a last CFA, a five-factor solution, in order to provide each factor's explained variance.

Finally, correlation analysis has been carried out in order to evaluate the construct validity, which is viewed as the extent to which an operational measure truly reflects the underlying safety culture concept, and if they operate in a consistent manner.

Based on this analytical process, five factors (1) interaction, (2) reporting practices, (3) competence, (4) local management, and (5) work situation were found to be reliable and valid. The aforementioned factors are presented further in detail in the next section.

4 RESULTS

4.1 *Results from descriptive analysis*

Regarding demographics, 21 different nationalities are represented. The Filipino contingent forms the largest group constituting 63 % of the sample, followed by the Norwegian group with almost 11 %, and the Polish which represents 9 %. The last major group was the Russians with 6 %. The other remaining 17 nationalities were represented in a range from 3 % to 1%.

There is also great variation with regard to employment conditions. All in all, 12 % of the sample consists of permanent employees, of whom 80 % are Norwegian and 16 % from the European Union. 91% of the Norwegians are permanent employee. The remaining 9% are apprentices, substitutes or newly employed on probation. Only 3 % of the non Norwegian sailors are permanent employees. With regard to the Filipino seafarers, the largest nationality, 99.6 % are contract employees, most on 9 month contracts (62 %), followed by 6 month contracts (27 %). The extended use of contract employment is reflected in their experience. All in all, 85 % had three years or more experience within shipping in general. However, 69 % of the sample had worked on the current vessel for only 1 year or less.

The employment terms were in general different for the captains. The captains normally do not have sailing periods that exceed 6 months. The most typical sailing period for the captains is 3 months or less.

4.2 *Results from factor analyses*

From the 9 theoretical safety culture constructs, a five factor solution was derived, (1) interaction, (2) reporting practices, (3) competence, (4) local management, and (5) work situation.. With regard to the "local management", "competence" and "work situation" factor both EFA and CFA result in final solutions consisting of the same items, but with minor differences in factor loading. The CFA included three more items in the "interaction" factor than the EFA, and the final factor, "reporting practices" resulted from only the CFA.

Four of the constructs did not pass the reliability tests. The first, "top management's safety priorities", was excluded due to low representative reliability across subpopulations. This construct also consisted of too few items. The remaining three constructs, "procedures and guidelines", "responsibility and sanctions" and "working environment" were excluded due to low validity, mostly resulting from poor theoretical relationship within the items of each construct.

For the further analysis the results from the CFA are used. The 5 factors in question are presented in Table 2 along with number of items and explained variance.

Table 2 Final factors, number of items and explained variance

Factor	Number of items	Explained variance
Interaction	8	35,63 %
Reporting practices	5	9.77 %
Competence	4	7.12 %
Local management	3	5.96 %
Work situation	3	5.08 %

Each factors Cronbach's alpha value and inter item statistics is presented in table 3.

Table 3. Final factors, Cronbach's alpha and inter-item statistics

Factor	Alpha	Inter-item range	Item-total range
Interaction	.878	.360 - .606	.520 - .724
Reporting practices	.808	.335 - .761	.491 - .668
Competence	.839	.497 – 682	.628 - .712
Local Management	.866	.692 - .716	.724 - 774
Work situation	.817	.512 - .749	.554 - .739

The alpha values range from .808 to .878, and the internal item statistics are all within the recommended levels. The five factors are therefore considered to be a reliable and valid reflection of the underlying safety culture concept.

Further,table 4 presents the correlation coefficients between the factors, or safety culture dimensions. All correlations are significant at the 0.01 level (2-tailed)

Table 4. Factor correlation matrix. Pearson's *r.*

	F1	F2	F3	F4	F5
F1: Interaction	1				
F2: Reporting Practices	.352	1			
F3: Competence	.639	.323	1		
F4: Local management	.474	-..362	.367	1	
F5: Work Situation	.494	.322	..441	.444	1

The five safety culture dimensions correlate in a positive direction, which is consistent with the theoretical concept, and they are therefore considered to be a valid reflection of the underlying safety culture construct.

5 DISCUSSION

All three constructs have a good alpha level, and as the alpha levels are concerned with the variance that is common among the items, these constructs also reflect the areas where it is possible to speak about safety culture. With reference to Cooper's framework towards safety culture, we will further discuss how the organisation's factors such as crewing strategy, witch includes employment terms, rotations system and policy towards the on board shipping management, may affect the on board safety culture and climate represented by the identified dimensions. The organisation's structural factors are all to be found within Cooper's element of *situation,* while the identified safety culture dimensions are to be found within the elements of *person* and *behaviour*.

Interaction is the dimension accounting for the largest proportion of the total explained variance, with 35.63 %, meaning that with regard to safety culture most of the variance in the original data is explained by this dimension. When taking into account how distinctive a ship is as a work place, this is no surprise. A ship may be characterised as a total institution since both work and leisure time happen at the same place and with few possibilities to interact with the surrounding world (Goffman 1968). In such a setting the crew members are socialised into a common culture and rules of interaction. Schein (2004) refers to this as internal integration. The interaction climate is characterised by lack of stability within the crew due to different terms of employment. First of all, permanent employment seems to be reserved for the Norwegian sailors. Sailors of other nationalities are almost all contract employees. In addition, the length of contract varies and all crew members have different dates for signing on and signing off. Schein (2004) points out that lack of stability may be a threat to the possibility of developing a culture: *" (…) there must be a history of shared experience, which in turn implies some stability of membership in the group."* Even if the crew as a group is in constant change, they all have common history as seafarers. So even if lack of stability within the group indicates that a common culture should not develop on the ship, a common culture of how to act and interact may have developed amongst the seafarers, and when a new crewmember is signed on a new vessel, he knows what is expected from him. However, the question is if such a culture is a safe culture? Reason (2001, 2003) emphasize that to reach a safe culture, the organisation should strive for an informed culture where those who manage and operate the system, both on board and on shore, have current knowledge about the factors that determine the safety of the system as a whole, which again depends on that the crew on board are prepared to report their errors and near misses, and the *reporting practice* is one of the dimensions deriving from the analyses, explaining 9.77 % of the variance. This dimension also includes feedback on reported events. In order to attain good reporting practices, the organisation should strive to create an atmosphere of openness, trust and loyalty. Integrating into the group is also a survival mechanism, and every crewmember will most likely make an effort to integrate. If not, he would most likely have a hard time during his contract period with no possibility to leave the vessel and the other crewmembers. However, to compromise oneself and be open about one's own mistakes is not always an easy task, especially not in an unknown working environment. Something that may reinforce the crewmembers' fear of reporting their own mistakes is the ongoing practice that each crew member is evaluated by their senior officer / captain, and based

on this report get recommended or not recommended for re-hire. Interviews have revealed that this evaluation practice differs. Some practise an open evaluation where all parts are involved, with focus on how to improve the evaluated crew's shortcomings, and where the shore organisation seeks to ensure that the evaluation is conducted in as objective a way as possible. At other vessels, the evaluation is closed for insight by the evaluated and may also be highly subjective. Some of the respondents have expressed that by reporting, their next contract may be at stake, or they may meet with other negative consequences. So, lack of stability and constantly changing working groups may sacrifice a trusting and open environment, and thus also the sailors' commitment to safety.

A crew committed to safety is essential, but not enough. Lack of competence may cause a situation where the crew do not identify potential dangerous situations, or create them. *Competence*, which accounts for 7.12 % of the total variance, is in this setting comprised of activities performed on board the vessel, and is all under the control of the captain, training, drills and familiarisation when signing on. Also, the competence dimension does correlate strongly with the interaction dimension with a correlation coefficient at .639. This indicates that a situation when the sailors are feeling confident with the nature of their task also results in a better interaction climate where conflicts are more likely to be absent. As with the interaction climate, competence will also be affected by the crew stability. A crew member that is constantly signing on new vessels and that has to interact with new crew members and leaders, uses more effort adapting to the new situation, working out how things are done at that specific vessel, the informal structure onboard and so on. When more stability is provided, more effort may be placed on upgrading their competence, and the competence will be kept within the vessel and organisation. Both the training activities and crewing strategy may be controlled by the ship management, and thus these safety culture dimensions are also, to a certain degree, controllable.

The dimension of *work situation* consists of pro-active activities as Safe Job Analysis (SJA), safety evaluations and the possibility they have to prioritize safety in their daily work. So how may the organisation affect this? For one, they may supply sufficient crew. Today many vessels are sailing with a smaller crew at the same time as new standards and resolutions like the ISM-code increase the amount of paperwork to be done. Both own observations and interviews reveal that inter alia check lists and SJA are done in a mechanical manner. This may originate from various reasons such as an overload of work, no understanding of the importance of those activities, lack of feedback or improper planning by the local management.

The *local management* dimension, accounts for 5.96 % of the explained variance, and the direct effect of local management is relatively small. However, local management is considered to have an indirect effect on the safety climate through the managers, or senior officers, affect on the interaction climate, competence and training activities, reporting practices and the work situation. Again we wish to focus on the importance of stability within the work group. Most captains have a sailing period of 3 months or less, while most of the non Norwegian ratings have a sailing period of 9 months. Most senior officers also have a shorter sailing period then an ordinary rating. Then a rating possibly has to deal with several different leaders during his stay. And each captain and department manager's leadership style may vary, and are sometimes even destructive, as shown by following comment from a Pilipino engineer. *"The only problem on board is the treatment of senior officers to the lowest rank. (..) There are some senior officers who are always very insulting towards jr. officers and rating."* Schein (2004) regards the leader as an important key figure in the cultural development. At sea the captain holds a key role. The captain is the one in command at every vessel, and according to Schein (2004) the captain's orientation will affect the working climate, which precedes the existence of a culture. So, in a situation where lack of crew stability impedes the development of a safety culture, the role of the captain is even more vital. Also, it is important to take into account that the leadership style that is practised on board not only affect the sphere of work, but also time off. However the Captains themselves may not be aware of their own importance, or how they affect safety. Most Captains, or other department leaders for that matter, do not have managerial training or education. When adopting a cultural view towards safety, as in this research, in as opposed to a behaviour based view, more emphasis is placed on organisational factors. Decisions regarding crewing strategy, employment terms and managerial development programmes are all strategic decisions made on shore. With reference to Schein's culture definition, we will argue that the safety culture originates within the organisation on shore. Based on Scheins' definitions of culture there ought to exist a pattern of shared basic assumptions that may solve the problems the shipping industry is facing. Our case however has revealed an offshore practise characterised by extended use of contract employment, lack of stable working conditions on board the vessels, and little or no use of managerial training and development. This practice does not promote a good safety culture and is considered to has a negative effect on the overall safety level.

6 CONCLUSIONS

The aim of this paper was to analyse the characteristics of the safety culture on Norwegian tankers and bulk carriers, and identify what organisational factors may affect the safety culture on board vessels. Statistical analysis identified five safety related dimensions on board the vessels: interaction climate, reporting practices, competence, local management and work situation. Within shipping the interaction climate is characterised by unstable working conditions. Under such conditions it is difficult to achieve and maintain a stable crew, and proper management becomes even more important. Also the Captain has a vital role, as he has the possibility to directly affect all the other safety related aspects through his own leadership style. The Captains, officers and ratings normally have different employment terms and shift terms. This may jeopardise the development of a sound safety culture as the crew has a poor possibility of developing common behaviour practices and a mutual understanding of how to do things right. As neither the Captains nor the officers normally have any managerial training, their leadership styles often affect the safety in a negative direction. The on board situation is to a large extend considered to be created by the on-shore crewing strategy and management policy.

In order to develop a sound safety culture on-board, the shipping companies should go in new directions and pursue a crewing strategy which offers more favourable employment terms and fixed shifts for all nationalities, and strive for a more stable workforce. Another measure would be to accept the Captain's and department managers' roles as leaders, and offer managerial development. A final measure will be to develop a policy and system that ensure proper onboard management.

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The use of safety management systems within the Norwegian tanker industry – do they really improve safety?

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ABSTRACT: Since the implementation of the ISM-code, all shipping companies have been required to have a safety management system. This paper explores the Norwegian controlled shipping industry's safety management performance with regard to incident and near miss reporting practices, data analysis, procedures and checklists, and the balance between commercial pressures and safety concerns. In so doing, the research is limited to the tanker sector, with the emphasis on the sailors' perspective. The statistical data used are derived from a survey carried out in 2006, supported by qualitative information deriving from two case studies. The results indicate several deficiencies with regard to all parts of the system. In order to work with safety management based on other principles, the adoption of an organizational approach towards safety management is proposed, as opposed to a person approach i.e. awareness of characteristics and limitations of human nature and taking crews' experience seriously with regard to areas such as procedural development and resource requirements. Also to make clear, in terms of communication and actions, that safety is the top priority. It is also suggested that a closer and more stable relationship towards contract employee crew would facilitate improved safety management. Moreover, it should be recognized that riskiness will always be a part of life, and that it may never be totally eliminated.

1 INTRODUCTION

Safety management within shipping is regulated by the International Safety Management (ISM) code. The ISM code came into force on the 2 July 1998, as a consequence of a mounting concern about poor management standards within the industry. By implementing the ISM code, the International Maritime Organization (IMO) seeks to better ensure that each shipping company pays attention to safety in ship operations. The code requires companies to establish safeguards against all identified risks, with functional requirements to develop, implement and maintain a safety management system (SMS). Further, the code requires that the SMS should be founded on reporting of accidents and non conformities, in order to develop safety measures (International Maritime Organization, 1994). Within the industry, it is well known that large variations with regard to companies' adherence to the code exist. In 2007 the Paris Memorandum of Understanding (Paris MoU) carried out 5,427 inspections on 5,120 ships in the European and North Atlantic region. One in five of the inspections showed ISM deficiencies, of which reports of non-conformities and accident occurrence were amongst the most common deficiency. This raised interest in further research into to how the requirements of the ISM code are put into practice within the industry. Hence, the objective of this paper is to explore safety management status within the Norwegian controlled shipping industry, by gas and liquid cargo carriers (tankers). The following areas for research will be explored:

- Description of the current situation within safety management.
- Identification of factors that may influence the safety management performance.

2 THE THEORETICAL RATIONALE OF THE ISM CODE

Safety management, as described in the ISM Code, is founded on a linear causality where attempts are made to predict and prevent future incidents by reflecting upon previous experience. The information flow in such a SMS is presented in Figure 1.

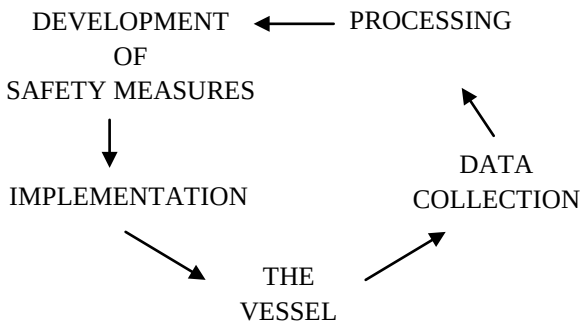

Figure 1 Flow of information in a safety management system (Source: Adapted from Kjellén, 2000)

As shown in Figure 1, the SMS contains several sub systems. First, a system of reporting and collection of experience data from the vessel itself is required. This is followed by a system of data processing, i.e. summarization and analysis in order to reveal causal factors and perform trend analysis, which forms the basis for the development of safety measures. One critical system requirement is the reliability and accuracy of input data, i.e. near miss and accidents reports. As long as the input is reliable, the overall system presupposes the possibility of developing efficient measures, in order to control operational safety (Kjellén, 2000). Another critical factor is how the organization reconciles commercial pressures and safety concerns. Safe performance and safety management require resources in the form of personnel, money and time. At the same time the organization need to make profits and to be able to compete. Safety versus efficiency may be difficult to balance, and are often experienced as conflicting goals (Rasmussen, 1997).

3 METHODOLOGY

A multi-method approach combining surveys and case studies, including field studies and interviews, is adopted. The survey aims to indicate the interrelated patterns of the sailors' perceptions of and attitudes towards the SMS. The quantitative results aim to give a more thorough understanding of the overall situation, underlying processes and the seafarers' experiences with the SMS.

3.1 *Case studies*

Two tanker companies were studied in late 2007 and early 2008. In order to ensure the companies' anonymity, company and vessel specific information is retained. In both companies the HSQ manager and Crewing Manager have been interviewed. In one company the SMS data system was examined. In the other company all available statistics, experience feedback from reported cases and safety bulletins available for the vessel were examined. Two field studies have been carried out on one vessel in each company.

3.2 *Survey*

A total of 987 questionnaires were distributed to 44 randomly selected vessels, of which 41 vessels returned a total of 768 completed questionnaires. This gives a vessel response rate of 93% and an individual response rate of 78 %. All vessels were flying a flag listed on the Paris MOU white or grey list. This survey forms part of a major safety culture survey carried out in 2006, performed with a validated instrument (Oltedal, Engen, 2008).

In addition, 297 respondents have given written comments. The written comments from the survey are categorized in three groups as they relate to (1) the crews' reporting practices, (2) procedures and guidelines and (3) the crews' perceptions of the balance between safety and efficiency (Rasmussen, 1997).

3.3 *Statistical analysis*

All statistical analysis is performed using SPSS version 16.0. Principal Component Analysis (PCA) with Varimax rotation and Pairwise deletion is carried out in order to examine the survey items' interrelationship, and in terms of their common underlying dimension. The extracted rotated component matrix with factor structure and loadings is presented. The loading represents the correlation between the variable and the extracted factor(s), with estimates ranging from 0 to 1.00. Items that load strongest on a given factor are considered to be most like the factor, and thus the underlying latent dimension. (Hair 1998, Pett, Lackey & Sullivan, 2003).

Descriptive statistics for each item, including percentage frequency distribution, mean and standard deviation are presented.

4 PRESENTATION OF RESULTS

The results are presented in sections as they relate to the SMS; (1) crews' reporting practices, (2) analysis and follow up by shore side, (3) procedures and checklists, and (4) perceived balance between commercial pressures and safety concerns. Results relating to data analysis and follow up by shore side are derived from qualitative data only. Each section is brought to a close with a discussion of the presented data and results, where qualitative data is used as a framework for interpretation.

5 REPORTING PRACTICES ON BOARD

5.1 *Qualitative results*

Both companies from the case study have similar formal reporting procedures. Reports on near misses and incidents may be directed towards the reporters' closest superior, or directly to the captain using a standard reporting formula. Reports may also be placed anonymously in a mail box, which is placed on the vessels. All reports are then registered in the computer system by a designated officer. When registered, the report is approved by the captain before it is passed on to the shore side for follow up.

In the questionnaire, 41 respondents commented their reasons for not reporting, which have been categorized in following four sub groups; system related (n=11), blame related (n=10), (3) ship management related (n=9) and others (n=11), summarized in Table 1.

Table 1: Reasons for not reporting – survey comments

11 resp:	The reporting system itself is too complicated, time consuming and paper producing.
10 resp:	Experience that ship management and/or company are after finding someone to blame.
9 resp:	Related to ship management, i.e. management altering report, captain not passing report to shore.
11 resp:	Not possible to categorize, include personal attitude, responsibility, and practice depending on vessel/company specific conditions.

5.2 *Quantitative results from survey*

Survey questions related to reporting practices are presented in Table 2, together with question reference (ref) and number of respondents (n).

Table 2: Reporting practices - survey questions

Ref		n
R1:	Do close calls get reported in writing?	671
R2:	Do minor incidents get reported in writing?	694
R3:	Do you receive constructive feedback from the company on the conditions you report?	639
R4:	Are reports of undesirable incidents ever "fixed up" to cover mistakes?	642
R5:	When an undesirable incident has occurred, people are more preoccupied with placing blame than finding the cause of the incident.	733
R6:	Reporting is important to prevent the recurrence of accidents or incidents.	730

Explanation for interrelationship between survey questions: Reporting practices (R1, R2 & R4) are assumed to improve if the crew gets feedback from the report follow up (R3), and when the importance of reporting and its role in safety management is comprehended (R6). A blame policy (R5) is supposed to reduce reporting (R1 & R2) and increase the probability of a cover up of own mistakes (R4) (Reason, 2001). A blame policy is when people are blamed for an unwanted situation rather than the situational circumstances.

Descriptive statistics related to reporting practices are presented in Table 3, with scale information and coding of response alternatives given below.

Table 3: Reporting practices – descriptive statistic

Ref	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	Mean	Std
R1	2.5	8.8	25.0	42.2	21.5	3.7	0.98
R2	4.0	8.6	22.8	38.9	25.6	3.7	1.06
R3	14.9	11.3	21.9	31.8	20.2	3.3	1.31
R4	46.9	17.6	22.8	9.7	4.0	2.1	1.19
R5	18.4	43.4	12.4	22.2	3.5	2.5	1.13
R6	0.7	0.8	2.9	44.2	51.4	4.5	0.66

R1 through R4: 1=very seldom/never, 2=seldom, 3=sometime, 4=often and 5=very often/always.
R5 and R6: 1 = strongly disagree, 2 = disagree, 3 = not sure, 4 = agree and 5 = strongly agree.

The respondents were also asked to list their reasons for not reporting incidents. Each respondent could mark up to three of eleven pre specified alternatives, or write any other reason if not listed. The three major reasons are listed in Table 4.

Table 4: Reasons for not reporting an incident – from survey

	Response (%)
The incident did not have any serious consequence.	30.3
There could be negative reactions from my co-workers.	29.8
I am afraid that the information will be used against me.	22.8

The factor structure matrix and loadings are presented in Table 5.

Table 5: Reporting practices - factor structure and loadings

Ref		Fac. 1	Fac. 2
R1	Do close calls get reported in writing?	<u>.875</u>	-.185
R2	Do minor incidents get reported in writing?	<u>.837</u>	-.178
R3	Do you receive constructive feedback from the company on the conditions you report?	<u>.652</u>	.029
R4	Are reports of undesirable incidents ever "fixed up" to cover mistakes?	.052	<u>.812</u>
R5	When an undesirable incident has occurred, people are more preoccupied with placing blame than finding the cause of the incident.	-.098	<u>.790</u>
R6	Reporting is important to prevent the recurrence of accidents or incidents.	.174	<u>-.409</u>

* Underlined loadings indicate the factor on which the item was placed.

5.3 *Section discussion*

The factor structure matrix indicates two underlying reporting dimensions. One reflecting desired reporting practices (factor 1) and one reflecting undesired reporting practices (factor 2).

Factor 1 indicates interrelationship between the tendency to report and the feedback given on the report from the shore side (Table 5), which indicates that improved feedback also increases reporting frequency. The descriptive statistics point to a situation of substantial underreporting. A total of 36.3% of the respondents state that they never or only sometimes report close calls, and 35.4% that they never or only sometimes report minor incidents. In addition, feedback given on reports seems to be inadequate, as 48.1% stated that they never or only sometimes received constructive feedback (R1, R2 & R3, Table 3). The qualitative data also confirm that feedback is perceived to be inadequate, too general and delayed. However, the most frequent reason given for not reporting is that the incident did not have any serious consequences, ticked of by 30.3% of the respondents (Table 4). This suggests that the crew do not understand the purpose of reporting less serious incidents in order do prevent the more serious ones. The crew at the vessels visited also had major problems explaining the definition of close call and near miss.

Factor 2 indicates interrelationship between the tendency to alter the reports to cover up own mistakes and a blame-policy (Table 5). A total of 36.5% of the respondents admit to sometimes, often or always fixing up the reports, and 25.7% perceive that a blame culture is present (R4 & R5, Table 3). However, the tendency to alter reports is counteracted by the crews' understanding of reporting as a preventive measure, pointed out by item R6's negative loading (factor 2, Table 5). As few as 1.5% of the respondents disagree about the statement of whether reporting is important to prevent recurrence of accidents or incidents (R6, Table 3.) This suggests that greater improvement in the SMS can be achieved abandoning a blame-policy. This is supported by the fact that both the second and third most frequent reason for not reporting is related to blame; fear of negative reactions from co workers and that information may be used against them (Table 4). When it comes to negative reaction from co workers, ship management and the captain, the information retrieved from field studies suggest large variation from vessel to vessel, and most crew regard the captain as the one setting the standard on board. Although both companies acknowledged having captains who possess less leadership skills, and who do not practice the official company policy, they are both reluctant to evaluate their captains.

Another hindrance towards reporting is the reporting system itself, which is perceived to be too complicated and time consuming (Table 1). A common understanding on the vessels is that the SMS is a paper producing system which requires constantly increasing administrative work, without having a proportionate effect on safety. The field studies have revealed situations where administrative tasks have been carried out at the expense of time spent focusing on practical work and operational challenges.

6 ANALYSIS AND FOLLOW UP BY SHORE SIDE

6.1 *Qualitative results*

Both companies stated that they operate a no-blame policy, but did acknowledge that the no-blame policy did not always get through to the crew. In their experience, the no-blame policy is put in to practice differently on the various vessels, and that this may depart from their official policy. However, when going through the reports, it is noted that report analysis most often stopped with the crew as a cause, with explanations as "*lack of safety awareness*" and "*bad attitude*". Situations involving known technical mal functioning and unfortunate situational circumstances such as bad weather have also been explained by human error as root cause. Safety is monitored with the use of metrics such as lost-time injuries, sick leaves and number of reports, all metrics that may be traced back to the individual.

6.2 *Section discussion*

The case studies indicate that the companies apply a person model in their follow up. A person model views people as free agents capable of choosing between safe and unsafe behavior, and therefore unsafe behavior is seen as voluntary actions and as a cause. In an alternative organizational model, human error is seen more as a consequence than a cause, induced by latent conditions in the system at large (Reason, 2001). There are several draw backs with the person model. First, when human error is seen as a cause, the crew may perceive this as placing blame. As mentioned in section 5, a blaming policy is suggested to aggravate the reporting practices on board. A second drawback is related to developments of safety measures. In the person model, when human error is seen as a cause, safety measures tend to attempt to control human behavior by, inter alia, procedures and checklists. And when the real cause is to be found elsewhere in the organization, the measures may have limited effect. When measures have little or

no effect upon the error producing factors, error continue being involved in incidents and accidents. This situation may develop to a vicious blame cycle, where in the next situation crew get even more blame as they have already been warned (Reason, 2001).

7 PROCEDURES AND CHECKLISTS

7.1 *Qualitative results*

Within the tanker sector there is an extensive use of procedures and checklists. It is custom that crew have to deal with procedures and checklists from own company, charterer, customer and oil installation. Of which all are different but at the same time standardized to fit all.

Officers at both vessels do regard procedures and check lists as valuable for safety reasons within certain limits. Procedures and checklists are also seen as problematic as there are too many of them, too detailed and too standardized. The crew experience that less standardization and a possibility to accommodate procedures and checklist in accordance to the ship specific situation would improve safety more. Problems with completing checklists and following procedures are mostly experienced during hectic operation, such as calling at and leaving port.

In the questionnaire, 62 respondents made written comments related to procedures and check lists. The comments have been categorized into following three sub groupings; (1) procedure quality (n=33), (2) commercial pressure (n=11) and (3) others (n=18). The results are summarized in Table 6.

Table 6 procedures and checklists – survey comments

33 resp:	Procedures and checklists are not applicable and do not reflect the situation on board: too detailed, too many, and look like they have been developed by people with no sea going experience.
11 resp:	Procedures are being breached due to commercial pressure.
18 resp:	Other, i.e. the relevance of training and work specific situations.

7.2 *Statistical results from survey*

Survey questions related to the perception of procedures are presented in Table 7, with question reference (ref) and number of respondents (n).

Table 7: Procedures - survey questions

Ref		n
P1	The procedures are helpful in my work.	755
P2	I have received good training in the company's procedures.	757
P3	We have the opportunity to influence and form the procedures.	739
P4	I feel that it is difficult to know which procedures are applicable.	750
P5	The procedures are difficult to understand or are poorly written.	751

Explanation for interrelationship between survey questions: Good procedures are supposed to be helpful in the work (P1). It is assumed that procedures are more easily put into operational practice if the user has received training in how to understand and apply the procedures, and the safety role they play (P2). They are also assumed to be more workable if they reflect the reality of the working process. That is ensured through involving the crew in the development of procedures, and by paying attention to crews' experience (P3). If these factors (P2 & P3) are not present, the procedural system may be perceived as confusing and difficult to relate to (P4 & P5) (Reason, 2001).

Descriptive statistics related to reporting practices are presented in Table 8, with scale information and coding of response alternatives beneath.

Table 8: Procedures – descriptive statistics

Ref	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	Mean	Std
P1	0.9	1.2	4.9	52.5	40.5	4.3	0.70
P2	1.1	2.9	6.1	55.9	34.1	4.3	0.76
P3	3.4	13.4	16.2	53.5	13.5	3.6	0.99
P4	15.6	45.7	16.5	19.3	2.8	2.5	1.06
P5	16.6	54.2	12.9	15.2	2.1	2.3	0.99

P1 through P5: 1 = strongly disagree, 2 = disagree, 3 = not sure, 4 = agree and 5 = strongly agree.

The respondents were also asked to list their reasons for not following procedures. Each respondent could mark up to three of seven pre specified options, or write any other reason if not listed. The three most frequent reasons are listed in Table 9.

Table 9: Reasons for not following procedures

	Response (%)
The work will be done faster.	47.3
The procedures do not work as intended.	44.4
There are too many procedures.	36.8

Factor analysis also included item R5 "*When an undesirable incident has occurred, people are more preoccupied with placing blame than finding the cause of the incident"* Our hypothesis is that organizations inclined to focus at the human as a cause, as in a person model (Reason, 2001), are also more inclined to react by adding more procedures, which may result in a procedural system difficult to relate to (P4 & P5, Table 7). Factor structure matrix and loadings are presented in Table 10.

Table 10: Procedures – factor structure and loadings

Ref		Fac. 1	Fac. 2
P4	I feel that it is difficult to know which procedures are applicable.	.815	-.060
P5	The procedures are difficult to understand or are poorly written.	.806	-.165
R5	When an undesirable incident has occurred, people are more preoccupied with placing blame than finding the cause of the incident.	.560	-.054
P1	The procedures are helpful in my work.	-.147	.776
P2	I have received good training in the company's procedures.	-.206	.739
P3	We have the opportunity to influence and form the procedures.	.041	.685

* Underlined loadings indicate the factor on which the item was placed.

7.3 *Section discussion*

The factor structure matrix indicates two underlying dimensions related to procedures. One is reflecting poor procedures (factor 1) and one reflecting helpful procedures (factor 2).

Factor 1 indicates an interrelationship between the use of a person model in follow up (R5) and how easily the procedural system is comprehended (P4 & P5, Table 10). In all, 25.7% perceive blame as more important than finding the cause of an incident (R5, Table 3), 22.1% find it difficult to know which procedures are applicable and 17.3% finds them difficult to understand or to be poorly written (P4 & P5, Table 8).

On the other hand, factor 2 indicates that procedures are perceived as helpful when training is provided and the users get involved in the development process (P1, P2 & P3, Table 10). Although 93% of the respondents regard procedures as helpful (P1, Table 8), qualitative information suggests the situation to be more nuanced. In the survey, 33 respondents commented that the procedures and checklists are not applicable and do not reflect the situation on board. Moreover, they are felt to be too detailed, too numerous, and look like they were developed by people with no sea going experience (Table 6). Also, two of three major reasons given for not following procedures are that the procedures do not work as intended and that there are too many of them, stated by 44.4% and 36.8% respectively (Table 9). This is considered as another drawback related to the person model, anexity-avoidance. Anexity-avoidance describes an organization which has discovered a technique to reduce risk, and who repeat it over and over again regardless of its effectiveness, like constantly adding yet another procedure in response to unwanted incidents (Reason, 2001). With regard to procedure development, the crews should, as professionals, be involved in the process, and their experience taken seriously. However, both companies are using multinational contract employee crew, which may make involvement difficult. Contract employment may cause more crew instability, and when crewing is outsourced the company is more disconnected to, inter alia, training and skills upgrading programs. The field study reveals that mostly top officers are involved in procedural development. Procedures and checklists are experienced as being more difficult to follow during hectic operations such as loading, discharging and entering port, and are, in these situations, also most often deviated from. Also, ship inspections on behalf of flag states, port states, and classification societies and so on, take place at port and increase the crew's workload. On average, each tanker is inspected 11 times per year. A total of 50 hours is allocated for these inspections however this does not include preparation time (Knapp, Franses, 2006). It is known that some vessels may experience up to 40 inspections per year from their customers alone (Guest, 2008).

However, the top reason for not following procedures is to do the work faster, stated by 47.3% of the respondents (Table 9), which brings us to the next section: the balance between commercial pressures and safety concerns.

8 BALANCE BETWEEN COMMERCIAL PRESSURES AND SAFETY CONCERNS

8.1 *Qualitative results*

Both companies stated their main priority as safety. However at sea, the sailors often experienced commercial pressure and efficiency to be the shore sides' priority. This experience is supported by real situations with direct pressure from shore. Most comments related to efficiency pressure are also related to the on board manning level.

In the questionnaire, 118 respondents have commented on these issues. The comments have been divided into following sub groups; crewing level (n=33), demand for efficiency (n=35), rest

hours (n=30) and others (n=10). The results are summarized in Table 11.

Table 11 Balance between commercial pressures and safety concerns – survey comments

33 resp:	The number of crewmembers is too low compared to work tasks, which are constantly increasing in quantity especially administrative.
35 resp:	High demand for efficiency and time pressure, especially when calling for and leaving port.
30 resp:	Rest hours are not followed, mostly due to low crewing level and high work load.
10 resp:	Not possible to categorize. Comments as *"sorry, I am tired"* and *"I fell asleep on the watch"*.

8.2 *Quantitative results from survey*

Survey questions related to crew's perception of their priority of safety versus efficiency are presented in Table 12, together with question reference (ref) and number of respondents (n).

Table 12 Balance between commercial pressures and safety concerns - survey questions

Ref		n
SE1	The management doesn't care how we do our work as long as the work gets done.	736
SE2	I am confident that my company always prioritizes the crew's safety.	754
SE3	The on-shore top management in my company prioritizes safety before economy.	756
SE4	I experience that safety is more a façade than a real priority area.	736
SE5	Do you ever feel forced to continue your work even if safety may be threatened?	745
SE6	Do you have the possibility to prioritize safety first in your daily work?	761
SE7	The number of crewmembers is not sufficient to ensure safety on board.	744

Explanation for interrelationship between survey questions: The priority of safety versus efficiency is supposed to be communicated from the organization's top management (SE3) down to the lower levels of the organization (SE2), which are, ideally, aligned (Reason, 2001). However, deviation from official policies and goals may be experienced (SE1, SE4). The level of stress experienced is interrelated with crewing level. Crewing constitutes a major part of operational expenditures, and how safety is prioritized may be reflected in the on board crewing level (SE7), which again influences the crew's opportunity to prioritize safety in their daily work (SE5, SE6).

Descriptive statistics related to the priority of safety versus efficiency are presented in Table 13, with scale information and coding of item answers.

Table 13 Balance between commercial pressures and safety concerns - descriptive results

Ref	1 (%)	2 (%)	3 (%)	4 (%)	5 (%)	Mean	Std
SE1	27.9	46.5	12.6	9.1	3.9	2.2	1.05
SE2	0.9	2.0	6.5	45.0	45.6	4.3	0.76
SE3	2.0	5.3	8.5	47.8	36.5	4.1	0.91
SE4	19.7	35.7	9.0	26.8	8.8	2.7	1.29
SE5	43.5	24.2	26.8	3.6	2.5	2.0	1.01
SE6	0.3	0.7	4.5	31.9	62.7	4.6	0.64
SE7	20.6	35.2	16.8	21.0	6.5	2.6	1.21

SE1 through SE4 & SE7: 1 = strongly disagree, 2 = disagree, 3 = not sure, 4 = agree and 5 = strongly agree.
SE5 & SE6:1=very seldom/never, 2=seldom, 3=sometime, 4=often and 5=very often/always.

Factor structure matrix and loadings are presented in Table 14.

Table 14 Balance between commercial pressures and safety concerns – factor structure and loadings

Ref		Fac. 1	Fac. 2
SE1	The management doesn't care how we do our work as long as the work gets done.	.690	-.308
SE7	The number of crewmembers is not sufficient to ensure safety on board.	.676	-.093
SE5	Do you ever feel forced to continue your work even if safety may be threatened?	.647	-.169
SE4	I experience that safety is more a façade than a real priority area.	.625	.035
SE2	I am confident that my company always prioritizes the crew's safety.	-.112	.819
SE3	The on-shore top management in my company prioritizes safety before economy.	-.081	.771
SE6	Do you have the possibility to prioritize safety first in your daily work?	-.135	.583

* Underlined loadings indicate the factor on which the item was placed.

8.3 *Section discussion*

The factor structure matrix indicates two underlying dimensions related to the balance between commercial pressure and safety concerns (Table 14). One is reflecting when commercial pressure and efficiency is perceived to be of priority (factor 1) and the other when safety concerns are of priority (factor 2).

Factor 1 indicates a relationship between the perception that management does not care how they work as long as it is done, and low crew level (SE1 & SE7, Table 14). Shortage of crew when compared to work load and demand for efficiency is also the most commented issue at the survey (Table 11). In all, 27.5% of the respondents perceive the crewing level as too low to ensure safety on board (SE7, Table 13). As seen in factor 1, the consequence is that 32.9% of the crew feel forced to continue work even if safety is

threatened. Also, safety is perceived as a façade by 35.6% (SE5 & SE4, Table 13). When safety is seen as a façade, we expect that safety management related work is also mistrusted, which again may affect the willingness to report.

On the other hand, factor 2 indicates that when the top management in the company manages to communicate safety as priority, the crew also prioritizes safety in their daily work (SE2, SE3 & SE6, Table 14). If safety is to be a priority, it is not enough simply to have an official statement of safety; it must be supported by actions. Such actions should include providing the crew with whatever manpower or equipment they deem necessary to carry out their responsibilities safely; emphasizing measures which are low cost will not be sufficient.

9 CONCLUSION

Statistical analysis and qualitative data indicate that SMS within the Norwegian tanker industry have several deficiencies. Firstly, there is a substantial under reporting of experience data from the vessels. And reports that are placed may be intentionally altered to not include a correct description of the events. The situation may be explained by the crew's fear of negative consequences, a complicated reporting system and a lack of understanding of the overall safety management system. When it comes to shore side's follow up and data analysis, the findings indicate a person orientated approach. This is resulting in underlying latent causes not being revealed and contributes to the perception of an organizational blame policy. Moreover, when applying a person oriented approach, measures developed tend to aim at controlling human actions, often in form of excess use of procedures and checklists. Procedures and check lists are perceived by the crew as being problematic to use in their daily work. This may be explained by lack of crew involvement in the development process, that crews' experience not being taking seriously and poor opportunities for local adjustments to each vessel. This again may lead to more frequent and deliberate breaching of procedures, which again affects the willingness to report, as the system is not understood in terms of its contribution to good safety management. This is an undermining and safety degrading vicious circle. To break out of such a cycle, following four facts regarding human nature and error should be recognized (Reason, 2001). Firstly, human actions are almost always constrained by factors beyond an individual's immediate control. Secondly, people cannot easily avoid actions which they did not intend to perform in the first place. Thirdly, error has multiple causes including personal, task related, situational and organizational. And finally, within a skilled, experienced and largely well intentioned workforce, situations are more amenable to improvement than people. With reference to the latter, the field studies revealed several episodes where experience and good seamanship gave solutions to situations that deviated from the ordinary. Under such circumstances, with experienced crew on board, an organizational approach towards safety may be more appropriate. Also, we suggest that employment conditions and crew stability are influential factors. Trust, good safety management and proper safety practices are all things which evolve over time, as a result of close interaction and experience feedback between all organizational members. Safety as priority has to be communicated with a united voice throughout the organization, supported by evidential actions. The crew needs to be provided with the required recourses, and support if work is delayed due to safety reasons. Each vessel, even within the same fleet, is different with regard to factors such as structural condition, crew experience and competence. In such peculiar situations, standardized measures may be experienced as poorly fitted, and safety could be managed more efficiently if crew were given the opportunity of making local adjustments. Finally, in a SMS, all of its parts are equally important and mutually dependent. Amendments should pertain to the system as a whole, and not be limited to individual components.

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Article 4

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Article 5

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Reporting practices in merchant shipping, and the identification of influencing factors

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Abstract

The objective of this paper is to identify the factors determining the reporting frequency of experience data e.g. incidents and accidents. The empirical setting is the Norwegian controlled merchant fleet. Data were collected from a survey carried out in 2006, where 1,262 questionnaires were gathered from 76 vessels. The data were subjected to explorative factor analysis, method of principal component and varimax rotation. Seven factors, representing latent dimensions of safety culture, were extracted. Internal consistency (Cronbach Alpha) and scale reliability were found to be acceptable. The factor scores were used in an ordered logistic regression to examine the factors' relationships to reporting practices. The results show that enhanced safety related training, a trusting and open relationship among the crew, safety oriented ship management, performance of pro-active risk identification activities and feedback on reported events all are significantly related to higher reporting frequency. On the other hand, demand for efficiency and lack of attention to safety from shore personnel, are significantly related to lower reporting frequency. The results also show a significantly lower reporting frequency among those who have worked with their local manager less than 1 year. Bulk and dry cargo vessels also show significantly lower reporting frequency than those working on liquid bulk carriers.

Keywords: Reporting practices; safety management; safety culture; ordered logistic regression; shipping; seafaring

1 Introduction

Information about incidents, near-misses, operational failures and successes are crucial when taking a proactive approach to safety. Such information is often collected and processed into basic data for remedial actions through the use of a formal safety management system, which constitutes a cornerstone of organizational learning (Kjellén 2000, Reason 2001). Within the maritime industry, at the international administrative level, guidelines for formal safety assessment systems have already been developed. In these, identification of potential hazards is the first step (International Maritime Organization 2007a). At company level, safety management is regulated by the International Safety Management (ISM) code, which requires shipping companies to have a system of reporting and collecting experience data (International Maritime Organization 2002). Although various systems for safety management do exist, safety management *per se* is not only a system property. It is

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not sufficient simply to have a system for the collection of safety related data. The system efficiency is determined by its human interrelationships (crew, shore personnel, analysts and others). A fundamental pillar of safety management is that information reported into the system is reliable and reflects the actual situation in working operations. Thus, under-reporting of safety related events constitutes a major threat to the efficiency and utility of a safety management system.

There is an extensive literature considering reporting practices and the factors which influence these. Particular interest has been shown in high-risk sectors such as civil aviation and nuclear power plants. Attention has also been given to road and rail transportation, health care and oil & gas related activities. Although the importance of reporting practices in determining the outcome of a safety management system has been acknowledged in the literature, little attention has been given to the topic within merchant shipping. This is somewhat surprising given that seafaring is regarded as a high-risk occupation (Anderson 2003, Hansen, Pedersen 1996, Håvold 2005, Roberts, Marlow 2005).

A few studies which examine merchant shipping have been retrieved by searching through the Science Direct database for peer review publications. The findings indicate a culture of under-reporting of safety information, which represents a shortcoming in the their safety management (Psarros, Skjong & Eide 2009, Oltedal 2010, International Maritime Organization 2007b, Ellis, Bloor,Michael, Sampson,Helen 2010). An analysis of accident data from the Lloyd's Register FairPlay (LRFP) and the Norwegian Maritime Directorate (NMD) for vessels registered in Norway, suggests that only 30% of accidents experienced were reported (Psarros, Skjong & Eide 2009). Own research indicates that 36% of ship board tanker crew never or only sometimes report near-misses or minor incidents (Oltedal 2010). Within the dry cargo sector, around 40% state that they never or only sometime report a minor incident or near-miss (Oltedal, Engen 2010). Differences in reporting practices between dry cargo and tanker vessels are also suggested by others (Ellis, Bloor,Michael, Sampson,Helen 2010).

The International Maritime Organization (IMO) expresses an awareness of the under-reporting of safety information, and highlights that this must be improved (International Maritime Organization 2007b).

1.1 Theoretical foundation

Although various safety management models exist (see (Kjellén 2000), of fundamental importance in all of them is the collection of safety information from the operational productions system, used with intention the intention of preventing future accidents and other unwanted episodes. A model of a safety management system is illustrated in Figure 1.

Figure 1
Safety management system (adapted from Kjellen 2000)

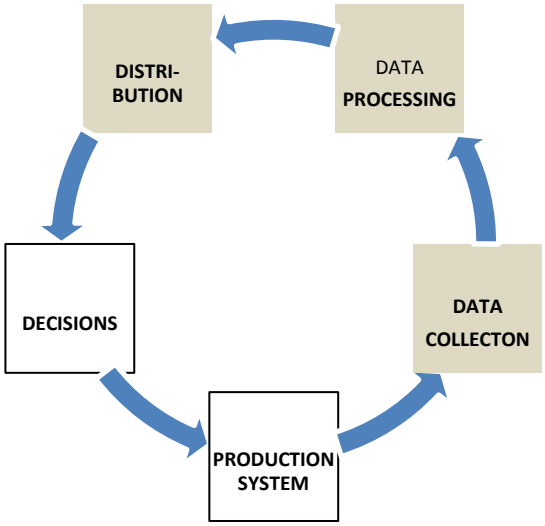

Figure 1 shows the flow of information in a safety management system. The shaded areas represent the safety information system, that is, the part of the safety management system which provides information needed for decisions and signalling related to safety matters. Reporting and the collection of data on, for instance, operational accident risk by means of self reported accidents, incidents and near-misses is regarded as a critical function of the overall system. Information processing and the development of remedial actions all depend on the reliability and accuracy of the reported information (Kjellén 2000).

When it comes to the under-reporting of safety related events, Kjellen (2000) uses behavioural theory to explain different propensities to report. Behavioural theory is primarily used to explain why people deliberately violate safety rules. It focuses on the consequences of behaviour and how these consequences affect people's judgments in relation to recurring situations, and their ingrained action patterns in these situations. For instance, when performing an operation, people may have two action alternatives to choose between: one which is considered safe and one considered unsafe. Experience shows that people are inclined to choose the unsafe alternative when this alternative provides a consequence regarded as positive, such as saving time or other resources. When people in turn get positive feedback for their efficiency, deliberately violating safety rules becomes a valuable skill, and over time a part of the organizational culture. This safety-efficiency trade-off has also been noted by other researchers, for example (Hollnagel 2009). The reporting of an incident or accident is often a time consuming activity, and it is therefore reasonable to expect that demand for efficiency will lead to less reporting, as well as an increase in situations that should have been reported in the first place.

Another factor influencing people's propensity to report is how the organization handles blame and punishment (Reason 2001). Reason (2001) emphasises the importance of organizations developing a just culture. In a just culture, there is an atmosphere of trust in which people are encouraged or even rewarded for providing essential safety related information, but in which there is also a clear line between acceptable and unacceptable behaviour. For example, if efficiency by unsafe acts is knowingly accepted during normal operations, the operator should not be

blamed and punished when that very same action is a causal factor in an unwanted event.

Feedback of the results to the reporter is considered a motivating factor, as the individuals understand the relevance of reporting and see that is taken seriously. However, feedback on reported events in the form of constantly developing new procedures may also be perceived as blame, as it is signalling that the operator did something wrong. Such a person oriented approach also has another drawback. When searching for human error, the organization often does not look behind the operators when looking for causal factors, which could be found elsewhere in the organization such as, for instance, a pressure for efficiency.

Reporting practices, how the organization handles, blame, punishment and feedback, and the general functionality of the organization's safety management, are regarded as key elements in an organization's safety culture (Reason 2001). Management characteristics and leadership, at all levels in the organization both shore-side and ship-board, are regarded as major enablers and barriers with respect to the development of an efficient safety culture (Maritime and Coastguard Agency 2004), and thus also an adequate reporting culture.

1.2 Previous research

The under-reporting of safety related information has been identified as a problem in several industries. For example, it is suggested that up to 68% of all workplace accidents and injuries are not captured in the national injury surveillance systems, which were set up by the Occupational Safety and Health Administration (OSHA) and the Bureau of Labor Statistics (BLS) in the United States (US)(Rosenman et al. 2006). Others suggest that 81% of injuries experienced remain unreported (Probst, Brubaker & Barsotti 2008). Within the health industry, barriers against reporting include fear of reprisals, lack of confidentiality, time constraints and lack of post-reporting feedback (Espin et al. 2007).

Although Psarros (2009) concludes that under-reporting constitutes a major problem within the maritime industry, the reasons for non-reporting are not addressed (Psarros, Skjong & Eide 2009). Neil et al. (2010) suggest that under-reporting is more frequent on general cargo vessels compared to others. However, these conclusions are drawn based on differences in aggregate data in administrations, and not reporting practices directly. Barriers against reporting are not reliably identified, however differences in national / cultural risk perception have been suggested (Ellis, Bloor,Michael, Sampson,Helen 2010).

A recent cross-industrial review indicates that a fear of blame and punishment (legal, organizational or from co-workers) is the most commonly cited barrier to reporting (van der Schaaf, Kanse 2004). The International Maritime Organization also addresses fear of being thought blameworthy or of being disciplined, embarrassment, fear of legal liability, and so on, as the main barriers towards reporting (International Maritime Organization 2007b). Schaaf (2004) has also identified other common barriers such as: a lack of follow-up, managerial issues such as no commitment or distrust, time demands, a paper producing reporting system and a lack of understanding of what constitutes a near-miss and incident. Own research indicates that all of these factors are present within the shipping industry (Oltedal 2010). Moreover, Schaaf (2004) reports that a 'macho' environment may discourage reporting, and that injury in such environments is regarded as a part of the work. Based on his review, Scaaf (2004) identifies four main categories of reporting barriers: 1) fear of disciplinary action (as a result of a ‘‘blame culture’’ where those

who commit an error are punished) or of other people's reactions (embarrassment); 2) risk acceptance (incidents are part of the job, cannot be prevented, the 'macho' perspective); 3) useless (perceived attitudes of management taking no notice, not likely to do anything about it) and 4) practical reasons (too time-consuming, too difficult).

1.3 The objective of the paper.

It is evident that the under-reporting of safety information and risk, is a problem within the merchant shipping industry, yet we have not been able to find any research which empirically explores which factors affect the on-board reporting practices. As stated earlier, a considerable amount of research has been undertaken looking at reporting practices and the factors influencing it within other industries. However, working within merchant shipping is in many ways different from shore-based activities. Life and work on board is a 24-hour-a-day activity, where the crew has little opportunity to interact with the surrounding society. Most of the sailors are contract employees, comprised of multiple nationalities, with a typical sailing period of 9 months at a time. Also, due to its global nature, the industry is highly exposed to competition. (Oltedal, Engen 2009). We have therefore identified a need for more research on the factors influencing reporting practices in the setting of merchant shipping.

The objectives of the study are:

1) To determine the structure of safety culture in Norwegian controlled merchant shipping by liquid tankers and bulk carriers using exploratory factor analysis.
2) Explore the relationship between on board reporting practices and safety culture factors.
3) Check for differences in reporting practices and familiarity with their local manager.
4) Check for differences in reporting practices between type of vessel; liquid tanker versus bulk / dry cargo carrier.

2 Method

2.1 Survey samples and administration

The survey forms part of a PhD-research project which explores the relationship between ship-board safety culture and management on Norwegian controlled liquid- and drybulk cargo vessels, with a second goal of looking for differences between the two vessel classes.

The sample was randomly selected from the Norwegian Ship-owners' Association's list of members for 2005, and the sample was stratified with regard to type of vessel (general cargo, bulk carrier, oil tanker, gas tanker and chemical tanker). Initially, 150 vessels were selected, which constitutes about 15% of the population. Following the initial selection, telephone calls were made to each company to ask for their participation. Thirty one companies agreed to participate with 83 vessels. Forty five companies with 67 vessels declined to participate. Reasons for not participating included:

- Being unable to contact the company despite repeated efforts (23 vessels, 16 companies).

- The vessel was not owned by a Norwegian party, and therefore not defined as Norwegian controlled (15 vessels, 8 companies).
- Ship management was outsourced to a non Norwegian country, and therefore not defined as Norwegian controlled (14 vessels, 8 companies).
- The company refused to participate (12 vessels, 10 companies).
- The remaining vessels were sold (3 vessels, 3 companies).

The population was redefined, and vessels managed from a non-Norwegian country were not considered Norwegian controlled.

On an international basis, the various flag states' performances are assessed on standards of safety, environment and social performance and are maintained and enforced by flag states, in full compliance with international maritime regulations. Based on their performance, the flag states are then categorized into three sub groupings; the white list (good performance), the grey list (mediocre performance) and the black list (poor performance) (MARISEC 2008). It turned out that companies operating vessels flying a black listed flag declined to participate in the study. Thus, the sample is representative only for vessels flying a white and grey listed flag.

The results of the study were based on self-completed questionnaire data. In total, 1,574 questionnaires were distributed to 83 tankers and bulk carriers. 76 vessels from 29 companies returned a total of 1,262 forms, which gives an individual response rate of 80.2 %, a vessel response rate of 91.5 % and a company response rate of 93.5%. Each vessel received a package with individual questionnaires and a sealable return envelope. On each vessel, the safety delegate received instructions regarding administration, purpose and anonymity. Vessels not returning any questionnaires were reminded up to four times. The survey was administrated during the spring/summer of 2006.

2.2 Questionnaire development

The questionnaire was developed by Studio Apertura (2004) (a constituent centre of The Norwegian University of Science and Technology (NTNU), in collaboration with the Norwegian DNV and the research institution SINTEF (2003)) as a part of a programme for research in risk and safety in transport (RISIT) founded by The Research Council of Norway. The main part of the questionnaire was made up of 10 sections representing the following dimensions of safety culture: top management's safety priorities, local management, procedures and guidelines, interaction, work situation, competence, responsibility and sanctions, working environment, learning from incidents, and description of the organization. All these constructs were measured on five point Likert scales ranging from `strongly disagree' to `strongly agree', or from `very seldom/never' to `very often/always'.

Håvold and Nesset (2009) discuss the issue of language and response style. They proceed using only an English and Norwegian version of their questionnaire. McCrae (2001) studied Norwegians and Filipinos who completed questionnaires both in their own language (Norwegian/Tagalog) as well as in English. He found no significant differences in the mean responses. However, in a cross-national study, Harzing (2005) found that English language versions tended to be more homogenized, potentially obscuring cross-national differences.

Given that forcing the respondents to answer in the official working language of English could potentially bias the results, the questionnaire was also made available in Norwegian, Polish and Tagalog. This covered the main languages in use on-board. In

addition, during the fieldwork it became obvious that there was significant variation in the English-language abilities of the crew. This provides further support for the approach adopted here. All participants were issued with questionnaires in their own national language and English. They were free to choose which version to return.

2.3 Demographics

Questionnaires were returned from 40 liquid bulk carriers (liquid tanker) and 36 dry bulk carriers (dry cargo). 63% of the respondents were employed on a liquid tanker and 37% at a dry cargo vessel. The sample was male dominated (92.5% of the respondents). 22 nationalities were represented. The majority from the Philippines (65.5%), followed by Norway (9.2%), Poland (8.1%) and Russia (5.5%). Just over 56% of respondents were under the age of 40.

3 Results

The Statistical Package for the Social Sciences (SPSS) v.16.0 and STATA v. 10.1 were used for the data analysis.

3.1 Dependent variable: Reporting frequency

The dependent variable, reporting frequency, was measured by the item: *"Do minor incidents get reported in writing".* A total of 13% stated 'never or seldom report' (N=164), 20.7% stated that they sometimes did report (N=261), 31.8% that they often reported N=401) and 23.5% that they always reported minor incidents. The remaining 11.1% were missing (N=140).

3.2 Factor analysis

All 1262 responses were submitted to explorative principal component factor analysis with Varimax rotation, in order to identify the latent underlying dimensions of safety culture. The data were deemed appropriate for analysis, according to the Kaiser-Meyer-Olkin measure of sampling value of .858, and significant Barlett's test. Factors were extracted based on the following three analytical criteria: (1) Pairwise deletion, (2) Eigen value more than 1.0 and (3) factor loading more than 0.50. Items that failed to attain minimum loading of 0.5, or which loaded significantly on more than one factor, were omitted. This resulted in the extraction of 7 factors, explaining 71.305% of the total variance.

This was followed by a scale-reliability test. Each factor was evaluated based on the following three criteria: (1) Cronbach's Alpha coefficient > 0.70 (2) item-total correlation > 0.40, (3) inter-item correlation > 0.30, <0.80. However, these cut-off points are rules of thumb, and no clear consensus with regard to where the cut-off points exist (Hair 1998, Field 2005, Pett, Lackey & Sullivan 2003). Each item's theoretical significance was also taken into account.

Factor correlations analysis was carried out to evaluate the construct validity, which concerns the theoretical relationship between the factors. (Hair 1998, Field 2005). All extracted factors were found to be a valid and reliable representation of the underlying safety culture construct.

Each factor's explained variance, Cronbarch's Alpha value, inter-item range and item total range are presented in Table 1. Extracted factor structure, item description and loadings are presented in Table 2. Loadings in bold indicate the factor on to which the item was placed.

Table 1
Factor scale reliability test, number of items and explained variance

Factor ID	N items	Explained variance	Cronbach's Alpha	Inter-item range	Item-total range
F1	4	30.621	.914	.651 - .806	.781 - .821
F2	4	10.102	.825	.453 - .680	.604 - .673
F3	3	7.917	.867	.647 - .710	.731 - .779
F4	3	7.296	.819	.527 - .741	.564 - .733
F5	3	5.612	.790	.440 - .767	.470 - .732
F6	4	5.391	.669	.262 - .405	.410 - .527
F7	2	4.366	.852	.743 - .743	.743 - .743

Table 2
Seven factor rotated solution with factor loadings, and explained variance

	F1	F2	F3	F4	F5	F6	F7
I have received the training that is necessary in order to handle critical or hazardous situations.	**.856**	.165	.111	.163	.053	-.015	-.055
I have received the education that is necessary in order to handle critical or hazardous situations.	**.855**	.152	.117	.168	.078	-.034	-.070
I have received the education that is necessary in order to work safely.	**.849**	.246	.063	.103	.089	-.096	-.031
I have received the training that is necessary in order to work safely.	**.813**	.270	.097	.087	.082	-.102	-.037
We receive sufficient safety-related information when we sign on / start a new sailing period.	.191	**.749**	.137	.153	.042	-.138	-.039
We receive sufficient safety-related information when we start a new watch.	.239	**.746**	.151	.139	.106	-.097	-.016
We solve problems and conflicts in a good manner.	.232	**.745**	.143	.173	.016	-.080	-.098
The working environment on board is characterized by openness and dialog.	.157	**.730**	.124	.087	.091	-.120	-.127
Does your closest superior follow up to ensure that all work on board is done in a safe manner?	.115	.142	**.848**	.193	.105	-.120	-.080
Is your closest superior a good role model when it comes to attending to his own and others' safety?	.093	.212	**.821**	.104	.079	-.139	-.059
Is your closest superior clear in his engagement to ensuring his co-workers' safety?	.141	.163	**.817**	.182	.072	-.140	-.076
Do you carry out a "Safe Job Analysis"/"Risk Analysis" before high-risk operations?	.130	.131	.136	**.871**	.048	-.063	-.075
Do you carry out a safety evaluation before new working methods, tools, or routines are introduced?	.185	.151	.169	**.840**	.115	-.108	-.036
Do you have the possibility to prioritize safety first in your daily work?	.190	.288	.202	**.622**	.112	-.051	-.101
Do you receive constructive feedback from the company on the conditions you report?	.087	.063	.103	.029	**.883**	-.089	-.041
Do you receive constructive feedback from the captain on the conditions you report?	.078	.041	.152	.056	**.875**	-.022	-.077
Do you get information from incidents/accidents on other vessels?	.066	.089	-.020	.120	**.684**	-.101	-.022
In my company, they are more preoccupied with the statistics than the human consequences of an incident.	-.089	-.021	-.098	-.030	-.154	**.784**	.091
Reporting in itself take too much time.	-.115	-.078	-.059	-.177	.031	**.709**	.029
I experience that safety work is more a facade than a real priority area.	.070	-.104	-.063	.024	-.110	**.606**	.222
When an undesirable incident has occurred,	-.085	-.249	-.204	-.027	-.016	**.560**	.193

people are more preoccupied with placing blame than finding the cause of the incident.							
Due to the captain's demand for efficiency we sometimes have to violate procedures.	-.093	-.134	-.130	-.039	-.091	.228	**.878**
Due to the company's demand for efficiency we sometimes have to violate procedures.	-.066	-.093	-.059	-.146	-.052	.253	**.865**

The 7 extracted factors in Table 2, representing the on board safety culture, were labelled as followed *(label in italic)*:

Factor 1; *competence,* reflecting the crews' perception of their own training and education, in order to work safely and handle critical and hazardous situations.

Factor 2; *interpersonal*, reflecting the relationship amongst the crew, problem solving abilities, form of communication and sharing of safety information.

Factor 3; *management*, reflecting the crews' perception of their closest manager as a role model, engagement and interest in ensuring safety in work operations.

Factor 4; *work practices*, reflecting performance of proactive activities as safe job analysis and hazard identification, and how safety is prioritised in daily operations.

Factor 5; *feedback*, reflecting feedback given to crew on reported safety information, and experience reports from other vessels.

Factor 6; s*hore orientation*, reflecting the shore-side part of organisations' attitude towards and prioritising of safety.

Factor 7; *efficiency*, reflecting the relationship between perceived demand for efficiency and safe working practices.

3.3 Ordered logistic regression

The dependent variable "reporting frequency" has an ordinal nature, with 4 possible outcomes (1=never/seldom, 2=sometimes, 3=often and, 4=always). It is possible to handle such data in a number of ways. Ordinary least squares is seldom appropriate for such data since it requires a continuous dependant variable. To convert our dependant variable to a continuous variable would require an assumption about the distance between each of the categories. Rather than impose such an assumption, we choose an alternative technique: the ordered logistic regression model.

The ordered logit regression model can be seen as an extension of standard logistic regression. Standard logistic regression utilises a dichotomous dependant variable. For a polytomous variable, this can be extended to a multinomial logit model. However, this neglects the fact that the variables are ordinal, and assumes that they are simply nominal. The ordinal logistic regression model utilises this important information. In the model, m-1 equation are simultaneously estimated, where m is the number of categories of the dependant variable. The equations are formed by pooling the data i.e. category 1 versus categories 2,3 and 4, categories 1 and 2 versus categories 3 and 4 and then categories 1, 2 and 3 versus category 4.

The assumption made is that the effect of the independent variables on the dependant variable is independent of the category. This assumption may be referred to

as the proportional-odds assumption or the parallel regressions assumption. Like any assumption, it is not always met in practice. It can be tested by estimating a generalised ordered logit regression (which does not impose coefficient equality across the equations) and comparing it to the ordered logit regression using a likelihood ration test. We performed this test and obtained a p-value of 0.036. This indicates that at the 5% level of significance, the assumption of parallel regressions is not met.

There are a number of options available at this stage. We can assume that the failure of the assumption is due to sampling variability and proceed with the standard logistic regression. We could also move to a multinomial logit and disregard the ordinal nature of the data. However, more insight can be gained by proceeding with the generalised logistic regression. This model allows the parameter estimates to vary by category. However, it may be the case that the parallel regression assumption is violated only with some of the included regressors. It is possible to test for this by imposing equality restrictions across equations on parameter estimates and testing the validity of these constraints using a Wald test. If there are good reasons, *a priori*, to select such constraints then these can be tested. Otherwise, a stepwise regression approach can be used to test which variables violate the assumption. In our case, there was no reason to suspect that some variables were more likely than others to violate the assumption. For this reason, we chose the stepwise approach. The resulting model is far more parsimonious than the unconstrained generalised logistic regression. The results are presented in Table 3.

Table 4
Results from the constrained generalised ordered logistic regression analysis with factor scores (FAC). Odds ratios are presented.

Beta	**Odds Ratio**	**Std. Err.**	**z**	**P>|z|**
FAC1 Competence	1.4949	0.1387	4.33	0.0000
FAC2 Interpersonal	1.1971	0.1095	1.97	0.0490
FAC3 Management	1.5573	0.1489	4.63	0.0000
FAC4 Work practices	1.3319	0.1262	3.02	0.0020
FAC5 Feedback	1.8090	0.2943	3.64	0.0000
FAC6 Shore orientation	0.6094	0.0594	-5.08	0.0000
FAC7 Efficiency	0.7581	0.0942	-2.94	0.0030
Vessel (Tank=1)	0.5328	0.3104	-2.03	0.0430
Management (exp. > 1 year = 1)	2.9817	0.3215	3.40	0.0010
Deviations from Proportionality 2				
FAC5 Feedback	1.4424	0.1578	2.32	0.0200
Vessel (Tank=1)	0.8117	0.2967	-0.70	0.4820
Management (exp. > 1 year = 1)	0.9719	0.3092	-0.09	0.9260
Deviations from Proportionality 3				
FAC5 Feedback	1.6840	0.2202	2.37	0.0180
Vessel (Tank=1)	1.6483	0.3701	1.35	0.1770
Management (exp. > 1 year = 1)	0.4595	0.3915	-1.99	0.0470
Constants				
CONS1	1.6840	0.2792	6.05	0.0000

CONS2	1.6483	0.2153	0.89	0.3750
CONS3	0.4595	0.2634	-6.54	0.0000
n = 473				
$\ell = -526.055$				
Pseudo R^2 = 0.1561				
Wald$\sim\chi^2(15)$ =154.99			p-value=0.0000	

The results are presented as a set of 'base' coefficients and then deviations from proportionality. These deviations are calculated by taking the ratio of coefficients between equations (since the model is presented using odds ratios). For example, the parameters given under the heading "Deviations from Proportionality 2" are obtained by dividing equation 1 by equation 2. So, for example, the odds ratio for category 3 for the variable 'Vessel' can be calculated as 1.6483*0.5328=0.8782. Parameters which are constrained to be equal across equations are not shown.

The results from the model are in line with expectations. The odds ratios are in the expected order of magnitude and are jointly significant. The factors competence, interpersonal, management, work practices and feedbacks all increase the odds of being in a higher category of the reporting frequency measure. The two factors reflecting shore orientation and efficiency significantly decrease the odds of being in a higher category of the reporting frequency measure. Crews on tanker vessels are more likely to have a lower reporting frequency than those on bulk vessels. Crews who have been working with their closest manager for more than one year tend to report more often.

The three variables which did not meet the parallel regressions assumption were FAC5 Feedback, Vessel and Management. This means that the effect of these variables is dependent on the category of the dependant variable.

3.4 Validity and limitations

There is a possibility that some of the relationships reported in this section are subject to the common method bias (Campell and Fiske, 1959). This results from the fact that the data come from a common source. For example, a common scale to the different questions. Potential statistical remedies have been suggested. Spector (2006) is sceptical of the merits of such approaches. He argues that given that it is not possible to know the existence or extent of any possible bias, treating it could in fact introduce more bias than existed in the first instance. He recommends using a multi-method strategy so that results do not only rely on the results of one questionnaire. In this research, case studies, interviews, participatory and field studies have been used to validate the data. The results have also been presented to people working within the industry who have expressed that they believe the results to give an accurate representation of the true situation.

4 Discussion

The results suggest that there is a positive association between the respondent's perception of their local manager's leadership skills and reporting frequency (p>0.001, odds ratio=1.5573). A leadership style where the manager is perceived as a good role model ensures and follows up that all work on board is done in a safe

manner, were positively related to increased reporting frequency. This relationship is also supported by other research. Perception of management, as management/leadership style, commitment and visibility, is the most commonly measured dimension in safety research in general (Flin et al. 2000). Within the maritime sector, research initiated by the Maritime and Coastguard Agency in the United Kingdom, identified various core leadership qualities as being necessary for effective safety leadership (Maritime and Coastguard Agency 2004). Shipboard, it was found that these qualities were primarily geared towards the captain as a key leader for safety, however also for lower ranks with leadership responsibilities. However, perceived gaps between desirable leadership qualities and what is currently being exhibited were also identified. With reference to the explosion and sinking of the chemical tanker "Bow Mariner" (United States Coast Guard 2005), poor leadership skills were on the agenda of the IMO (International Maritime Organization 31 October 2007).

The results also suggest increased reporting frequency for those who have worked with their closest superior/manager for one year or more. This "leadership-familiarity" variable did not meet the parallel assumptions, and thus it is indicated that the effect is dependent on the category. Apparently the effect of being familiar with your superior is larger when moving from the category "never or seldom" to "sometimes" report ($P>0.001$, odds ratio=2.9817), and the effect decrease slightly when moving to the higher categories of "sometimes" to "often", and "often" to "always". Leadership and management do have various facets, and may be seen as being both social and cognitive in nature. Social skills include things such as team building, consideration of others, conflict resolution etc. We would suggest that such social skills are of particular importance within this maritime setting. Work at sea may be characterized as a total institution, as defined by (Goffman 1968), where both work and leisure time happen at the same time, with few and limited possibilities to interact with the surrounding world. In such settings, leadership and management style influences work and social life in a more all-embracing manner, including the interpersonal relationship among crew members. Although the research regarding managements importance for safety within the off-shore shipping industry is scarce, research from other industries has established a relationship between management, leadership and safety related matters (Geldart et al. 2010, Wu, Chen & Li 2008, Vredenburgh 2002, Zohar 1980), thus management does not only have a direct effect upon safety and reporting practices, but also an indirect effect by influencing the other factors in the model, further discussed below.

The results also indicate that the interpersonal relationship among the crew influences reporting practices (odds ratio: 1.1971, $P> 0.0490$). With regard to reporting practices, interpersonal relationships relate to, inter alia, the degree of trust and open communication amongst the crewmembers. Reason (2001) regards a trusting relationship as a key factor in getting individuals to report their own mistakes and experiences. Interpersonal relationships amongst crew, in practice, also reflects to which degree the crew shares safety related information when changing shifts, and more informal processes of sharing safety related information during operations. For both subordinated and superior and managerial positions, additional challenges may arise in relation to multinational-crew and unstable crewing with low stability within teams. When signing on a new ship, new crew will be unfamiliar with the ship management's and closest superior's management style as well as fellow crewmembers and the on-board working climate. The seafarers require time to familiarize and adjust to the new situation. For instance, if the ship management on

the seafarers' previous vessel were blame oriented, this seafarer will most likely sign join the new vessel with this latest experience in mind, and be cautious about reporting their own mistakes for fear of being blamed or sanctioned. In time, the seafarer will learn how the management is oriented on that particular vessel. The problem is even more pronounced when the seafarer is constantly changing vessel, with new management each sailing period, and thus has to go through this familiarization process each time. The management style is known to vary within the sector, and poor shipboard management and leadership is identified in other research (Oltedal, Engen 2009, Knudsen 2003).

The results indicate a positive relationship between competence and reporting frequency (odds ratio: 1.4949, P> 0.0000). Competence is among the top five most commonly measured themes within safety research (Flin et al. 2000), and refers to the perception of own skills and ability to handle critical and hazardous situations, and their ability to perform their work in a safe manner. In our analysis, competence is comprised of two sub facets, formal education and training. Minimum training requirements are covered by international conventions and regulations developed by the IMO, where parts are required to be performed on-board. For example, it is required that every crew member participates in at least one abandon ship and one fire drill every month. Also that these drills, as far as practicable, be conducted as if there were an actual emergency (International Convention for the Safety of Life at Sea (1974), International Maritime Organization 2009). On-board, the captain and ship management are ultimately responsible for how such drills, and other on-board training arrangements, are carried out. Experience from the field shows that in this area there are large variations. On some vessels, if performed, the drills are arranged as mustering, while others are arranged for realism. Variation in on-board training efficiency may be a result of various situations such as a lack of time due to demand for efficiency. The results indicate a negative relationship between demand for efficiency and reporting practices (odds ratio: 0.7581, P> 0.0030). Demand for efficiency, caused by inter alia commercial pressure, has been one of the most frequent reasons for violations of procedures and checklists (Oltedal 2010), as well as an important influencing factor for collisions and groundings (MacRae 2009).

However, with regard to competence, we suggest that one significant cause could be that the minimum requirements for leadership and managerial skills stated in the international conventions and regulations are inadequate (also noted by IMO in (International Maritime Organization 31 October 2007)). It is therefore up to each maritime educational establishment to decide to what degree managerial and leadership should be covered, or to each shipping company with regard to the provision of further education. Insufficient managerial and leadership skills could also result in time pressure and demand for efficiency through inadequate planning and resource management.

We also suggest that the same relationships exist with regard to the factor concerning proactive work practices (leadership, managerial skills, time available and competence interrelationship). Work practices refers to the degree to which the crew perform proactive activities like safe job analyses and safety analysis before risk activities, and to which degree they have the opportunity to prioritize safety in their daily work. Such activities increase the chances of revealing potentially dangerous situations, and thus increases the amount of reportable safety information (Kjellén 2000)

The results indicate that proactive work practices have a positive relationship with reporting frequency (odds ratio: 1.3319, P> 0.0020).

Feedback on reported events is held to stimulate organizational learning, and thus better premises for safety improvements, by, inter alia, sharing of experience of near misses and incidents, as guidelines for corrective actions as well as being a motivator for increased reporting (Reason 2001). A positive relationship between reporting frequency and feedback is also shown in our data (odds ratio: 1.8090, P> 0.0000). However, the relationship did deviate from proportionality meaning that the effect of feedback is dependent on the category of the dependant variable reporting frequency. Thus, the effect from feedback is larger when moving between the higher categories "sometimes" to "often", and "often" to "always", than when mowing between the lower categories "never or seldom" to "sometimes" Treatment of non-conformance and development or remedial actions is normally done by shore personnel. To what degree seafaring personnel are involved in these processes varies within companies. Shipboard feedback is given by the captain and/or shipboard management, who in turn receive the information from the shore side of the company. Thus the quality of feedback given is not only dependent upon theship management, but also the shore side's orientation towards safety. This relationship between shipboard reporting practices and shore-side safety orientation is also indicated by the results (odds ratio: 0.6094, P> 0.0000). When the shore side's safety effort is perceived as a facade and person orientated, it is reflected in lower reporting frequency.

Finally, it is indicated that the reporting frequency is lower on dry cargo vessels than on tanker vessels. The relationship deviates from proportionality, meaning that the effect of type of vessel is larger when moving between the higher categories "often" to "always", than when mowing between the lower categories "never or seldom" to "sometimes". Differences between the liquid and dry cargo sector are further discussed in Oltedal and Engen (2010).

5 Conclusion, limitations and suggestions for future research

This article has studied the factors which influence the frequency of reporting of experience data such as data on accidents/incidents. The previous research outlined in the paper has shown that underreporting is a significant problem within the merchant shipping industry. Underreporting undermines the foundations on which any safety management system is constructed. If accidents/incidents are not reported then past mistakes cannot be learned from and the probability of future accidents/incidents cannot be reduced. In particular, the analysis presented in this paper is important since it not only identifies the significance of potentially influential factors, but also quantifies the relative strength of these factors. This allows a better targeting of budgetary resources to improve safety.

In particular,the objective of this article was to assess the relationship between reporting practices and dimensions of safety culture, management and vessel in the Norwegian controlled shipping industry. The results indicated that high competence, a good and open interpersonal relationship among the crew, a safety oriented management, execution of proactive work practices and feedback upon reported events all increase reporting frequency. The two dimensions reflecting when shore orientation downgrade safety and when efficiency is given importance decreases reporting frequency. The three variables which did not meet the parallel regressions

assumption were FAC5 Feedback, Vessel and Management. This means that the effect of these variables is dependent on the category of the dependant variable. Crews who have been working with their closest manager for more than one year tend to report more often.

However, none of the identified factors should be addressed in isolation from each other. As the discussion made clear, they are all important and mutually dependent. It would therefore be of further interest to explore the internal relationships between the identified dimensions of safety culture, for example with structural equation modelling and/or path-analysis.

The data are representative of vessels flying a white and grey flag only, as those registered under a black listed flag did not want to participate. As participation was voluntary on the behalf of the company, we assume that those participating do, in general, emphasise safety in their operations, and the development of a sound reporting culture. However, it would be of further interest to address potential differences between flag of registration and safety.

It would also be of interest to further explore the difference with regard to type of vessel. The differences in reporting frequency could be a result of other variables related to type of vessel, as for example customer specific

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Article 6

Oltedal, H. A., & Engen, O. A. (2010). Safety Management in Shipping—Making Sense of limited Success. *Safety Science Monitor*, submitted.

Appendix 1: Survey questionnaire and letter of introduction

Dear crew member

In this survey I want to assess how safety is handled on Norwegian-controlled bulk cargo and tanker vessels and how the crew onboard perceive safety. This is part of my PhD work, which is aimed at improving our understanding of how various safety-related circumstances work in practice. The results of the survey will help your shipping company make safety-related decisions, enabling your safety to be better ensured.

All information that is obtained through the survey is **anonymous**. It will not be possible to trace any answers to individuals, shipping companies or vessels. My research has been financed by Stord/Haugesund University College and I am therefore acting independently of all shipping companies, public authorities and other organisations and interests. As a PhD student and researcher, my work will be carried out in line with Norwegian guidelines for research ethics, which among other things protect your right to be anonymous. Only I will handle the completed forms or have other access to the data.

To optimise the quality of the survey, it is important that as many people as possible complete the form. It will take about 30 minutes to complete the form. It is also important that the questions are answered as frankly as possible. When you have completed the form, place it in the enclosed envelope, seal the envelope and deliver it directly to the vessel's safety delegate or the chosen contact person onboard for this survey.

- As regards the answering of the questions on the form itself, please relate your answers to the circumstances onboard this particular vessel.
- As regards comments concerning questions and suggestions for improvements, you can relate these to the experience you have of the sector in general.

This type of survey is very common in Norway. Both Norwegian companies and authorities want the safety of employees to be given the highest priority. From similar surveys we have learned that safety-related matters often do not function as intended, and that the reason can be traced back to weaknesses linked to the company's management or other organisational factors. Some of the questions may be difficult to answer, but the aim is not to place the blame on individuals. We know for example that procedures can be broken without the blame resting on the individual who breaks the procedure but on other levels within an organisation. In such cases I want to identify the organisational reasons for breakdowns in procedure. Possible reasons here include insufficient involvement in the development of procedures, the existence of too many procedures or the adoption of dangerous procedures.

Participation in and completion of the questionnaire is voluntary. If you choose not to take part in the survey, please fill in the enclosed green sheet and return it in the same way as the questionnaire.

If you have any questions concerning the survey, you can contact me, Helle Oltedal, on telephone no. (+47) 93 82 61 87 or (+47) 52 70 26 44.

Thank you for taking the time to fill in the questionnaire!

Yours sincerely,
Helle Oltedal,
Stord/Haugesund University College

Safety Culture Survey

Please indicate your answer by crossing off a box for each question like this: ☒. Mark wrong answers like this: ■ Where it is not possible to select an answer, please provide an alternative in the space provided for **other** or **fill inn.**

PLEASE WRITE ALL COMMENTS OR SUGGESTIONS IN ENGLISH

1. Background Information

A Gender: Female ☐1 Male ☐2

B Job position/title: Captain ☐1 Mate ☐2 Engineer ☐3 AB /Seaman ☐4 Electrician ☐5 Catering ☐6 Apprentice ☐7 Other (**Fill in**):_____

C Vessel class/cargo: Bulk ☐1 Combined ☐2 Shuttle tanker ☐3 Gas ☐4 General Cargo ☐5 Chemical ☐6 Oiltanker ☐7 Other (**Fill in**)_____

D Age: Under 31 years ☐1 31-40 years ☐2 41-50 years ☐3 51-60 years ☐4 Over 60 years ☐5

E Nationality: Norwegian ☐1 Polish ☐2 Filipino ☐3 Other (**Fill in**):_____

F How long have you been working within shipping? 0-2 year(s) ☐1 3-5 years ☐2 6-10 years ☐3 11-20 years ☐4 Over 20 years ☐5

G How long have you been working for this shipping company? **Fill in:**_____

H All in all, how long have you been working at this vessel? **Fill in:**_____

I Which kind of employment contract do you have?

Permanent employee ☐1

9 months duration ☐2

6 months duration ☐3

3 months duration ☐4

Other (Fill in):

J How long is your ordinary work /sailing schedule at the ship? *(for contract workers this will often be the same as the contract duration)* **(Fill in)**_____

K How long do you usually stay at home or on shore between each work / sailing period? **(Fill in)**_____

L Do you normally work at the same vessel at every work / sailing period?

Very seldom /never ☐1

Sometime ☐2

Very often / always ☐3

M How is your ordinary watch system, without overtime? *(for example Dayman, or 4-8-4 meaning 4 hours work – 8 hours off – 4 hours work)* **(Fill in)**_____

2. Top Management's Safety Priorities

	Only select one answer per question	Strongly disagree	Disagree	Not sure	Agree	Strongly agree	Don't know
A	The on-shore top management in my company prioritizes safety before economy.	☐1	☐2	☐3	☐4	☐5	☐6
B	I experience conflicting requirements from my company and the captain.	☐1	☐2	☐3	☐4	☐5	☐6
C	I experience that safety work is more a facade than a real priority area.	☐1	☐2	☐3	☐4	☐5	☐6
D	I am familiar with the company's safety goal.	☐1	☐2	☐3	☐4	☐5	☐6

Comments and suggestions:

3. Local Management

Please state your evaluation of your <u>closest</u> superior's attitude toward safety. If you are the captain, relate the questions to the closest on-shore manager.

A All in all, for how long have you been working with your closest superior?(Fill inn) _____

	Only select one answer per question	Very seldom /never	Seldom	Sometime	Often	Very often /always	Don't know
B	Is your closest superior clear in his engagement to ensuring his co-workers' safety?	☐1	☐2	☐3	☐4	☐5	☐6
C	Does your closest superior follow up to ensure that all work on board is done in a safe manner?	☐1	☐2	☐3	☐4	☐5	☐6
D	Is your closest superior a good role model when it comes to attending to his own and others' safety?	☐1	☐2	☐3	☐4	☐5	☐6
		Once a week	**Twice a month**	**Once a month**	**Once every 2nd month**	**Once every 6 moths**	**More seldom**
E	How often do you participate in meetings with your closest superior where safety is a topic?	☐1	☐2	☐3	☐4	☐5	☐6
		Strongly disagree	**Disagree**	**Not sure**	**Agree**	**Strongly agree**	**Don't know**
F	My closest superior appreciates that the crew is willing to discuss safety-related conditions.	☐1	☐2	☐3	☐4	☐5	☐6
G	My closest superior is not afraid of admitting his own mistakes.	☐1	☐2	☐3	☐4	☐5	☐6
H	My closest superior has too little confidence in his co-workers.	☐1	☐2	☐3	☐4	☐5	☐6
I	My closest superior is supportive if safety is prioritized in all situations	☐1	☐2	☐3	☐4	☐5	☐6

Comments and suggestions:

4 Procedures and Guidelines

Only select one answer per question	Strongly disagree	Disagree	Not sure	Agree	Strongly agree	Don't know
A Due to the company's demand for efficiency we sometimes have to violate procedures.	☐1	☐2	☐3	☐4	☐5	☐6
B Due to the captain's demand for efficiency we sometimes have to violate procedures.	☐1	☐2	☐3	☐4	☐5	☐6
C I have received good training in the company's procedures.	☐1	☐2	☐3	☐4	☐5	☐6
D I feel that it is difficult to know which procedures are applicable.	☐1	☐2	☐3	☐4	☐5	☐6
E The procedures are helpful in my work.	☐1	☐2	☐3	☐4	☐5	☐6
F The procedures are difficult to understand or are poorly written.	☐1	☐2	☐3	☐4	☐5	☐6
G We have the opportunity to influence and form the procedures.	☐1	☐2	☐3	☐4	☐5	☐6

If you don't follow the procedures in a specific situation, what may be the reason? ***Please don't mark more than three options.***

A The work will be done faster.	☐1
B The rest of the crew does it.	☐2
C I feel pressured because I am overloaded with work.	☐3
D It improves the quality of my work.	☐4
E I am not familiar with the applicable procedures.	☐5
F The procedures do not work as intended.	☐6
G There are too many procedures.	☐7
H Others **(please specify):**	

Comments and suggestions:

5. Interaction

In relation to following questions <u>safety</u> will be any issue or condition that you feel may threaten or cause any injury or damage to yourself, your co-workers or the vessel.

Only select one answer per question	Very seldom /never	Seldom	Sometime	Often	Very often /always	Don't know
A Do you normally work with the same team members within your working area / working group?	☐1	☐2	☐3	☐4	☐5	☐6
B Do you discuss safety issues with your co-workers?	☐1	☐2	☐3	☐4	☐5	☐6
C Do you ever feel forced to continue your work even if safety may be threatened?	☐1	☐2	☐3	☐4	☐5	☐6

Only select one answer per question	Very seldom /never	Seldom	Sometime	Often	Very often /always	Don't know
D Does the crew get positive feedback when they raise safety issues?	☐1	☐2	☐3	☐4	☐5	☐6
E Can you tell the captain to "stop"/"time out" if you feel that safety is threatened?	☐1	☐2	☐3	☐4	☐5	☐6
F Can you say "stop"/"time out" to the company if you feel that safety is threatened?	☐1	☐2	☐3	☐4	☐5	☐6
	Strongly disagree	**Disagree**	**Not sure**	**Agree**	**Strongly agree**	**Don't know**
G The working environment on board is characterized by openness and dialog.	☐1	☐2	☐3	☐4	☐5	☐6
H We solve problems and conflicts in a good manner.	☐1	☐2	☐3	☐4	☐5	☐6
I We receive sufficient safety-related information when we start a new watch.	☐1	☐2	☐3	☐4	☐5	☐6
J We receive sufficient safety-related information when we sign on / start a new sailing period.	☐1	☐2	☐3	☐4	☐5	☐6
K I am confident that my company always prioritizes the crew's safety.	☐1	☐2	☐3	☐4	☐5	☐6
L I am confident that the captain always prioritizes the crew's safety.	☐1	☐2	☐3	☐4	☐5	☐6
M If I ask for help I will appear incompetent.	☐1	☐2	☐3	☐4	☐5	☐6
N We usually speak up to a co-worker if we notice that he is doing his work in a risky manner.	☐1	☐2	☐3	☐4	☐5	☐6
O We usually speak up to the ship management if we notice that a co-worker is doing his work in a risky manner.	☐1	☐2	☐3	☐4	☐5	☐6
P I stop work if I am not sure that safety is satisfactorily ensured.	☐1	☐2	☐3	☐4	☐5	☐6
Q I feel appreciated by my co-workers.	☐1	☐2	☐3	☐4	☐5	☐6
R I feel appreciated by the ship management.	☐1	☐2	☐3	☐4	☐5	☐6
S My co-workers do their jobs in a way that makes me feel safe.	☐1	☐2	☐3	☐4	☐5	☐6
T My co-workers can communicate effectively in English.	☐1	☐2	☐3	☐4	☐5	☐6
U Different languages on board may represent a safety risk.	☐1	☐2	☐3	☐4	☐5	☐6
V Different national cultures on board may represent a safety risk.	☐1	☐2	☐3	☐4	☐5	☐6

Comments and suggestions:

6. Work Situation

Only select one answer per question	Very seldom /never	Seldom	Sometime	Often	Very often /always	Don't know
A Do you have the possibility to prioritize safety <u>first</u> in your daily work?	☐1	☐2	☐3	☐4	☐5	☐6
B Do you carry out a "Safe Job Analysis"/"Risk Analysis" before high-risk operations?	☐1	☐2	☐3	☐4	☐5	☐6
C Do you carry out a safety evaluation before new working methods, tools, or routines are introduced?	☐1	☐2	☐3	☐4	☐5	☐6
D Have you experienced situations where you need to expose your self to danger to get the work done?	☐1	☐2	☐3	☐4	☐5	☐6
E Do you take a "time-out" when unforeseen situations occur?	☐1	☐2	☐3	☐4	☐5	☐6
F Do you use protective equipment in situations when it is mandatory?	☐1	☐2	☐3	☐4	☐5	☐6
G Do you feel sufficiently rested to carry out your tasks in a safe manner on your shift?	☐1	☐2	☐3	☐4	☐5	☐6
H Is the safety documentation you need readily available?	☐1	☐2	☐3	☐4	☐5	☐6
I Is the safety documentation you need up to date?	☐1	☐2	☐3	☐4	☐5	☐6
J Is anyone ever intoxicated/drunk on board?	☐1	☐2	☐3	☐4	☐5	☐6
	Strongly disagree	**Disagree**	**Not sure**	**Agree**	**Strongly agree**	**Don't know**
K The number of crewmembers is <u>not</u> sufficient to ensure safety on board.	☐1	☐2	☐3	☐4	☐5	☐6
L The management doesn't care how we do our work as long as the work gets done.	☐1	☐2	☐3	☐4	☐5	☐6
M I miss feedback on the work I do.	☐1	☐2	☐3	☐4	☐5	☐6
N The on-board maintenance is sufficient to ensure safety.	☐1	☐2	☐3	☐4	☐5	☐6
O I am familiar with the on-board safety goals.	☐1	☐2	☐3	☐4	☐5	☐6
P I have to work much overtime to get the work done	☐1	☐2	☐3	☐4	☐5	☐6

Comments and suggestions:

7. Competence

Only select one answer per question	Strongly disagree	Disagree	Not sure	Agree	Strongly agree	Don't know
A I have received the **training** that is necessary in order to work safely.	☐1	☐2	☐3	☐4	☐5	☐6
B I have received the **education** that is necessary in order to work safely.	☐1	☐2	☐3	☐4	☐5	☐6
C I have received the **training** that is necessary in order to handle critical or hazardous situations.	☐1	☐2	☐3	☐4	☐5	☐6
D I have received the **education** that is necessary in order to handle critical or hazardous situations.	☐1	☐2	☐3	☐4	☐5	☐6
E New crew members get a thorough introduction to safety-related issues.	☐1	☐2	☐3	☐4	☐5	☐6
F On our vessel we frequently carry out drills in safety procedures.	☐1	☐2	☐3	☐4	☐5	☐6
G What we learn in courses is not relevant in practice.	☐1	☐2	☐3	☐4	☐5	☐6
H Some of my co-workers lack experience.	☐1	☐2	☐3	☐4	☐5	☐6

Comments and suggestions:

8. Responsibility & Sanctions

Only select one answer per question	Strongly disagree	Disagree	Not sure	Agree	Strongly agree	Don't know
A In my day-to-day work there is no doubt about who is responsible for the different tasks.	☐1	☐2	☐3	☐4	☐5	☐6
B When an undesirable incident has occurred, people are more preoccupied with placing blame than finding the cause of the incident.	☐1	☐2	☐3	☐4	☐5	☐6
C If I violate the safety regulations, there will be negative consequences for me.	☐1	☐2	☐3	☐4	☐5	☐6
D Vague responsibilities on board contribute toward creating hazardous situations.	☐1	☐2	☐3	☐4	☐5	☐6
E In my opinion, the consequences for violating the company's safety regulations are fair.	☐1	☐2	☐3	☐4	☐5	☐6
F Responsibility for the safety of others is a motivational factor in the performance of my work.	☐1	☐2	☐3	☐4	☐5	☐6
G I know which tasks I am responsible for if a critical or hazardous situation should occur.	☐1	☐2	☐3	☐4	☐5	☐6

Comments and suggestions:

9. Working Environment

Only select one answer per question	Strongly disagree	Disagree	Not sure	Agree	Strongly agree	Don't know
A I enjoy my job.	☐1	☐2	☐3	☐4	☐5	☐6
B I feel sure that I will not loose my job.	☐1	☐2	☐3	☐4	☐5	☐6
C I feel that the work we do on board is too little appreciated by the company.	☐1	☐2	☐3	☐4	☐5	☐6
D This company is a good employer compared to others.	☐1	☐2	☐3	☐4	☐5	☐6
E I have too little influence on my working situation.	☐1	☐2	☐3	☐4	☐5	☐6
F The working situation is less **physically** challenging than 2 years ago.	☐1	☐2	☐3	☐4	☐5	☐6
G The working situation is less **mentally** challenging than 2 years ago.	☐1	☐2	☐3	☐4	☐5	☐6
H The safety delegates have an important role in ensuring safety at my work site.	☐1	☐2	☐3	☐4	☐5	☐6
I I feel certain that I will not be exposed to an injury/ accident at my work site.	☐1	☐2	☐3	☐4	☐5	☐6

Comments and suggestions:

10. Learning from Incidents

If accidents or severe incidents happen on board, I believe they happen because….
Do not select more than 3 alternatives.

A The crew has a large work load.	☐1
B The crew does not feel enough responsibility for their tasks.	☐2
C The crew lacks knowledge and experience in relation to the job they are doing.	☐3
D There is no tradition for speaking up when someone is working in a hazardous manner.	☐4
E There are too many interruptions in the work.	☐5
F Procedures/best practice is not followed.	☐6
G There are inadequate instructions for using technical equipment.	☐7
H There are mistakes or deficiencies in the procedures.	☐8
I There is bad maintenance.	☐9
J There is defective equipment.	☐10
K Others **(please specify):**	

Comments and suggestions:

Only select one answer per question

A	During the last 2 years, have you been involved in a serious **incident/accident?**	Yes	☐1	No	☐2	
B	During the last 2 years, have any of your co-workers been involved in a serious **incident/accident?**	Yes	☐1	No	☐2	I don't know ☐3

If yes, please comment <u>the last</u> incident / accident that happened:

C	During the last 2 years, have you been involved in what was **almost** a serious incident/accident?	Yes	☐1	No	☐2	
D	During the last 2 years, have any of your co-workers been involved in what was **almost** a serious incident/accident?	Yes	☐1	No	☐2	I don't know ☐3

If yes, please comment <u>the last</u> episode that happened:

	Only select one answer per question	**Very seldom /never**	**Seldom**	**Sometime**	**Often**	**Very often /always**	**Don't know**
E	Do **minor incidents** get reported in writing?	☐1	☐2	☐3	☐4	☐5	☐6
F	Do **close calls** get reported in writing?	☐1	☐2	☐3	☐4	☐5	☐6
G	Are reports of undesirable incidents ever "fixed up" to cover mistakes?	☐1	☐2	☐3	☐4	☐5	☐6
H	Do you receive constructive feedback from the **company** on the conditions you report?	☐1	☐2	☐3	☐4	☐5	☐6
I	Do you receive constructive feedback from the **captain** on the conditions you report?	☐1	☐2	☐3	☐4	☐5	☐6
J	Do you get information from incidents/accidents on other vessels?	☐1	☐2	☐3	☐4	☐5	☐6
		Strongly disagree	**Disagree**	**Not sure**	**Agree**	**Strongly agree**	**Don't know**
K	Here it is seldom improvements are made before something has gone wrong.	☐1	☐2	☐3	☐4	☐5	☐6
L	Reporting is important to prevent the recurrence of accidents or incidents.	☐1	☐2	☐3	☐4	☐5	☐6
M	Most of all, I report incidents because I have to.	☐1	☐2	☐3	☐4	☐5	☐6
N	In my company, they are more preoccupied with the statistics than the human consequences of an incident.	☐1	☐2	☐3	☐4	☐5	☐6
O	Reporting in itself take too much time.	☐1	☐2	☐3	☐4	☐5	☐6

Comments and suggestions:

Assume that you were involved in an incident. Would some of the following conditions stop you from reporting the incident? ***Do not mark more than 3 alternatives.***

A There is no tradition for reporting all incidents that happen.	☐1
B No improvements ever happen based on the reports.	☐2
C The incident didn't have any serious consequences.	☐3
D I am afraid that the information will be used against me.	☐4
E I am afraid that the information will be used again my co-workers.	☐5
F This could cause the company to loose contracts.	☐6
I There could be negative reactions from my co-workers.	☐7
J I don't feel comfortable discussing my actions/mistakes.	☐8
K We have too much to do and don't have time to write reports.	☐9
L Mistakes I make don't concern anyone but me.	☐10
M I don't know how to report an incident.	☐11
N Other **(please specify)**:	

Comments and suggestions:

11. Description of the Organization

How would you describe this organization? Please provide your estimate based on the statements below. ***Select only <u>one box</u> per statement.***

The work is characterized by control in detail and overall control.	☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9 ☐10	The work is characterized by flexibility and democracy/influence.
It is important to do what we are told.	☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9 ☐10	It is important to be creative and original.
The work is usually performed on an individual basis.	☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9 ☐10	The work is usually performed as a team.

12. Risk perception

How would you assess the risk involved with your work? Please provide your estimate based on the statements below. ***Select only <u>one box</u> per statement..***

A) All in all, how would you assess the safety in your working situation?

Very bad ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9 ☐10 Very good

B) All in all, how do feel that the level of safety has developed over the last two years?

It is much poorer ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9 ☐10 It is much better

C) All in all, how likely is it that you will have an accident on the vessel during the next 12 months?

Very likely ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9 ☐10 Very unlikely

D) All in all, how likely is it that any of the other crew members will have an accident on the vessel during the next 12 months?

Very likely ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9 ☐10 Very unlikely

E) How safe do you feel when you consider the risk involved with your work on board?

Very safe ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9 ☐10 Very unsafe

F) How much do you worry when you consider the risk involved with your work on board?

Very much ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9 ☐10 Very little

13. Suggestions for New Safety Actions or Other Comments