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.

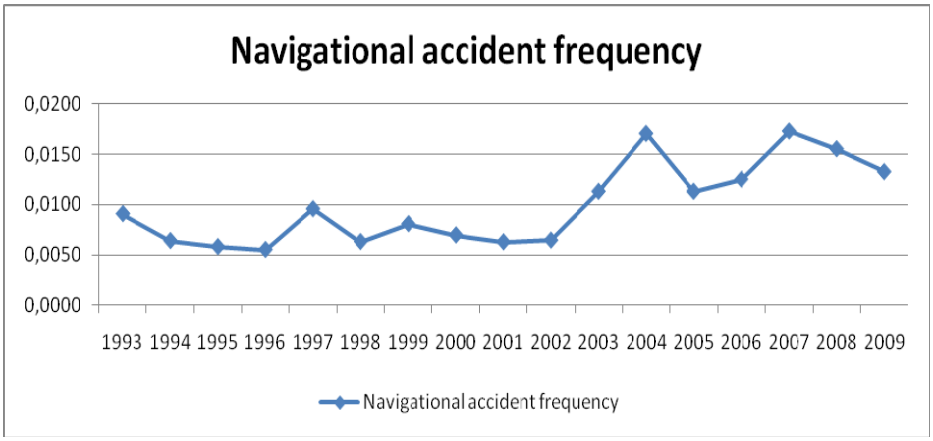

***Figure 1*: Navigational accident frequency in relation to the world fleet size, 1993-2009 (Source: Lloyds' Fairplay, 2010) Fleet size in number of crude oil tankers over 100,000 dwt, chemical tankers over 10,000 dwt, containers over 20,000 dwt, RoRo cargo over 10,000 dwt, bulk over 50,000 dwt.**

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).

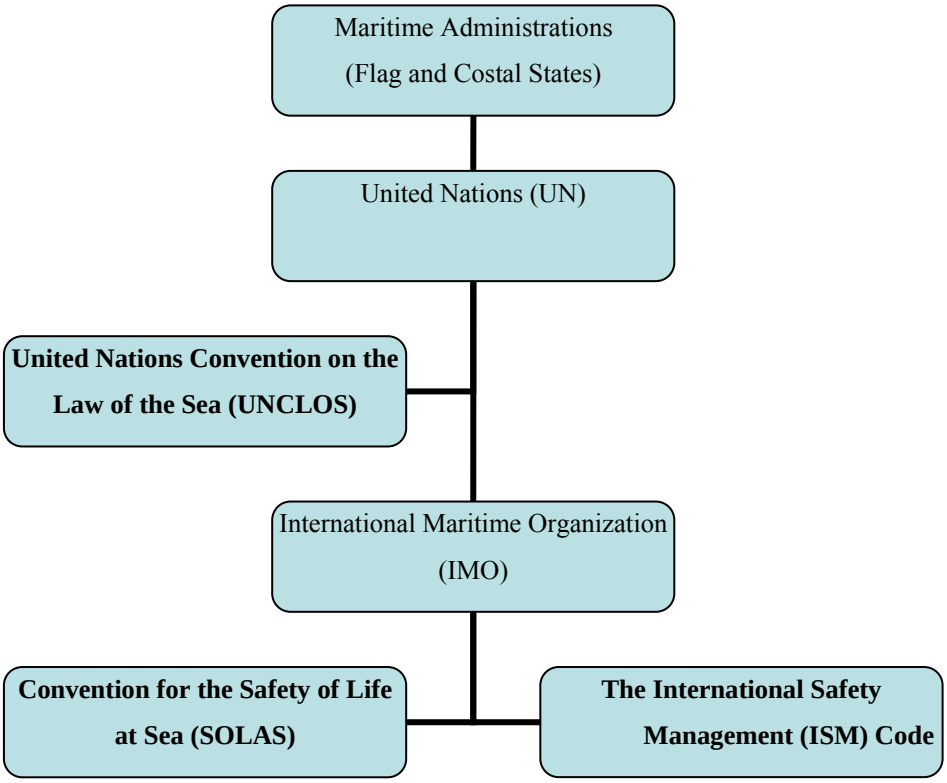

Figure 2: The maritime international regulatory system related to safety management

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.

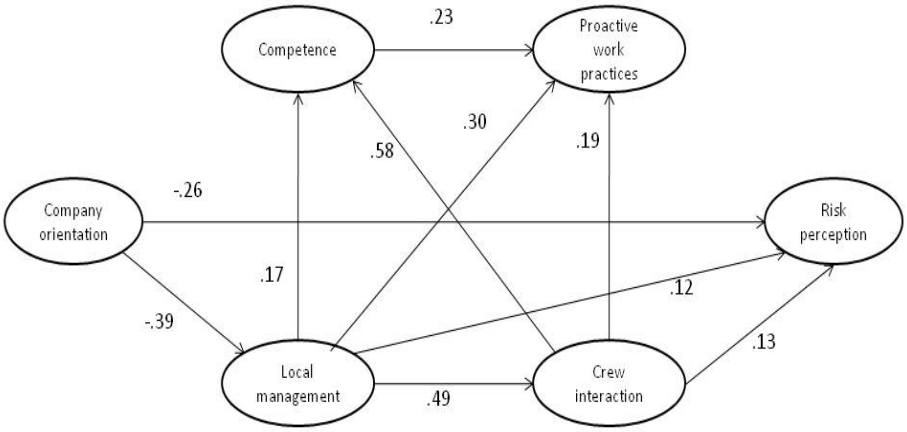

***Figure 4*: Structural model testing for validity of causal structure**

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

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

Article 6

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Article 1

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Article 6

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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