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A study on the effectiveness of the ISM Code on the seafarers' awareness of safety culture

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A STUDY ON THE EFFECTIVENESS OF THE ISM CODE ON THE SEAFARERS' AWARENESS OF SAFETY CULTURE

By

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DISSERTATION DECLARATION FORM

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

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ABSTRACT

Title of Dissertation: A Study on the Effectiveness of the ISM Code on the Seafarers' Awareness of Safety Culture

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The purpose of this dissertation is to explore whether the ISM Code is effective in promoting maritime safety culture. This dissertation measures seafarers' perceptions of safety culture by distinguishing seafarers employed in ocean-going vessels applying the Code from those in domestic vessels not applying the Code. Through a comparison of the level of the consciousness of the two groups of seafarers on safety culture, it is possible to verify the effectiveness of the Code on safety culture. The dissertation assumes that the implementation of the Code impacts positively on safety culture.

To measure seafarers' awareness of safety culture, a questionnaire including 43 items based on seven safety culture indicators was developed through a review of the relevant literature. A survey was conducted of Korean seafarers, and 208 responses were used for analysis.

The result showed that there were significant differences between the perceptions of safety culture between the two groups in organisational commitment, management involvement, reporting system, learning and reward system, and it was confirmed that the consciousness level of seafarers employed on ocean going vessels on these factors was high. Nevertheless, there were no significant differences between the two groups in employee empowerment and communication, so the Code could partly affect safety culture.

In this dissertation, the effectiveness of the ISM Code was verified by quantitative measurement of the perception of safety culture by Korean seafarers. This study is meaningful because it carried out empirical measurement of safety culture and it is expected that it can contribute to the establishment of measures to enhance safety culture.

KEYWORDS: Safety culture, Safety climate, ISM, effectiveness, seafarer

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ABS	American Bureau of Shipping
BBC/HP	Bare boat charter with hire purchase
CANSO	Civil Air Navigation Service Organisation
CASS	Commercial aviation safety survey
DOC	Document of Compliance
DWT	Dead Weight Tonnage
IAEA	International Atomic Energy Agency
ICS	International Chamber of Shipping
IMO	International Maritime Organisation
IMCO	International Maritime Consultative Organisation
ISO 9000	International Organisation for Standardisation
ISM Code	International Safety Management Code
JAIC	Joint Accident Investigation Commission
KMST	Korea Maritime Safety Tribunal
KMO	Kaiser-Meyer-Olkin
KR	Korea Register of Shipping
KTSA	Korea Transportation Safety Authority
MAFRO	Maritime Affairs and Fisheries Regional Offices
MLTM	Ministry of Land, Transport and Maritime Affair
MODU	Mobile offshore drilling units
MOF	Minister of Oceans and Fisheries
NASA	National Aeronautics and Space Administration
NLIC	National Law Information Centre
NTSB	National Transportation Safety Board
QMS	Quality Management System
PSC	Port State Control
RO	Recognised Organisation

SMC	Safety Management Certificate
SMS	Safety Management System
SOLAS	International Convention for the Safety of Life at Sea
VDR	Voyage Data Recorder
VLCC	Very Large Crude Oil Carrier

1. INTRODUCTION

1.1 Background

Since the International Maritime Organisation (IMO), which was formally known as the IMCO, was established in 1948, the IMO and its Member States have been contributing to prevent accidents at sea through developing and improving rules and regulations related not only to hardware such as ships' hull design, stability and equipment but also human resources such as seafarers. Although these efforts have resulted in substantial improvements in the reliability of ships' hardware as well as the quality of crews, maritime incidents are still a major concern for the shipping community (Rothblum, 2000; Ceyhun, 2014).

It has been shown in many studies that more than 80% of maritime accidents are caused by human error, for instance, failure of situational awareness, mistakes, slips and violations of regulations by crews on ships. However, at a deeper level, it can be seen that there are problems with organizational climate and management (KTSA, 2008).

From the late 1980s to the 1990s, major catastrophes occurred at Sea, for instance, the *Herald of Free Enterprise,* a ro-ro passenger ferry, capsized in the Dover Strait with loss of 193 lives in 1987, the *Exxon Valdez*, a very large crude oil tanker, grounded in Alaska in 1989, and another ro-ro passenger ferry*, the Estonia,* sank in the Baltic Sea with loss of 852 lives and only 137 survivors in 1994 (Jung, 2016). Through the analysis of these accidents, it is understood that human error was the direct cause (Lee, 2016). At the same time, it has been found through accident

investigations that deficiencies in safety culture lie in the management of companies' employees and ships' crews (Lappalainen, 2016). These accidents remind the international community of the importance of the human element and the need to promote safety culture to ensure maritime safety.

With the perception of the importance of the safety culture in the maritime sector, the IMO has established measures to promote safety culture on ships. In 1994, the International Safety Management System (ISM) Code was implemented by the International Convention for the Safety of Life at Sea (SOLAS) and was promoted by the IMO with the safety culture on the maritime industries including ships and in ship owners (IMO, 2013; Anderson, 2015). In August 2016, the Secretary-General of IMO deemed that the Code was considered as the measure designed to directly influence maritime safety culture at a conference in Singapore (IMO, 2016).

The IMO set the objective of the ISM Code *"to ensure safety at sea, prevention of human injury or loss of life and avoidance of damage to the marine environment* (IMO, 1993, p.5)*"*. The Code includes provisions for establishing Safety Management System (SMS) to ships and ship owners to prevent human errors by assessing and identifying all risks and managing them.

According to the International Chamber of Shipping (ICS), the safety culture can be described as *"the values and practices that management and personnel share to ensure that risks are always minimized and mitigated to the greatest degree possible.* (ICS, 2013, p.2)" The safety culture makes employees of shipping companies possible to improve their behaviour by allowing them to think and act based on safety and share a value of safety; thereby, it can bring enhancement of safety. Furthermore, the safety culture is essential for ships operation that is constantly exposed to potential risks, and it also an essential virtue required for personnel performing on-board operations and staff working for shipping companies.

The safety culture was considered very important not only in the shipping sector but also in other industries. Prior to the introduction of safety culture in the maritime sector, the term "safety culture" was first used by the International Atomic Energy Agency (IAEA) following the Soviet Chernobyl nuclear accident in 1986. In the aviation field, safety culture has been studied since the NASA Challenger accident in 1986

and the Continental Express Flight 2574 accident in 1991 (von Thaden & Gibbons, 2008). Therefore, several studies have been carried out to assess safety culture, focusing on aviation pilots and traffic management operators.

In order to improve maritime safety, it is necessary to obtain an understanding of the detailed concepts of safety culture and establish a concrete approach to the safety culture. Therefore, a tool to assess the perception of safety culture can be a good measure to understand the characteristics of an organization, and make it possible to find a specific prescription to enhance safety culture.

Seafarers should work based on the perception that safety is the best way to prevent human error. It can be prevented by crews having high alertness about safety and an organizational culture should be promoted. Therefore, assessing seafarers' awareness of safety culture can be a more active measure to prevent accidents on ships. In order to survey the awareness of the safety culture of the seafarers, it is important to apply an adequate tool that can be assessed quantitatively using reasonable indicators, and there are several studies to estimate seafarers' awareness of safety culture.

With regard to the ISM Code, there is a question to whether the application of the Code has improved the awareness of safety culture of ship workers. As the Code has been enforced over the last two decades, many research and studies have evaluated the effectiveness of the ISM code. The IMO has also studied the impact of the ISM Code, which was introduced at eighty-first session of the Maritime Safety Committee (MSC) in 2006 (IMO, 2016). The study (IMO, 2005) found that the Code contributed to the enhancement of safety culture with positive benefits, and one of the recommendations was that further study was needed for the improvement of the Code reflecting safety culture. However, there were some studies relating negative effects of the Code. For instance, Bhattacharya (2012) argued that there were substantial gaps between seafarers' and managers' perception on the Code (Jung, 2016).

In the above previous studies, the perceived effectiveness of the ISM Code was measured by asking respondents' opinions about the implementation of the Code through interviews or questionnaires. However, this study will develop a questionnaire based on indicators for measuring safety culture, and the effectiveness of the Code

will be measured specifically based on the indicators by conducting surveys targeting crews working on the Code applied ships and non-applied ships.

Through this study, it is possible to understand the perception of the safety culture of seafarers, and to measure the level of safety culture on ships that apply and do not apply the ISM Code, so that the effectiveness of the ISM to the safety culture can be estimated. Furthermore, it is possible to compare and analyse its effectiveness based on the safety indicators, and it will be possible to identify the factors that need improvement to enhance the performance of ISM.

1.2 Objectives

This study aims to show a correlation between seafarers' awareness of safety culture and ISM Code. Specifically, it aims to establish whether seafarers who are working on ships applying the ISM Code have a high level of consciousness of safety culture. Furthermore, the effectiveness of the Code in terms of promoting safety culture will be assessed based on indicators. In addition, the perception of the safety culture of seafarers will be compared and analysed based on the indicators by distinguishing crews working on the Code applied and non- the Code applied vessels.

For that purpose, the concept of safety culture will be examined in this study and optimum tool will be developed to assess seafarers' perception of maritime safety culture. Therefore, this dissertation:

- Studies the concept of safety culture by examining past studies in the aviation field and shipping industry.
- Collects safety indicators for the assessment of safety culture based on past similar studies of aviation and the maritime sector.
- Analyses elements of the ISM Code and the safety culture indicators, and develops optimum safety indicators, and develops a questionnaire based on the safety indicators.
- Surveys more than two hundred Korean seafarers who are working on

international and domestic ships using questionnaires. And analyses the results using SPSS.

- Analyses the characteristics of the awareness of Korean seafarers and examines the correlation between ISM and the safety culture.

1.3 The structure of the dissertation

This study consists of seven chapters. Chapter one includes the background, the objectives and the structure of the thesis.

Chapter two will conduct a literature review related to the development of the concept of safety culture and relevant research to assess safety culture in the aviation and maritime fields. Furthermore, studies in terms of the effectiveness of the ISM Code will be reviewed.

Chapter three will examine the background, the role and the function of the ISM Code and elements of the Code. In addition, the implementation of the Code in Korea will be shown.

Chapter four will show the hypothesis and the methodology for this study. As the main hypothesis, the correlation between safety culture and the ISM will be suggested. With this hypothesis, other sub-hypotheses will be added in order to grasp the characteristics of Korean seafarers' perceptions of safety culture. Moreover, the design of the questionnaire will be shown in this chapter.

Chapter five contains an empirical analysis, which describes the characteristics of the data, evaluation of measurement items, and hypothesis testing. The collected questionnaires are analysed by using IBM SPSS Statistic 20, and analysis of frequencies, factors, reliabilities and t-test are conducted in order to enhance the objectivity of the research.

Chapter six will provide the discussion of findings, conclusion, and limitation of the study and future topics.

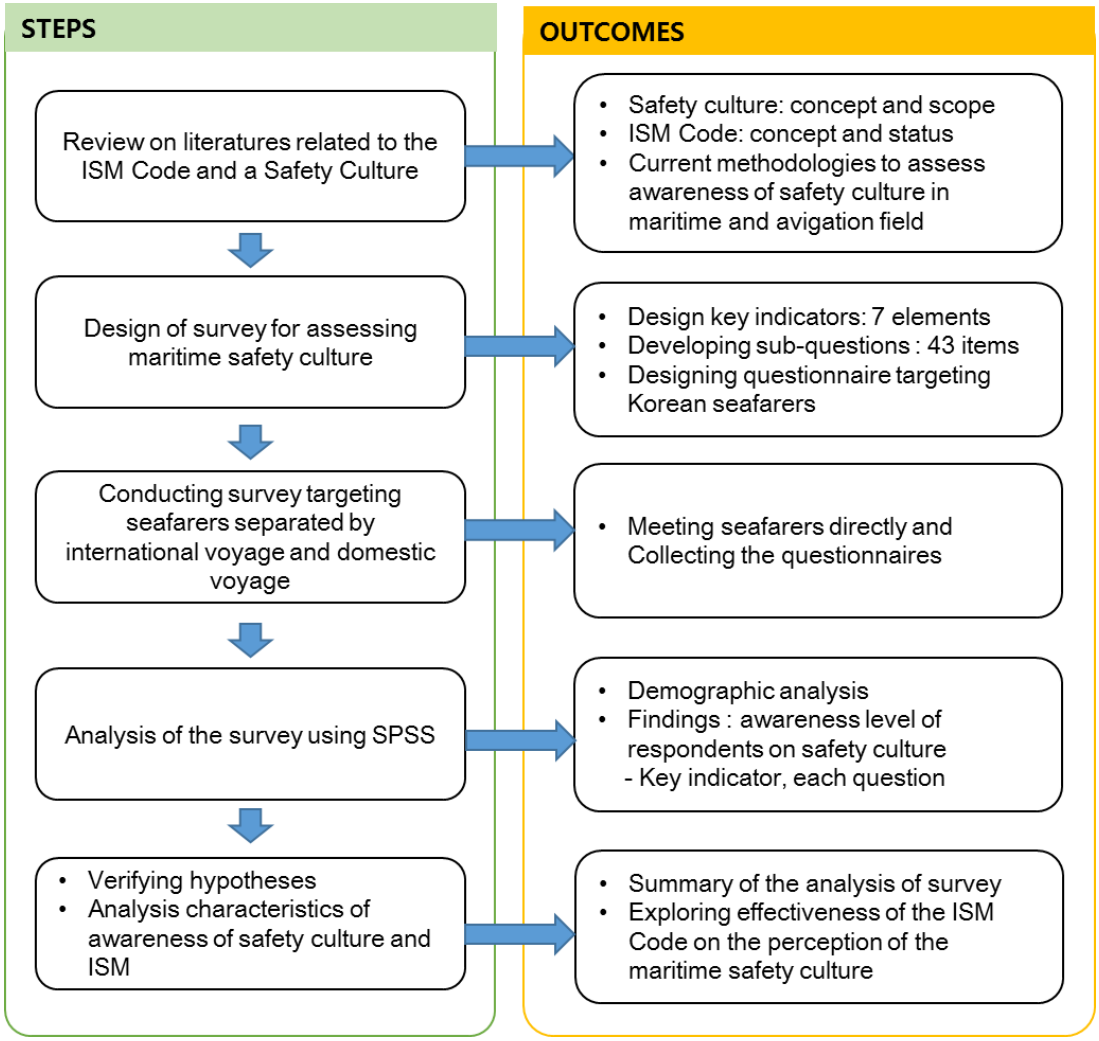


Figure 1 Process of the study

2. THEORETICAL REVIEW OF SAFETY CULTURE

2.1 Historical background of safety culture

The term safety culture was first introduced in the report of the Post-Accident Review Meeting written after the Chernobyl Accident by the International Nuclear Safety Group in 1986. According to the report, the IAEA indicated that the major cause of the nuclear power station accident was derived from a “poor safety culture” in the Soviet Union (IAEA, 1991).

Following the Chernobyl accident, a series of several major catastrophes occurred, for instance, a fire on the King’s Cross underground in 1987 and an explosion on the oil production platform, *Piper Alpha,* in 1988. The main causes of these accidents were also referred to as poor safety culture (Cox & Flin, 1998; Pidgeon, 1998: KTSA, 2008). Meanwhile, the explosion of the space shuttle Challenger in 1987 brought attention to safety culture in aviation. In addition, the *Continental Express Flight 2574* crash occurred in 1991, also raising concerns about safety culture (von Thaden & Gibbons, 2008). The NTSB (1991) noted that *“The failure of Continental Express Flight 2574’s management to establish a corporate culture which encouraged and enforced adherence to approved maintenance and quality assurance procedures*”(p.54). Since this accident, the commercial aviation industry has conducted a number of studies related to safety culture (von Thaden & Gibbons, 2008).

In the maritime field, safety culture has also begun to be recognized following a number of large-scale marine accidents, just as in the other industries. On 6th March 1987, the ro-ro passenger ferry *Herald of free enterprise* capsized in four minutes just after its departure, and there was a loss of 193 lives. This catastrophe brought about full attention to safety culture in the maritime industry. Gill and Wahner (2012) and Lappalainen (2016) indicated that *the Herald of free enterprise*, which was operated by Townsend Car Ferries Limited, had a lack of safety culture among the ship's crews as well as the shore-based management. Moreover, the shore-side managers of the ferry had always forced the crew to leave five minutes early from ports. On the day of the incident, there was a hasty departure due to delayed shipments. At the time of the departure of the ferry, the chief officer should have confirmed that the bow door of the ship was closed. However, due to the climate of the company's management to make a fast departure, he had to be on the navigational bridge. This climate of the company's management resulted in the chief officer's mistake of failing to ensure that the bow door was closed. Several months before the accident occurred, the master asked the manager of the shipping company to install a means to indicate the closed or open position of the bow doors, but the communication between the shore-based manager and the master was not effective. It resulted from the corporate culture that seeks to benefit rather than protect (Gill & Wahner, 2012).

Seven years following the *Herald of Free Enterprise* accident, another serious maritime accident that raised awareness about safety culture occurred in the Baltic Sea. On 28 September 1994, the car ferry *Estonia* capsized and sank due to a separation of its bow visor in the rough sea. From the accident, 852 people died or were missing and only 137 people survived. The direct cause was the separation of the bow visor, which pulled off the watertight ramp behind it. After that, a huge amount of water flooded into the ferry. According to the report of the Joint Accident Investigation Commission (1997), prior to the Estonia accident, there had been numerous failures involving bow visors on similar types of ships, which were constructed at similar times, including one of the Estonia's sister ships. However, there had been no systematic remedies for existing ro-ro passenger ferries. Since information or reports about those failures were not shared, the crew and master of the *Estonia* were unaware of the potential dangers to the bow visor closure (JAIC,

1997).

Safety culture has been introduced and studied to ensure safe working environment and to prevent an accident as an important concept to manage risks in various industries (Berg, 2013). It is clear that the importance of safety culture gains recognition following a major disaster in any industry. If a safety culture is lacking in any organisation, such as a ship or a company, it would be very difficult to manage risk factors, and the lack of management can lead to major accidents.

2.2 Concept of safety culture and safety climate

The definition of safety culture has been studied since the 1980s following the occurrence of the Chernobyl disaster. Firstly, the IAEA (1991) defined safety culture as "*Safety culture is that assembly of characteristics and attitudes in organizations and individuals which establish that, as an overriding priority, protection and safety issues receive the attention warranted by their significance.* (p.4)*"* Since then, there have been many areas that deal with safety culture; however, there has been no consensual definition of safety culture (Guldenmund, 2000; Wiegmann, Zhang, von Thaden, Sharma & Mitchell, 2002). Many attempts have been made to define safety climate, along with studies on the definition of safety culture.

Zhang, Wiegmann, and von Thaden (2002) conducted comprehensive reviews on the concept of safety culture, along with safety climate, to better understand safety culture. The study analysed a total of 107 documents and papers, and 30 articles related to safety culture and safety climate.

According to the study (Zhang et al. 2002), safety culture was defined as the flowing:

> The enduring value and priority placed on worker and public safety by everyone in every group at every level of an organization. It refers to the extent to which individuals and groups will commit to personal responsibility for safety; act to preserve, enhance and communicate safety concerns; strive to actively learn, adapt and modify (both individual and organizational) behaviour based on lessons

learned from mistakes; and be rewarded in a manner consistent with these values. (p. 1406)

Furthermore, Zhang et al. (2002) defined safety climate as the flowing:

> The temporal state measure of safety culture, subject to commonalities among individual perceptions of the organization. It is therefore situationally based, refers to the perceived state of safety at a particular place at a particular time, is relatively unstable, and subject to change depending on the features of the current environment or prevailing conditions. (p.1406)

Bhattacharya (2015) argued that there were differences between the concepts of safety culture and safety climate. Safety culture comes from inherent historical contexts or organizational operations, values, and traditions, and is formed over a long period (Cooper, 2000). On the other hand, safety climate is affected by the environment and the situation. By analogy, the safety climate can be relatively unstable and instantaneous, with the concept of a snapshot of the safety culture (Bhattacharya, 2015).

Safety culture is an inherent belief in a somewhat deeper core shared among its members and is expressed through a safety climate. In other words, if the safety climate is the environment in which the organization is located at that time, the safety culture is the nature of the organization (Cox & Flin, 1998). Therefore, most of the facts about safety culture are also true of safety climate (Guldenmund, 2000; Oltedal, 2011).

To sum up, safety climate has been assessed in many other studies. Measuring the current safety climate will identify a cross-section of the safety culture that the contemporary society or organisation has. By diagnosing the current state, it is believed that it will be possible to grasp what elements the current organisation or society has and what elements it can improve. Therefore, the safety culture should be recognised through measuring the safety climate in an organisation or society

2.3 ISM Code and safety culture

According to the ISM Code, Ship Management System (SMS), which refers to a structured and documented system designed to ensure that a company's employees can implement its policies for the safe operation of ships and the protection of the marine environment (IMO, 2013), shall be applied to ships. Moreover, the IMO encourages the establishment of a safety culture in the shipping sector through the establishment of the SMS (Anderson, 2015; IMO, 2013; Kongsvik, Størkersen, & Antonsen, 2014; Schröder-Hinrichs, 2010).

The question has been raised as to what constitutes a good safety culture. Promoting safety culture can be effective to enhance the safety of an organisation (Lee, 2012). Wiegmann et al. (2002) identified the following features as to what is a "good" safety culture (Lappalanine, 2016). There are five organisational indicators of safety culture: "*organizational commitment, management involvement, employee empowerment, reward systems, and reporting system"* (Wiegmann et al., 2002, p.11).

The organizational commitment means upper-level management to promote safety culture. Practically, it entails a persistent attitude to safety, and adequate funding and allocation of resources for the development and implementation of safety (Wiegmann et al., 2002).

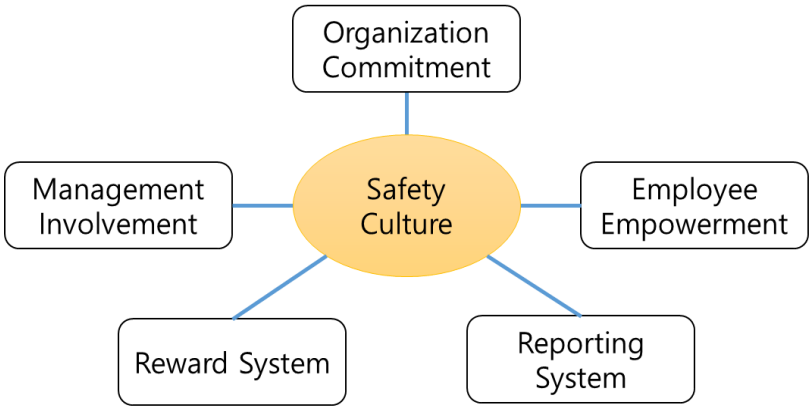


Figure 2 Indicators of safety culture

Management involvement refers to the degree to which senior management and middle managers are directly involved in important safety activities within the organization. This includes good communication between the top and bottom (Wiegmann et al., 2002).

Employee empowerment is the last defence to prevent errors by preventing worker errors (e.g. pilot) in the field. Organizations that have a good safety culture should delegate authority to employees to encourage them to actively participate and play an important role in promoting safety (Wiegmann et al., 2002).

Eiff (1999, p. 17) indicated that *"One of the foundations of a true safety culture is that it is a reporting culture."* The reporting system is a system for reporting incompatible elements and errors. It focuses on whether employees are encouraged to report safety issues without any difficulties, and whether they are well communicated (Wiegmann et al., 2002).

The reward system is necessary to establish an organizational culture, and both safe acts and unsafe acts need to be evaluated. A fair evaluation system will promote safety culture. Organizations with a good safety culture should look to ensure that the distinction between safe and unsafe behaviour is clear and has a clear and correct system of punishment (Wiegmann et al., 2002).

Lappalainen (2016) argued that the list of indicators developed by Wiegmann et al. (2002) does not clearly present a "continuous improvement process", but stated that the reporting and rewarding system could be used as a practical tool for that purpose. Furthermore, Lappalainen (2016) indicated that there is no doubt that the characteristics of a good safety culture are implemented in the Code like a religious position.

Since the implementation of the ISM Code in 1994, considerable research has been conducted to study the effectiveness of the ISM code for improving maritime safety. This maritime safety promotion is also closely linked to the improvement of maritime safety culture. This is because the IMO anticipated that the ISM Code would enhance the safety culture of ship and ship owners (IMO, 2016).

A group of experts set up by the IMO surveyed to measure the effectiveness of the ISM Code, and a total of 3,109 respondents answered the questionnaire (IMO, 2005). An analysis by the expert groups showed that the ISM Code worked properly on ships and in shipping companies and improved maritime safety management positively. Furthermore, it showed that safety culture was promoted by implementing the ISM Code as the majority of respondents (96 to 99 percent) evaluated the ISM Code positively. However, the expert group noted that the survey was voluntary so respondents who participated in the survey had a positive attitude toward the ISM Code. Therefore, the survey had a limitation, whereby an overwhelmingly positive evaluation would have been made due to respondents who had positive attitudes to the survey (IMO, 2005).

Although the IMO determined that the evaluation of the effectiveness of the Code was positive, there have been several studies to suggest the implementation of the Code has negative aspects (Lappalainen, 2016). Bharttacharya (2011) indicated that managers had been bureaucratically applying the ISM Code by directing and enforcing guidelines to crew members in a top-down manner in implementing safety management. The crews applied their own experiences rather than using the ISM Code to conduct safe shipboard operations (Bhattacharya, 2012). These are the reasons why the effectiveness of the Code seems to be negative in the study. Besides, Anderson (2003) argued that the Code requires a lot of documentation on the part of seafarers, so it can be burdensome and complex, and Knudsen (2009) and Batalden and Sydnes (2014) noted that documents and procedures under the ISM Code are effectively applied to real work of seafarers. In addition, Bhattacharya (2012) noted that there was a considerable difference in the recognition of the crew members and the ship managers about the performance and execution of the ISM Code.

A recent study conducted interviews and observation on personnel's conceptions of SMS and safety culture. Lappalainen (2016) scrutinised the views of personnel on the impact of the ISM Code on maritime safety culture. As a result, perception of safety culture was influenced by the ISM Code, but the effect seemed not to be strong. Some interviewees had positive thinking on the SMS, and believed that the implementation of ISM Code brought substantial benefits (Lappalainen 2016).

However, there were negative views on the effectiveness of incident reporting and documentation.

In Korea, the safety culture of seafarers has not been comprehensively studied. A survey of seafarers' perceptions about safety culture was conducted. Kim (2013) found that there were no differences in safety culture awareness among seafarers of different ship types and ranks, and the main survey items were related to the responsibility and attitude toward safety of seafarers. Furthermore, compliance with the ISM Code can contribute to the promotion of safety culture.

In summary, most studies that have been conducted in the past have been related to the definition and concept of safety culture, and there have been few studies on the relationship between Safety Culture and the ISM Code (Guldenmund, 2010: Lappalainen, 2016). In addition, research on the effectiveness of the ISM Code itself has been conducted, but studies on whether it contributes to safety culture are not sufficient. In particular, there are no studies that quantitatively measure the effectiveness of the ISM Code on safety culture.

2.4 Approaches and related studies to assess safety culture

Since safety culture is covered in many fields such as nuclear power, road, railway, manufacturing and aviation, various research and evaluation methods exist. Furthermore, due to the importance of safety culture, many studies have been conducted to define and to assess safety culture (Wiegmann et al., 2002). Therefore, there is no standardised measurement tool that can be applied to all industrial fields (Cox & Flin, 1998).

To research safety culture, there have been many ways to evaluate safety culture depending on the approach. Guldenmund (2010) indicated three approaches to the research of safety culture as shown in Table 1. First, the analytical approach is commonly applied to an assessment of safety culture, and questionnaires are utilised for this approach. Second, a pragmatic approach aims to assess the maturity of the safety culture of an organisation and tries to find a way to improve the current status

of the culture. The last approach is an academic approach which is mainly conducted as a qualitative study, and it aims to grasp the status of a culture through interviews, observations and document studies (Guldenmund, 2010).

In recent years, combining these three approaches has been considered as useful in interpreting the concept of safety culture and understanding the safety management system. It would not be accurate to say that one method is perfect. By combining these approaches, one might be able to interpret the concepts of safety culture and apply them usefully to understanding the safety management system (Guldenmund, 2010).

As to methods of measurement of safety culture, Wiegmann et al. (2002) indicated that they could be practically divided into qualitative and quantitative methods as shown in Table 2. On the one hand, qualitative methods can be comprised of employee observation, focus group discussion, historical information review, and case studies. Through qualitative methodologies, deep and intensive information can be obtained based on the content discussed (Wiegmann et al., 2002). On the other hand, the quantitative approach measures safety culture by using standardized and coordinated procedures - interviews, surveys and questionnaires (Wiegmann et al., 2002). The culture can be assessed through a questionnaire, including safety factors or indicators, and it is easy to acquire people's perceptions of the culture.

Table 1 Guldenmund (2010)'s approaches for study on safety culture edited by author

Approach	objectives	Tools & methodology	Feature
Analytical	Psychological safety climate	Questionnaires - Quantitative methodology	Grasping the present culture
Pragmatic	Assessment of the safety culture maturity of an organisation	Q-sort or rating scales for making appraisals Expert opinions	Experience-based approach
Academic	Understanding or describing a culture	Interviews, case study, observations or documentation	Focusing on core of the culture

		- Qualitative methodology	

Each method has advantages and disadvantages. The qualitative approach can analyse and answer the internal factors through an in-depth approach to the questions and discussions, while the results can be biased according to the analyst's opinion. The quantitative approach can analyse the perception of the climate objectively by asking the opinions of the respondents through standardized questionnaires; however, it is difficult to analyse the responses of the participants in depth.

To assess safety climate, safety dimensions such as factors are needed. There have been several studies for developing tools to evaluate the level of safety culture in the aviation sector. The Korea Transportation Safety Authority [KTSA] (2008) conducted an assessment of safety culture and developed an index of safety culture for measuring the safety culture awareness level of aviation pilots. The survey developed a questionnaire utilizing the commercial aviation safety survey (CASS) scale which was developed by Wiegmann, Zhang, von Thaden, Sharman, and Gibbon (2003). Furthermore, the study utilised the indicators which were *organisation commitment, management involvement, reward system, employee empowerment and reporting system.* The CASS's questionnaire originally contained 86 questions, but the KTSA limited their questionnaire to 46 questions due to realistic constraints such as pilots' hectic schedule.

Table 2 Measurement of safety culture (Wiegmann et al., 2002; Lee, 2012)

Division	Tools & Methodologies

Qualitative Measurement	- Observation - Focus group discussion - Historical Information review - Case study
Quantitative measurement	-Structured interview -Questionnaire -Q-sorts

Wang and Sun (2012) proposed a new index system for safety culture evaluation and showed its effectiveness and application for the assessment of safety culture at intrinsic and extrinsic levels, with seven sub-culture components: *priority, standardizing, flexibility, learning, teamwork, reporting and just culture*. Their survey, using a questionnaire, was carried out targeting a local aviation operator in Tanjin, China.

Song (2014) assessed safety climate in the aviation sector, targeting 30 traffic management operators and 25 pilots using a questionnaire with 50 questions. Safety factors developed by the Civil Air Navigation Service Organisation (CANSO) were utilised in the study. The factors were *management skill, attitude, resource management, learning, communication, organisational structure, and management of change.*

With regard to studies on assessment of maritime safety culture, Ek, Runefores and Borell (2013) conducted a study to assess the safety culture of six passenger ships. The study developed nine aspects of safety culture: *flexibility, risk perception, behaviour, reporting, work situation, justness, attitudes, learning, communication and safety culture*. The study presented the relationships between the nine aspects though using a questionnaire targeting crew working onboard the passenger ships.

Bhattacharya (2015) carried out research to grasp the difference in perception of safety culture between seafarers, shore managers and ship owners. Among the seafarers, junior and senior officers' perception was also compared. In this study, five experts participated in the development of a questionnaire, and finally, all 19 items were used for the measurement of safety. In addition, the study analysed the correlation between the 19 items and seven safety drivers which were *support on*

safety, organisation support, resource availability, work environment, job demands, just culture and safety compliance.

Moreover, Arslan, Kurt, Turan and Wolff (2016) determined that safety culture could be scored on ten safety factors to assess safety culture for maritime organisations. The factors were developed based on the index for measuring safety culture developed by the American Bureau of Shipping (ABS, 2012). The factors were *communication, employer employee trust, feedback, involvement, mutual trust, problem identification, promotion of safety, responsiveness, safety awareness and training and competence.* They utilised the index of ABS's model as a basis for their questionnaire. To develop the questionnaire, a meticulous literature review was carried out, and the developed questionnaire, including 85 questions, was tested by experts. The survey was administered to both shore staff and crew members.

The above-listed studies mainly used a quantitative methodology, and it was found that various dimensions of safety culture were utilized for the survey. Table 3 summarizes the safety-related dimensions used in the studies. It can be seen that various dimensions have been utilised in the aviation and maritime sectors.

Division	Study	Survey target	Dimensions or features
Aviation	KTSA (2008)	248 pilots	*Organisation commitment, management involvement, reward system, employee empowerment and reporting system.*
	Wang & Sun (2012)	123 civil aviation operators	*Priority, standardizing, flexible, learning, teamwork, reporting and just culture*
	Song (2014)	30 traffic management operators and 25 pilots	*Skill, attitude, resource management, learning, communication, organisational structure, management of change.*
Shipping Sector	Ek et al. (2013)	528 seafarers on six Swedish passenger ships	*Flexibility, risk perception, behaviour, reporting, work situation, justness, attitudes, learning, communication and safety culture*

Bhattacharya (2015)	433 Indian seafarers	*Safety, organisation support, resource availability, work environment, job demands, just culture and safety compliance*.
Arslan, Kurt, Turan and Wolff (2016)	70 respondents of shore staffs and seafarers	*Communication, employer employee trust, feedback, involvement, mutual trust, problem identification, promotion of safety, responsiveness, safety awareness and training and competence.*
ABS (2012)	This was published as guidance for a survey	*Communication, empowerment, feedback, mutual trust, problem identification, promotion of safety, responsiveness, safety awareness*

Table 3 Summaries of safety culture dimensions edited by the author

3. ISM CODE

In the previous chapter, a relationship of the ISM Code and safety culture was reviewed. A concept and a structure of the Code will be shown in this chapter. Furthermore, the current stage of the implementation of the ISM Code carried out and the problems faced by Korean shipping, such as a status of maritime accidents, will be explained.

3.1 The concept of the ISM Code

For an importance of human factor and a promotion of a safety culture in the maritime sector, the ISM Code was adopted by resolution A.741 (18) at the 18th

General Assembly of the IMO in 1993. At first, however, the Code was not a mandatory measure. Therefore, the IMO has enforced the Code through the establishment of Chapter 9 of the 1974/78 SOLAS Convention for the full and immediate implementation of the ISM Code in May 1994. Since 1998, the ISM Code has been phased into all the ratifying countries of the 1974/78 SOLAS Convention, and since July 1, 1998, all passenger ships and over 500 tons of oil tankers, chemical tankers, gas carriers, bulk carriers and high-speed cargo ships. In addition, the Code has been applied to mobile offshore drilling units (MODUs) over 500 tons since 1 July 2002 (IMO, 2013).

The ISM Code requires shipping companies to establish a safety management system for offshore department and ships and maintain their level above certain international standards. To this end, direct involvement of top management in the company and the responsibilities, abilities, Motivation is being encouraged. The SMS in the Code is used in the ISO 9000 family of quality management systems. In other words, while the ISO 9000 family quality management system is intended to improve the quality of the product, the SMS aims to ensure safety of ships and prevention of marine pollution. These objectives have pursued through software including Quality Management System (QMS) and SMS (MLTM, 2010).

In addition, according to the Code, the flag state or the Recognised Organisation (RO) issues to the shipping company to ensure good SMS after the audit. A Document of Compliance (DOC) is issued to the ship owner and a Safety Management Certificate (SMC) is issued to the ship. The Code is implemented through periodical audit, and the contents of the SMS and the validity of the certificate is checked in the inspection of the Port State Control (PSC).

According to the Code, establishing a SMS shall be documented in the form of procedures or manuals for all duties of vessels and shore based operations carried out for safe navigation of ships. Furthermore, it is institutionalised so that the main duties may be carried out by the documented system. It means establishing a system that can check the implementation processes and identify irrelevant matters for correcting defects. Therefore, it is ideal that the system document has a hierarchical structure as shown in figure 3. Furthermore, twelve elements have been established as mandatory in the part A of the ISM Code as following Table 4.

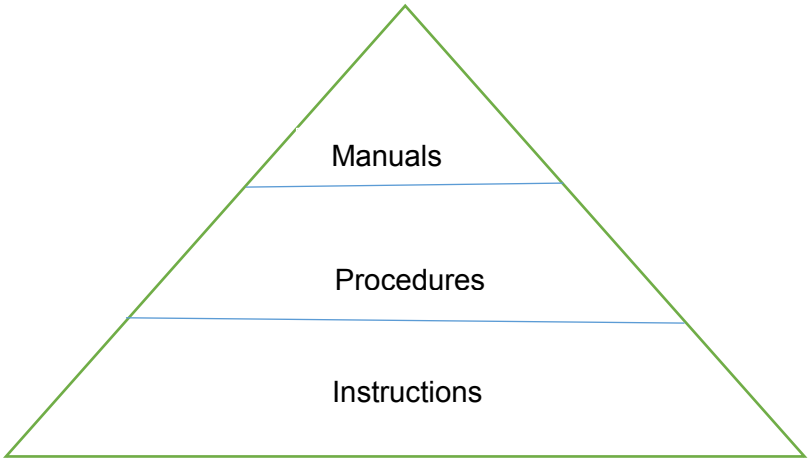


Figure 3 Layer of document of safety management system

Table 4 Elements of ISM Code (IMO, 2013)

Number	Title of each element
2	Safety and environmental policy
3	Company responsibility and authority
4	Designated persons
5	Master's responsibility and authority
6	Resource and personnel
7	Shipboard operations
8	Emergency preparedness
9	Reports and analysis of Non-Conformities, accidents and hazardous occurrences
10	Maintenance of the ship and equipment
11	Documentation
12	Company verification, review and evaluation

3.2 Implementation of the ISM Code in Korea

With the enforcement of the ISM Code, the Korean government revised the Maritime Traffic Safety Act on Feb. 8, 1999 to establish the safety management system over ships flying the Korean flag and ship owners. The procedures for the SMS were in Section 2 of the Act. In the SOLAS Convention, the ISM Code is applied to all passenger ships engaged on international voyages, oil tankers, gas carriers, chemical carriers, bulk carriers and high-speed cargo ships of 500 gross tonnage and above, and this application standard was reflected in in the Korean Maritime Traffic Safety Act. On June 15, 2011, the Act was revised and promulgated to the Maritime Safety Act (MLTM, 2010).

According to Article 46 of the Act, the Minister of Oceans and Fisheries (MOF) shall establish and manage policies for a ship owner and ships through the establishment of the SMS to enhance safe operation of the ship. The implementation of the ISM Code in Korea aims to maintain the level of safety management of ship owners and vessels above certain international standards, and calls for direct participation of top management in the enterprise as well as the responsibility, competence, attitude and motivation of all stakeholders. However, such a purpose will be achieved on vessels engaged in international voyages. This is because a more simplified SMS is applied to vessels engaged in domestic voyages. Therefore, for domestic vessels, an SMS that meets international standards does not apply.

Since the oil spill accident of the Very Large Crude Oil Carrier (VLCC) Hebei sprit, caused by a collision of crane barges towed by tugs on Dec. 7, 2007, there was a recognition of the necessity to apply the SMS to barges. Therefore, the relevant domestic regulation has been more stringently enforced compared to SOLAS. According to the Act, barges over 3,000 gross tons or tugs towing with lines more than 100 meters were included in the scope of the application of the SMS. Therefore, the application of the Act is as follows (NLIC, 2015).

a) Ships engaged in maritime passenger transportation business (except for the domestic passenger transport business and the inner port passenger transport business)

b) Vessels of at least 500 gross tons (including barges tightly combined with steamers), which engage in marine cargo transportation services, and other vessels as prescribed by the Presidential Decree

c) Carriers transporting catches of fish and mobile offshores with a gross tonnage of 500 tons or more engaged in international voyages

d) Wig crafts

Furthermore, the Korean SMC shall contain the eleven elements in accordance with Article 46 (4) of the Act. However, under Article 15 (2) of the Enforcement Decree of the same Act, a simplified SMS can be established in the case of a domestic vessel, through exempting some of the 11 elements. As the ISM code was legislated to the domestic Act, the elements of the Code were thoroughly reflected in the Act.

Ships and ship owners applying the ISM Code should be audited to prove that an SMS is well maintained. In Korea, the audit procedure has been established in Article 48 of the Act. According to the Act, the audits for vessels engaged in international voyages are carried out by the Korean Register of shipping (KR) as a RO, and the audits for ships engaged mainly in domestic voyages are handled directly by the Maritime Affairs and Fisheries Regional Offices (MAFRO). Table 5 shows the results of certification audit for Korean shipping companies.

Table 5 Audit status of SMS and DOC on Dec 31, 2009 (MLTM, 2010)

Division	Shipping companies audited	Ships audited	Audit organisation
International voyages	137	678	KR
Domestic voyages	128	293	MAFRO

3.3 Challenges faced in Korean shipping society

The seaborne trade and shipbuilding industries have played a pivotal role in the Korean economy. As of 2016, the total world fleet of the world's top 30 shipping countries was recorded as 1,657 million Dead Weight Tonnage (DWT), and Korea ranked fifth in the world, with a total 85.9 million tons (MOF, 2016). Table 7 shows the status of Korean Flagged ships. Over the past five years, the overall number of vessels has remained at a similar level without any big change. However, the number of vessels of Bare Boat Charter with Hire Purchase (BBC/HP) is increasing.

Regarding the status of licensed and registered vessels in Korea, vessels sailing coastal waters are registered more than ocean-going vessels. The Table 6 represents the number of Korean vessels registered and licenced in 2015. The total number of ships was 3,824; the number of vessels operating in coastal waters was 2,225, and the number of ocean going vessels was estimated to be 1,599, so that the number of coastal vessels was higher. Furthermore, except other vessels such as tugs and barges, conventional cargo vessels were the most registered, followed by tankers. The conventional ships include general cargo ships and bulk carriers. Moreover, the number of Korean seafarers employed in Korea is 36,976 as shown in Table 7 below.

Table 6 Licensed and Registered Vessels in Korea

(Unit: Number, Ton, TEU, 31 Dec, 2015)

Kind of Ships / Classification	Total		Passenger Vessels		Conventional Cargo Vessels		Container Ship			Tankers		Others	
	Number of ships	Gross Ton	Number of ships	Gross Ton	Number of ships	Gross Ton	TEU	Number of ships	Gross Ton	Number of ships	Gross Ton	Number of ships	Gross Ton
Total	3,824	64,924,680	145	97,273	1,105	36,652,353	1,215,766	316	13,583,020	662	13,340,626	1,596	1,251,407
Coastal Line	2,225	1,972,190	145	97,273	265	536,049	-	-	-	246	252,025	1,569	1,086,842
Ocean-going ship	1,599	62,952,490	-	-	840	36,116,304	1,215,766	316	13,583,020	416	13,088,601	27	164,565
Liner	313	13,461,756	-	-	1	7,589	1,207,263	312	13,454,167	-	-	-	-
Irregular liner	1,286	49,490,734	-	-	839	36,108,715	8,503	4	128,853	416	13,088,601	27	164,565

Note: 1. Based on licensed and registered vessels
2. Passenger ships include reserve ships on subsided remote island route, and others include barges
3. Includes BBC/HP ships

Source: Ministry of Oceans and Fisheries(MOF), Shipping Policy Division

Table 7 Status of the number of seafarers' employment in Korea

(Unit: person, 31 Dec. 2015)

Classification		Employment of seafarers	Foreign seafarers employed in Korea
Total		36,976	24,624
Korean Flag vessels	Ocean going vessels	9,307	12,066 70 (passenger vessels)
	Costal vessels	7,847	673
	Ocean going fishing vessels	1,492	3,374
	Coastal/inshore fishing vessels	15,328	8,441
Foreign flag vessels		3,001	-

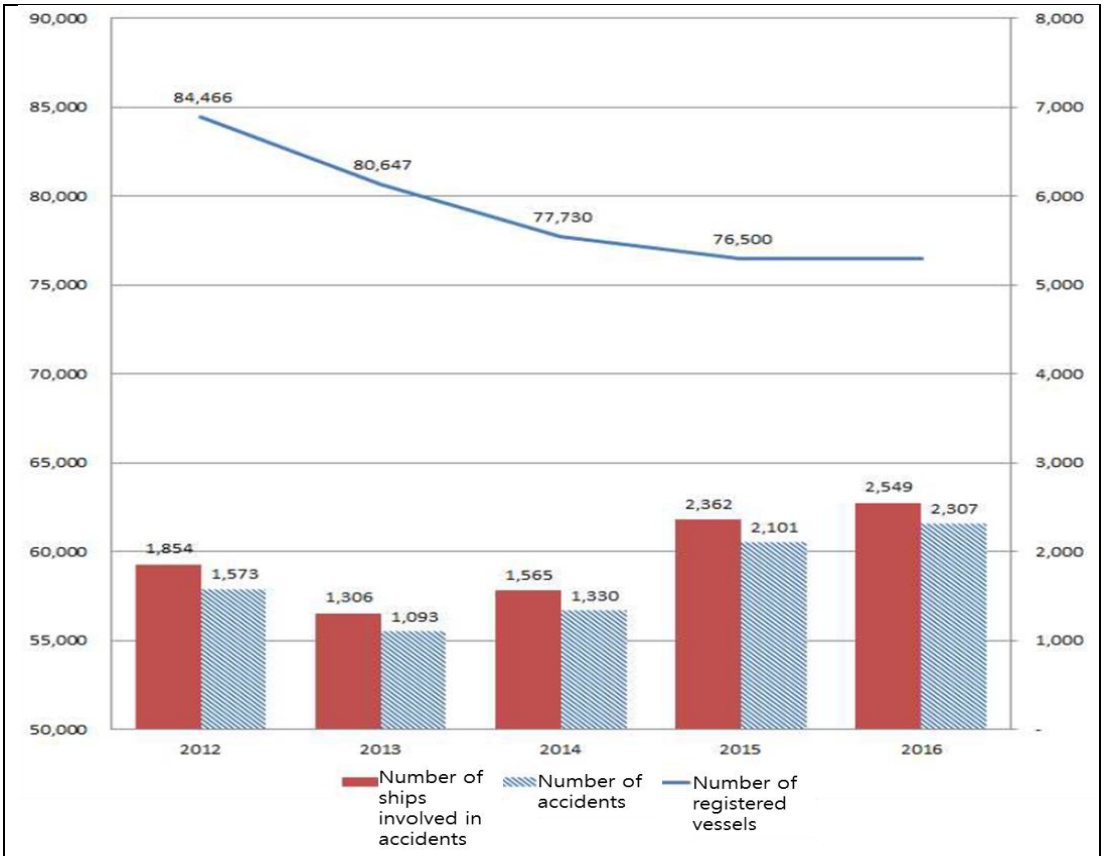
According to the statistical yearbook of maritime and fisheries (MOF, 2016), the total number of domestic vessels registered in 2015 was 2,225, and there were 233 accidents, which was 10.4 percent among the vessels. While 1,599 ocean-going vessels were registered in the same year, the accident rate was 6.7 percent. As a result, ocean-going vessels experienced 21 percent fewer accidents than domestic vessels.

In light of the major causes of ship accidents, it can be ascertained that human errors are the major factors. Tables 10 and 11 show the causes of accidents that occurred in domestic and ocean-going vessels, judged by the Korea Maritime Safety Tribunal (KMST) from 2012 to 2016. There are also several causes of maritime accidents. Moreover, operational errors, such as improper maintenance of engine facilities and inappropriate safety procedures, are considered to belong to a category of human errors. While the rate of accidents caused by human error was 89.2 percent of 130 cases on ocean-going, as shown in Table 10, it was 93.2 percent of total 266 cases on domestic vessels. Therefore, it is possible to say that maritime accidents are mainly caused by human error, and it is important to reduce the human errors and improve human factors to reduce maritime casualties.

Table 8 Comparison of the ratio of accident between domestic vessels and ocean-going vessels

	The number of registered vessel	The number of maritime accidents	The Ratio of registered vessels to accidents
Domestic vessels	2,225	233	10.4%
Ocean-going vessels	1,599	107	6.7%

Table 9 The ratio of the number of registered ships and maritime accidents



Number / Year	2012	2013	2014	2015	2016
The number of registered vessels (A)	84,466	80,647	77,730	76,500	-
The number of ships involved in accidents (B)	1,854	1,306	1,565	2,362	2,549
The number of accidents	1,573	1,093	1,330	2,101	2,307
Maritime accidents occurrence rate (B/A)	2.19%	1.62%	2.01%	3.09%	-

Source: Ministry of Oceans and Fisheries (MOF), Shipping Policy Division

Table 10 status of maritime casualties of ocean-going merchant vessels from 2012 to 2016 (Accidents of which judgment were completed by the KMST)

Causes of marine accidents \ Type of ships		Passenger ship	Cargo ship	Tanker	tug	sum
Operational failures	Violation of navigation laws and regulations for avoiding collisions		5	1	6	12
	Failure to comply with general principles for navigation such as look out, position fixing and keeping ships' course	3	34	18	3	58
	Inappropriate departure preparation such as securing openings, checking loading condition, charts and publications	-	-	-	-	-
	Failure to comply with duty orders and inappropriate report and taking over duties	-	2	-	1	3
	Others	1	7	1	-	9
	Sum	4	48	20	10	82
Inappropriate maintenance of engine facilities and spare part		4	7	4	2	17
Inappropriate safety actions for accident prevention on cargo, fishing and other onboard works		-	6	11	-	17
Inadequate working environments such as rest hours and measure for preventing dangers		-	-	-	-	-
Safety defects on engine structure and machinery parts		1	1	2	-	4
Inadequate navigational facilities such as traffic routes and aids to navigation		-	-	-	-	-
Safety defects on electronic appliances and loading and unloading equipment		1	1	2	-	4
Deficiencies in ship safety management		-	-	-	-	-
Act of God		-	3	-	1	4
others		-	-	1	-	1
Unknown of origins		-	1	-	-	1
Sum		9	67	39	15	130

Source: KMST (2016)

Table 11 status of maritime casualties of domestic merchant vessels from 2012 to 2016 (Accidents of which judgment were completed by the KMST)

Causes of marine accidents \ Type of ships		Passenger ship	Cargo ship	Tanker	tug	sum
Operational failures	Violation of navigation laws and regulations for avoiding collisions	1	2	3	4	10
	Failure to comply with general principles for navigation such as look out, position fixing and keeping ships' course	23	31	22	60	136
	Inappropriate departure preparation such as securing openings, checking loading condition, charts and publications	3	-	-	3	6
	Failure to comply with duty orders and inappropriate report and taking over duties	1	1	1	3	6
	Others	3	-	-	-	3
	Sum	**31**	**34**	**26**	**70**	**161**
Inappropriate maintenance of engine facilities and spare part		36	5	4	6	51
Inappropriate safety actions for accident prevention on cargo, fishing and other onboard works		1	6	10	19	36
Inadequate working environments such as rest hours and measure for preventing dangers		-	-	-	-	-
Safety defects on engine structure and machinery parts		2	-	-	2	4
Inadequate navigational facilities such as traffic routes and aids to navigation		-	-	-	2	2
Safety defects on electronic appliances and loading and unloading equipment		1	1	-	2	4
Deficiencies in ship safety management		-	-	1	4	5
Act of God		1	1	-	-	2
others		-	-	1	-	1
Unknown of origins		-	-	-	-	-
Sum		**72**	**47**	**42**	**105**	**266**

Source: KMST (2016)

Recently, serious marine accidents have been occurring in Korean territorial waters and the Ocean. On April 16, 2014, the ro-ro ferry, *Sewol,* capsized 3.1 miles off the southwest coast of Korea, resulting in 295 deaths and nine missing of 476 passengers. According to the safety investigation report of the KMST, the direct cause of the accident was the lack of stability of the ship so that a steep list occurred when the ship

was trying to change its course. However, immediately after the accident, the crew did not make enough effort to get passengers to evacuate the listing ship, resulting in many victims. Also, despite the suggestion of the captain, the company placed excessive cargo on the ship, usually in favour of operating profit rather than the safety of the ship (KMST 2014). This is considered to be due to a serious lack of safety culture because the management had focused on profitability rather than safety and had not been able to communicate properly with the crew members.

Another example of a major accident that occurred recently is the *Wuysan* oil spill accident, caused by an allision with an oil pipe at the Gwangyang oil terminal in Korea. On December 31, 2014, a VLCC, *Wuysan*, collided with GS-Caltex Crulde Oil Dolphin, which is the name of one of the berths at the terminal, due to failing to reduce its speed as it approached the quay according to the pilot's control for berthing. In the safety investigation report, the lack of communication between the captain and the pilot was pointed out as an underlying cause in the social and cultural aspect (KMST 2015).

The occurrence of these major accidents has led to improvements in the maritime safety system of Korea through amendments of rules and regulations as shown in Table 12. However, it is doubtful that these strengthened legal systems are sufficient for maritime safety and prevention of human error. Since the subject of the implementation of the regime is ultimately the person, it is difficult to discipline human consciousness and beliefs only through the legal system. Therefore, focusing on safety culture and preparing measures to enhance human factors should be a direct path to maritime safety.

Table 12 Legal improvement after the Sewol accident
edited by the author

Name of the ship / Subsequent improvements	Improvements	Title of relevant Law
Ship's facility	- Strengthen performance standards for cargo securing devices for car ferries - 5 % of the maximum number of people on board the life vest near the muster station - Revision of ship's structure for increase of cargo for car ferries - Mandatory installation of Voyage Data Recorder (VDR) for domestic passenger ships over 300 gross ton	- Standard of the structure and facilities of car ferry - Ships' safety Act
Crew qualification	- Five-year cycle of job aptitude test for captain working in a car ferry - The captain and crew must not leave the ship until the passenger is rescued in an emergency.	- Seafarer Act
Management system	- Strengthen master's responsibilities on inspection of seaworthiness and report to the ship owner - Ship owner who is noticed with problems from the inspection shall take necessary measures to safely operate the ship	- Seafarer Act
Inspection	- Introduction of maritime safety supervisor system (Unusual check for car ferries) - Strengthen passenger identification procedures	- Maritime safety Act - Shipping Act
Organisation	- Revision of government organisation (Maritime Police Organization absorbed into the Ministry of Public Safety and Security)	-
Training	- Establishment of passenger ship job and safety training	- Seafarer Act

4. RESEARCH METHODOLOGY

4.1 Research method and design appropriateness

Through the review of previous studies in chapter 2, qualitative and quantitative research methodologies have been used primarily for the evaluation of safety culture, or it has been studied in a combined way. This study is carried out by a quantitative method that enables information collection and data analysis in a short period and use of standardised research methods on the related topic. Therefore, it is said to be less risky as a traditional way. Furthermore, the safety climate represents the aspect of safety culture, so measuring cultural aspects of seafarers can reveal the level of safety culture.

Meanwhile, in other industries such as aviation and nuclear power, research on safety climate has been carried out to improve safety culture since the 1990s. From the second half of 2000, several studies have evaluated the safety culture of maritime employees. However, in Korea, there are not enough studies on the safety culture of seafarers compared with other countries, and there is no study that verifies the correlation between the ISM Code and safety culture.

Therefore, this study assesses the safety climate through a quantitative methodology, targeting seafarers to understand the level of safety culture in the Korean maritime sector. For the purpose of the study, a questionnaire was developed based on the factors of safety culture that were extracted from past studies. The study cited the five safety indicators from Weigman (2002) as a basis for developing a questionnaire and added two additional indicators required for the safety management system in the maritime field. These questions were also amended to fit

the seafarer.

To evaluate the effect of the implementation of the ISM Code on the recognition of safety culture by seafarers, the survey, using the questionnaire, was administered to crews employed in ocean going vessels that are fully covered by the ISM Code and seafarers employed in domestic vessels that are covered by the safety management system in the Korean domestic Law. Furthermore, the questionnaire was developed to obtain a high level of reliability and validity to ensure that the safety culture of the seafarers could be measured properly through a quantitative method, utilising a survey tool. The survey data was analysed by using the SPSS for the exploratory factor analysis to verify the reliability and validity of the measurement tool.

4.2 Research model

To investigate the effectiveness of the ISM Code on enhancing safety culture, a survey on safety culture perceptions of seafarers was conducted. The following figure (Figure 4) is a research model to achieve the objective of the study. The survey target was divided into two groups that were comprised of seafarers working on ocean going vessels and those working on domestic ships. Based on the results of the survey, the perception of the seven safety culture indicators among the two groups of crew members was compared and analysed, and the effectiveness of the ISM Code on safety culture was evaluated.

Figure 1 Concept of research model

4.3 Development of indicators for assessing safety culture

The study requires the selection of proper indicators for safety cultural measurements, as the selection influences the validity of the survey result. As a result of reviewing the relevant literature in the previous Chapters, it was concluded that the indicators derived from the study of Wiegmann et al. (2003) were suitable as the safety indicators to be used in this study. This is because Wiegmann et al. (2003) had selected indicators based on a thorough review of sufficient literature on safety culture and safety climate. The author believes that these indicators comprehensively cover the various factors used in other studies (described in Table 3). In addition to the Wiegmann's indicators, two indicators of *learning* and *communication* supplemented the design of the questionnaire. Therefore, in this study, questionnaire items were constructed based on seven indicators which are "*organisational commitment, management involvement, reward system, employee empowerment, reporting system, learning and communication"* (Wiegmann et al., 2002, p.11).

- Organisational commitment

  It is an indicator of the continued interest and support of management on safety, and whether safety is a core value in an organisation (Wiegmann et al. 2002).

- Management involvement

  It refers to the degree to which management and middle managers participate in safety activities, and means active monitoring (Wiegmann et al. 2002).

- Reward system

  Whether a behaviour is a safe or an unsafe behaviour within an organisation, it is evaluated and given a reward or punishment consistently according to the evaluation (Wiegmann et al. 2002).

- Employee empowerment

  It includes safety tasks as a way to prevent errors when employees work, the level of reflection of employees in the safety-related decisions, the pride of employees, and the responsibility for others (Wiegmann et al. 2002).

- Reporting system

The reporting system allows members to be willing to report their mistakes or near misses and to share that information. (Wiegmann et al. 2002).

- Learning

It is a proactive approach to monitoring and acquiring information and acquiring knowledge from the organisation, and it is necessary to be willing to implement improvements. (Ostrom, Wilhelmsen, & Kaplan, 1993: Ek, 2006)

- Communication

It is to make good communication in everyday work for proper decision making. Clear communication must be performed especially for safety culture. (Glendon & Stanton, 2000; Ostrom et al., 1993: Ek, 2006)

4.4 Relationship between factors of safety culture and ISM code

Although the effectiveness of the ISM Code remains controversial, it has been found (IMO, 2005) to have a positive effect on safety culture. To understand the direct relationship between the ISM Code and safety culture, the contents of the eleven elements constituting the Code were examined and linked to the relevant factors of safety culture.

As shown in Figure 5, the seven factors of safety culture were found to be associated with all elements of the Code without any separate concept. In this study, when the level of perception of the safety culture is quantitatively measured, the effectiveness of the ISM Code can be predicted in conjunction with the relationship. When the safety culture of the seafarers is highly perceived, the Code will be expected to be effective.

Using the measurement tool of the study, the effectiveness of the Code can be analysed through comparing the level of perception of safety culture of seafarers employed in ocean going vessels, wherein the ISM Code is applied, to those

employed in domestic vessels, wherein the safety management system, the simplified version of the Code, is applied by Korean domestic Law.

Using the measurement tools in this study, it is possible to analyse the effectiveness of the Code when the consciousness of safety culture of seafarers on ships that apply and do not apply the ISM Code is measured and compared. In particular, it is possible to recognise which safety factors have a positive effect on the Code.

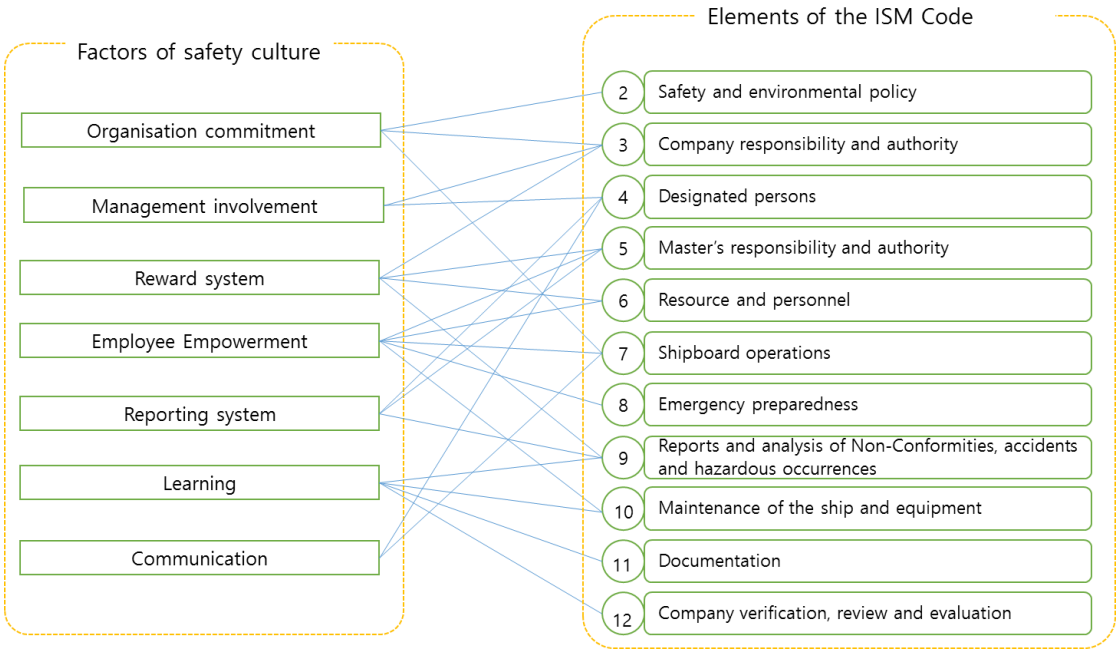


Figure 2 Relation between Safety culture factors and the ISM Code

4.5 Research questions and hypotheses

One of the major objectives of the ISM Code is to promote safety culture at sea. Although it is recognised that the implementation of the ISM Code has contributed to reducing maritime accidents, it is also true that substantial efforts were needed by seafarers and staff of shipping companies. At this point - approximately 20 years after the ISM Code was enforced in shipping - it would be necessary to see how the Code has contributed to enhancing safety culture and how it affects human behaviour.

According to the ICS (2013), safety culture can improve effectively human

behaviour through the implementation of an SMS appropriately. Furthermore, the IMO's position is that safety culture and safety management are rooted in seafarer's professionalism (Havold, 2010). Therefore, to reduce human error, which is the leading cause of accidents on ships, it is the best way for the seafarers to perform safety management with professionalism based on safety culture.

The fundamental research question is whether the implementation of the ISM Code has a positive impact on the safety culture. If the ISM Code contributes to promoting safety culture, seafarers aboard ships on which the ISM Code is applied would have a higher awareness of it than those on domestic ships. Under these assumptions, the main hypothesis was formulated as 'the perception of the safety culture of seafarers employed in international sailing vessels is higher than that of seafarers engaged in domestic vessels". Furthermore, the sub-hypotheses to be proved in this study are as detailed in Table 13:

Table 13 Seven hypotheses

H1	The awareness of o*rganisational commitment* of seafarers employed on ocean going vessels will be higher than that of seafarers on domestic vessels.
H2	The awareness of *management involvement* of seafarers employed on ocean going vessels will be higher than that of seafarers on domestic vessels.
H3	The awareness of *reward system* of seafarers of seafarers employed on ocean going vessels will be higher than that of seafarers on domestic vessels.
H4	The awareness of *employ empowerment* of seafarers employed on ocean going vessels will be higher than that of seafarers on domestic vessels.
H5	The awareness of *reporting system* of seafarers employed on ocean going vessels will be higher than that of seafarers on domestic vessels.
H6	The awareness of *learning* of seafarers employed on ocean going vessels will be higher than that of seafarers on domestic vessels.
H7	The awareness of the *communication* of seafarers employed on ocean going vessels will be higher than that of seafarers on domestic vessels.

4.6 Design of the questionnaire

To measure the safety climate of seafarers, the safety culture indicators and questionnaire items selected through literature review were revised and edited to fit the maritime crews. Meanwhile, considering the busy schedules of seafarers, a short questionnaire was required. Therefore, the questionnaire was comprised of 43 questions because it was necessary to survey the seafarers who were temporarily trained for a short period. Since seafarers are the subject of the implementation of the Code, the questionnaire was targeted at merchant officers, including captains and chief engineers and excluded members of rating and other departments such as the cooking department.

The studies of Wiegmann et al. (2003) and KTSA (2008) were utilised to develop the questionnaire items but modified to fit the maritime context. In addition, related to the learning and communication indicators, which were added, the relevant questions were prepared using the items that were developed in other studies (ABS, 2012; Song, 2014).

The response was chosen from the 5-point Likert scale, with one as "not at all" and five as "very agree". Questions by indicators are arranged randomly in the questionnaire, and to increase the reliability of the response, some of the items were prepared as negative statements. The survey items are attached in the Appendix B of this dissertation.

5. DATA ANALYSIS

5.1 Demographic characteristics of respondents

The survey was conducted from July 20, 2017 to August 18, 2017 at a training institute in Korea. Seafarers in active service were targeted, and 261 respondents replied. Excluding the unanswered questionnaires, the questionnaires of 208 respondents were utilised for the analysis. The general characteristics of the respondents are described in Table 14.

Table 14 General characteristic of the respondents

Division		Ocean going ships		Coastal ships		Total	
		No	Percent	No	Percent	No	Percent
Total number of respondents		126	60.6	82	39.4	208	100
Gender	Female	5	55.6	4	44.4	9	4.3
	Male	121	60.8	78	39.2	199	95.7
Rank	Senior officers	59	51.8	55	44.4	114	54.8
	Junior officers	67	71.3	27	39.2	94	45.2
Years of service	1-4 years	61	77.2	18	22.8	79	38.0
	5-9 years	22	73.3	8	26.7	30	14.4
	10-14 years	7	43.8	9	56.3	16	7.7
	15-19 years	12	66.7	6	33.3	18	8.7
	20 – 24 years	9	47.4	10	52.6	19	9.1
	More than 25 years	15	32.6	31	67.4	46	22.1
Type of ship	Container	14	82.4	3	17.6	17	8.2
	Bulk carrier	18	94.7	1	5.3	19	9.1
	Tanker	24	75.0	8	25.0	32	15.4
	LNG carrier	10	100.0	0	0.0	10	4.8
	Passenger ship	9	27.3	24	72.7	33	15.9
	Car carrier	4	100.0	0	0.0	4	1.9
	General cargo	16	53.3	14	46.7	30	14.4
	Chemical carrier	18	75.0	6	25.0	24	11.5
	Others	13	33.3	26	66.7	39	18.8

All respondents selected were officers, including captains and chief engineers who are working as managers on vessels. Furthermore, the respondents were distinguished as seafarers aboard vessels engaged on international voyages (ocean-going seafarers) and seafarers aboard vessels engaged on domestic voyages (domestic-sailing seafarers). 126 ocean-going seafarers accounted for 60.6 percent of the total respondents, while 82 domestic sailing seafarers (39. 4 percent) replied. Regarding gender, only 4.3 percent of the respondents were female officers, which accounted for a negligible portion.

Regarding the rank, the survey was targeted at both deck officers and engine officers. Senior officers such as captains, chief engineers, chief officers and 1st engineers replied, accounting for 54 percent of the total, while junior officers including 2nd officers, 2nd engineers, 3rd officers and 3rd engineers accounted for 45 percent. Therefore, the response rate of the higher ranking officers was higher than that of junior officers.

In addition, except for 79 of the respondents (38 percent of respondents), the remaining respondents have more than five years of work experience, so their work experience seems to be abundant. The majority of respondents were engaged on passenger ships, tankers and general cargo ships. In addition, 39 respondents were engaged on other ships, which include tugboats, and cable laying ships.

5.2 Reliability and validity of measurement instruments

When designing questionnaires and conducting statistical analyses, the reliability and validity of these measures are considered important for the study. Reliability analysis is a process required to show the accuracy of the measurement tool, and it is a process of confirming whether it is accurate and consistently measured by a survey respondent. Validity also indicates whether a tool is measuring the concept (Song, 2015).

First, for the reliability measurement, the value of the Cronbach α for internal consistency is widely used in studies, and a value of 0.6 or more is considered to be reliable. Therefore, through exploratory factor analysis, the Cronbach α Coefficient for

each of the items classified by the same factor was identified in the results of the rotated component matrix by Varimax. The items with low reliability were removed from all the items, and the measurement was repeated, confirming that all factors satisfied the reliability test. In the initial 43 items, exploratory factor analysis and reliability analysis were performed. After removing six items that were considered to be problematic in reliability, the Cronbach α value of all items was found to be 0.6 or higher as shown in Table 15.

Table 15 Reliability of measurement items

Items / Indicators	Items	Delated items	Final items	Cronbach α
Organisational Commitment	Q6, Q3, Q5, Q13, Q1, Q12, Q43, Q17	-	Q6, Q3, Q5, Q13, Q1, Q12, Q43, Q17	.93
Management Involvement	Q4, Q7, Q18, Q19, Q22, Q23	-	Q4, Q7, Q18, Q19, Q22, Q23	.86
Reward system	Q8, Q9, Q14, Q15, Q16	Q8	Q9, Q14, Q15, Q16	.68
Employee empowerment	Q10, Q11, Q20, Q21, Q24, Q25, Q26	Q10, Q24, Q26	Q11, Q20, Q21, Q25	.70
Reporting system	Q27, Q28, Q29, Q31, Q32, Q33, Q36	-	Q27, Q28, Q29, Q31, Q32, Q33, Q36	.90
Learning	Q30, Q34, Q35, Q37, Q38	Q30, Q38	Q34, Q35, Q37	.84
Communication	Q39, Q40, Q41, Q42, Q2	-	Q39, Q40, Q41, Q42, Q2	.82
Sum of the number	43	6	37	-

For the purpose of verifying the validity of the measurement instrument, exploratory factor analysis was conducted. Principal component analysis was used to extract the constituent factors for the measurement variables, and the orthogonal rotation method (Varimax) was adopted to simplify factor loading, which refers to the correlation between each variable and factor. A value of factor loading of 0.4 or greater is considered a significant variable. Therefore, in this study, items were constructed based on seven common factors through principal component analysis, and items with factor loading value of 0.4 or higher were selected. Among 43 items, one item was removed from the Reward system, three items from the Employee empowerment,

and two items from Learning were removed, and 37 items were finally selected.

The value of Kaiser-Meyer-Olkin (KMO) is a measure of the degree to which the correlation between variables is explained by other variables. This is used to verify the suitability of the factor analysis and indicates that a value of 0.8 or higher is favourable (Song, 2014: Song, 2015). The results of this study showed that the KMO value was 0.928 and the selection of the variables was satisfactory. As a result of Bartlett's sphere formation test, the significance probability was less than 0.01, and the factor analysis model was found to be suitable.

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Table 16 Result of the exploratory factor analysis

Factor	Items	Loading factor	Commonalities	Eigen value	Variance
Organizational commitment	Q6	.819	.764	5.660	15.298
	Q3	.788	.710		
	Q5	.780	.653		
	Q13	.774	.746		
	Q1	.743	.724		
	Q12	.736	.735		
	Q43	.651	.723		
	Q17	.642	.612		
Reporting System	Q33	.772	.664	4.568	12.346
	Q29	.751	.649		
	Q28	.736	.684		
	Q32	.708	.640		
	Q27	.687	.680		
	Q36	.643	.696		
	Q31	.641	.657		
Management Involvement	Q22	.716	.752	3.797	10.263
	Q18	.682	.610		
	Q7	.665	.652		
	Q4	.649	.644		
	Q19	.642	.546		
	Q23	.601	.550		
Communication	Q40	.784	.655	3.339	9.025
	Q39	.739	.655		
	Q42	.714	.667		
	Q41	.666	.615		
	Q2	.535	.485		
Employee empowerment	Q20	.692	.585	2.356	6.367
	Q11	.658	.616		
	Q21	.620	.454		
	Q25	.543	.520		
Learning	Q34	.785	.733	2.139	5.781
	Q35	.684	.746		
	Q37	.633	.748		
Reward System	Q16	.750	.666	2.083	5.630
	Q9	.670	.578		
	Q14	.642	.637		
	Q15	.563	.492		
Kaiser-Meyer-Olkin (KMO)			0.928		
Bartlett's Test of Sphericity			4433.675		
Sig. (p<0.001)			0.000		

5.3 Data analysis of safety culture indicators

5.3.1 Overall analysis of the survey result

The mean values of safety culture perception of seafarers working on the ocean going vessels wherein the Code applied and the coastal going ships wherein the simplified Code applied by the domestic law was described as shown in Figure 6. Comparing the average values of perceptions of the seven factors of safety culture, the mean values of the ocean-going vessels and coastal going vessels were 3.50 and 3.33, respectively. Therefore, the perception of the seafarers employed in ships engaged on international voyages is higher than the perception of the seafarers employed in ships engaged in coastal going voyages. Among the seven factors of safety culture, employee empowerment was the highest in both groups, while the lowest factors were organisational commitment (3.33) in the group of seafarers employed in ocean-going vessels and reporting system (2.99) in the group of seafarers employed in domestic vessels.

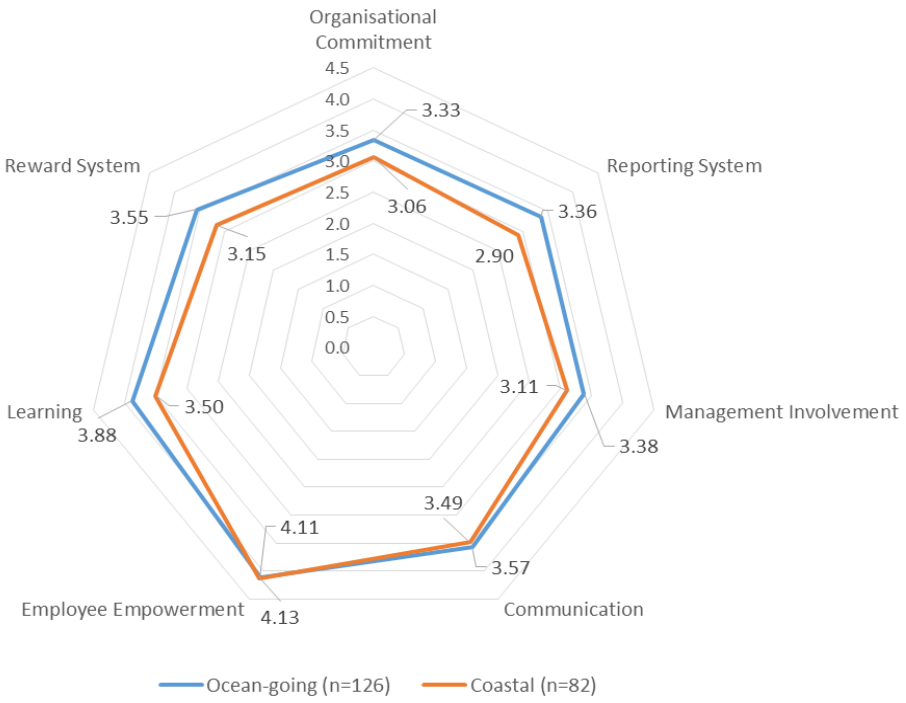

Figure 3 Comparisons of perception on safety culture indicators

Table 17 Comparisons of perception on safety culture indicators

Divisions	Mean		Std. Deviation	
	Ocean-going	Coastal	Ocean-going	Coastal
Organisational Commitment	3.33	3.06	0.84	0.82
Reporting System	3.36	2.90	0.80	0.69
Management Involvement	3.38	3.11	0.74	0.81
Communication	3.57	3.49	0.67	0.77
Employee Empowerment	4.11	4.13	0.65	0.70
Learning	3.88	3.50	0.74	0.78
Reward System	3.55	3.15	0.48	0.69
Average	3.60	3.33	0.70	0.75

5.3.2 Comparative analysis of average value of safety culture indicators

Comparing the mean difference on each safety culture factor between the two groups, the remaining six safety culture factors, except employee empowerment, showed that the perception of seafarers on board ocean going vessels was higher than the perception of those on domestic ships as shown in Figure 7. Among the indicators that were above the overall mean value (0.26), the most significant difference was the reporting system (0.45), followed by the Reward system (0.41),

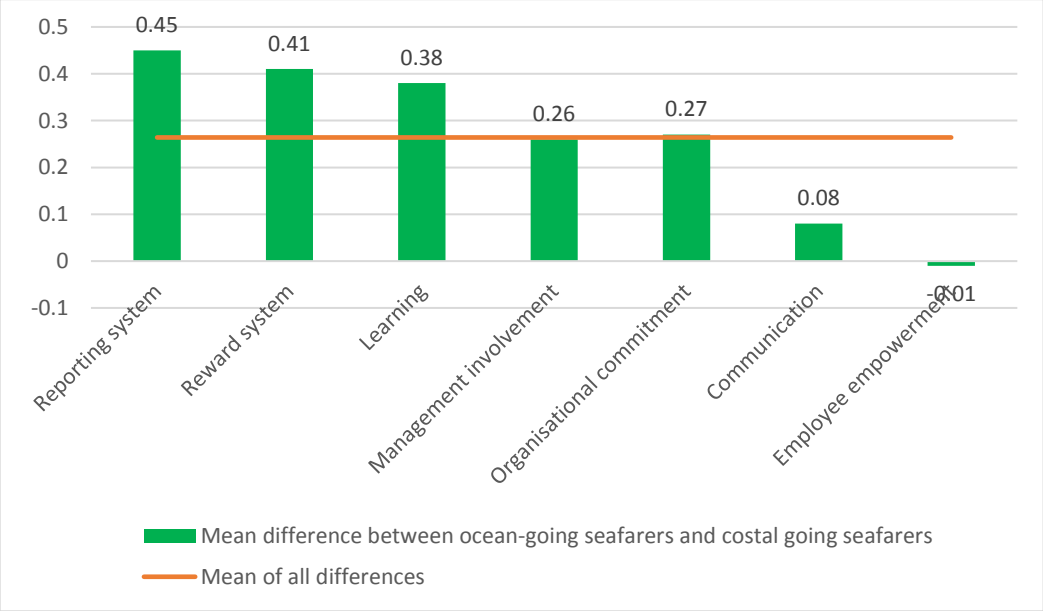

Figure 4 Mean differences of safety culture indicators

Learning (038), Organizational Commitment (0.27), and Management Involvement (0.26). Therefore, reporting, reward system, learning, organisational commitment, and management involvement among all safety culture factors could be deemed to be the five factors of safety culture that have the greatest influence from the application of the Code.

5.3.3 Analysis of the correlation of the safety culture indicators

A correlation analysis was conducted with the safety culture average (3.49) and each of the seven safety factors to identify the correlation between the safety culture and all its factors as shown in Table 18. In the analysis, the closer the value is to ±1, the higher the correlation has. The closer to 0, the lower the correlation. In general, if the value is 0.5 or more, the correlation is higher (KTSA, 2008).

Table 18 Correlation analysis of the safety factor and the seven factors

		Safety Culture	Organisational Commitment	Reporting System	Management Involvement	Communi-cation	Reward System	Employee Empowerment	Learning
Safety Culture	Pearson Correlation	1							
	Sig. (2-tailed)								
Organisational Commitment	Pearson Correlation	.771**	1						
	Sig. (2-tailed)	.000							
Reporting System	Pearson Correlation	.775**	.595**	1					
	Sig. (2-tailed)	.000	.000						
Management Involvement	Pearson Correlation	.791**	.634**	.646**	1				
	Sig. (2-tailed)	.000	.000	.000					
Communi-cation	Pearson Correlation	.695**	.359**	.413**	.431**	1			
	Sig. (2-tailed)	.000	.000	.000	.000				
Reward System	Pearson Correlation	.571**	.408**	.302**	.372**	.260**	1		
	Sig. (2-tailed)	.000	.000	.000	.000	.000			
Employee Empowerment	Pearson Correlation	.615**	.284*	.312**	.294**	.520**	.318**	1	
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000		
Learning	Pearson Correlation	.769**	.481**	.528**	.510**	.525**	.324**	.447**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	

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

Each sub-index showed a high correlation with the average (3.49) of the safety culture, which indicates that each sub-index is well represented as an element of safety culture (KTSA, 2008). In particular, the correlation between safety culture and management involvement (0.791) was the most correlated. It can be said that management's interest and involvement are closely related to safety culture. Furthermore, management involvement was closely correlated with reporting system (0.646), which had a significant difference between the two groups.

5.4 Hypothesis testing

To test the hypothesis that ocean-going seafarers' awareness of maritime safety culture is higher than that of coastal going seafarers, an analysis was conducted by using an independent-sampled t-test on each indicator of maritime safety culture as shown in Table 19.

As a result of the t-test for the total safety culture (the average of the seven factors) and the seven sub-indicators, there was statistically a significant difference in the overall perception of safety culture according to the navigational area ($p < 0.01$). In other words, there was a difference in the perception of safety culture of the seafarers of ocean-going vessels and domestic vessels, and the perception of those on ocean going ships is higher than that of those on domestic ships.

Table 19 the result of independent sampled t-test analysis

Divisions	Mean		Std. Deviation		t	p
	Ocean -going	Coastal	Ocean-going	Coastal		
Safety culture	3.60	3.33	0.55	0.46	3.599	.000
Organisational Commitment	3.33	3.06	0.84	0.82	2.304	.022
Management Involvement	3.38	3.11	0.74	0.81	2.535	.012
Reward System	3.55	3.15	0.48	0.69	4.984	.000
Employee empowerment	4.11	4.13	0.65	0.70	-.147	.884
Reporting System	3.36	2.90	0.80	0.69	4.200	.000
Learning	3.88	3.50	0.74	0.78	3.504	.001
Communication	3.57	3.49	0.67	0.77	.789	.431

There were no statistically significant differences (P> 0.05) in *communication* and *employee empowerment* factors among the seven indicators of maritime safety culture between two groups.

On the other hand, the perception of the safety culture at sea was different between the two groups regarding *organizational commitment, reporting system, management involvement, learning and reward system*, and seafarers of ocean-going vessels had a high perception ($p < 0.05$).

According to the result of the T-test, the hypothesis H1 that the recognition of the crew employed on vessels engaged in international voyages of organisational commitment is higher than that of those engaged on domestic vessels was adopted as $p < 0.05$ ($p = 0.022$) and $t = 2.304$. Hypothesis H2 on the management involvement was adopted as $p < 0.05$ ($p = 0.12$) and $t = 2.535$. Hypothesis H3 about reward system was adopted as $p < 0.01$ ($p = 0.000$) and $t = 4.984$. However, hypothesis H4 about employee empowerment was rejected with $p > 0.05$ ($p = 0.884$) and t value with -0.147. Meanwhile, hypothesis H5 about reporting system was adopted as t value of 4.200 for $p < 0.01$ ($p = 0.000$) and hypothesis H6 about learning was adopted for $p < 0.01$ ($p = 0.001$) and t value of 3.504. Finally, hypothesis H7 on communication was rejected as $p > 0.05$ ($p = 0.431$) and t value as 0.789. The results of the hypotheses verification are shown in Table 20 below.

Table 20 Testing hypotheses

No	The description of the Hypothesis	Result of t-test
H1	The awareness of o*rganisation commitment* of seafarers employed on ocean going vessels will be higher than that of seafarers on domestic vessels.	Adoption
H2	The awareness of *management involvement* of seafarers employed on ocean going vessels will be higher than that of seafarers on domestic vessels.	Adoption
H3	The awareness of *reward system* of seafarers of seafarers employed on ocean going vessels will be higher than that of seafarers on domestic vessels.	Adoption
H4	The awareness of *employ empowerment* of seafarers employed on ocean going vessels will be higher than that of seafarers on domestic vessels.	Dismissal
H5	The awareness of *reporting system* of seafarers employed on ocean going vessels will be higher than that of seafarers on domestic vessels.	Adoption
H6	The awareness of *learning* of seafarers employed on ocean going vessels will be higher than that of seafarers on domestic vessels.	Adoption
H7	The awareness of the *communication* of seafarers employed on ocean going vessels will be higher than that of seafarers on domestic vessels.	Dismissal

5.5 Summary of the main results

The basic research question in this study is whether the implementation of the ISM Code (the Code) positively affects the safety culture awareness of seafarers. To find the answer, seafarers' consciousness about safety culture was investigated, and the result of the survey are as follows.

i) Dimensions for measuring safety culture

To develop a tool for measuring the safety culture perception of seafarers, the five factors of safety culture were found based on the study of Weigmann (2003) among research cases in aviation. Two factors related to the ISM Code and maritime safety culture were added to these, and a total of seven safety culture factors were derived.

- As a result, the following were obtained: organizational commitment, management involvement, reporting system, employee empowerment, reward system, learning, and communication. Forty-three questionnaire items for safety culture measurement were selected according to these factors.

ii) Relationship between ISM Code and safety culture

As shown in Figure 5 in Chapter 4, all safety culture factors were closely related to the elements of the ISM Code, as a result of analyzing the correlation between the elements of the Code and the seven safety culture factors derived. Therefore, if the level of safety culture consciousness is high, the implementation of the ISM Code will be considered effective.

iii) Results of the survey

As a result of analyzing the level of seafarers' perception of safety culture between the two groups, there were significant differences in five of the safety culture factors, except for employee empowerment and communication. The seafarers' awareness

level of the safety culture of ocean-going ships was higher than that of those on domestic vessels.

- The difference was most significant in the perception of reporting system between seafarers in ocean-going vessels and those in domestic ships. Reward system, learning, organizational commitment, and management involvement also showed a significant difference between the two groups.
- Both groups had the highest level of perception of employee empowerment among the safety culture factors with a score of 4.0 or higher.
- As a result of correlation analysis between safety culture and its seven factors, it was found that safety culture has the highest correlation with management involvement.

iv) The result based on the t-test to verify hypotheses was acquired as shown in Table 19.

6. DISCUSSION AND CONCLUSION

6.1 Discussion of the findings

The main points of this study will be examined based on the results of the hypotheses verification.

First, they are related to whether the ISM Code is effective in the promotion of safety culture. Since the implementation of the Code, various studies have been conducted on its effectiveness. The IMO (2004) and Lappalaine (2016) found that the implementation of the Code had a positive impact on the formation of a good safety culture. Through this study, it was quantitatively proved that the safety culture perception of seafarers on vessels to which the Code is applied is significantly higher than that of seafarers onboard domestic vessels. Since safety culture and the ISM system are closely related, it was confirmed that the Code had a positive effect on promoting safety culture.

Second, regarding the survey results of the seven factors of safety culture, there were significant differences in the reporting system, reward, and learning system between both groups at the significance level compared with the overall mean difference. It also showed that management involvement and organizational commitment had significant differences. However, there was no significant difference in employee empowerment and communication. Therefore, it can be seen that the ISM Code positively affects safety culture, especially the reporting system, reward system, learning, management involvement, and organizational commitment among the safety culture factors. Nevertheless, studies of the impact of the Code also pointed to weakness in employee empowerment and communication. Bhattacharya (2009)

found that since the implementation of ISM, there has been a lack of communication related to safety issues between shore and ship and that the Code has not had a significant effect on communication. Furthermore, Bhattacharya (2012) indicated that *"employee participation in the management of shipboard safety were largely absent in the maritime context."* As a result, it is proven quantitatively that the effectiveness of the ISM Code on employee empowerment and communication is not significant. Therefore, the ISM Code affects partially the promotion of safety culture.

Third, in relation to the suitability of the survey tool for safety culture measurement, the results obtained in this study and the results of other studies on safety culture measurements performed in the aeronautical field are compared, although the validity and reliability of the tool were already examined in Chapter 5. When comparing the results of the study of KTSA (2008) based on the five factors of safety culture (Weigmann et al., 2002) and the average of the result of this study (3.41), the average value of the perception of safety culture of aviation pilots working in Korean airlines was measured to be 3.40, and that of American pilots was measured to be 3.60. Similar results were obtained when compared with the aeronautical measurement results. Therefore, it is considered that the safety culture measurement tool applied in this study is appropriate.

Fourth, through the analysis of the correlation between factors of safety culture, it was confirmed that management involvement and reporting system are the most influential factors in safety culture. Management's interest and participation in ship operations and safety activities will be the most important factor in promoting ship safety culture. This is also consistent with the study of KTSA (2008), which identified management involvement as an important factor in building a good safety culture. Meanwhile, in relation to the reporting system, there should be an atmosphere that encourages reporting of the errors and problems in the ship voluntarily and without difficulties at the employee level.

Finally, regarding the level of recognition of safety culture of Korean seafarers, employee empowerment was the highest among factors of safety culture, and there was no significant difference in the perceptions of the seafarers. Employee empowerment is mainly the responsibility of the seafarers and the fulfilment of authorities. According to Kim (2013), the characteristics of Korean seafarers were

basically *"affection to others,*" and Confucian customs have a great influence on the consciousness of the seafarer. In other words, it is a characteristic of Korean seafarers that hierarchical order is emphasized. The results of the survey showed that these characteristics were well demonstrated. The items with a score of 4.0 or higher were “I want to be respected by other crews through safety activities” and “I have to do everything I can to prevent accidents.” Employee empowerment relates to the unique national character of Koreans, and the evaluation result is considered to be of a high level. Therefore, it can be seen that the dominant safety culture characteristic of Korean seafarers is employee empowerment resulting from a strong sense of responsibility.

6.2 Conclusion

This study began with questions in the relevant academic dispute over the effectiveness of the ISM Code on safety culture. To prove the proposition that the ISM Code has a positive effect on safety culture, a qualitative study was conducted. Since the development of a scale to measure seafarer perception of safety culture was required, the concept of safety culture and safety climate and the factors for forming a good safety culture were explored. In this process, it was possible to select the seven factors of safety culture, which are organizational commitment, management involvement, employee empowerment, reporting system, learning, reward system, and communication. The questionnaire items were developed to target seafarers through a review of past literature and research. In addition, an analysis of the relationship between the elements of the ISM Code and factors of safety culture was conducted, and it was confirmed that these seven safety culture factors are closely related to elements in the ISM Code.

In the result of the survey of Korean seafarers, the perception of safety culture of seafarers engaged in ocean-going vessels where the ISM Code applied is higher than that of those in domestic vessels where the simplified ISM Code is applied. There were significant differences in recognition among the safety factors except for two: employee empowerment and communication. For the five factors that differed, the

seafarers on international vessels had higher perception than those on domestic vessels. In particular, the reporting system, reward system, and learning showed great differences between the two groups, and the ISM Code was found to be the most effective for these factors. As for employee participation and communication, there was no difference between the two groups, and it was found that the ISM Code was not effective for these factors. This is consistent with other studies (Bhattacharya, 2012; Lappalainen, 2016). Furthermore, among the safety culture factors, it is possible to recognize that the unique characteristics of Korean seafarers are employee empowerment, which means active participation in safety-related shipboard work and employee responsibility for safety.

Through this study, it will be possible to establish measures to promote safety culture. As the rate of Korean domestic vessel accidents is higher than that of international voyages, it is necessary to identify vulnerable elements of safety culture and strengthen safety management. Based on the results of the study, a more effective way to promote safety culture would be if the maritime education system and safety management system related to the reporting system and the reward system, which have low recognition levels compared to seafarers working on international vessels, would be improved.

To prevent maritime accidents, efforts should be made to improve maritime safety culture. Furthermore, it is necessary to grasp the level of awareness of the present safety culture so that more concrete improvement measures will be prepared. In the meantime, safety culture has been recognized, and safety systems and regulations have been improved following the occurrence of major disasters. What is required for safety enhancement is an empirical study on safety culture with a concrete approach. Through this study, appropriate tools for maritime safety culture measurement were developed for seafarers. This study was able to quantitatively measure the perception of safety culture, meaning that the effectiveness of the ISM Code on safety culture can be verified as an empirical study.

6.3 Limitation and further studies

In this study, the seafarers were classified into two groups: those employed in vessels sailing on international voyages and those employed in ships sailing on domestic voyages. However, Zohar (2000) suggested that when measuring safety culture, a single organization or a group should be analyzed or compared. Chouhry, Fang and Mohamed (2007) noted that safety culture research needs to be aware of whether selected groups or organizational levels truly represent natural groups with a relatively homogeneous culture. As safety culture is based on the common consciousness of the members of an organization, a limitation of this study is that seafarers belonging to various ship types and shipping companies are set as one group. In a follow-up study, it is necessary to develop a safety culture measurement method by narrowing the research subjects to one organization or one ship type.

In addition, this study evaluated the consciousness level of safety culture of the crew quantitatively through questionnaires. As a result, the interpretation of the questionnaire could not be conducted through in-depth interviews with the same seafarers who responded to the questionnaire. For a comprehensive conceptual approach to studying safety culture, qualitative research methods should be carried out with quantitative research methods (Guldenmund, 2000). Therefore, in future research, it will be necessary to introduce the interview technique in parallel with questionnaires to get more in-depth results.

The third issue is related to whether the ISM Code is the only factor that creates a difference in the safety culture consciousness level of seafarers. In reality, there are many potential complexities for seafarers regarding education level, salary level, welfare level, and job consciousness. In this study, there is a limitation that only the navigation area is classified, and only matters concerning the application of the ISM Code are evaluated.

Future research will need to study how to use the results of safety culture measurement. To promote safety culture effectively, it is necessary to conduct further studies to develop the methods to be applied to the ships, for instance, promotions, education, and training system.

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APPENDIX A

Survey result arranged by indicators

	Questionnaire items	Mean	
		Ocean	Coastal
Organisational commitment	Q.1 Following safety procedures is consistently expected.	3.94	3.38
	Q.3 Management doesn't show much concern for safety until there is an accident or incident.*	3.45	2.95
	Q.5 If work is busy, safety work may not work well.*	3.05	2.94
	Q.6 Management tries to get around safety requirements whenever they get a chance.*	3.37	3.13
	Q.12 Management is willing to invest money and effort to improve safety.	3.34	3.13
	Q.13 Management is more concerned with making money than being safe.*	2.94	2.78
	Q.17 My company does not cut corners where safety is concerned.	3.22	2.99
	Q.43 Management does all it can to prevent accidents or incidents.	3.35	3.18
	Average	3.33	3.06
Management involvement	Q.4. Management involvement in safety issues has a high priority at my company.	3.55	3.17
	Q.7 My company's safety department is doing a good job.	3.52	3.13
	Q.18 Upper level management gets personally involved in safety activities.	2.95	2.85
	Q.19 Safety standards are seldom discussed openly.*	3.33	3.13
	Q.22 Management is receptive to learning about safety concerns.	3.79	3.27
	Q.23 Managers does not hesitate to approach masters or crew members to discuss safety issues.	3.15	3.07
	Average	3.38	3.11
Reward system	Q9 Management negatively evaluates crew members who behave recklessly.	3.90	3.38
	Q14 Safe crew members' performance is evaluated using clear standards.	3.43	3.21
	Q15. Crew members who cause accidents or incidents are not held sufficiently accountable for their actions.*	3.31	2.87
	Q.16 Action is consistently taken against crew members who violate safety procedures or rules.	3.56	3.13
	Average	3.55	3.15

	Questionnaire items	Mean	
		Ocean	Coastal
Employee empowerment	Q11. The best officer or master or chief engineer in the group expect other crews to behave safely.	4.08	4.15
	Q20. Crews do all they can to prevent accidents.	4.37	4.32
	Q21. Management ensures that all crews are responsible and accountable for safe operation.	3.88	3.84
	Q25. It is important for me to operate safely if I am to keep the respect of other crews in my ship.	4.11	4.20
	Average	4.04	4.12
Reporting system	Q27. I am familiar with the system for formally reporting safety issues in my company.	3.64	3.16
	Q28. Safety issues raised by crews are communicated regularly to all crews in the company.	3.82	3.12
	Q29. Crews hesitate to report minor injuries and incidents.*	3.00	2.57
	Q31. When a crew member reports a safety problem, management acts quickly to correct safety issues.	3.41	3.00
	Q32. Crews who raise safety concerns are seen as troublemakers.*	3.47	2.94
	Q33. There is no point in reporting a near miss.*	2.87	2.48
	Q36. I am satisfied with the way this company deals with safety reports.	3.28	3.06
	Average	3.36	2.90
Learning	Q34. I think support for education is very valuable.	4.26	3.76
	Q35. The issue of safety is shared by all crew members as a best practice through review and analysis.	3.76	3.44
	Q37. Safety system (issues) is improved based on past experiences, news related the safety issue or recognized solution.	3.62	3.32
	Average	3.88	3.50
Communication	Q2. There is good communication on this ship about safety issues.	3.72	3.57
	Q39. I always give proper instructions when I initiate any work.	3.67	3.60
	Q40. I can tell my straightforward thoughts without fear of being subjected to retaliatory measures.	3.30	3.32
	Q41. I always ask questions if I do not understand the instructions given to me, or I am unsure of the relevant safety precautions.	3.76	3.54
	Q42 There is mutual trust between the manager and crew based on honesty and truthfulness.	3.37	3.40
	Average	3.57	3.49

Appendix B

Questionnaire

This is a questionnaire for measuring the climate on board. All materials will be used for research purposes and will be anonymized. Therefore, please read the question, and I would appreciate it if you would like to be honest.

<Personal information>

1. What is your rank?

□ Captain □ Chief Officer □ 2nd Officer □ 3rd Officer
□ Chief Engineer □ 1st Engineer □ 2nd Engineer
□ 3rd Engineer □ Others ( )

2. Gender

□ Female □ Male

3. Type of ships

Container □ Bulk carrier □ Oil tanker □ LNG carrier □
Passenger ship □ Car carrier □ General cargo □
Chemical carrier □ others □

4. Navigational service area

Ocean going voyage □ Domestic voyage □

5. Years of work experience at sea

( )years

6. Ship tonnage – the latest ship

100- 499 G/T □ 500 – 1000 G/T □ 1000- 2000 G/T □
2000- 5000 G/T □ 5000-10000 G/T □ 10000 – 30000 G/T □
30000- G/T □

7. Have you experienced an accident or incident? Yes □ No □

8. Have you experienced a near miss? Yes □ No □

	Please answer the following questions, by checking one number from one to five.	Disagree	Disagree slightly	Netual	Agree slightly	Agree
1	Following safety procedures is consistently expected.	①	②	③	④	⑤
2	There is good communication on this ship about safety issues.	①	②	③	④	⑤
3	Management doesn't show much concern for safety until there is an accident or incident.	①	②	③	④	⑤
4	Management involvement in safety issues has a high priority at my company.	①	②	③	④	⑤
5	If work is busy, safety work may not work well.	①	②	③	④	⑤
6	Management tries to get around safety requirements whenever they get a chance.	①	②	③	④	⑤
7	My company's safety department is doing a good job.	①	②	③	④	⑤
8	Being involved in an accident or incident has an adverse effect on a seafarer's future with this company.	①	②	③	④	⑤
9	Management negatively evaluates crew members who behave recklessly.	①	②	③	④	⑤
10	Crew members are seldom asked for input when safety procedures or other guideline are developed or changed.*	①	②	③	④	⑤
11	The best officer or master or chief engineer in the group expect other crews to behave safely.	①	②	③	④	⑤
12	Management is willing to invest money and effort to improve safety.	①	②	③	④	⑤
13	Management is more concerned with making money than being safe.	①	②	③	④	⑤
14	Safe crew members' performance is evaluated using clear standards.	①	②	③	④	⑤

15	Crew members who cause accidents or incidents are not held sufficiently accountable for their actions.	①	②	③	④	⑤
16	Action is consistently taken against crew members who violate safety procedures or rules.	①	②	③	④	⑤
17	My company does not cut corners where safety is concerned.	①	②	③	④	⑤
18	Upper level management gets personally involved in safety activities.	①	②	③	④	⑤
19	Safety standards are seldom discussed openly.	①	②	③	④	⑤
20	Crews do all they can to prevent accidents.	①	②	③	④	⑤
21	Management ensures that all crews are responsible and accountable for safe operation.	①	②	③	④	⑤
22	Management is receptive to learning about safety concerns.	①	②	③	④	⑤
23	Managers does not hesitate to approach masters or crew members to discuss safety issues.	①	②	③	④	⑤
24	Crews try to get around safety requirements whenever they get a chance.	①	②	③	④	⑤
25	It is important for me to operate safely if I am to keep the respect of other crews in my ship.	①	②	③	④	⑤
26	Crews often encourage one another to work safely.	①	②	③	④	⑤
27	I am familiar with the system for formally reporting safety issues in my company.	①	②	③	④	⑤
28	Safety issues raised by crews are communicated regularly to all crews in the company.	①	②	③	④	⑤
29	Crews hesitate to report minor injuries and incidents.	①	②	③	④	⑤
30	Crews are given enough training to perform their work safely.	①	②	③	④	⑤

31	When a crew member reports a safety problem, management acts quickly to correct safety issues.	①	②	③	④	⑤
32	Crews who raise safety concerns are seen as troublemakers.	①	②	③	④	⑤
33	There is no point in reporting a near miss.	①	②	③	④	⑤
34	I think support for education is very valuable.	①	②	③	④	⑤
35	The issue of safety is shared by all crew members as a best practice through review and analysis.	①	②	③	④	⑤
36	I am satisfied with the way this company deals with safety reports.	①	②	③	④	⑤
37	Safety system (issues) is improved based on past experiences, news related the safety issue or recognized solution.	①	②	③	④	⑤
38	If you have reported concerns on ship's safety, you feel measures are not taken within reasonable time	①	②	③	④	⑤
39	I always give proper instructions when I initiate any work.	①	②	③	④	⑤
40	I can tell my straightforward thoughts without fear of being subjected to retaliatory measures.	①	②	③	④	⑤
41	I always ask questions if I do not understand the instructions given to me, or I am unsure of the relevant safety precautions.	①	②	③	④	⑤
42	There is mutual trust between the manager and crew based on honesty and truthfulness.	①	②	③	④	⑤
43	Management does all it can to prevent accidents or incidents	①	②	③	④	⑤