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WORLD MARITIME UNIVERSITY

Malmö, Sweden

**A STUDY ON THE EFFECTIVENESS OF THE
ISM CODE THROUGH A COMPARATIVE
ANALYSIS OF ISM AND PSC DATA**

By

Min-Jung Lee

The Republic of Korea

A dissertation submitted to the World Maritime University in partial
Fulfilment of the requirements for the award of the degree of

MASTER OF SCIENCE

In

MARITIME AFFAIRS

(MARITIME SAFETY AND ENVIRONMENT ADMINISTRATION)

2016

DECLARATION

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 through a comparative analysis of ISM and PSC data

Degree: **MSc**

This dissertation aims to examine the effectiveness of the ISM Code in the shipping industry through a comparative analysis of ISM audit and PSC inspection data. This paper focuses on the improvement mechanism of the ISM Code which, to an extent, can be an indicator to measure the effectiveness of the Code. The assumption is that if the ISM Code is working correctly, the ISM audit (PSC inspection) should have a positive impact on the following PSC inspection (ISM audit). On that basis, the paper analysed how the ISM audits and PSC inspections influenced each other, and how this influence changes in two separate time frames.

The analysis revealed that the ISM audit showed a positive impact on overall aspects of the safety management system; on the other hand, the effects of the PSC have appeared in limited areas such as maintenance, and documentation where the ISM audit showed vulnerability. It also found that the effect of the ISM audit appeared after a longer period, while the impact of the PSC inspection was exhibited in the short term period.

The result affirmed that the ISM Code has strengths in its continuous improvement which requires a systematic approach, whereas PSC is robust in addressing immediate problems through its police function. The paper identified a complementary relationship between the ISM Code and PSC inspection. It showed the possibility that the police power of the PSC can supplement the weakness of the ISM Code in the short term, and at the same time, the continuous improvement of the ISM Code can make the PSC inspection more effective.

This dissertation found that the ISM Code is partially working. In order to address the improper functioning of the improvement mechanism relating to the PSC deficiencies, it was proposed that more attention be given to whether corrective actions were appropriately taken concerning previous PSC deficiencies.

KEYWORDS: ISM, PSC, Effectiveness, improvement mechanism, police power

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LIST OF ABBREVIATIONS

Abuja MoU	The memorandum of understanding on port state control for the west and central Africa region
APCIS	The Asia-Pacific Computerized Information System
Black sea MoU	The memorandum of understanding on port state control in the Black sea region
BWM	Ballast Water Management
Caribbean MoU	The memorandum of understanding on port state control in the Caribbean region
CIC	Concentrated Inspection Campaign
Circ.	Circulation letter
Civil Liability Convention	International Convention on Civil Liability for Oil Pollution Damage
Def.	Deficiency(-ies)
DOC	Document of Compliance
DP	Designated Person
GISIS	Global Integrated Shipping Information System
G/T	Gross Tonnage
Hong Kong Convention	The Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships
HCG	Hellenic Coast Guard
IACS	International Association of Classification Societies
ILO	International Labour Organization
IMCO	Inter-governmental Maritime Consultative Organization
IMO	International Maritime Organization
Indian Ocean MoU	The memorandum of understanding on port state control for the Indian Ocean region
ISM Code	International Management Code for the Safe Operation of Ships and for Pollution Prevention
ISM-first group	The group of ships have data with ISM audit records followed by PSC inspection
ISO	International Standard Organization

ISPS Code	The International Ship and Port Facility Security Code
Intervention Convention	International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties
ITOPF	The International Tanker Owners Pollution Federation
KR	Korean Register of Shipping
Load Line Convention	International Convention on Load Lines
MarNIS	Maritime Navigation and Information Service
MARPOL	International Convention for the Prevention of Pollution from Ships
Mediterranean MoU	The memorandum of understanding on port state control in the Mediterranean region
MEPC	Marine Environment Protection Committee
MLC	The Maritime Labor Convention
MLTM	Ministry of Land and Transportation and Maritime
MOF	Ministry of Oceans and Fisheries
MOMAF	Ministry of Maritime Affairs and Fisheries
MoU	Memorandum of Understanding
MSC	Maritime Safety Committee
N/A	Not Applicable
NC(s)	Non-Conformity(-ies)
NIR	The New Inspection Regime
OPRC	The international Convention on Oil Pollution Preparedness, Response and Co-operation
Paris MoU	Paris Memorandum of Understanding on Port State Control
P&I	Protection and indemnity
PCs	Pieces
PSC	Port State Control
PSC-first group	The group of ships have data with PSC inspection records followed by ISM audit
PSCO	Port State Control Officer
Res. A	Assembly Resolution
Res. MSC	Maritime Safety Committee Resolution
Riyadh MoU	Riyadh memorandum of understanding on port state control

RO	Responsible Organization
SAR Convention	International Convention on Maritime Search and Rescue
SMC	Safety Management Certificate
SMS	Safety Management System
STCW Convention	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers
SOLAS	International Convention for the Safety of Life at Sea
Tokyo-MoU	The Memorandum of Understanding on Port State Control in the Asia-Pacific region
Tonnage Convention	International Convention on Tonnage Measurement of Ships
UK	United Kingdom of Great Britain and Northern Ireland
UNCLOS	United Nations Convention on the Law of Sea
US	United States
USCG	United States Coast Guard
USD	United States Dollars
UN	United Nations
Viña del Mar	The Acuerdo de Viña del Mar agreement on Port State Control

1. INTRODUCTION

1.1 Background

Since commercial shipping appeared in human history, the shipping industry has been developing safety regulations under its own initiative to protect its property from marine casualties (Anderson, 2003a). The classification societies, for instance, were founded in the nineteenth century to ensure the seaworthiness of ships for insurance purposes, which contributed to considerable technical advances in ships. However, as seaborne trade grew and public concerns escalated due to constant catastrophic marine casualties, the flag States gained the incentive to introduce safety policies (Boisson, 1999).

By this means, various laws and rules of flag States formed traditions in shipping whereby ships are obliged to comply with those safety rules. Simultaneously, flag States took responsibility for ensuring the safety of the shipping fleets flying their flags. This was written into international Conventions under the legal term 'Genuine Link'¹, requiring a flag State to exercise effective control and jurisdiction over vessels flying its flag (Özcayir, 2001).

The International Maritime Organization (IMO), established based on the traditions of flag State responsibility as a specialized agency of the United Nations and, formed by the Member States, enacted the highest practicable international standards for safety, security of ships and pollution prevention. Ever since the establishment of the IMO, the organization has focused on technical issues to

¹ The Geneva Convention on the High Seas 1958, Art.91 of the UNCLOS 1982

improve the safety level of ships, which was ineffective in addressing the underlying factors causing marine accidents (Anderson, 2003a).

Research regarding a series of accidents² in the second half of 1980s and 1990s identified the human element as a major contributing factor to accidents, which provoked a reassessment of IMO's policies and incited a new systematic approach toward maritime safety. In international efforts to eliminate human errors leading to shipping casualties, spearheaded by the UK, the ISM Code was developed. The ISM Code became mandatory through its incorporation in the SOLAS Convention 1974 as Chapter IX at the 2nd session of the SOLAS Conference on 24 May 1994.

The principle objectives of the ISM Code are to ensure safety and pollution prevention concerning ship operations. The Code, unlike prescriptive regulations, has not clearly stated specific technical requirements for ship structure, equipment, and operational aspects. Instead, it sets goal based mandates, requiring shipping companies to develop and implement their own safety management systems based on their individual circumstances. This flexibility, designed to apply the ISM Code to all types of ships, provides the shipping industry with room for further development in terms of safety management but also demands a matured safety management by the industry.

The ISM Code requires shipping companies to establish Safety Management Systems (SMS) which allows verification of the implementation status of various sets of international instruments. Shipping companies can maintain the compliance with internationally endorsed rules by providing SMS, which should be regularly verified by the flag State or Recognized Organization. The SMS ranges from company policies on safety and pollution prevention to procedures for management reviews, which implies that the management of shipping and shipboard work procedures fall into the areas required to comply with international rules.

² Herald of free enterprise (1987), Dona Paz (1987), Exxon Valdez (1989), Scandinavian Star (1990), Agip Abruzzo (1991), Haven (1991), Salem Express (1991), Aegean Sea (1992), Braer (1993), Estonia (1994), Sea Empress (1996)

In fact, regulating the operational procedure was not a completely new concept for the shipping industry. Operational requirements, developed throughout history, have been incorporated into various current rules. For instance, in the middle ages, the large Mediterranean ports enacted stringent regulations to prevent overloading, which passed down to the Merchant Shipping Act of 1876, known as the 'Plimsol Act,' in the UK (Boisson, 1999)

Nevertheless, the value of the ISM Code should be distinguished from the existing operational requirements because it expanded the areas to be regulated to shore management and provided improvement mechanisms for the management system, whereas specific operational requirements are merely focused on specific shipboard activity and take a fragmentary approach. This made the ISM Code one of the most comprehensive and effective tools for ensuring the implementation of flag State obligations together with Port State Control (PSC).

Provided the flag State is a primary actor in the safety of shipping, port State might be called a supporter. The first port State jurisdiction of control over foreign vessels was presented in the SOLAS Convention in 1914, failing to come into force due to World War I. The authority and legal capacity of the port State has been discussed to establish the limits in protecting the interests of port States in various international Conventions³. As the enforcement came into practice in many countries, the PSC regime was widely accepted by the maritime industry as a 'Safety Net' to monitor the safety of shipping and environmental protection (Özcayir, 2001).

The deficiencies identified by PSC inspections do not only imply the defective condition of the ship. The results of the inspections directly present the safety condition of the particular ship, and also the degree of implementation of flag State obligations if they are extended to the whole fleet of the flag State. The rates of detention are commonly utilized in the assessment of the safety level of the flag

³ SOLAS 74, reg. I /19, reg. IX/6 and reg. XI/4; Load Line Convention 1966, Art.21; MARPOL 73/78, Arts.5 and 6, reg.8A of Annex I, reg.15 of Annex II, reg.8 of Annex III and reg.8 of Annex V; STCW 78, Art. X and reg. I/4; Tonnage Convention 1969, Art.12

State by regional PSC MoUs⁴. And the results of PSC inspections have been acknowledged by the way of explicit index as evaluating the performance of the ISM Code since the deficiencies can be said to be the outcome of improper implementation of the Code.

Along with the indicative functions for assessing the performance of the Code, more importantly, PSC inspections substantially impact the safety management systems of ships. If the SMS works properly, the deficiencies identified during PSC inspections should be processed and thereby remedial action should be taken according to the improvement mechanisms of the SMS. In this regard, Anderson (1998) argued that the implementation of the ISM Code depends on how the SMS is addressed and monitored by PSC inspection.

It might be possible to observe, in this respect, how the ISM Code works if we measure the PSC performance after the ISM audit and, equally, evaluating the performance of an ISM audit following PSC inspection would help us to determine whether or not the ISM Code works. Besides, it would be possible to witness how the good performers in ISM audits would perform at the following PSC inspection, which would be practical information for the shipping industry to appreciate the benefit of maintaining fair safety management systems in its companies.

1.2 Objectives

This dissertation started asking whether the ISM Code, and the PSC regime positively impact the safety of ships as much previous literature investigated. Are the audit and PSC inspections contributing to the safety of ship operations? If so, can we demonstrate the same by comparing ISM audit records and PSC inspection records to each other? This paper, based on this idea, will research the effectiveness of the ISM Code by examining how the ISM audit impacts the PSC inspection and vice versa. The study will focus on the data analysis of relations

⁴ Memorandum of Understanding

between performances in ISM audits and PSC inspections. Based on the analysis, it will attempt to interpret the analysis results and seek further improvements to ensure the effective implementation of both regimes.

It is hoped that the study will provide the shipping industry and Administrators with better awareness of the ISM Code and PSC regime, and hopefully it would be taken into account when maritime safety policies are established. Therefore, this dissertation:

- Reviews the pre-literature and methodologies related to examinations of the efficiency of the ISM Code and Port State Control.
- Studies the historical background, features and legal implications of the ISM Code and Port State Control.
- Analyzes the data of ISM audits and PSC inspection results for sampled ships flying the Korean flag for a period of 2.5 years from the 2nd half of 2013 to 2015.
- Tries to interpret the dataset and identify the statistical tendency from it.
- Discusses the implication of the analysis and identifies areas to be addressed for the further improvements.

1.3 Scope of the study

To achieve the objectives of the research, this dissertation consists of 7 Chapters. Chapter 1 introduces the background, objectives and the scope of the study which allows a better understanding of the purpose of the dissertation.

A literature review in connection with the impact and effectiveness of the ISM Code will be undertaken in Chapter 2 to appreciate which methodologies have been applied to seek the results, and how the shipping industry and academia have perceived the impact of the ISM Code. Equally, the paper will look into the literature relating to the impact and benefit on the safety of shipping, legal jurisdiction, targeting and harmonization, and influence of PSC on the shipping industry.

In Chapter 3, the background of the ISM Code as an international regulation will be introduced. The legal implications and relations with flag State obligations and the ISM Code will be studied through international Conventions and literature. In addition, the way in which the ISM Code is implemented in Korea will be presented. It will be concluded with that the main characteristics, the legal implications and traits of the ISM Code to assist in understanding the analysis and discussion of the data in Chapter 6.

In the way of the previous Chapter, Chapter 4 will review the background and the emerging PSC MoUs around the world. The legal implication and current roles of PSCs in relation to maritime safety and pollution prevention will be presented by looking into the relevant Conventions and regional PSC agreements. Further, the PSC practice in the Tokyo-MoU will be briefly addressed, and the implications of PSC regimes on the maritime industry will be summarized.

Chapter 5 will describe the hypothesis of the dissertation and methodology. The expected results, the analysis will be addressed in detail. The method of data analysis including data sources, time frame, coding method, and data classification principles applied will be explained.

As a core part of the writing, the data analysis results will be given in Chapter 6. The outcomes of the study will show how the ISM Code impacts subsequent PSC inspections with the passage of the time, and the same manner of analysis to measure the impact of PSC inspections will be carried out. Furthermore, based on the statistical analysis, the outcomes will be interpreted and discussed, by which, the paper will demonstrate the hypothesis and identify potential areas for ensuring the effective implementation of the ISM Code and PSC inspection.

Finally, Chapter 7 will recap and summarize the findings. It concludes with the effectiveness of the ISM Code to the shipping industry and how the PSC regime supports better implementation of the ISM Code and suggests areas for further study.

2. LITERATURE REVIEW

2.1 The International Safety Management Code

It would be significant work for administrators to evaluate the implementation condition of a new policy, apart from appropriateness, after a certain period has lapsed. In the maritime domain, for instance, if a new regulation for certain equipment on board is adopted, it might be easy to verify it through the established ship survey system. But, if the new policy is related to an intangible requirement, for instance, the ISM Code, it would be challenging to verify its efficacy. It is virtually impossible to verify overall compliance with the Code in a limited time, no matter how well trained and experienced the auditor.

Some might say the relevant documents, such as Document of Compliance (DOC) or Safety Management Certificate (SMC), indicate that the Code is working. Nevertheless, they would not be sufficient to prove that the ISM Code had been internalized and is working in the shipping companies and ships as intended. It is not surprising that some argue that the SMC has become a mere license for ship operations (Lloyds list, 2003). However, much of the literature confirms that the ISM Code has, to some extent, had positive impacts on the shipping industry despite associated problems, which hinder the effective implementation of the Code.

The literature regarding the ISM Code has focused primarily on the impact and effectiveness of the Code on the shipping industry, along with the challenges associated with its proper implementation. At the early stages of the first Phase of the implementation of the ISM Code, researchers showed interest in the readiness of the industry and attempted to identify the key elements to assist the shipping

industry in the implementation of the Code. Chauvel (1997) compared the ISM Code and the quality management system; ISO 9002. Chauvel specified that the Code is established “based on a structural and controlled approach similar to ISO 9000 standard relating to the quality control system”.

Anderson (1998) studied the potential impact on the shipping industry from a legal perspective and practical aspects of the Code. The paper raised key issues related to the ISM Code; the actors of the Code, limitation of liability, insurance implications, and potential effects of the role of the designated person. Anderson concluded that the success of the Code and impact on the company depends on how it is developed and implemented in practice. Rodriguez & Hubbard (1999) also stressed the legal implications of the introduction of the ISM Code, studying relations with various regional laws and charter parties of insurance as a “New level of uniformity.” The authors claimed that the SMS would be significant evidence when an accident occurs, for government investigators, underwriters, and courts, regarding how the company had a positive approach as to safety as well as a useful management tool for prudent ship owners.

After the introduction of the ISM Code, interest shifted to the impact of the new Code. Many studies showed that the ISM Code has a positive impact, and has contributed to the enhancement of the safety of ships and protection of the environment. IMO (2005) confirmed that the ISM Code is heading in a positive direction through a report⁵, submitted at the 81st session of the Maritime Safety Committee (MSC), the first work on evaluating the effectiveness of the Code in 2005. The expert group, established by IMO, concluded that the “overwhelming majority of responses were supportive of the ISM Code” and “the ISM Code is embraced as a positive step toward efficiency through a safety culture, tangible positive benefits are evident”.

⁵ Assessment of the impact and effectiveness of implementation of the ISM Code, MSC 81/17/1, 21 December 2005

The positive impacts of the ISM Code were proved by way of financial benefits as well. New Swedish club (2001) demonstrated the beneficial impacts of the ISM Code through statistical data analysis of claims. The study found that the hull claims showed a clear downward trend, which made the club conclude that the investment in the ISM Code had been very worthwhile and effective implementation of ISM Code has a beneficial influence on the company. The club also found that respondents became more positive to the ISM Code as time lapsed (New Swedish Club, 2001).

Anderson (2003a) described in the published research, "Cracking the Code", that the shipping industry also recognized the benefit of the Code since incidents declined by virtue of the Code's implementation in general. Anderson also surveyed in his thesis that the majority of the Masters, ship operators, and other stake holders agree that the number of incidents has decreased since phase one of the ISM Code (Anderson, 2003b)

According to the MOMAF (2006), it was noted that Korean seafarers were also aware of the function of the ISM Code in enhancing ship safety. One hundred and nineteen seafarers responding to a survey gave a rating of 3.8 out of 5.0 points to the question of whether the ISM Code contributes to safe ship operation. Unexpectedly, the report underlined that the rating increased with the responder's maritime experience, contradicting the assumption that resistance to the ISM Code comes primarily from mature seafarers. In contrast, relating to the role of the ISM Code in the prevention of marine accidents, workers in the Korean shipping industry held the view that its impact was minimal.

Research presented in 2010 revealed that 30.7% of 417 respondents agreed that the Code contributed clearly to the decrease in accidents, but 47.2% agreed only partly (MLTM, 2010). The report concluded that the ISM Code had not, so far, exhibited clear effects on preventing accidents in the Republic of Korea even though the majority of individuals in the industry recognized the positive impact of the Code.

The effectiveness and impact might be two sides of the same coin because the positive impact would not appear if the ISM Code was not working effectively. In this paper, in relation to the ISM Code, the impact is understood as the consequences of the Code, while the effectiveness is understood as whether or not the Code is working as it is designed to. The effectiveness of the Code has significant concerns for academia as well. Most of the research recognizes that the Code is working to some degree in practical ship operations, but there are still challenges facing the achievement of its goals.

Anderson (2003) acknowledged that the Code was partly working and achieving its objectives of the Code. The research revealed the interesting result that perceptions relating to the ISM Code vary with the seafarers' nationality. Anderson suggested the necessity of taking cultural background into consideration when undertaking a qualitative survey. The effectiveness of the Code was proved in the Finnish shipping industry. Lappalainen et al. (2012) evaluated a Finnish shipping company to determine the strengths and weaknesses of the policy instrument in the implementation of the Code. The paper determined that the main objective of the ISM Code had been achieved, which allowed the improvement of the safety level in the Finnish company.

A Statistical approach has attempted to evaluate the effectiveness of the ISM Code. Mejia (2005) measured its effectiveness by contrasting the deficiency rate and detention rate of ships on which ISM phase 1 and 2 have been applied and exempted vessel, using the PSC data, collected from Swedish vessels, Swedish Maritime Administration, and publications of regional PSC MoU. According to Mejia, PSC inspection results of foreign ships in Swedish ports showed statistically meaningful drops in the number of deficiencies per inspection, and Swedish vessels with accelerated implementation of the ISM Code also exhibited significantly better performances than others.

The study found that regional PSC Statistics also showed an overall positive effect. The paper cautiously concluded that the ISM Code has positive potential for the safety of ships while admitting the limitations of the PSC inspection regime and

restricted representativeness. The study validated the possible usefulness of using PSC inspection Statistics in assessing the effectiveness of the ISM Code.

Kokotos (2012) conducted a study using a statistical approach through analyzing investigation reports by the Hellenic Coast Guard (HCG) of accidents which occurred in the restricted waters⁶ over the period of 1995-2011. The research identified significant reductions in the human errors, leading to accidents. The results do not necessarily represent a cause and effect relationship between the reduction in accidents attributed to human error and impacts of the ISM Code. But, bearing in mind that one of the purposes of the ISM Code is to eliminate human error in shipping, the study confirmed that the introduction of the ISM Code proved to be effective for the enhancement of safety in the shipping industry.

Considerable research has contributed to the identification of challenges arising during the implementation of the ISM Code. A number of studies claimed that too much paperwork demotivated the seafarers' involvement in the safety management system. The typical off-the-shelf safety management system in the shipping company does not help safety management and seafarers are complaining about increased paperwork, including vetting inspection, and PSC (Nautical Institute, 2004). Such issues can cause seafarers to lose their primary purpose for working on board (Anderson, 2003a).

According to IMO (2005), the Expert Group also recognized the burdens of paperwork on board. The group recommended reducing administrative process and using electronic technology to reduce the paper workload for further efficient implementation. Lappalainen et al. (2012) also pointed out that bureaucracy was a significant problem for the ISM Code and that it acted as a barrier to the flexible development of the safety management practice of the company.

Hahne (2000) tried to find obstacles in the organizational aspect such as organizational structure and safety policy, and qualification of the personnel. Hahne

⁶ Ports, Canals, Straits, Anchorages, Coastal waters, etc

determined that the attitudes and perceptions of personnel involved are the most crucial factor for the success of the ISM Code. The lack of safety culture such as no-blame, in the shipping company, has constantly been pointed out. Seafarers are still reluctant to report hazardous occurrences for fear of being blamed for the mistake, which undermines the continuous improvement of the SMS (Lappalainen et al., 2012; Lappalainen & Salmi, 2009; Sagen, 1999).

Anderson (2003) stressed the importance of motivating the individuals involved in the implementation of the Code, which can arise only within the concept of the culture. Anderson emphasized the significance of the safety culture by citing an interview that “the success of the SMS depends on the dissemination level of the safety culture on shipping company and the ship” (Anderson, 2003b).

Another key organizational factor affecting ineffective implementation of the Code is poor support of personnel and resources by the company. Bhattacharya (2012) found a significant disparity in the safety management level between two different tanker organizations whereby there was a lack of seafarer participation in the safety management of one company. The research concluded that the reason for the low participation was caused by poor employment conditions, lack of organizational supports and low-trust relationship with managers. The paper also affirmed the lack of preconditions to achieve effective safety management in the shore-based workplace.

Anderson (2003) also pointed out that insufficient company support relating to resources, including physical, human resources, and training, causes unsatisfactory implementation of the Code. Possibly, passive involvement in the SMS of seafarers who belong to scrupulous companies are an expected response, but one which ultimately has an adverse impact on the ISM Code.

The lack of interpretation has also been raised as one of the problems impeding the successful implementation of the Code. Owing to the nature of the ISM Code, the flexibility gives potential to the company to develop its customized skills. However, this has brought about another issue. The researcher introduced the

testimony of a person involved, which stated that the auditors or Administrators had different interpretations of the same defect due to lack of uniform interpretation and the guidelines of the ISM Code. The shipping industry has suffered from confusion due to vague interpretations of the requirements of the Code and it is resulting in inconsistent implementation. Particularly, when auditing, the auditors tend to rely on personal skills and experience. Some interviewees in the maritime industry suggested that the Administration should develop its auditing practice. (Anderson, 2003; Lappalainen et al., 2012; Sagen, 1999).

Batalden & Sydnes (2014) tried to examine how the underlying causal factors in marine accidents are allocated in the functional requirement of the ISM Code related to human and organizational factors. They revealed the challenges of ineffective implementation of the Code wherein the primary challenge lies in section 7 of the ISM Code; “development of plans for shipboard operations.” The poor management of the ‘resources and personnel’ (section 6), ‘master’s responsibility and authority’ (section 5), and ‘company verification, review and evaluation’ (section 12) were also noted as significant shortcomings in the implementation of the ISM Code.

According to the previous literature regarding the ISM Code, in summary, it was learned that the ISM Code has settled down in the shipping industry, and is showing positive impacts therein as evidenced by the perceptions of personnel involved, and reductions of marine accidents. However, the studies measuring the effectiveness of the Code seemingly need to be more empirical to convince the shipping industry that the ISM Code is beneficial to them in a practical way, and to make shipping companies aware of obstacles to its proper implementation. Such studies could provide the shipping industry with practical assistance to overcome these problems.

2.2 Port State Control

PSC has been performing as a “safety net of last resort” for the shipping industry against improper exercise of flag State responsibility since it was established (Özcayir, 2008). There is considerable literature regarding the impact and the effective exercise of PSC inspection. Since the existing PSC literature uses the

terms impact together with effectiveness in a general sense, the terms will not be distinguished in this section. PSC inspection has some inherent penalizing functions for substandard ships, so the impacts of PSC inspections can be found in many aspects.

If we look at the direct impact of the PSC, it might be a decrease in substandard ships and marine accidents or vessel-source pollution. Hare (1997) studied the overall PSC procedures, practice and domestic arrangement of several countries. Although there were no explicit changes in the number of fatalities of seafarers and total losses of vessels at that time, Hare concluded that PSC would be the most effective measure in removing substandard ships and unscrupulous ship owners from the industry based on efforts being undertaken by various entities.

However, Anderson (2002) applied a long term perspective, and proved 35 percent cuts in the number of total losses since the 1970s, using the data taken from Lloyd's Register of Shipping, as evidence of positive impact of the PSC. It was assessed that the rate of total loss of merchant ships has been declining by four percent every year since PSC was introduced.

Cariou et al. (2008) conducted an investigation into the effect of an PSC inspection on the following inspection in the number of deficiencies. The study found that the percentage of vessels that had fewer deficiencies than in the previous inspection was 63% for all age categories. The authors concluded that this demonstrated the strong impact of PSC inspection on the safety condition of particular vessels.

The same research was conducted again using PSC data in the Indian Ocean MoU. The analysis demonstrated that more than 60% of the vessels had fewer deficiencies in the following inspections (Mejia, Cariou, & Wolff, 2010). The study suggested that PSC inspection resulted in positive effects on successive PSC inspections, although to different extent, depending on the age of the vessels.

Regarding the preventive effect on pollution, Bang (2008) carried out research on the impact of PSC on vessel-source pollution using data from regional PSC MoUs

and the USCG. Bang found that regarding breaches under MARPOL 73/78, there was 60% reduction of oil pollutions during the 1980s in the US, and some deficiencies related to MARPOL Annex I, and Annex II have declined in the Paris MoU. The paper also showed that detention and deficiency rates were decreasing in the Paris MoU and Tokyo MoU.

The paper concluded that it was too early to assess the practical effects; however, it could be a positive signal that the substandard ships are being controlled appropriately by the PSC in general. In other words, the PSC regime has achieved its purpose, by virtue of rigorous inspections, of preventing vessel-source pollution, particularly from substandard vessels.

Knapp et al. (2011) carried out research to measure the monetary profits of PSC. The study suggested that estimated cost savings on average, calculated based on the total insured value, was in the range of USD 74,000 to 192,800 due to risk reduction of total loss. It was also found that the cost savings went up as the vessels aged except for passenger vessels, and the vessels in the group of undefined flags and unknown classification society benefit from higher cost savings. Bearing in mind that maintaining safety requires investment, it can be said that the shipping industry benefits from port States taking certain parts of the costs.

The impact of PSC does not remain in safety itself, but changes the business ecosystem as well. The PSC regime has been intensifying every year worldwide, driving unscrupulous ship owners to change their ships' flag and classification society. It was confirmed that PSC inspection does not remain in monitoring the safety performance of vessels, but influences the probability of flag-out and transfer of classification society (Cariou & Wolff, 2011).

As the targeting system is enforced, vessels with poor performing flag State nationalities and classification societies are likely to undergo repetitive and intensified inspections in a shorter period, which causes flag-hopping and class-hopping to avoid severe PSC inspections. Fan et al. (2014) found based on the

data⁷ that the inspection rate of the ship was the most dominant determinant to increase the probability of flag-out, while the size of the ship was a less significant factor. With regard to the classification society, vessels registered to members of the International Association of Classification Societies (IACS) changed flags less frequently than those registered in non-IACS member classification societies.

In connection with the effective exercise of the PSC, research has been undertaken in various aspects. Bang (2008, 2013), mainly focused on anti-pollution aspects, and recommended the proliferation of regional cooperative initiatives for the exercise of port State Jurisdiction. It was also stressed that the port State should be able to receive reliable information in case of vessel-source pollution. In addition, suspension of certification of seafarers committing willful discharge of pollutants, uniform statistical data management by the various PSC MoUs and several targeting methods were suggested. For example, the PSC should target ships which are not using port reception facilities. Fan et al. (2014) suggested considering other possible measures such as monetary penalties for deficiencies, insisting that current detentions or deficiencies are not enough to achieve effective enforcement.

Concerning the targeting methodology, it has become one of the most interesting areas for Regional PSC MoUs how to effectively allocate the enforcement resources in targeting substandard ships from a cost and benefit point of view. The regional PSC MoUs have developed their targeting system to prioritize the vessels to be inspected, and academia has contributed in line with targeting issues by providing various studies.

Degré (2007) carried out research to identify high-risk vessels on the basis of the concept of risk. The study took the probability of casualties and subsequent consequences into consideration, as a part of the work of the European project

⁷ Data from Lloyd's Register, Port State Control inspection data from various Regional PSC MoUs, Annual Report from Economic Freedom of the World, BMCO's Shipping Industry Flag State Performance, World Casualty Statistics from Lloyd's Fairplay, and existing literature

MarNIS⁸ of the 6th Framework Program. The research suggested that the ship variables (type, size, age) be combined with the Paris MoU list of criteria in order to improve the efficacy of the targeting system. The following year, the author proposed a change to the targeting system, based on the worldwide casualty database platform, to an individual vessel based targeting system by using a multivariate approach taking into account the casualty records during a specified period (Degré, 2008).

Cariou et al. (2007) attempted to determine which relevant factors should be considered in targeting vessels. The paper found three main determining factors, which are the age of vessel at inspection, the type of vessel, and the flag of registry. The study revealed that the relationship between age of vessel and number of deficiencies varied by the type of vessel. Cariou et al. (2009) attempted to ascertain how to weigh the factors in selecting the vessels to be targeted. The research showed that the age of vessel was the primary contributory factor in its detention, followed by RO and place of the inspection. They also underlined that the weight of the individual factors is variable depending on the type of deficiencies, and the detention rate is also considerably affected by the inspecting authority, which calls for the necessity of harmonized inspection regimes in the regional PSC MoU.

As far as harmonized PSC inspection is concerned, a series of studies was carried out to look into the different probabilities of detention and different treatment of vessels across regional PSC MoUs (Knapp & Franses, 2006, 2008; Knapp & van de Velden, 2009). The studies pointed out that a ship subjected to too many repetitive inspections in a relatively short period would lose the benefit of inspection. It also turned out that the probability of the detention was affected by different levels of enforcement from one place to another, and also the personal background of inspectors, as demonstrated recently (Ravira & Piniella, 2016).

On the other hand, the profile of vessels, such as size, flag, classification society or ship owner, was not necessarily significant. The researchers found that different

⁸ Maritime Navigation and Information Service

areas of interest in terms of inspection by the inspection regime exist. The finding indicates further room for improvement in the harmonization of the practical inspection procedure. It was proposed to facilitate the harmonization at two levels; IMO and regional level, which can be enhanced by uniform procedures, technical assistance using GISIS⁹, and unified deficiency coding system.

To be brief, the PSC regime has been contributing not only to the enhancement of the safety of the ship and prevention of maritime pollution but also to a sustainable shipping business. To ensure the effective exercise of the PSC regime, refined targeting methods and harmonized inspection procedures have been suggested. However, more attention should be paid to finding the way to create more synergy between the PSC regime and other influential maritime safety initiatives such as the ISM Code.

⁹ Global Integrated Shipping Information System

3. INTERNATIONAL SAFETY MANAGEMENT CODE

3.1 The Herald of Free Enterprise

Major international Conventions have developed in the wake of historical marine accidents, for instance, the sinking of the Titanic gave birth to the SOLAS Convention. Likewise remarkable disaster that triggered international conversation on the management issue was the Herald of Free Enterprise. The Herald of Free Enterprise, a 7,951 G/T, Roll on/Roll off passenger and freight ferry built in 1980, registered at Dover, classed by Lloyd's Register of shipping, engaged in the route between Dover and Zeebrugge, capsized on 6 March 1987, resulting in the loss of life of 193 passengers and crew.

The investigation report of the UK discovered that the Herald of Free Enterprise surprisingly sailed out with its bow door open, which allowed the quick ingress of water into the car deck, ending in rapid capsizing. The faults causing the accident seemed to be errors of individuals who should have taken responsibility on board; however, the investigation report, more importantly, stressed the underlying faults contributing to the chain of errors from the shore-based management.

To be precise, the investigators witnessed the collapse of the safety management system across the company. They concluded that the unreasonable errors on board which led to the disaster were consequences of the poor management of the company stating that "From top to bottom the body corporate was infected with the disease of sloppiness" (Department of Transport, 1987). As an aftermath of the

tragic incident, IMO Resolution A. 596(15)¹⁰ which directed the IMO to move forward to establish the shipboard and shore based management procedure, which later became the ISM Code, was accepted on 19 November 1987 by member States (IMO, 1987). Without a doubt, the Herald of Free Enterprise, in this regard, was obviously a turning point in maritime safety regulations (Schröder-Hinrichs et al., 2013).

3.2 New safety management approach of IMO instruments

The IMO has progressed, since 1959, from an international forum to discuss maritime regulations related to technical standards. Article 1(a) of the Intergovernmental Maritime Consultative Organization (IMCO, the former organization of IMO) was "to provide machinery for cooperation among Governments"..... regulation and practices relating to technical matters of all kinds....." It evidently shows the innate characteristic of IMO as a technical body (IMO, n.d.). It must be, indeed, a reasonable approach considering the technologies relating to hardware of vessels that had rapidly developed at that time, providing considerable room to explore technical aspects.

In response to major marine casualties, IMO has developed new regulations and guidelines mostly leaning towards technical issues as shown in Table 1. It illustrates that the IMO's response heavily relied on technical matters except for the STCW Convention (Schröder-Hinrichs et al., 2013). Despite the efforts of the IMO to prevent marine casualty, major incidents exploded during the 1980s and early 1990s, which gave alert to international society and made Administrators ask themselves what went wrong.

For instance, 'The Human Element in Shipping Casualties' in 1988, commissioned by UK Department of Transport, and 'Analysis of Major Claims' in 1991 issued by Thomas Miller P&I, suggested the clear message to the industry that marine casualties occur primarily due to human errors (Anderson, 2003a). The messages

¹⁰ Safety of passenger Ro-Ro ferries

enabled IMO heed the human element issues, resulted in the paradigm shift of maritime administration policy at the international level, which is still ongoing (Mejia, 2005). As one of the solutions to tackle the problems in conjunction with human error, the ISM Code was developed based on a holistic approach, providing a framework for safety management of shore and ship operations.

Table 1 Selected accidents and the reactive follow-up in IMO

Year	Ship name	Resulting measure/instrument	In force Since
1967	Torrey Canyon	Intervention Convention, 1969 Civil Liability Convention, 1969 MARPOL Convention, 1973 STCW Convention, 1978	1975 1975 1983 1984
1976	Argo Merchant	MARPOL Convention, Protocol of 1978	1983
1987	Herald of Free Enterprise	ISM Code, 1994	1998
1989	Exxon Valdez	OPRC Convention, 1990 MARPOL Convention, 1998 amendments	1995 1995
1994	Estonia	SAR Convention, 1998 amendments	2000
1999 2002	Erika Prestige	Res. 949(23) Guidelines on places of refuge for ship in need of assistance	2003

Note. From "Maritime human factors and IMO policy" by Schröder-Hinrichs et al., 2013, *Maritime Policy & Management*, 40(3), p. 246.

3.3 Flag State responsibility and the ISM Code

According to the Geneva Convention on the High Sea 1958¹¹, the United Nations Convention on the Law of Sea (UNCLOS)¹², a "Genuine Link" between flag State

¹¹ Article 5

1. Each State shall fix the conditions for the grant of its nationality to ships, for the registration of ships in its territory, and for the right to fly its flag. Ships have the nationality of the State whose flag they are entitled to fly. There must exist a genuine link between the State and the ship; in particular, the State must effectively exercise its jurisdiction and control in administrative, technical and social matters over ships flying its flag.
2. Each State shall issue to ships to which it has granted the right to fly its flag documents to that effect

¹² Article 91 Nationality of ships

and ship should exist. Herewith, the flag State should be in a position “to exercise effectively its jurisdiction and control in administrative, technical and social matters over the ships flying its flag”, which is a responsibility conferred on the flag State by Article 94¹³ of the UNCLOS (UN, 1982).

Article 94 of the UNCLOS imposes on the flag State responsibility for the safety at sea of ships flying its flag, based on the principle of “Genuine Link”. *Inter alia*, construction, maintenance and seaworthiness; manning, labor conditions and competence of crew; and prevention of collision and provided legal obligations to cope with national law and international treaties (Özcayir, 2001).

The duties of the flag State given by Article 94 of UNCLOS have been manifested through various Conventions, codes, and guidelines developed by the IMO. Although the ISM Code does not require specific technical or operating regulations for the safety of the ship, it provides tools to monitor the implementation conditions of safety and anti-pollution activities on shore and aboard in general. The ISM Code requires in its objectives that the safety management system should encompass compliances with the rules and regulations, codes, guidelines, and standards recommended by internationally accepted organizations¹⁴ (IMO, 1993).

Namely, the ISM Code has an umbrella function in the discharging of obligations of the flag State imposed by internationally accepted regulations. In addition, the ISM Code provides a mechanism to ensure compliances with the code by the audit and certification procedures in part B; Certification and Verification. Consequently, it can be said that the effective implementation of the ISM Code is crucial not only to the

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1. Every State shall fix the conditions for the grant of its nationality to ships, for the registration of ships in its territory, and for the right to fly its flag. Ships have the nationality of the State whose flag they are entitled to fly. There must exist a genuine link between the State and the ship.
 2. Every State shall issue to ships to which it has granted the right to fly its flag documents to that effect.

¹³ Article 94 Duties of the flag State

¹⁴ “1.2.3 The safety-management system should ensure:

- .1 compliance with mandatory rules and regulations; and
- .2 that applicable codes, guidelines and standards recommended by the Organization, Administrations, classification societies and maritime industry organizations are taken into account.”

performance of the single Code itself but also to fulfilling flag State's responsibility to ensure the safety of ships and protection of the marine environment.

3.4 Traits of the ISM Code

The ISM Code consists of part A and part B, and associated guidelines for proper implementation of the Code¹⁵ that was clarified by IMO Res. MSC. 353 (92)¹⁶. Part A mainly institutes implementation requirements for company and vessel, which is the main concern of this dissertation, while part B provides States with the administrative procedures to verify and issue certificates in harmonized practice.

The primary trait of the Code is company's responsibility. The terms 'company' is the most repeated word throughout the text of the Code, an evidence highlighting the role of the company above all else. The preamble to the Code says that 'the cornerstone of good safety management is the commitment from the top', which announces that the commitment related to safety and environmental protection from the highest level of the company, reflected in section 2, has become a prerequisite in the international shipping business (IMO, 1993).

The Code also stresses the safety management objective of the company in 1.2.2 and identifies the authority and responsibility of key players of the Code; company, designated person, and Master in sections 2, 3, 5, and 6. Addressing and clarifying the roles of the key players, focusing primarily on the roles of the shore, can be fundamental and innovative measures in tackling the hazardous operations of the ship.

¹⁵ Guidelines for the operational implementation of the International Safety Management Code by Companies (MSC-MEPC.7/Circ.8), Guidance on the qualifications, training and experience necessary for undertaking the role of the designated person under the provisions of the International Safety Management Code (MSC-MEPC.7/Circ.6), Guidance on near-miss reporting (MSC-MEPC.7/Circ.7), Guidelines for the operational implementation of the International Safety Management Code by Companies (MSC-MEPC.7/Circ.8).

¹⁶ Amendments to the International Management Code for the Safe operation of Ships and for Pollution (International Safety Management (ISM) Code), Adopted on 21 June 2013

No one can deny that the shipping industry has been affected by those requirements concerning the cultivation of a safety culture, even if it is not the case in reality to some extent (Heijari & Tapaninen, 2010). Taking into account the lesson learned from ‘the disease of sloppiness’ and the commercial pressures today that possibly cause poor company support and occurrence of accidents, the company’s responsibility is one of the critical elements supporting the proper work of the ISM Code (Withington, n.d.).

Secondly, flexibility should be another trait of the ISM Code. The preamble to the Code explains the virtue of flexibility by recognizing the different conditions in which companies exist. And the drafters of the Code tried to express this in broad terms by the general principles and objectives (IMO, 1993). In exchange for providing flexibility, the Code required the company to establish and implement the Safety Management System (SMS) including essential functional requirements as set out in 1.4 of the Code. Different from other conventional regulations, this flexibility enables the company to keep its optimum operation procedures and room to develop beyond the regulations required by the Conventions.

The continuous training and customized work procedures for shipboard operations with check lists might be one of the most effective measures to address human error, which is caused by improper design, poor management on board or the ship management practice, resulting in major causes of the marine accidents (Etman & Halawa, 2007; Rodriguez & Hubbard, 1999; Rothblum et al., 2002; Squire, n.d.; Townsend, Mariner, & Tatman, 2006). In this regard, the functional requirements enabling customized SMS, supported by the flexibility concept, are one of the valuable elements in achieving the goal of the ISM Code.

Thirdly, the improvement mechanism may be the most important function of the ISM Code in terms of maintaining the practical and robust system, which is achieved by the Master’s review, reports and analysis of non-conformities, accidents and hazardous occurrence, and company’s verification set out in the 5.1.5, 9, and 12 of part A. The mechanism maintains the system in a dynamic condition in compliance with the ISM Code and free from deviations during the implementation of the SMS.

Certainly, the improvement mechanism ensures the company maintains its optimum SMS and prevents recurrence of unsafe operations in its vessels.

In spite of the advantages of the mechanism, the improvement mechanism is still considered to be the utmost challenging area due to the 'fear of blame culture', and lack of understanding as to the philosophy of the Code (P. Anderson, 2003a; Berg, 2013; Bhattacharya, 2009; Jouni Lappalainen & Salmi, 2009). The industry seemingly lost the benefit of learning opportunities instead of repeating mishaps. Furthermore, the mechanism could be an actual effective barometer of how the ISM Code works appropriately and how the ISM Code has a positive impact on the industry, which will be discussed in this dissertation in Chapter 6. Therefore, continuous improvement is the key component to providing the company with a self-assessment and evolvement process.

3.5 The ISM Code in the Republic of Korea

The Maritime Administration of Korea, Ministry of Maritime and Fisheries Affairs, promulgated "the directive on the implementation of the ISM Code" in May 1997 following IMO Res. A. 741(18). The directive was enforced without penalties for those violated the regulations until the "Sea traffic safety Act" was revised, incorporating the directives in February 1999. The enforcement of the ISM Code, by type of vessels, followed the same timetable as SOLAS, which was accomplished 1 July 2002.

Peculiarly, the Maritime Administration decided to apply the ISM Code to domestic service vessels in 2002. The vessels carrying dangerous cargo on and above 500 G/T were required to comply with regulations set out in the Act, which were simplified version of the ISM Code taking into account the domestic shipping environment. The domestic vessels subject to the simplified safety management system extended gradually in size and type of vessel. In 2003, it was applied to general cargo ships on and above 500 G/T, and it was completed by vessels carrying dangerous cargo above 100 G/T in July 2012. But domestic passenger

vessels were excluded from it because they had been developing a similar safety management system since the 1970s.

Coming back to the ISM Code, the Maritime Administration has delegated the authority of verification and certification to a classification society, exclusively to the Korean Register of Shipping, based on the Memorandum of Understanding on the delegation of statutory survey and certifications. But audits and certifications for domestic shipping are done by government inspectors in local offices, which keep auditing skills in the house of the Administration.

The classification society should abide by the legal criteria to perform the statutory functions, such as number of service network, qualification and experience of the auditor, relevant directives for the audit and certification. Furthermore, the Administration undertakes the oversight programs on the status of statutory activities of the RO such as periodical reports of the performance in various aspects, annual audit, and special audit on RO when the Administration believes it to be needed.

The Administration may carry out a special audit on a ship and its company when the Administration judges that it is required. By special audit, an auditor from the Administration may withdraw the relevant certificate or request corrective actions as a practice of the regular audit procedures. The cases that apply to the special audit are as follows;

- Upon the supervision over vessels detained by the PSC inspection, if the Administration judges that it is needed to ensure the ship's safety or to prevent detention by PSC inspection in a foreign port.
- Upon the supervision over vessels in order to check the implementation of safety management, if the Administration judges that it is needed to ensure safety and prevention of accident.
- Upon a marine accident, if the Administration judges that it is needed to ensure the safety and prevention of further accident.

3.6 Implications and roles of the ISM Code

As it was reviewed in this Chapter, the ISM Code provides the company with the framework of safety and environmental protection. It ensures the facilitation of efficient monitoring of compliance with international rules that the vessel is subjected to. The flag State also benefits in the enforcement of its obligations since the Administrator can overview the performance of the fleet flying its flag through the audit and certification process.

Seafarers also benefit from it even though some criticisms exist relating to bureaucracy and workload (Bhattacharya, 2009; Lappalainen et al., 2012; Nautical Institute, 2004). For instance, clear definition of responsibility between shore and ship has brought responsible management practice and changed the culture so that seafarers can report poor support from the company. There are some concerns that seafarers may lose maritime knowledge, expertise, and skills because of too much dependence on the SMS, but it is also true that uniform work procedures are helpful in reducing human errors.

Owing to the enhanced safety of shipping, the insurance industry enjoys a decrease in marine accidents as well (New Swedish Club, 2001). However, if the company and seafarers do not exercise due diligent implementation of the Code, they take legal risks such as breaching the terms of insurance coverage and losing the right to limit financial liability when a marine accident occurs (Anderson, 1998). Consequently, it can be said that the ISM Code contributes to safer and cleaner shipping, simultaneously; legal responsibility will be imposed on unscrupulous ship owners.

4. PORT STATE CONTROL

4.1 The Amoco Cadiz

On the morning of March 16, 1978, the crude oil tanker, Amoco Cadiz¹⁷, Liberian registered, owned by Amoco, carrying 1,604,500 barrels of crude oil from the Middle East, experienced a failure in its steering gear system. The crew discovered that the steering gear went wrong due to hydraulic oil leakage from broken bolts connecting oil pipes, and tried to repair it, but it was soon found to be beyond their capability.

The Master of the Amoco Cadiz called the salvage tugboat, "PACIFIC", but the negotiation between the Amoco Cadiz and Salvage Company to reach an agreement took some time, which made the ship drifting closer to the coastline by fierce winds and rough sea. In the end, the tug boat had not enough capacity to tow the tanker in severe weather conditions, resulting in the Amoco Cadiz grounding as the tug struggled. (Bauer et al., 1992; Spooner, 1978)

The aftermath of the grounding was catastrophic. The ship tore into two parts and its entire cargo oil and 4,000 tons of bunker fuel spilled into the sea. An oil slick 18 miles wide, 80 miles long affected around 200 miles of the Brittany coastline of France. Beaches and 76 Breton communities were polluted. The oil spill resulted in the tremendous loss of marine life and destroyed the ecosystem to a great scale. It was reported that 20,000 diving birds died, and 9,000 tons of oysters were devastated (Bauer et al., 1992; ITOPF, n.d.). Since the Amoco Cadiz oil pollution

¹⁷ 233,690 DWT, 334.02LX51.06B X19.8D, built in 1975, 44 crew members, 1 X 30,400 HP Diesel engine, Single screw

occurred one month after the adoption of the 78 protocol of the MARPOL Convention, the international society was even more traumatized by the accident.

The Amoco Cadiz drove IMO to elaborate the salvage rule, which later on developed into London Salvage Convention of 1989¹⁸ and enforcement of Port State Control regime, which became IMO resolution A.466 (12)¹⁹ in 1981. Besides, the Amoco Cadiz became a driving force for West European countries to extend the 'Hague Memorandum' in 1978, which was mainly concerned with living and working conditions required by the International Labor Organization Convention no. 147²⁰, to include safety and environmental protection regulations of shipping. This issue was discussed at the Regional European Conference on Maritime Safety in 1980, and two years later, the Paris Memorandum of Understanding²¹ was signed by fourteen countries in Paris, which had suffered enormously from the Amoco Cadiz disaster (Hare, 1997; Paris MoU, n.d.-a)

4.2 Emerging of PSC MoUs

Port State Control was not created in one day by the Paris MoU. Various types of controls existed throughout shipping history in European ports because the port States have recognized the need to control substandard ships for a long time. This belief was reflected in various international maritime Conventions so there were not barriers in the exercise of PSC at that time. Although some countries in Europe had port State inspections in their ports through their domestic laws, willingness to join international cooperation for harmonized control over substandard ships was not yet mature (Özcayir, 2008).

The Amoco Cadiz changed that way of thinking. Members of the initial Paris MoU were convinced that they could be the next victims, and face political pressures after a similar disaster to what France had suffered. Nowadays, the Paris MoU consists of

¹⁸ entered into force 14 July 1996

¹⁹ Procedures for the Control of the Ships, IMO A. Res. 466 (12), adopted 19 November 1981

²⁰ ILO Convention (No. 147) concerning Minimum Standards in Merchant Ships, (*Geneva, 29 October 1976*)

²¹ The Paris Memorandum of Understanding on Port State Control 1982 (Paris MOU)

27 maritime Administrations, and undertakes more than 18,000 inspections with a mission that is “to eliminate the operation of sub-standard ships through a harmonized system of Port State Control” (Paris MoU, n.d.-b). The Paris MoU still exerts the strongest influence on the PSC inspection regime and international maritime industry. So, the awareness of the necessity of stringent control over foreign ships had developed a proliferation of regional agreements on PSC as well as IMO rules for ensuring uniform conduct of PSC inspections.

Following the pioneering Paris MoU, with the same aims, many regional PSC MoUs developed during the 1990s and early 2000s. The Latin American Agreement on Port State Control of vessels²² was adopted in 1992. The countries in the region of Asia-Pacific gathered in Tokyo and came to an agreement²³ in 1993. Notably, the USCG joined as an observer and Chile, a member of de Viña del Mar, is also a member of the Tokyo MoU. In 1996, the Caribbean countries signed an agreement²⁴ in Barbados on February 9. The Mediterranean region²⁵ also launched an MoU in 1997, and the Indian Ocean region²⁶ in 1998. The Abuja MoU²⁷ was signed for the West and Central Africa region in 1999, Black Sea region²⁸ in 2000 and the MoU in the Gulf region²⁹ was signed in 2004. As a result, ten regional MoUs including the USCG around the world are organized and working for the elimination of substandard ships as a “safety net”.

The regional MoUs on PSC commonly contain, *inter alia*;

- Structure (Organization) of the MoU.
- Relevant international instruments.
- Port State Control procedures; inspection, reporting, detention, etc.
- Appeal process.
- Amendment to the MoU.

²² The Acuerdo de Viña del Mar agreement on port state control 1992

²³ The memorandum of understanding on port state control in the Asia-Pacific region 1993

²⁴ The memorandum of understanding on port state control in the Caribbean region 1996

²⁵ The memorandum of understanding on port state control in the Mediterranean region 1997

²⁶ The memorandum of understanding on port state control for the Indian Ocean region 1998

²⁷ The memorandum of understanding on port state control for the west and central Africa region 1999

²⁸ The memorandum of understanding on port state control in the Black sea region 2000

²⁹ Riyadh memorandum of understanding on port state control 2004

- Ship risk profile and Information system.
- Administrative provisions.

4.3 PSC in Conventions

The legal ground for the jurisdiction of the port State can be found in UNCLOS, which is mostly related to the issue of prevention of pollution. Article. 211(3) deals with the legislative jurisdiction that empowers the State to establish its requirements for the prevention, reduction, and control of pollution of the marine environment by foreign vessels entered into its ports or territorial waters. However, the port State should not hamper the right of innocent passage in its own territorial waters (UN, 1982).

According to Article 211(3), the port State has the right to commence investigation into foreign vessels that are in one of its ports voluntarily by Article 218, and also the port State may institute proceedings in its local court on the illegal discharge of a pollutant. But the proceeding can be commenced only if the associated flag State has made a request or the State where the pollution occurred or a State damaged or otherwise threatened by it. In addition, according to Article 219, the port State should take appropriate actions to a vessel in its port if the ship has violated the international rules and standards in conjunction with the seaworthiness of vessels that may threaten damage to the marine environment. It stipulates the detention of vessels until the deficiencies have been removed and conditional release for sailing to the nearest port for permanent repairs.

While UNCLOS provides the legal foundations of jurisdiction and broader features of the port State's authority, IMO instruments contain precise provisions relating to the implementation of PSC inspections. In addition, while port State jurisdiction has primarily developed concerning prevention of pollution in UNCLOS, IMO instruments encompass not only pollution but also all safety-related issues such as ship design, equipment, manning, and competence of seafarers.

PSC requirements in the IMO instruments originated from the 1914 SOLAS Convention which was created in response to the Titanic disaster. Even though the responsibility for safety of ships lies with the flag State, States recognized the needs to control foreign vessels at the early stages of international maritime Conventions, and these values are successfully reflected in the major Conventions of IMO. The IMO instruments which contain PSC provisions are;

- SOLAS 74, reg. I/19, reg. IX/6 and reg. XI/4;
- Load Line Convention 1966, Art. 21;
- MARPOL 73/78, Art. 5, 6, reg. 8A of Annex I, reg. 15 of Annex II, reg. 8 of Annex III and reg. 8 of Annex V;
- STCW 78, Art. X and reg. I/4;
- Tonnage Convention 1969, Art. 12;
- International Convention on the control of harmful anti-fouling on the ships, 2001, Art. 11;
- International Convention on civil liability for oil pollution damage, 1969, 1992 protocol.

The Maritime Labor Convention 2006 (MLC 2006), which is called one of the pillars of maritime safety, also provides a PSC regime in Article V paragraph 4 by which a port State may determine the compliance of a ship in its port with the requirements of the Convention. In order to facilitate harmonized and unified inspections of the PSC, IMO and ILO³⁰ have developed a number of guidelines. IMO has been developing a variety of resolutions relating to PSC procedures and Res. A. 1052(27) was adopted³¹ in 2011, and there are guidelines for particular Conventions which are not incorporated in Res. A. 1052 (27), for instance, guidelines for PSC Ballast Water Management (BWM), Hong Kong Convention, Anti-fouling system. Each regional PSC MoU has also developed its inspection procedures on the basis of the IMO guidelines.

³⁰ Guidelines for PSC Officers on Maritime Labour Convention, 2006

³¹ IMO Res. A. 787(19), A.882(21) which revoked by Res. A. 1052(27)

The PSC inspection begins with checking the validity of vessel's certificates on the grounds that flag State's compliance with related Conventions should be verified. However; if PSCO finds clear grounds that the vessel does not meet the required regulations, the vessel is subjected to a detailed inspection. The 'no more favorable treatment'³² principle is applied to all vessels including those registered to non-parties to relevant Conventions which evidently enhances the PSC regime as an influential safeguard in international shipping.

4.4 PSC practice in the Tokyo-MoU

The Tokyo MoU consists of 20 member States and one co-operating member. The Secretariat is based in Tokyo and 'The Asia-Pacific Computerized Information System (APCIS)' was established and coordinated by the Russian Federation. According to Article 1.4 of the MoU, Member States determine the goal of inspections annually by the percentage of individual foreign ships, and the committee monitors the Members' activities. The substantial target of inspections by the committee is 80%, meanwhile, it was reported that Member States achieved around 70% in 2015 (Tokyo MoU, 1993, 2016).

The New Inspection Regime (NIR) was introduced in 2014 for selecting vessels to be inspected (Tokyo MoU, 2015). The NIR, risk profile based targeting, is encouraged for use by the Member States for prioritizing and determining inspection intervals other than in cases in which the port State was notified by another Authority or other party relating to safety issues. The qualification of PSCO and overall PSC procedures follow IMO Res. A. 1052(27). The MoU is undertaking a joint concentrated inspection campaign (CIC) with Paris MoU on different issues every year and publishes a report.

The MoU subdivided deficiencies into 566 codes by the nature of the deficiency which is nearly authentic to that of Paris MoU. One attracting attention is ISM-related deficiency Code. Tokyo MoU classifies the deficiency codes by ISM Code

³² SOLAS Protocol 78, Article II(3); MARPOL 73/78, Article 5(4); STCW 78, Article X(5)

modules, for instance, 1501; Safety and environment policy, 15103; designated person(s). It will be useful if the data accumulates in the future in analyzing the ISM-related performances (Tokyo MoU, 2013). The deficiency action Code is the same for other regional PSC MoUs.

In 2015, member States of the Tokyo-MoU carried out 31,407 inspections, and 1,153 vessels under 62 flags were detained, which is 3.67% of total inspections. The MoU announced the Black-grey-white list based on the performance level of the flag State over a three-year rolling period. The number of deficiencies per ship was 2.66 and the top three major vulnerable areas were fire safety measures, the safety of navigation and life-saving appliances (Tokyo MoU, 2016).

4.5 Implications and roles of PSC

Port State Control has become the most effective measure for ridding the world's ports and oceans of substandard, unseaworthy and dangerous ships (Hare, 1997). Owing to the regional agreement, the 'safety net' has been tighter which allows the shipping industry to enjoy sound competition, while ship owners carrying on business with poor investment in safety are confronted with serious difficulties.

Intensified PSC inspections motivate the shipping companies to maintain their fleet compliance, and it has become a substantial measure to keep passengers and seafarers safe even if some seafarers complain of the work burdens. Further, PSC inspection has contributed to promoting seafarers' awareness related to safety and protection of the marine environment.

For flag States and classification societies, PSC inspection applies performance pressure in the implementation of responsibility imposed by international Conventions. The Black-grey-white list of flag States, published by regional MoUs, has become a powerful tool to foster competition among flag States with regard to their performance. Moreover, detention rates and RO responsible deficiencies in regional PSC statistics has become an indicator of the evaluating performance of classification societies.

The 'safety net' function of PSC has extended to the security issue and fair working conditions and welfare of seafarers. Hence, the PSC regime implies not only protecting port State interests but also serves a complementary function to the flag State's responsibility to ensure the safety of the ship and protection of the environment.

5. HYPOTHESIS AND METHODOLOGY

5.1 Hypothesis

The ISM Code has great value in terms of providing a framework for a safety management system for the company. However, the positive effect of the ISM Code is not merely limited to the establishment of the SMS. The real virtue of the Code lies in the implementation. Among other things, the continuous improvement in the execution of the SMS should be highlighted since it permits enhancement of the safety management system and awareness and understanding of all personnel involved in SMS, and ultimately the prevention of marine accidents.

Identified non-conformity (NC) should be dealt with through various means of the improvement mechanism. This self-regulating safety management system helps the company to find what went wrong and eliminate the shortcomings of the SMS and improve the safety management system. Once the typical NCs due to improper safety management system are identified through near-miss or deficiencies during the PSC inspection, the company should investigate them and take necessary actions to prevent recurrence. This improvement mechanism keeps the SMS dynamic, which is invaluable to the company.

In an effort to evaluate the effectiveness of the ISM Code, as reviewed in Chapter 2, a variety of means have been attempted. The number of marine accidents, insurance claims, PSC detention rates before and after the introduction of the ISM Code were compared, and also comprehensive interviews were carried out and analyzed. This paper, unlike previous studies, focused on the improvement

mechanism of the individual ship which can be an indicator to measure whether the ISM Code works correctly or not.

Likewise, noting that the PSC inspection is the most effective and feasible indicator to measure the safety level of an individual vessel, it should be possible to examine the improvement mechanism of the ISM code by contrasting performance in an ISM audit and PSC inspection. If the improvement mechanism works well, we can say that the ISM Code works; on the other hand, if the mechanism does not work, the ISM Code may be ineffective.

This dissertation aims to examine the effectiveness of the ISM Code, by using PSC inspection data and ISM audits of sampled vessels through tracking the history of two datasets. It will also explore how PSC inspection influences ISM audits. Thus, the hypothesis of this dissertation is;

- If the ISM Code works, improvements should be seen following a PSC inspection or an ISM audit. Particularly, it would be represented by;
 - A good PSC performance following an ISM audit with bad performance.
 - A good performance in an ISM audit following a PSC inspection with bad performance.
 - Partial or no relationship between two events by the nature of the findings.

- If the ISM Code does not work, improvement would not be seen - neither in the PSC inspections before or after the audit. It would be represented by;
 - A bad PSC performance following an ISM audit with bad performance.
 - A bad performance in an ISM audit following PSC inspection with bad performance.
 - Strong relationship between two events by the nature of the findings.

The Figure 1 illustrates the hypothesis.

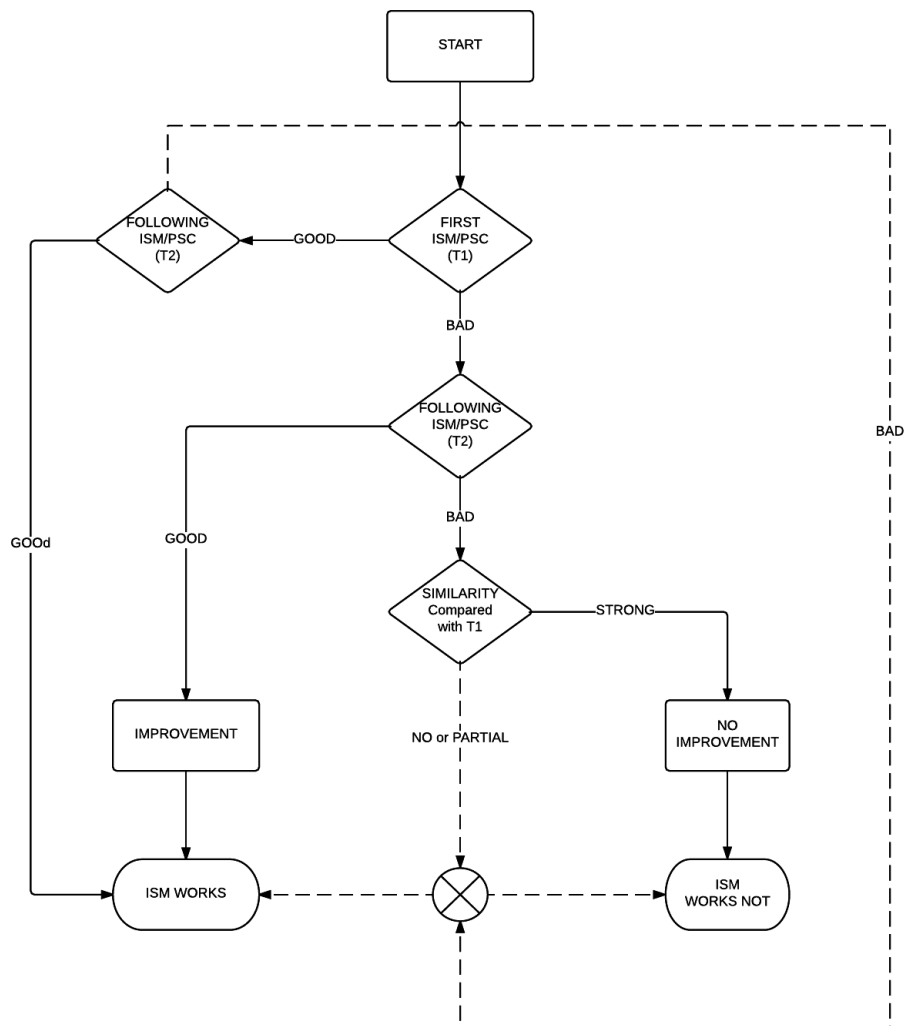


Figure 1 Hypothesis diagram

This paper will not discuss the dotted lines which resulted in a bad performance at following ISM/PSC of good performance and 'no or partial similarity' after similarity analysis. This is because it is difficult to determine whether the ISM Code works or not solely by the number and limited data analysis, which needs to be elaborated case by case. These cases may be affected by several options such as the collapse of the SMS, false first ISM/PSC, and application of different measure at the following event (i.e. Concentrated Inspection Campaign; CIC), temporary or partial malfunctions of SMS and so on.

5.2 Datasets

Considering the accessibility of the data, Korean vessel data was used. Datasets, tabulated spreadsheets, relating to ISM audits and PSC inspection records were collected from the Ministry of Oceans and Fisheries (MOF) of the Republic of Korea, the author's home country. PSC inspection data was restricted to the inspection records in the Tokyo MoU region. The ISM audit data was compiled by the Korean Register of Shipping (KR) which carries out ISM audits on behalf of MOF.

The audit records are used for ships, not the company. And the Interim audit records were left out of the ISM audit data because interim audit does not cover all aspects of the ISM Code requirements so that it is difficult to determine the effectiveness of the ISM Code. Meanwhile, the deficiencies related to the International Ship and Port Facility Security Code (ISPS Code) and Maritime Labor Convention 2006 (MLC 2006) were excluded in the PSC data because ISPS and MLC 2006 have their management systems verified by the flag State.

The time frame of both datasets ranged from 2011 to 2015; a period of 5 years. During that time frame, Korean vessels underwent 6,972 PSC inspections with 24,711 deficiencies, and 44 detentions in the Tokyo MoU region. In the meantime, 1,402 ISM audits were undertaken with 2,743 minor NCs and 69 major NCs. Due to the enormous amount of data, it was decided to decrease the timeframe to between the 2nd half of 2013 and 2015 (2.5 years). To maintain the consistency of PSC data, the PSC inspection data used is from 2014 when NIR was introduced in the Tokyo MoU region, while the ISM data is from the 2nd half of 2013. Five hundred and ninety-two vessels were selected based on the condition that vessels have audit records since the 2nd half of 2013 as well as PSC inspection records after 1 January 2014

To determine how the improvement mechanism works as time passes, namely, how an ISM audit impacts the following PSC inspection or how a PSC inspection influences the following ISM audit in the different time interval between two events, vessels with 0~180 days and 181~365 days between inspections and audits were

selected. Vessels were not duplicated. For example, if a ship had undergone an ISM audit on a certain day (T1) and the ship received a PSC inspection on a certain day after T1 (T2), the number of days between the two events will be T2 minus T1³³. In the 180 day interval category, 275 vessels with ISM audit records followed by PSC inspection records were selected, and similarly 174 vessels with PSC inspection records followed by ISM audit records were selected. In the same manner, 74 vessels with ISM audits followed by PSC inspections and 32 vessels with PSC inspections followed by ISM audits were derived from datasets with 365 days apart.

Only those vessels that did not undergo any ISM audit or PSC inspection between two events were chosen, which would allow us to observe the immediate impact on the following event. The reason why the data group in the 365 day interval category was smaller than the 180 day group can be explained by repetitive PSC inspections with indiscriminate targeting practice. Among the 592 vessels, there were 37 vessels intervals beyond 365 days or erroneous entries, which were omitted from the analysis.

Table 2 Number of vessels with 180 days and 365 days intervals between two events

Intervals	ISM audit first	PSC inspection first	Total	Remark
0~180 Days	275	174	449	37 vessels with invalid intervals
181~365 Days	74	32	106	
Total	349	206	555	

Finally, the dataset was reduced to 50 vessels for four cases³⁴ by using random sampling other than the case of PSC inspection followed by ISM audit with 365 day interval because there were only 32 applicable vessels available in that category. 182 vessels, therefore, were employed in the analysis.

³³ If ISM audit carried out in 1 January 2014 and then first PSC inspection after the audit was done in 31 October 2014, there is 10 months (approximately 300 days) interval between two events.

³⁴ ① ISM audit followed by PSC inspection with 180 days interval, ② PSC inspection followed by ISM audit with 180 days interval, ③ ISM audit followed by PSC inspection with 365 days interval, ④ PSC inspection followed by ISM audit with 365 days interval

5.3 Methodology

This paper is a comparative analysis to determine whether or not the ISM Code works by analyzing the records of ISM audits and PSC inspections. Thus, the ISM audits and PSC inspection datasets for 182 vessels were combined into one dataset. The data of 182 vessels with corresponding records was taken from both datasets. The data from the PSC dataset includes the date of inspection, the number of deficiencies, and description of the deficiencies. The ISM audit records also contained the date of the audit, the number of NCs and description of the NCs.

During the analysis of the integrated datasets, the improvement in each vessel in response to the leading event was examined in the following event. This thesis classified the performance level into two groups for ISM audit and PSC inspection, good performer and bad performer, for simple conceptualization. Taking into account the average number of deficiencies per ship in the Tokyo MoU³⁵ and NCs³⁶ from the audit of Korean vessels in the past five years, a vessel was categorized as a good performer if deficiencies or NCs were fewer than three, which means zero to two. Ships with three or more than three deficiencies or NCs were classified as the bad performers.

- Good performers \leq 2 findings (NCs or Def.)
- Bad performers \geq 3 findings (NCs or Def.)

In determining the areas of improvement, all NCs and deficiencies were classified according to the nature of the problems by the ISM modules ranging from safety and environmental policy in section 2 to company verification, review, and evaluation in section 12 as shown in Table 3. A careful examination determined which modules should be subject to NCs and deficiencies based on the ISM Code requirements

³⁵ Deficiencies per inspection was 2.66 according to 2015 annual report of Tokyo MoU, (83,606 deficiencies / 31,407 inspections)

³⁶ During 2011 to 2015, 2,812 NCs were identified in 1,402 vessels in the ISM audits in Korean vessels, which means average number of NC per audit was 2.0

and relevant guidelines. This work provides an understanding of whether or not the ship undertook an improvement mechanism. It could be noted, for example, that the improvement mechanism of ship 'A' has worked if ship 'A' has no deficiency in 'emergency preparedness at PSC inspection, following an ISM audit with NCs relating to the 'emergency preparedness.'

In the course of classification, it was found that certain deficiencies and NCs could be subject to multiple ISM modules. If PSCO, for instance, identified a deficiency whereby the battery for starting a lifeboat engine was not charged, it was classified as 'maintenance of the ship and equipment' rather than 'emergency preparedness'. The work of classification was carried out in a point of identifying the ultimate problematic issue which led to the deficiency.

Table 3 ISM Code module

Module	Title
2	Safety and environmental policy
3	Company responsibility and authority
4	Designated person(s)
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

Furthermore, by using this codification, the similarity of the performance, and the nature of the problems will be analyzed to ensure the cause and effect relationship between ISM audit and PSC inspection of the individual ship. The similarity formula was developed with criteria of the level of similarity to provide a clear picture. If the percentage of the similarity is 50% or more than 50% according to the calculation, it might be said that a strong relationship exists with the previous audit or inspection. If

the percentage of similarity is between 1 and 49, it was categorized as partial similarity.

$$\text{Similarity (\%)} = [(N_{nc-t1} \text{ or } N_{def-t1} / N_{t1}) \times (N_{def-t2} \text{ or } N_{nc-t2} / N_{t2})] \times 100$$

- N_{nc-t1} : Number of NC in the ISM audit followed by PSC inspection
- N_{def-t1} : Number of deficiency in the PSC inspection followed by ISM audit
- N_{t1} : Total Number of deficiency or NC in the preceding event
- N_{def-t2} : Number of deficiency in the PSC inspection following ISM audit
- N_{nc-t2} : Number of NC in the ISM audit following PSC inspection
- N_{t2} : Total Number of deficiency or NC in the following event
- Criteria of Similarity : Strong - more than 50%, Partial - 1~49%, No – 0

In the case of N/A, since the similarity cannot be calculated if there were no findings in the leading event, it was classified as N/A. In contrast, if there were no findings in the following event, although the similarity cannot be calculated, it was categorized as no relationship since this paper is looking for the impact of the leading event.

Table 4 Example of similarity calculations

ISM NCs (PSC deficiencies)	PSC deficiencies (ISM NCs)	Calculation	Result
5, 6, 8, 8, 10, 10	10,10, 4	$[(2/6) \times (2/3)] \times 100 = 22.2 \%$	Partial
9,10,12	10	$[(1/3) \times 1] \times 100 = 33.3\%$	Partial
10,10	10,11	$[1 \times (1/2)] \times 100 = 50\%$	Strong
8,9,10	11	-	No
-	10	-	N/A
7	-	-	No

6. DATA ANALYSIS AND DISCUSSIONS

6.1 Analysis of ISM audit followed by PSC inspection (ISM-first group)

6.1.1 Overview of ISM-first group.

The NCs in the ISM audit and deficiencies in the following PSC inspection of each sampled ship (50) were contrasted by number to examine how the ISM audit impacted the following PSC inspection. Table 5 shows that the number of NCs when the interval was 180 days (hereinafter 'short term') was larger than when the interval was between 181 and 365 days (hereinafter 'long term'), whereas the deficiencies in the PSC were reversed.

Table 5 Total number of NCs and Def. in two timeframes

Time	NCs	NCs/ship	Def.	Def./ship
0~180 D	102	2.04	137	2.74
181~365 D	81	1.62	161	3.22

(Unit: pcs / ships)

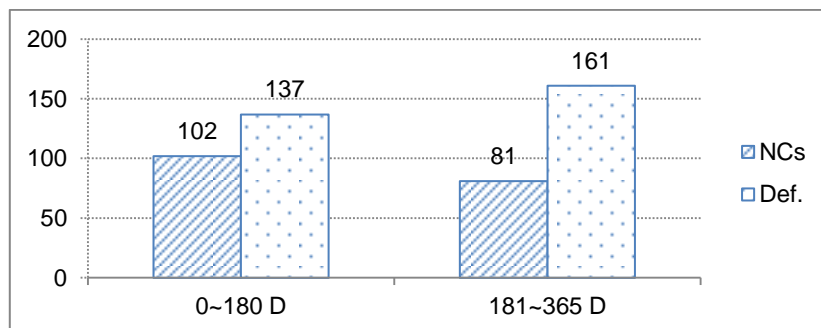


Figure 2 Number of NCs/Def. of ISM-first group

6.1.2 Analysis by the number of findings

Table 6 describes the number of ships contrasted by the number of NCs and deficiencies in the short term period. This table permits us to see how a particular ship with a certain number of NCs presented performances in the following PSC inspection. Namely, we can picture how the ISM audit impacts on the following PSC inspection and whether the improvement mechanism of the ISM Code works or not. Statistical analysis was derived as follows;

- 58% of Ships (29) had the same or higher number of NCs than the number of deficiencies in the following PSC inspection.
- Nineteen ships had no deficiency and 56% of ships (28) had good performances in the following PSC inspection.
- Among ships with good performance in the ISM audit (34), 70.6% of ships (24) maintained good performance in the PSC inspection, while 29.4% of ships (10) showed the same or worse performance in the PSC inspection.
- Among ships with bad performances in the ISM audit (16), 25% of ships (4) showed improvement in the PSC inspection, while 75% of ships (12) showed the same or worse performance in the PSC inspection.

Table 6 Number of ships compared by the number of NCs and Def. in short term

Number of NCs	Number of deficiencies												Total	
	0	1	2	3	4	5	6	7	8	9	10	11		
0	9		1	1		1								12
1	4	2	2	2						1				11
2	4	1	1	1		2	1		1					11
3				2	1		1	1						5
4	2	1				1					1			5
5		1		1				1				1		4
7							1			1				2
Total	19	5	4	7	1	4	3	2	1	2	1	1		50

(unit: ships)

In summary, 70.6% of ships among good performers in the ISM audit maintained their good performance in the following PSC inspections, while 29.4% of ships became worse. Meanwhile, 25% of ships among bad performers in the ISM audit exhibited improvement in their performance in the following PSC inspections, while 75% of them showed the same or worse performance level.

Therefore, it could be appreciated that the good performers in the ISM audit also show good performance in the PSC inspection, in general, which is normal. Simultaneously, the majority of bad performers maintain the same or worse performances category in the PSC inspection, which possibly indicates that the SMS does not work effectively on improvement. However, it was seen that good performers in the ISM Code have positive results on the following PSC inspection in the short term.

Table 7 presents the number of ships contrasted by the number of NCs and deficiencies in the long term period. By analyzing the different timeframe, it would be possible to see how the ISM audit influences the following PSC inspection as time goes by. Statistical analysis was derived as follows;

- 56% of Ships (28) had the same or higher number of NCs than the number of deficiencies in the following PSC inspection. However, the total number of deficiencies was increased compared to the short term.
- Eighteen ships had no deficiency and interestingly, identical with the short term, 56% of ships (28) had good performance in the following PSC inspection.
- Among ships with good performance in the ISM audit (35), only 51.4 % of ships (18) maintained good performance in the following PSC inspection, while 48.6 % of ships (17) showed the worse performances in the following PSC inspection.
- Among ships with bad performance in the ISM audit (15), 75% of ships (10) showed improvement in the PSC inspection, while 25 % of ships (5) showed same or worse performances in the PSC inspection.

Table 7 Number of ships compared by the number of NCs and Def. in long term

Number of NCs	Number of deficiencies													Total
	0	1	2	3	4	5	6	7	9	10	11	12	21	
0	8	1	2		1	4		1		1		1		19
1	1	1	1		2	1	1		1		1		1	10
2	4			1				1						6
3	1	3	1	1				1						7
4	3			1	1									5
5			1											1
6					1									1
7	1													1
Total	18	5	5	3	5	5	1	3	1	1	1	1	1	50

(unit: ships)

According to Table 7, among good performers in the ISM audit, 51.4% of ships maintained their good performance in the following PSC inspection, while 48.6% of them got worse. In the meantime, 75% of ships among bad performers in the ISM audit improved their performance in the following PSC inspection, while 25% of them stayed at the same or worse performance level.

It should be noted primarily that the bad performers make a remarkable improvement in the long term period, which is a different outcome from the short term period although the number of deficiencies was larger compared to the short term. It is also found that the increase in the number of deficiencies in the long term period was primarily concentrated in the good performers in the ISM audit, which resulted in the good performer's degradation. Declined performances of good performers are a somewhat expected result.

6.1.3 Similarity analysis

It would not be sufficient to conclude that the decrease in the number of findings represents a positive impact of the ISM audit on the following PSC inspection. For example, if a ship that was given five NCs including two NCs relating to 'Master's

responsibility' in the ISM audit received three deficiencies concerning 'Master's responsibility' in the following PSC inspection, we could not simply say that the ship made an improvement due to the reduction of findings. Instead, it should be noted that the management system has not shown improvement because the ship revealed similar deficiencies in the following PSC inspection, which indicates that the improvement mechanism has not worked properly.

The strong similarity, therefore, in findings between two events could be understood as evidence for the improper implementation of the ISM Code. If a ship has a strong similarity in the following event, it could be that the ship has not made an improvement; conversely, if a ship has no similarity, then it could mean that the ship has some improvement. Of course, there will be some different cases in which this cause and effect relationship does not work if both events have a different focus in terms of enforcement. However, the cause and effect relationship can be measured by the similarity analysis in general between ISM and PSC.

The higher number of 'no similarity' or 'partial similarities' will show fewer repetitions of the same deficiencies in the PSC inspection. In order to examine the similarity, as mentioned in Chapter 5, the findings, NCs and deficiencies, were coded by the ISM module, which is the requirement same as the section of Part A of the ISM Code. The calculation formula is as follows;

$$\text{Similarity (\%)} = [(N_{nc-t1} \text{ or } N_{def-t1} / N_{t1}) \times (N_{def-t2} \text{ or } N_{nc-t2} / N_{t2})] \times 100$$

- N_{nc-t1} : Number of NC in the ISM audit followed by PSC inspection
- N_{def-t1} : Number of deficiency in the PSC inspection followed by ISM audit
- N_{t1} : Total Number of deficiency or NC in the preceding event
- N_{def-t2} : Number of deficiency in the PSC inspection following ISM audit
- N_{nc-t2} : Number of NC in the ISM audit following PSC inspection
- N_{t2} : Total Number of deficiency or NC in the following event
- Criteria of Similarity : Strong - more than 50%, Partial - 1~49%, No - 0

Table 8 shows the results of the similarity analysis of the ISM-first group. Each number in the table indicates the number of ships with the corresponding similarity degree derived by the above calculation formula. N/A represents case in which a

ship with no NC has recorded more than one deficiency in the following PSC inspection.

Table 8 Similarity comparison by the timeframe

Degree	No	Part	Strong	N/A	Total
0~180D	24	9	14	3	50
181~365D	23	11	5	11	50

(unit: ships)

It illustrates that fourteen ships in the short term have strong similarity, while there are five ships with strong similarity in the long term period. For the fourteen ships with strong similarity in the short term, it can be inferred that similar findings were repeated at the following PSC, which resulted in 75% of ships with same or worse performances. The number of ships with strong similarity in the long term is only five, which supports the explanation indirectly that 75% of ships improved their performance in the long term as discussed above.

But it needs to be understood that the reduction in the number of ships with strong similarity does not necessarily mean that all ships in the long term made the improvement because of N/A. So it is necessary to examine the number of N/A in the long term, which is higher than in the short term. These ships with N/A are the cases, mentioned at the end of the 6.1.2, which contributed to the rise in deficiencies concentrated on the good performers in the ISM audit. It reveals that the similarity is not a robust indicator to measure improvement, but still it has a strong implication if other factors such as nature of the finding are evaluated accordingly.

However, if the similarity is compared to the bad performers, there was only one bad performer with strong similarity in the long term while there were ten bad performers with strong similarity in the short term. Since the bad performers are ships with three or more NCs, the strong similarity directly means the repetition of the problems in the following event. Therefore, the conclusion could be made that the bad performers in the ISM audit improved with the passage of time.

Table 9 Similarity by the performance

Similarity	0~180D			181~365D		
	Bad	Good	Total	Bad	Good	Total
No	2	22	24	8	15	23
Part	4	5	9	6	5	11
Strong	10	4	14	1	4	5
N/A		3	3		11	11
Total	16	34	50	15	35	50

(unit: ships)

If the similarity is compared with the nature of the findings to confirm the similarity analysis, it becomes apparent and gives a clearer picture. Table 10 and Table 11 show a comparison between the similarity and NCs coded by the ISM module. It can be seen from Table 10 that, for instances of the strong similarity, all ships with 51 NCs in the ISM audit, which means that ships with half of the total number of NCs, have the strong similarity with the deficiencies at the following PSC inspection.

In terms of NCs by ISM module, module 10 represents the highest number of NCs, which indicates that ships with NCs related to maintenance issues have taken similar deficiencies in the following PSC inspections. It can also be seen that ships with NCs related to modules 6, 7, and 8 have similar deficiencies in the following PSC inspection.

Table 10 Comparison of similarity and NCs by the ISM module in short term

Module \ Similarity	Number of NCs coded by ISM module											Total
	2	3	4	5	6	7	8	9	10	11	12	
No		1		2	1	6	2	3	9		1	25
Part		1		2	2	3	2	3	10	1	2	26
Strong		1		1	6	5	8	2	28			51
N/A³⁷												
Total		3		5	9	14	12	8	47	1	3	102

(unit: pcs)

³⁷ In the ISM-first group N/A is zero since N/A is the case that of some deficiencies in the PSC inspection with no NC in the previous ISM audit (Refer to the Chapter 5)

When it comes to the longer period, the NCs with strong similarity decrease drastically in nearly every ISM module. With this, apart from whether the ISM Code works or not, it is possible to say that, at least, ships with NCs rarely repeat similar deficiencies in the following PSC inspection in the long term. In other words, this represents indirectly that some dynamic activities were carried out to avoid similar nature of deficiencies in the wake of the ISM audit.

Table 11 Comparison of similarity and NCs by the ISM module in long term

Module \ Similarity	Number of NCs coded by ISM module											Total
	2	3	4	5	6	7	8	9	10	11	12	
No		2		5	5	7	3	5	10	3	2	42
Part			1	4	3	5	1	1	15		1	31
Strong						1			6	1		8
N/A												
Total		2	1	9	8	13	4	6	31	4	3	81

(unit: pcs)

In summary, there was high similarity in the findings between NCs and deficiencies in the short term period, particularly in maintenance issues, while the long term data showed little similarity. It can be affirmed that the similarity analysis correspond to the results of the analysis by the number of findings as the hypothesis expected.

6.1.4 Analysis by the nature of findings

In analyzing the ISM-first group, it was found that the ISM audit has a notable impact on the following PSC inspection in the long term, whereas relatively little impact was found in the short term. Then next step should be to verify which areas of the NCs are effective and ineffective to the following PSC inspection. As mentioned in 6.1.3, the findings coded by the ISM module were compared by the number of findings and portions.

By means of this, the relative importance could be determined along with the percentage of findings in the respective events by the ISM module. It is also possible to check the variations in nature of deficiencies in the following PSC inspection, which reveals which modules were effective, and why the ISM-first group made more improvement in the long term. Table 12 and Table 13 illustrate the outcome of this analysis in the short term and long term period.

It was found that there were different degrees of variations as time passed. Findings noted through Table 12 and Table 13 are as follows;

- Module 9 was the most effective in both timeframes.
- Modules 5, and 7 showed improvement in both timeframes and were notably strengthened with the passage of time
- Modules 8, and 10 were ineffective particularly as time passed
- Modules 3, 4, 6, and 12 had positive impacts and remained at a similar level regardless of the passage of time

Table 12 Findings by the ISM module in short term

Module	2	3	4	5	6	7	8	9	10	11	12	Total
ISM	0/0	3/2.9	0/0	5/4.9	9/8.8	14/13.7	12/11.8	8/7.8	47/46.2	1/1	3/2.9	102/100
PSC	0/0	0/0	0/0	5/3.7	13/9.4	14/10.2	14/10.2	0/0	86/62.8	5/3.7	0/0	137/100
Diff.(%)	0	-2.9	0	-1.2	+0.6	-3.5	-1.6	-7.8	+16.6	+2.7	-2.9	-

(Unit: pcs / %)

In the short term period, the PSC inspection made some improvement in modules 3, 5, 7, 8, 9, and 12 while in the long term period showed improvement in modules 3, 4, 5, 6, 7, 9, and 12. More specially, this tells us that the ISM audits primarily impact the Master's responsibility (module 5) and shipboard operations (module 7) as time passes. In addition to those modules, but most of the modules showed improvement along with the passage of time, supporting the analysis results in 6.1.2.

Table 13 Findings by the ISM module in long term

Module	2	3	4	5	6	7	8	9	10	11	12	Total
ISM	0/0	2/2.5	1/1.2	9/11.1	8/9.9	13/16.0	4/5.0	6/7.4	31/38.3	4/4.9	3/3.7	81/100
PSC	0/0	0/0	0/0	3/1.9	13/8.1	12/7.5	20/12.4	1/0.5	100/62.1	12/7.5	0/0	161/100
Diff.(%)	0	-2.5	-1.2	-9.2	-1.8	-8.5	+7.4	-6.9	+23.8	+2.6	-3.7	-

(Unit: pcs / %)

The ISM audit provided slight effects on company's responsibility (module 3), designated person (DP, module 4), resource and personnel (module 6), and company's verification (module 12). However, it was seen that the ISM audit did not have a clear impact on emergency preparedness (module 8), maintenance (module 10), or documentation (module 11).

Regarding Reporting accident and hazardous occurrence (module 9), it seemingly needs to be investigated more despite the fact that it showed the most significant improvement in the following PSC inspection. This might be because PSC does not look deeply into the management system without clear grounds. And also there were only a few deficiencies exhibited in the dataset. Therefore, it is difficult to rely on what the figure says and it seems to require more elaboration.

The picture becomes clearer when the analysis by nature of the findings is applied to bad performers. Table 14 and Table 15 indicate the analysis of bad performer findings by ISM module. From those tables, it is indicated that;

- Only module 9 showed effectiveness, and module 10 became worse in the short term.
- Most of the modules, except for module 9, were at a similar level in the short term.

Table 14 Findings (bad performers) by the ISM module in short term

Module	2	3	4	5	6	7	8	9	10	11	12	Total
ISM	0/0	1/1.5	0/0	1/1.5	6/8.7	8/11.6	9/13.0	6/8.7	35/50.7	1/1.5	2/2.8	69/100
PSC	0/0	0/0	0/0	2/2.6	8/10.6	7/9.2	9/11.8	0/0	48/63.2	2/2.6	0/0	76/100
Diff.(%)	0	-1.5	0	+1.1	+1.9	-2.4	-1.2	-8.7	+12.5	+1.1	-2.8	-

(Unit: pcs / %)

- Modules 3, 5, 7, 9, and 12 showed good progresses in the long term.
- Modules 8, and 10 got worse in the long term period.

Table 15 Findings (bad performers) by the ISM module in long term

Module	2	3	4	5	6	7	8	9	10	11	12	Total
ISM	0/0	2/3.4	1/1.7	8/13.6	4/6.8	11/18.6	3/5.1	4/6.8	19/32.2	4/6.7	3/5.1	59/100
PSC	0/0	0/0	0/0	0/0	2/7.1	0/0	7/25.0	0/0	17/60.7	2/7.2	0/0	28/100
Diff.(%)	0	-3.4	-1.7	-13.6	+0.3	-18.6	+19.9	-6.8	+28.5	+0.5	-5.1	-

(Unit: pcs / %)

Hereupon, it can be said that the ISM audit had a weak impact on the following PSC in the short term, except for module 9 in the group of bad performers, and even module 10 became worse. There were not many variations in improvement or deterioration in the short term. However, intense changes were recorded in the long term. This indicates that the ISM audit had a strong positive influence on the overall modules in the long term; in particular, there were remarkable improvements in the master's responsibility, and shipboard operation aspects.

6.1.5 Discussions

As suggested in Chapter 5, it was expected that, if the ISM Code works, a good performance would be seen in the PSC inspection if the starting point was a bad performance in the ISM audit. A partial or no relationship also should be found between the NCs and deficiencies. In order to test the hypothesis, three methods were used; compared by the number, similarity analysis, and by the nature of the findings.

It was consistently observed through those methods that improvement was made in the long term period, and more importantly, the bad performers in the long term have made a lot of positive progress. Table 16 summarizes the performance analysis. The table indicates that irrespective of the performance level in the ISM audit, there were not many performance variations at the next PSC inspection in the short term period, while the long term showed significant differences.

Table 16 Performances comparisons by the time passage

Performance Time frame	Good performers		Bad performers	
	0~180D	181~365D	0~180D	181~365D
Maintained or Improved	70.6%	51.4%	25.0%	75.0%
Similar or worsen	29.4%	48.6%	75.0%	25.0%

In the short term period, performance in the ISM audit maintained the same condition in 70~75% of cases. Namely, most of the bad performers in the ISM audit stayed in the PSC bad performers group, and ISM good performers remained in the good performer's group in the following PSC inspection. This was supported by the similarity analysis in Table 9 wherein 10 out of 16 bad performers in the ISM Code showed strong similarity, which implies that 62.5% of bad performers repeated similar problematic shipboard activities. And the similar performance was also seen by the nature of the findings in Table 12 wherein the PSC deficiencies showed nearly similar outcomes with the previous ISM audit, except for module 9.

This can occur when the same SMS is applied in the same manner without changes, for instance, if the SMS changed in the wrong way, it would create more problems. Contrariwise, if the SMS changed in a positive way, the system would achieve some improvement. Despite the 25% of improvement in the bad performers, and the 29.4% worse performance in the good performers, which are not meaningful in general, it could be concluded that the SMS in the short term timeframe is not showing dynamic changes by the improvement mechanism of the ISM Code. In

other words, the ISM Code is seemingly not working effectively in short term period for the ISM-first group.

In contrast, in the long term, only approximately half of the good performers maintained their performance level, while 75% of the bad performers made improvements in the following PSC inspection. While good performers did not maintain their condition as time passed, the bad performers achieved huge improvements. Regarding bad performers' improvement, as demonstrated in Table 9, only one out of 15 bad performers showed strong similarity with deficiencies in the following PSC inspection. This is a sign that the bad performers have worked on their vulnerabilities or at least made some positive progress to avoid the same deficiencies at subsequent PSC inspections.

Furthermore, it was found that the ISM audit has an impact on the overall safety management system. According to Table 13, it was underlined that the ISM audit impacted on the PSC inspection in the overall modules other than 8, 10, and 11 and the magnitude of the improvement became stronger as time passed. Moreover, bad performers presented clear enhanced performances relating to Master's responsibility, and shipboard operations in Table 15, which are impossible to progress without systematic approaches. This evidently corresponds to the hypothesis. So it might be possible to conclude that the improvement mechanism of SMS is functioning in the long term period, which means the ISM Code is working properly.

Apart from the conclusion, a question arises as to why the good performers were unable to maintain their performances as time passed. This might be explained by the limitation of the certification and the capacity of shore-based management. The good performers might have a good SMS with well-trained seafarers at the time of the audit. However, to maintain the performance, everyone involved in the SMS should exert constant efforts to cope with various dynamic, internal and external factors such as crew, training, maintenance, and new rules.

In practical terms, it is difficult for seafarers and companies to maintain their highest attention until the next verification. The same practice is seen in the periodical survey. In this regard, the role of shore-based management is paramount in maintaining the safety system. It may be inevitable to decline to some extent, but the key concern should be how to maintain a high level performance and how often the PSC inspection should monitor it.

In contrast, the bad performers gained positive results as time went by. This result could be explained by the traits of the ISM audit and improvement mechanism of the Code. As seen in Tables 12, and 13, the ISM audit mainly identified findings in the procedure-related modules such as modules 3, 4, 5, 6, 7, 9, and 12. This is because, unlike PSCO, the auditor does not focus much on immediate defects; instead auditors try to find underlying shortcomings of the system itself and improper execution of the SMS through records and interviews.

When looking at improvement areas of the bad performers in Table 15, the bad performers in the long term made progress in nearly every module. In particular, strong improvement was made in modules 5, and 7, which require a long time to take corrective actions. For instance, if NCs in shipboard operations (module 7) were identified during the audit, the corrective action should go through the revision of the SMS, distributing, training and evaluation processes. Therefore, it can be understood that the time-consuming nature of NCs results in fewer effects on the improvement mechanism in the short term, which was probably under the process. This can be another explanation for why positive effects of the ISM audit are revealed in the long term, not in the short term.

6.1.6 Summary of analysis of the ISM-first group

Key findings from analysis in 6.1 are as follows;

In the short term

- Most of the good performers in the ISM show good performance.
- The majority of bad performers remain in the bad performance category.

In the long term

- Good performers in the ISM audits show declined performances.
- Bad performers make remarkable improvement in many areas of SMS.

We could see that the ISM audit does not provide much impact on the following PSC inspection in the short term, which implies that the improvement mechanism probably does not work efficiently in that timeframe. In regard to the declining performance of the good performer, the significance of the constant shore-based attention to and management of the shipboard activities after the ISM audit is highlighted.

Furthermore, it is confirmed that the ISM audit has a positive impact on the following PSC inspection in the long term, which implies that positive effects of the ISM audit are revealed in the long term. It was also found by evaluating the safety management areas coded by the ISM module that there are improvements in many aspects compared to the short term period.

This can be attributed to the fact that it requires a certain time to reflect the findings into its SMS and internalize the procedures into real shipboard activities, and the effect of the improvement mechanism comes after a certain time period. It might be possible to say that the ISM Code is working properly in the long term period on the grounds of which the improvement mechanism of the SMS works correctly.

6.2 Analysis of PSC inspection followed by ISM audit (PSC-first group)

6.2.1 Overview of PSC-first group

The deficiencies in the PSC inspection and NCs in the following ISM audit of each sampled ship (50, 32) were contrasted by number to examine how the PSC inspection results impacted the following ISM audit. Table 17 shows that the number of deficiencies per ship in the short term was higher than in the long term, whereas the NCs per ship in the following ISM audits showed the same tendency.

Table 17 Total number of Def. and NCs in two timeframes

Time	Def.	Def./ship	NCs	NCs/ship
0~180D	155	3.1	133	2.7
181~365D	92	2.9	74	2.3

(Unit: pcs)

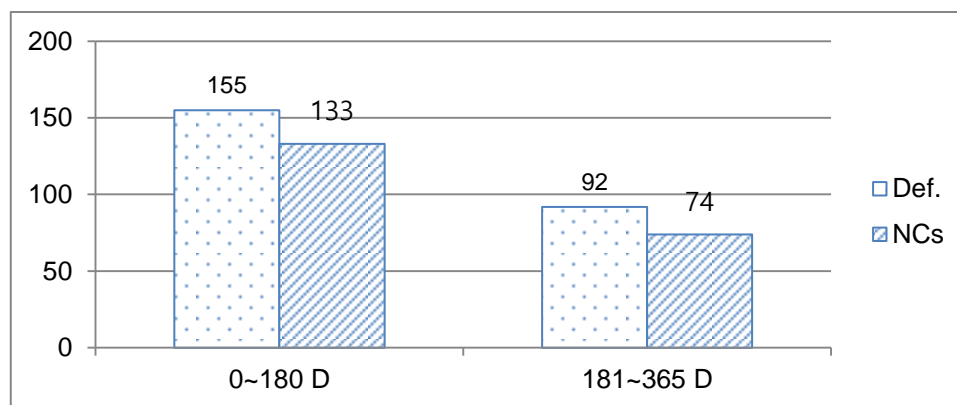


Figure 3 Number of Def./NCs of PSC-first group

6.2.2 Analysis by the number of findings

Table 18 exhibits the number of ships contrasted by the number of deficiencies and NCs in the short term period. This table indicates how a particular ship with a certain number of deficiencies undertook performances in the following ISM audit. It demonstrates the impact of the PSC inspection on the following ISM audit. As in

section 6.1.2, whether or not the improvement mechanism of the ISM Code works can be measured because PSC deficiencies should be taken as non-conformity with the SMS and thereby the ship operators have to take corrective actions. Statistical analysis is derived as follows;

- 48% of ships (24) had the same or higher number of deficiencies than the number of NCs in the following ISM audit.
- Nine ships had no NC and 52% of ships (26) had good performance in the following ISM audit.
- Among ships with good performance in the PSC inspection (29), 62.1% of ships maintained good performance in the ISM audit (18), while 37.9% of ships (11) showed the worse performance in the ISM audit.
- Among ships with bad performance in the PSC inspection (21), 38.1% of ships (8) showed improvement in the ISM audit, while 61.9% of ships (13) showed similar performance.

Table 18 Number of ships compared by the number of Def. and NCs in short term

Number of Def.	Number of NCs									Total
	0	1	2	3	4	5	6	7	8	
0	2	3	7	1	2	1	1	1		18
1	3			1						4
2	1	2		1	2	1				7
3		1			1	2	1			5
4	1									1
5	1	1			1		1			4
6	1	1	1	2	1					6
9			1		1					2
13									1	1
15					1					1
16				1						1
Total	9	8	9	6	9	4	3	1	1	50

(Unit: ships)

We can see from above that 62.1% of ships among good performers in the PSC inspection maintained their good performance in the following ISM audit; while 37.9%

of ships showed a worse condition. In the meantime, 38.1% of ships among bad performers exhibited improvement, whereas 61.9% showed worse performance.

The majority of good performers had good performance, which is quite similar to the ISM-first group. On the other hand, the bad performers showed approximately 40% improvements, which might be a signal that the improvement mechanism is working to some extent. But still, around 60% of bad performers remained at the similar levels.

Table 19 illustrates the number of ships compared with the number of deficiencies and NCs in the long period. It was analyzed as follows;

- 59.4% of ships (19) had the same or higher number of deficiencies than the number of NCs in the following ISM audit.
- Six ships had no NC and 62.5% ships (20) showed good performance in the following ISM audit.
- Among ships with good performance in the PSC inspection (20), 65.0% of ships maintained good performance in the ISM audit (13), while 35.0% of ships showed the same or worse performance (7).
- Among ships with bad performance in the PSC inspection (12), 58.3% of ships showed improvement in the following ISM audit (7), while 41.7% of ships showed similar or worse performance (5).

To summarize, 65% of good performers in the PSC inspection showed the same or improved performance in the following ISM audit, while 35% showed got worse. In the bad performers group, 58.3% of ships showed better performance in the following ISM audit, while 41.7% of ships did not. The good performers, in the long term, maintained their good performance to a relatively high level which is almost similar to the short term, which suggests a point for deliberation, taking into account the deterioration of performance as time passes, which is quite reasonable, unlike the ISM-first group. Also, it needs to be highlighted that the bad performers improved even though the extent of improvement was limited compared to the ISM-first group.

Table 19 Number of ships compared by the number of Def. and NCs in long term

Number of Def	Number of ships by number of NCs								Total	
	0	1	2	3	4	5	6	8		
0	2	2	2	1	1	1				9
1	1	4						1		6
2	1		1	1	2					5
3			1							1
4		1				2				3
5	1									1
6		1	2							3
8	1				1			1		3
14				1						1
Total	6	8	6	3	4	3	1	1		32

(Unit: ships)

6.2.3 Similarity analysis

The results of the similarity analysis on the PSC-first group are shown in Table 20, indicating how ships responded to the deficiencies identified in the PSC inspection. The ships with strong similarity in the short term represented only 14% of all ships, which reflects the fair performance of the PSC-first group in the short term period compared to the ISM-first group. And also there were only four ships with strong similarity in the long term period, which is 12.5%. As such, only a general impression is given that the deficiencies do not repeat in the following ISM audit in the PSC-first group. But variations on the findings should be investigated more thoroughly.

Table 20 Similarity comparison by the timeframe

Degree	No	Part	Strong	N/A	Total
0~180D	14	13	7	16	50
181~365D	15	6	4	7	32

(unit: ships)

With regard to the comparison of the performance, Table 21 indicates that only one bad performer presented strong similarity in the long term, while five ships showed strong similarity in the short term. It does not give a clear distinction between the two timeframes; however, at least it gives some impression that the deficiencies in the PSC-first group do not repeat similar NCs at the next ISM audit regardless of the performance level.

Table 21 Similarity by the performance

Similarity	0~180D			181~365D		
	Bad	Good	Total	Bad	Good	Total
No	5	9	14	6	9	15
Part	11	2	13	5	1	6
Strong	5	2	7	1	3	4
N/A		16	16		7	7
Total	21	29	50	12	20	32

(unit: ships)

If the similarity is compared by the nature of the findings, it becomes more apparent. Table 22 and Table 23 show the comparison between the similarity and deficiencies coded by ISM module. These tables imply that if there are many strong similarities, the ships tend to maintain a similar level of performance.

Table 22 illustrates this trend in the short term, for instance, all ships with 46 deficiencies in the PSC inspection have the strong similarity with the NCs at the following ISM audit, which means that ships with around 30% of total deficiencies have the strong similarity with the NCs at the following ISM audit. This is different results from the ISM-first group, which indicates that the PSC-first group has fewer repetitions of similar findings in the short term compared to the ISM-first group.

In the long term period, the deficiencies with strong similarity decreased further. The deficiencies are mostly found in the partial and no relation area. Specifically, despite the low number of deficiencies due to the smaller size of the dataset, the number of “no similarity” in module 10 is higher than short term period. Hence, the table reveals that, at least, ships in the long term did not take many NCs in similar areas at the following ISM audit

Table 22 Comparison of similarity and Def. by the ISM module in short term

Module \ Similarity	Number of Def. coded by ISM module											Total
	2	3	4	5	6	7	8	9	10	11	12	
No				2	3	1	5		18	5		34
Part					8	6	15		36	10		75
Strong				1	5	5	5		26	4		46
N/A												0
Total				3	16	12	25		80	19		155

(unit: pcs)

Table 23 Comparison of similarity and Def. by the ISM module in long term

Module \ Similarity	Number of Def. coded by ISM module											Total
	2	3	4	5	6	7	8	9	10	11	12	
No				2	3	1	2		36	6		50
Part					1	5	1		21	5		33
Strong					1				7	1		9
N/A												0
Total				2	5	6	3		64	12		92

(unit: pcs)

6.2.4 Analysis by the nature of findings

The deficiencies and NCs were coded by the ISM Code as in 6.1.4, and compared with each other by timeframe. The PSC inspection results in each module of the SMS can be seen by this analysis. In the ISM-first group, it was found that the ISM audit influenced the following PSC inspection in many aspects of the SMS but the result was somewhat different in the PSC-first group. The findings can be found in Table 24 and Table 25 as follows;

- Modules 8, 10, and 11 showed effectiveness in the short term.
- Modules 10, and 11 showed effectiveness in the long term.
- As time passes, the impact on modules 10, and 11 became stronger, while positive impact declined in module 8.
- No clear impact was found in modules 2, 3, 4, 5, 6, 7, 9, and 12.

Table 24 Findings by the ISM module in short term

Module	2	3	4	5	6	7	8	9	10	11	12	Total
PSC	0/0	0/0	0/0	3/1.9	16/10.3	12/7.8	25/16.1	0/0	80/51.6	19/12.5	0/0	155/100
ISM	0/0	7/5.2	0/0	10/7.5	21/15.8	20/15.0	9/6.8	10/7.5	48/36.1	3/2.3	5/3.8	133/100
Diff.(%)	0	+5.2	0	+5.6	+5.5	+7.2	-9.3	+7.5	-15.5	-10	+3.8	-

(Unit: pcs / %)

Table 25 Findings by the ISM module in long term

Module	2	3	4	5	6	7	8	9	10	11	12	Total
PSC	0/0	0/0	0/0	2/2.2	5/5.4	6/6.5	3/3.3	0/0	64/69.6	12/13.0	0/0	92/100
ISM	0/0	4/5.4	0/0	7/9.5	12/16.2	16/21.6	6/8.1	6/8.1	22/29.7	0/0	1/1.4	74/100
Diff.(%)	0	+5.4	0	+7.3	+10.8	+15.1	+4.8	+8.1	-39.9	-13.0	+1.4	-

(Unit: pcs / %)

Based on the analysis, it could be said that PSC inspection has an impact on emergency preparedness (module 8), maintenance (module 10), and documentation (module 11) which is opposite to the results of 6.1.4. In the ISM-first group, the ISM audit did not impact modules 8, 10, or 11; on the other hand, the PSC-first group showed the impact only in those modules where the ISM-first group did not have effects. This might be a typical relationship between PSC inspection and the ISM audit. Among modules positively impacted, PSC primarily impacts on the maintenance issue, which is being strengthened as time goes by. It was possible to see that the improvement in the maintenance issue contributes to the overall reduction in the number of findings. But this outcome might be due to different purposes and practices of both regimes.

It was also found that there was not clear impact on the following ISM audit in various modules other than modules 8, 10, and 11. There were no deficiencies relating to the modules 2, 3, 4, 9 or 12, and the deficiencies relating to module 5, remained at around 2% of deficiencies. Considering that the ISM audit influenced the PSC inspection in various modules, and it became wider as time passed, the PSC inspection has shown considerably different outcomes. Irrespective of the variations in the number of findings, this analysis strongly suggests that the PSC regime has little impact on the overall safety management system.

To validate the above analysis, the bad performers' data was analyzed again. Table 26 and 27 explain the comparisons of the findings of the bad performers in two timeframes.

- Positive impact was witnessed in modules 8, 10, and 11 in the short term.
- Most of the modules were similar or became worse, particularly modules 7, and 9.

Table 26 Findings (bad performers) by the ISM module in short term

Module	2	3	4	5	6	7	8	9	10	11	12	Total
PSC	0/0	0/0	0/0	3/2.2	15/10.9	9/6.6	22/16.1	0/0	71/51.8	17/12.4	0/0	137/100
ISM	0/0	3/4.5	0/0	7/10.6	10/15.2	12/18.2	3/4.6	5/7.6	22/33.3	2/3.0	2/3.0	66/100
Diff.(%)	0	+4.5	0	+8.4	+4.3	+11.6	-11.5	+7.6	-18.5	-9.4	+3.0	-

(Unit: pcs / %)

The bad performers in the short term showed precisely similar tendencies with the overall condition illustrated in Tables 24, and 25. Only three modules had some impact. But some inputs in modules 6, and 7 exist although there was no clear impact on the following ISM audit.

- Modules 10, and 11 showed positive impacts in the long term.
- No impact was found other than modules 10, and 11.
- The strong impacts were found in module 10.

Table 27 Findings (bad performers) by the ISM module in long term

Module	2	3	4	5	6	7	8	9	10	11	12	Total
PSC	0/0	0/0	0/0	1/1.3	4/5.3	5/6.6	2/2.6	0/0	55/72.4	9/11.8	0/0	76/100
ISM	0/0	2/6.1	0/0	6/18.2	5/15.2	9/27.3	2/6.0	2/6.0	7/21.2	0/0	0/0	33/100
Diff.(%)	0	+6.1	0	+16.9	+9.9	+20.7	+3.4	+6.0	-51.2	-11.8	0	-

(Unit: pcs / %)

It was confirmed again in the bad performers that there were only positive effects on modules 8, 10, and 11 in the short term and module 8 lost impact in the long term. The large decrease in the number of NCs in module 10 (maintenance) led to improvement in the long term; however, it is unclear whether this is due to limited data sampling. Based on the above figure, it becomes more obvious that PSC does not have much impact on various aspects of the safety management system, but it does have an influence on maintenance and documentation related issues. Consequently, it is possible to arrive at the logical conclusion that the performance of the PSC-first group and its performance variations were not strongly related to the outcome of the improvement mechanism of the ISM Code.

6.2.5 Discussions

Table 28 compares the performance of the PSC-first group in the two time frames. This table tells us that the good performers in the PSC inspection maintain a similar condition regardless of the timeframe, which is an entirely different result from the ISM-first group. Meanwhile, the bad performers make more improvement in the long term than in the short term period.

Table 28 Performances comparisons by the time passage

Performance Time frame	Good performers		Bad performers	
	0~180D	181~365D	0~180D	181~365D
Maintained or Improved	62.1%	65.0%	38.1%	58.3%
Similar or worsen	37.9%	35.0%	61.9%	41.7%

In the short term period, the good performers and bad performers commonly sustained similar condition of around 62%, which is the same pattern shown in the ISM-first group. As concluded in 6.1.5, from this similar trend, it can be understood that the SMS, particularly the improvement mechanism is not working properly. However, more attention needs to be paid to the bad performers' improvement (38.1%) which is higher than the ISM-first group (25.0%).

While the NCs in the ISM-first group were mostly associated with findings that require a long time to correct, the deficiencies of the PSC-first group, which constitute improvement in the short term, are connected with modules 8, 10, and 11, wherein remedial action can be made quickly. The reasonable interpretation is that intensified inspection regarding modules 8, 10, and 11 resulted in fewer NCs in those areas in the following ISM audit. It is not quite certain that the improvement mechanism worked on only those deficiencies, bearing in mind that most of the other modules did not give clear impact on the following audit. However, regardless of whether those improvements were made through the improvement system or not, it carries the strong implication that ships could benefit more immediately from PSC inspection than ISM audit in the specific areas mentioned above.

As a reason for immediate effect, the monetary burden should be highlighted. Considering that poor maintenance initiates most of PSC detentions, the ship owners tend to cope actively with the maintenance issue, which showed the biggest improvement in the PSC-first group as shown in Table 26. Once a ship is detained in a foreign port, costs will occur not only for the repair but also for market delays. The monetary burden and fear for detention could motivate ship owners to react more sensitively to the PSC than to the ISM audit. Therefore, it could be inferred that the bad performers' improvement in the short term period seems to be a consequence of the police power of PSC, which ultimately affects the safety management system of the ship.

In the long term period, the performance of the good performers maintained a fair level, while 58.3% of the bad performers maintained a same condition or made improvements. It is a somewhat unexpected outcome that the good performers maintained or enhanced their performance in spite of time passage. As discussed in 6.1.5, the degradation of performance as time lapses after the external stimulus is quite normal in reality. Besides, the data gives no clear statistical clues to interpret it. The similarity analysis was also not sufficient to provide the cause of the improvement as it simply captured an overall view.

However, relating to why the PSC-first group does not show degradation of performance as time passes, attention should be paid to Table 25 wherein the group made much improvement in module 10, where the majority of deficiencies were found, in the long term than short term period. This gives some idea when we recollect the explanations of the degradations as time passes, which were discussed in 6.1.5. The seafarers might keep their level of attention on the maintenance issue after the bad memory of PSC inspection. It should be noted that the ship would not be able to exactly anticipate the next PSC inspection; however, ship owners can somewhat assume the time window for inspection through the targeting system. Today, the regional MoUs have global coverage, and their member States share inspection records to achieve common goals in their region. This global cooperative regime makes the ship ready for inspection in daily operations, unlike periodical verification.

The bad performers in the long term period made notable improvement. But if looking inside, as discussed in 6.2.4, PSC does not have much impact on overall modules other than modules 10, and 11 where the improvement is mostly concentrated. It does not mean that the PSC had 'zero' impact on the following ISM audit since the deficiencies related to modules 5, 6, and 7 were influential to some extent as seen in Tables 24, 25, 26, and 27. But from the statistical point of view, it might be a correct expression that PSC does not impact to the safety management system in the bad performer group.

Some might say the improvements in modules 10, and 11 were due to the fact that PSC always records more deficiencies in module 10 than the ISM audit. This is the right point of view because, while auditors tend to look into the crew's activities with a systematic approach, PSCO begins its inspection with the certificates and documents and then by checking the overall maintenance condition of the ship. The argument that PSC only impacts maintenance and emergency drill or documentation and certifications, seems reasonable. However, we need to reconsider the functions of the ISM Code.

In theory, regardless of the number of deficiencies, if one ship has some deficiencies, the improvement mechanism should have been activated to avoid similar problems in the future. Therefore, it is premature to say that the PSC inspection does not impact the ISM audit considering the improvement mechanism of the ISM Code. Nonetheless the fact that the PSC did not identify deficiencies in modules 2, 3, 4, 9, or 12 as seen Tables 24, and 25 could be an innate limitation of the PSC regime to act as a robust safety net in the shipping industry. Therefore, even though bad performers in the PSC-first group showed better performance than the ISM-first group and fewer strong similarities were presented, the ISM Code might not be working as hypothesized. This might be a reason that its ostensible performance was not obtained through the improvement mechanism. However, we should highlight the power of the police function of the PSC in the maintenance issue.

Taking into account the innate characteristics of both regimes and how the improvement mechanism should work, it can be clarified that current PSC inspections give some input to the safety management system, but the shipboard activity does not make use of it productively. It seems that the deficiencies in the PSC inspection have not been processed according to the SMS and it has not been monitored properly either. In this point, there must be a cause and effect relationship with the fact that there was only one deficiency in module 9 in the datasets used. So it comes to the supposition that if the PSCO pays more attention to how the deficiencies in the PSC are processed using the improvement mechanism of the ISM Code, it might be possible to see more improvements triggered by PSC deficiencies instead of being left as just records of the inspections.

6.2.6 Summary of analysis of the PSC-first group

Key findings from analysis in 6.2 are as follows;

In the short term

- Good performers in the PSC showed good performance.
- Bad performers showed more improvement compared to the ISM-first group.

In the long term

- Good performers in the PSC improved their performances.
- Bad performers primarily made improvement in maintenance.

To recap, the analysis revealed that the PSC inspection has a positive impact on the following ISM audit to some extent in the short term, which is mainly due to the fear of detention and monetary burdens owing to the PSC inspection. Dissimilar to the ISM-first group, the good performers maintained a similar level or better regardless of time passage, which might mean that the unscheduled inspection and targeting system, contrary to the periodical survey, gives stronger and more powerful warnings to the shipping industry.

Furthermore, it is noted that the positive impact of PSC inspection mostly focused on the maintenance issue in the long term, while there were not many impacts on the overall safety management system of the ship. Even though few deficiencies related to procedural findings were identified in the PSC inspection due to the innate trait of the regime, deficiency should have been taken as NCs according to the improvement mechanism of the ISM Code. In connection with the hypothesis, the PSC-first group showed performances corresponding to the hypothesis, but it did not show progress by the nature of the findings. This might be because the reduction in the findings did not come from the improvement mechanism.

In this respect, it might be inferred that the improvement mechanism of the SMS does not function in response to deficiencies as appropriate, which makes the PSC inspection ineffective on the following ISM audit. It was suggested that PSCO should pay more attention to how the deficiencies are processed through the SMS procedures to prevent recurrence. Consequently, the PSC has little impact on the overall safety management system but has a much stronger impact on the limited area due to the police function of the PSC.

7. CONCLUSION

The objectives of this dissertation were to examine how the ISM Code impacts the PSC inspection, and how the PSC inspection influences the implementation of the ISM Code. To achieve these aims, the dissertation focused on the improvement mechanism of the ISM Code which should be activated if a ship has any deviation or defects during the implementation of the SMS. The continuous improvement indicates compliance with the ISM Code, and it would be a strong signal that the safety culture has been internalized in the company so that crews actively take part in the safety management system (Anderson, 2003; IMO, 2005; Lappalainen & Salmi, 2009).

Based on the concept of the improvement mechanism, the hypothesis was established. If the bad performers in ISM audit or PSC inspection show good performance in the following PSC inspection or ISM audit, with partial or no similarity, we could infer that the ISM Code is working properly. Conversely, if the bad performers exhibit similar results with strong similarity by the nature of the findings, the ISM Code might be working ineffectively because it would be the consequence of a malfunction of the improvement mechanism.

This paper used both ISM audit and PSC inspection records of Korean ships from the second half of 2013 to 2015, and compiled through tracking the history of individual ship records to observe the impact of the previous event on the successive event. In addition, the datasets were divided by time intervals (0~180 days and 181~365 days) between the two events to analyze the variations by passage of time, and only ships with no event during those intervals were used in the analysis to see immediate influences.

According to the analysis, it was found that, regardless of performance level, ISM audit did not noticeably impact the following PSC inspection and the performance level remained in a similar condition in the short term. This can occur when the SMS is in a static condition without any changes regardless of good or wrong directions. So it was concluded that the ISM-first group in the short term had no improvement, which might be due to insufficient time to address the NCs because the NCs were mostly concentrated in areas which require a systematic approach, safety culture and time to complete corrective actions. Nevertheless, this indicates that the improvement mechanism of the ISM Code does not have an effect on the safety system in this specific timeframe.

Meanwhile, in the long term period, dissimilar to short term results, a very strong positive impact of the ISM audit was witnessed in the bad performers on the following PSC inspection in all aspects of safety management. Simultaneously, some declining performance in the good performers was noticed. It was interpreted that the effect of the ISM Code was revealed in the long term since it requires a particular timeframe for the NCs to be reflected in the SMS and internalized into the procedures of real shipboard operations. In the meantime, degradation of the good performers represents the significance of the shore-based management and continuous monitoring by PSC. It was found in the ISM-first group that the improvement mechanism needs some time to function, and an action to keep the good performer in compliance is required.

In the PSC-first group, the bad performers in the short term period showed more improvement than the ISM-first group. But the improvement was mostly concentrated in limited areas, such as emergency preparedness, maintenance, and documentation, wherein the ISM-first group showed bad performance, while there were no improvements in other areas of the safety management system. This paper pointed out that the reason for the improvement was that the police power of the PSC motivated the ship owner to respond sensitively to the maintenance issues, which are the major deficiencies, to avoid detention and subsequent monetary burden.

In the long term of the PSC-first group, the bad performers exhibited considerable improvements, while the good performers showed enhanced performance without degradation over the time. In determining data, it was found that there were similar tendencies in the short term of PSC-first group whereby only limited areas of the SMS were affected. This outcome strengthened the explanation as to the effect of the police power of the PSC. Besides, relating to the good performers, it was discussed that maintaining a certain level of performance reflected the unexpected inspection characteristic of PSC, including the targeting system, which provides strong warnings to a shipping company to maintain its ships in fair condition at all times. In this regard, it is possible to conclude that the PSC has an impact on the following ISM audit directly through its police power.

Consequently, in a point of effectiveness of the ISM Code, the analysis of the ISM-first group presented corresponding outcomes to the hypothesis. It denoted that the ISM Code has been working although a particular time is required to show the effect of the improvement mechanism. Whereas the ISM Code is working partly in PSC-first group, it would be a more reasonable conclusion that the variations in performance are mainly attributed to the police function of the PSC. This is why the PSC-first group did not show progress in overall safety management system although it corresponded to the hypothesis.

From the ISM Code and PSC perspective, the ISM Code showed strong features in the long term period. It represented apparent improvement effects on the areas where the ship had NCs, which could result in the substantial improvement of the safety management system. But it would not be easy to expect the immediate improvement because certain time to manifest the effect of the improvement mechanism is required. On the other hand, PSC inspection indicates clear and powerful impact on some part of SMS. The police power of PSC had immediate impacts in the short term, which continued over time. On the other hand, it is difficult to expect the continuous improvement of safety management systems if it relies solely on the police power of PSC.

On the basis of the above, it is possible to conclude that there is a mutual complementary relationship between the ISM audit and PSC inspection. So if both regimes might be able to complement their weaknesses and utilize each other's merits, the effectiveness of the ISM Code and PSC will be evidently increased. As illustrated in Figure 4, PSC inspection has strong features in the short period in ensuring the maintenance condition of the vessel, documentation, such as certificates, and nautical charts through its police power, while it has shown some vulnerability in addressing continuous improvement. In contrast, ISM audit brings continuous improvement in the long term because the ISM audit has an effective impact on the overall safety management system by means of the improvement mechanism, which will cultivate a safety culture. The police power of the PSC, therefore, can supplement the weakness of the ISM Code in the short term, and at the same time, the continuous improvement under the systematic approach of the ISM Code can make the PSC inspection more powerful.

	<u>WEAK</u>	<u>STRONG</u>
<u>PSC</u>	System Continuous improvement Long term	Police power Short term Maintenance Documentation
<u>ISM</u>	Short term Police power Maintenance Documentation	Continuous improvement System Long term Culture

Figure 4 Strength and weakness of PSC inspection and ISM audit

On this point, it is worth undertaking further study seeking a way to create synergy by utilizing the strengths of both regimes. Moreover, although this paper has limited

representativeness of the data, a further study could expand the dataset and applies the methodology of this paper and incorporating further variables of the ship, such as type, age, and marine accident records. In addition, a qualitative survey might provide with more accurate and meaningful outcomes. Furthermore, it seemingly necessary in conducting the PSC inspection that PSCO focuses more on the continuous improvement function of the ISM Code, such as how the Master's review, incident report and company's verification, and previous PSC deficiencies were processed according to the SMS. Likewise, from the ISM auditors' point, more attention should be paid to whether permanent corrective actions were appropriately taken concerning PSC deficiencies.

References

- Anderson, D. (2002). The Effect of Port State Control on Substandard Shipping. *Journal of Maritime Studies*, 2002(125), 20–25.
- Anderson, P. (1998). *ISM Code : A practical guide to the legal and insurance implications*. London ; Singapore: LLP.
- Anderson, P. (2003a). *Cracking the code : the relevance of the ISM Code and its impact on shipping practices*. London: Nautical Institute.
- Anderson, P. (2003b). *Managing Safety at Sea - The findings and conclusions of an international survey*. Retrieved from Middlesex University's Research Repository.
- Bang, H.-S. (2008). Is Port State Control an Effective Means to Combat Vessel-Source Pollution? An Empirical Survey of the Practical Exercise by Port States of Their Powers of Control. *The International Journal of Marine and Coastal Law*, 23, 715–759.
- Bang, H.-S. (2013). Recommendations for Policies on Port State Control and Port State Jurisdiction. *Journal of Maritime Law & Commerce*, 44(1), 115–133.
- Batalden, B. M., & Sydnese, A. K. (2014). Maritime safety and the ISM code: A study of investigated casualties and incidents. *WMU Journal of Maritime Affairs*, 13(1), 3–25.
- Bauer, Easterbrook, & Fairchild. (1992). In the Matter of Oil Spill by the Amoco Cadiz off coast of France on march 16, 1978, 954. Retrieved from https://scholar.google.co.uk/scholar_case?case=10340577502813700047&q=Amoco+Cadiz&hl=en&as_sdt=2003
- Berg, H. P. (2013). Human Factors and Safety Culture in Maritime Safety (revised). *TransNav, the International Journal on Marine Navigation and Safety of Sea Transportation*, 7(3), 343–352.
- Bhattacharya, S. (2009). *The Impact of the ISM Code on the Management of Occupational Health and Safety in the Maritime Industry*.
- Bhattacharya, S. (2012). The effectiveness of the ISM Code: A qualitative enquiry. *Marine Policy*, 36(2), 528–535.
- Boisson, P. (1999). *Safety at sea : policies, regulations & international law*. Paris: Bureau Veritas.
- Cariou, P., Mejia, M. Q., & Wolff, F. (2009). Evidence on target factors used for port state control inspections. *Marine Policy*, 33(5), 847–859.
- Cariou, P., Mejia, M. Q., & Wolff, F.-C. (2007). An econometric analysis of deficiencies noted in port state control inspections. *Maritime Policy & Management*, 34(3), 243–258.
- Cariou, P., Mejia, M. Q., & Wolff, F.-C. (2008). On the effectiveness of port state control inspections. *Transportation Research Part E: Logistics and Transportation Review*, 44(3), 491–503.
- Cariou, P., & Wolff, F.-C. (2011). Do Port State Control Inspections Influence Flag- and Class-hopping Phenomena in shipping? *Journal of Transport Economics and Policy*, 45(2), 155–177.
- Chauvel, A.-M. (1997). *Managing safety and quality in shipping*. London: The Nautical Institute.
- Degré, T. (2007). The use of Risk Concept to characterize and select High Risk Vessels for ship inspections. *WMU Journal of Maritime Affairs*, 6(1), 37–49.

- Degré, T. (2008). From Black-Grey-White Detention-based Lists of Flags to Black-Grey-White Casualty-based Lists of Categories of Vessels? *Journal of Navigation*, 61(3), 485–497.
- Department of Transport. (1987). Herald of Free Enterprise report. *Transport*, (8074), 73. Retrieved from http://www.maib.gov.uk/publications/investigation_reports/herald_of_free_enterprise/herald_of_free_enterprise_report.cfm
- Etman, E., & Halawa, A. (2007). Safety Culture , the Cure for Human Error : A Critique. In *World Maritime excellence* (pp. 115–126). Odessa: Odessa National Maritime Academy.
- Fan, L., Luo, M., & Yin, J. (2014). Flag choice and Port State Control inspections- Empirical evidence using a simultaneous model. *Transport Policy*, 35, 350–357.
- Hahne, J. (2000). *Assessment of deficiencies in the organisation of work in shipping*. Dortmund, Germany: Federal Institute for Occupational Safety and Health.
- Hare, J. (1997). Port state control:strong medicine to cure a sick industry. *The Georgia Journal of International and Comparative Law*, 26(1996), 571–594.
- Heijari, J., & Tapaninen, U. (2010). *Efficiency of the the Ism Code in Finnish Shipping Companies*. Turku: Maritime Studies University of TURKU.
- IMO. (n.d.). Brief history of IMO. Retrieved from <http://www.imo.org/en/About/HistoryOfIMO/Pages/Default.aspx>
- IMO. (1987). Safety of passenger Ro-Ro ferries. *IMO Document Resolution A.596(15)*, London: IMO.
- IMO. (1993). International Management Code for the Safe Operation of Ships and for Pollution Prevention (International Safety Management (ISM) Code). *IMO Document Resolution A.741(18)*, London:IMO.
- IMO. (2005). Assessment of the impact and effectiveness of implementation of the ISM Code, International Maritime Organization. *IMO Document MSC 81/17*, London:IMO.
- ITOPF. (n.d.). AMOCO CADIZ, France, 1978. Retrieved from <http://www.itopf.com/in-action/case-studies/case-study/amoco-cadiz-france-1978/>
- Knapp, S., Bijwaard, G., & Heij, C. (2011). Estimated incident cost savings in shipping due to inspections. *Accident Analysis and Prevention*, 43(4), 1532–1539.
- Knapp, S., & Franses, P. H. (2006). *The Global View on Port State Control*. Econometric Institute Erasmus University Rotterdam. Retrieved from <http://hdl.handle.net/1765/7659>
- Knapp, S., & Franses, P. H. (2008). Econometric analysis to differentiate effects of various ship safety inspections. *Marine Policy*, 32(4), 653–662.
- Knapp, S., & van de Velden, M. (2009). Visualization of Differences in Treatment of Safety Inspections across Port State Control Regimes: A Case for Increased Harmonization Efforts. *Transport Reviews*, 29(4), 499–514.
- Kokotos, D. X. (2012). a Study of Shipping Accidents Validates the Effectiveness of Ism-Code. *European Scientific Journal*, June(Edition 1), 387–392.
- Lappalainen, J., Kuronen, J., & Tapaninen, U. (2012). Evaluation of the Ism Code in the finnish shipping companies. *Journal of Maritime Research*, 9(1), 23–32.
- Lappalainen, J., & Salmi, K. (2009). *Safety Culture and Maritime Personnel's Safety Attitudes*. Turku.

- Lloyds list. (2003). Let seafarers light way forward on ISM Code: The effectiveness of the ISM Code requires an urgent review, published : 16.05.2003.
- Mejia, M. Q. (2005). *Evaluating the ISM Code Using Port State Control Statistics*. Lund, Sweden ; Malmö, Sweden: Lund University. Dept. of Design Sciences. Div. of Ergonomics and Aerosol Technology ; World Maritime University.
- Mejia, M. Q., Cariou, P., & Wolff, F. C. (2010). Vessels at risk and the effectiveness of Port State Control inspections, 33(0), 0–25. Retrieved from <http://hal.archives-ouvertes.fr/hal-00470635/>
- MLTM. (2010). *Daehyungheayangsago yebangeul eulhan anjeongwanricheajea unyoenggaesunyeongu [Research on the improvement of the safety management system to prevent large scale marine accident]*. Gwacheon;Ministry of Land, Transport and Maritime affairs. Retrieved from <http://www.prism.go.kr>
- MOMAF. (2006). *Neahang yegeakseoneul unhanggwanni baljeonbanghyangea gwanhan yoengu [Research on the operation management system to enhance the domestic passenger ships]*. Seoul:Ministry of Maritime and Fisheries. Retrieved from <http://www.prism.go.kr>
- Nautical Institute. (2004). Paperwork, what paperwork ? *Alert!*, (2), 1–8.
- New Swedish Club. (2001). New Swedish Club study confirms ISM ' s beneficial impact. *The Swedish Club Highlights, December*.
- Özcayir, Z. O. (2001). *Port State Control*. London ; Hong Kong: LLP.
- Özcayir, Z. O. (2008). The use of port state control in maritime industry and application of the Paris MOU. *Ocean and Coastal Law Journal*, 14(2), 201–240.
- Paris MoU. (n.d.-a). History | Paris MoU. Retrieved from <https://www.parismou.org/about-us/history>
- Paris MoU. (n.d.-b). Organisation | Paris MoU. Retrieved from <https://www.parismou.org/about-us/organisation>
- Ravira, F. J., & Piniella, F. (2016). Evaluating the impact of PSC inspectors' professional profile: a case study of the Spanish Maritime Administration. *WMU Journal of Maritime Affairs*.
- Rodriguez, A. J., & Hubbard, M. C. (1999). The International Safety Management (ISM) Code: A New Level of Uniformity. *Tulane Law Review*, 73(5–6), 1585.
- Rothblum, A. M., Wheal, C. D., Withington, S., Shappell, S., Wiegmann, D. a, Boehm, W., & Chaderjian, M. (2002). Human Factors in Incident Investigation and Analysis. In *International workshop on human factors in offshore operations (HFW2002)* (pp. 1–150). Houston, Texas.
- Sagen, A. (1999). *The ISM Code in practice*. Oslo: Tano Aschehoug.
- Schröder-Hinrichs, J.-U., Hollnagel, E., Baldauf, M., Hofmann, S., & Kataria, A. (2013). Maritime human factors and IMO policy. *Maritime Policy & Management*, 40(3), 243–260.
- Spooner, M. F. (1978). *Amoco Cadiz oil spill*. Oxford ; New York: Pergamon Press.
- Squire, D. (n.d.). The human element in shipping. *Alert*. Retrieved from http://www.he-alert.org/filemanager/root/site_assets/standalone_pdfs_0355-/he00350.pdf
- Tokyo MoU. (1993). *Memorandum of Understanding on Port State Control in the Asia-Pacific Region*. Tokyo : Tokyo MoU. Retrieved from http://www.tokyo-mou.org/organization/memorandum_of_understanding.php

- Tokyo MoU. (2013). *List of Tokyo MOU Deficiency Codes*. Tokyo : Tokyo MoU. Retrieved from http://www.tokyo-mou.org/publications/tokyo_mou_deficiency_codes.php
- Tokyo MoU. (2015). *Annual Report on Port State Control in the Asia-Pacific Region 2014*. Tokyo :Tokyo MoU. Retrieved from http://www.tokyo-mou.org/publications/annual_report.php
- Tokyo MoU. (2016). *Annual Report on Port State Control in the Asia-Pacific Region 2015*. Tokyo : Tokyo MoU. Retrieved from http://www.tokyo-mou.org/publications/annual_report.php
- Townsend, C. P., Mariner, M., & Tatman, K. (2006). *A regulatory approach to the human element*. Retrieved from http://www.he-alert.org/filemanager/root/site_assets/standalone_pdfs_0355-/HE00585.pdf
- UN. (1982). *United Nations Convention on the Law of the Sea*, New York:United Nations.
- Withington, J. S. (n.d.). *ISM – What has been learned from marine accident investigation?* Retrieved from http://www.he-alert.org/filemanager/root/site_assets/standalone_pdfs_0355-/HE00475.pdf