Promoting maritime safety through the ISM Code - a research report within the project Säkerhetsorganisation, säkerhetskultur, riskhantering och sjösäkerhet- ett temaprojekt för implementering. Subproject 4 International comparative study of the ISM Code as a maritime safety regulatory framework and the status of its operation and implementation in the shipping industry

Mejia, Max

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Subproject 4

International comparative study of the ISM Code as a maritime safety regulatory framework and the status of its operation and implementation in the shipping industry

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Preface

This report summarizes the findings of the research undertaken for Subproject 4 within the research project "Safety organization, safety culture, risk management, and maritime safety – a thematic project for implementation *(Säkerhetsorganisation, säkerhetskultur, riskhantering och sjösäkerhet – ett temaprojekt för implementering)*" or MARSAF, as published in my Licentiate Thesis entitled "Evaluating the ISM Code Using Port State Control Statistics" submitted in 2005 to the Division of Ergonomics and Aerosol Technology, Department of Design Sciences, Lund Institute of Technology, Lund University.

MARSAF is a research project during the period 2002 to 2005 funded by the Swedish Maritime Administration (*Sjöfartsverket*), the Swedish Mercantile Marine Foundation (*Stiftelsen Sveriges Sjömanshus*), and the Swedish Agency for Innovation Systems (*Verket för innovationssystem, VINNOVA*). MARSAF consists of four subprojects. Subproject 1, by project manager Göran Jense (Associate Professor, Växjö University), looks at safety and occupational organization issues in the merchant marine. Subproject 2, by Bengt-Erik Stenmark (Ph.D., Luleå University of Technology), examines cultural and safety management on board cargo ships. Subproject 3, by Åsa Ek (Ph.D. candidate, Lund University), focuses on safety culture and safety management on board passenger vessels. Subproject 4, for which this report is written, evaluates ISM Code implementation and compliance. In addition, Roland Akselsson (Professor, Lund University) is also involved in both Subprojects 3 and 4.

Subproject 4 seeks to evaluate the Code's performance as a regulatory framework through an analysis of port state control (PSC) inspection statistics. PSC inspection statistics were selected because they offer a candid snapshot of the actual status of operational safety aboard vessels and, by extension, the effectiveness of the Code. The PSC inspection's random character differs sharply with announced statutory surveys where ships are notified in advance that government-appointed surveyors are scheduled to inspect the vessel for the purpose of certification. The advance notice enables operators and crews to prepare the vessel specifically for the appointed date. In contrast, PSC inspections are unannounced and therefore conducted on vessels in the normal daily mode of operations.

The analysis is undertaken by sorting the data between those relating to ISM Phase 1 and those relating to ISM Phase 2 and exempt vessels and comparing their respective deficiency rates (DFR) and detention rates (DTR). Phase 1 vessels are treated as the "test group" required to implement the requirements of the ISM Code by the year 1998, while Phase 2 and exempt vessels serve as the "control group" that would not be covered by the Code until four years later. When examining PSC statistics, Subproject 4 does not focus on whether ships comply with ISM documentation requirements; rather, it looks at all deficiencies as indicators of the implementation of the SMS and a reflection of the actual state of safety on board the vessel.

Subproject 4 concludes that there are indications that the ISM Code has the potential to promote safer practices in shipboard operations. This conclusion is based on a number of indicators that, though statistically not significant in some cases, suggest a tendency for ISM Code compliant vessels to perform better compared to non-ISM Code vessels during PSC inspections. Among these indicators are the relatively better performance of the test group (ISM Phase 1 vessels) in the post-1998 period in terms of DFR and DTR values, the number of multiple deficiencies noted per inspection, the number of clean inspection reports, and DFR values under specific categories of deficiencies.

The subproject also concludes that a number of inherent weaknesses in the port state control regime and the collation of inspection statistics make it impossible to treat PSC statistics as a free-standing criterion for evaluating the ISM Code's performance. PSC inspections are subjective exercises carried out by inspectors with diverse individual backgrounds, experiences, and biases. Additionally, the PSC statistics analyzed for this subproject do not capture some nuances that would have been relevant to the study.

PSC statistics are by no means the only appropriate indicator of the level of the ISM Code's performance. However, in examining PSC statistics, this subproject explores the potential of random third-party inspections for providing an indication of the effectiveness of one the most important regimes in the present international legal framework for maritime safety.

I wish to acknowledge the generosity of the Swedish Maritime Administration, the Swedish Mercantile Marine Foundation, the Swedish Agency for Innovation Systems (VINNOVA), and the World Maritime University R&D Fund in providing the necessary funds for the research for Subproject 4 and for the preparation of this report.

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Abbreviations

DFR .... deficiency rate

DOC .... document of compliance

DTR .... detention rate

FSI .... Subcommittee on Flag State Implementation of IMO

ILO .... International Labour Organization

IMO .... International Maritime Organization

ISM Code .... International Safety Management Code

MEPC .... Marine Environmental Protection Committee of IMO

MODU .... mobile offshore drilling unit

MoU .... memorandum of understanding

MSC ....Maritime Safety Committee of IMO

OR ....odds ratio

PSC ....port state control

Ro-Ro ....roll on/roll off

SMA ....Swedish Maritime Administration

SMC ....safety management certificate

SMM ....safety management manual

SMS ....safety management system

SOLAS ....International Convention for the Safety of Life at Sea, 1974, as modified by the Protocol of 1978, as amended

STCW ....International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as amended

UNCLOS ....United Nations Convention on the Law of the Sea, 1982

USCG..United States Coast Guard

INTRODUCTION

On April 10, 1912, the largest ship afloat, a luxury vessel aptly named the *Titanic*, left Southampton, England on her maiden voyage to New York City. Her owners, the White Star Line, made sure she became a legend even before she sailed. They were so confident that with the *Titanic* they had built an 'unsinkable' ship – indeed, they claimed it was history's safest ship ever – that she was fitted with only 20 lifeboats, providing space for only half her 2,200 passengers and crew. More lifeboats were out of the question not only because the ship was unsinkable, but also because they took up valuable deck space on a ship where the world's wealthiest basked in the elegance of first class accommodations while immigrants packed into steerage. On the fateful night of April the 14th, only four days into her maiden voyage, the *Titanic* struck an iceberg and sank in the icy waters of the North Atlantic within less than three hours. Around 1,500 of the more than 2,200 passengers and crew were lost.

The international legal framework of maritime safety

The relatively young history of international rulemaking to promote maritime safety in modern times traces its roots to the tragic sinking of the *Titanic* described above. The accident resulted in the adoption of the original version of the International Convention for the Safety of Life at Sea (SOLAS) by an international conference in 1914. The *Titanic* was not an isolated incident; it was actually indicative of the unsatisfactory standards in vessel safety prevailing in the 1900s. The *Titanic* was symptomatic of many issues more popularly associated with later maritime accidents; issues that would not come into the forefront until the 1960s such as public outcry and the influence of the media over governments, management errors, the precedence of financial aspects over maritime safety, and absent or flawed routine procedures.

Maritime safety is promoted today through the formulation, adoption, implementation, and enforcement of a framework consisting of international rules and conventions that affect a ship in each phase of its life cycle – design, equipment, operation, management, maintenance, and disposal, among others. The international legal framework of maritime safety consists mainly of the United Nations Convention on the Law of the Sea (UNCLOS), 1982, and a number of safety conventions adopted under the auspices of the International Maritime Organization (IMO).

The IMO is a specialized agency of the United Nations (UN) tasked with providing a "machinery for cooperation among Governments in the field of governmental regulation and practices relating to technical matters of all kinds affecting shipping engaged in international trade; to encourage and facilitate the general adoption of the highest practicable standards in matters concerning maritime safety, efficiency of navigation and prevention and control of marine pollution from ships." Since its first meeting in 1959, IMO has developed and adopted more than forty conventions dealing with many vital aspects of commercial maritime transportation including maritime safety, marine environmental protection, navigational safety, training and certification of seafarers, search and rescue, facilitation of international maritime traffic, unlawful acts at sea, and salvage. The promotion of maritime safety is arguably IMO's most important mandate, with at least eleven of the conventions adopted under its auspices relating to that aspect, namely,

- International Convention for the Safety of Life at Sea (SOLAS), 1974;
- International Convention on Load Lines (LL), 1966;
- Special Trade Passenger Ships Agreement (STP), 1971;
- Protocol on Space Requirements for Special Trade Passenger Ships, 1973;
- Convention on the International Regulations for Preventing Collisions at Sea (COLREG), 1972;
- International Convention for Safe Containers (CSC), 1972;
- Convention on the International Maritime Satellite Organization (INMARSAT), 1976;
- The Torremolinos International Convention for the Safety of Fishing Vessels (SFV), 1977;
- International Convention on Standards of Training, Certification & Watchkeeping for Seafarers (STCW), 1978;
- International Convention on Standards of Training, Certification and Watchkeeping for Fishing Vessel Personnel (STCW-F), 1995; and
- International Convention on Maritime Search and Rescue (SAR), 1979.

Among IMO's maritime safety conventions, SOLAS is the oldest and undeniably the most important and comprehensive in terms of vessel safety standards. The SOLAS Convention specifies minimum standards for vessel design, construction, equipment, operation, and maintenance. The technical provisions of the current version (1974) are found in 12 chapters dealing with subdivision and stability, machinery and electrical installations, fire protection, fire detection, fire extinction, life-saving appliances, radio communications, navigational safety, carriage of cargos, carriage of dangerous goods, nuclear ships, management for the safe operation of ships, safety measures for high-speed craft, special measures to enhance maritime safety, special measures to enhance maritime security, and additional safety measures for bulk carriers.

The international regulatory process

In ratifying or acceding to a maritime safety convention such as SOLAS, a state binds itself to incorporating the Convention into the body of national law through enabling legislation or parliamentary ratification. The adoption of maritime safety legislation normally sets off a series of regulation and rule-making activities on many different levels intended to give the Convention full and complete effect. Transport ministries and maritime administrations develop implementing rules and regulations that implement the provisions of the legislation. Boardrooms of shipping companies then adopt the appropriate policies, guidelines, and directives that give management the mandate to develop plans and work procedures designed to ensure compliance with maritime safety laws, rules, and regulations. At the direct level, the officers and crew on board ships translate the plans and procedures into action.

The regulatory process described above is not strictly unidirectional and top-down. A corresponding bottom-up process allows for the development of new or improved plans, policies, rules, regulations, and even possibly national laws and international conventions. Experiences, observations, and reports submitted by the shipboard work force to the management could result in revised company policies and plans. Companies could then, through shipowners' associations, collectively share their experiences with the maritime administration and thereby participate in shaping national rules and regulations. Maritime administrations can, in turn, exert influence over the amendment or development of laws in their capacities as technical advisors to legislators. Additionally, maritime administrations, as delegates of the national government to IMO meetings and conferences, are directly involved in the amendment of existing conventions (such as SOLAS) as well as the formulation of new ones.

THE ISM CODE

On the evening of March 6, 1987, the cross-channel Ro-Ro ferry *Herald of Free Enterprise*, carrying more than 450 passengers, around 80 crew, more than 80 cars, and close to 50 freight vehicles, left the Belgian port of Zebrügge for the English port of Dover. Soon after the *Herald of Free Enterprise* passed Zebrügge's breakwater, water flooded into the ferry's lower car deck and destabilized it, causing it to sink in a matter of minutes. 193 lives were lost. The immediate cause of the accident was that the bow door remained wide open, allowing the great inrush of water as the vessel increased speed, while the fatigued assistant boatswain directly responsible for closing it lay asleep in his cabin. The public inquiry led by Justice Sheen revealed that the assistant boatswain's negligence was simply the last in a long string of actions that laid the groundwork for a major accident. The Sheen Report did not stop at identifying the shortcomings of the ship's master and his crew. The inquiry revealed that the shore management, Townsend Car Ferries Ltd., was just as blameworthy. Numerous memos written by Townsend ship's masters pointing out the need to implement safety-enhancing measures or address serious deficiencies on board their vessels went unheeded. The Report summed up the management's cavalier attitude towards safety in the following statement: "From top to bottom the body corporate was infected with the disease of sloppiness."

The *Herald of Free Enterprise* was a modern ferry equipped with advanced technology and manned by a highly qualified crew. Only seven years prior to the accident, it was built in a German shipyard according to international standards. It is widely recognized that international maritime safety regulations have come a long way since the *Titanic*-inspired 1914 SOLAS in terms of technical scope and thoroughness. Why did the *Herald of Free Enterprise* capsize? The general frustration in the shipping industry following the capsizing of the *Herald of Free Enterprise* is typical of the kind of accident that precipitated in a paradigm shift in maritime safety administration and the development of the ISM Code.

The old or existing paradigm was characterized by heavy reliance on technological innovation and detailed rulemaking as solutions to the challenge of promoting safety at sea. However, the series of major casualties that occurred with what seemed to be increasing frequency, heavier loss of life, and greater harm to the marine environment gradually pushed world shipping closer to the edge of the old paradigm. The maritime community developed the ISM Code as an umbrella instrument to address maritime safety issues from a holistic perspective. The Code is a mandatory instrument that encourages the cultivation of a safety culture in the maritime industry by setting international standards for the safe management and operation of ships and for pollution prevention. It is implemented by the shipping company through a safety management system (SMS), the functional requirements for which include, inter alia, instructions and procedures to ensure safe operation of ships, defined levels of authority and lines of communication amongst shore and shipboard personnel, procedures for reporting accidents and non-conformities, procedures to respond to emergencies, and procedures for internal audits and management reviews.

The ISM Code's adoption signaled the Organization's departure from an almost exclusive reliance on technical standards and technological research as a means of promoting safety at sea. The maritime community developed the ISM Code as an umbrella instrument that could address maritime safety issues from a holistic perspective. More than any other IMO instrument adopted in the late 1980s, the Code has come to symbolize the paradigm shift. The next section of this subproject reviews the historical background of the ISM Code and provides a synopsis of its principal and distinctive features.

Historical background

The new Chapter IX "Management for the Safe Operation of Ships," adopted in May 1994 and entered into force on 1 July 1998, made the new Code mandatory for international shipping. Chapter IX is quite brief and consists of only 6 regulations (see Annex 1 of this subproject). According to regulation 2 government-operated ships used for noncommercial purposes are exempt from the provisions of Chapter IX. The chapter applies to passenger ships, high-speed craft, oil tankers, chemical tankers, gas carriers, bulk carriers and cargo high speed craft of 500 gross tonnage and above, with effect from 1 July 1998. As of 1 July 2002, the chapter applies to other cargo ships and mobile offshore drilling units (MODUs) of 500 gross tonnage and above. Regulation 4 provides for the issuance of a document of compliance (DOC) to every company, which complies with the Code. The DOC must be issued by the flag State administration or by a duly authorized organization such as a classification society. A safety management certificate (SMC) must be issued to every ship in the same manner upon determination that the company and its shipboard management are operating in accordance with the approved safety management system (SMS). Regulation 5 stipulates that the SMS must be maintained in accordance with the Code while regulation 6 requires periodic verification of the proper functioning of the SMS.

Principal and distinctive features

The ISM Code, as amended in December 2000, is reproduced in its entirety as Annex 2 at the end of this subproject. Following are some of its main features:

Section 1.2. Objectives. This section states the objectives of the Code. In Subsection 1.2.2., it specifies certain safety management objectives for the company such as, *inter alia*, the provision of safe practices in ship operation and a safe working environment, the establishment of safeguards against all identified risks, and the continuous improvement of safety management skills of personnel. Subsection 1.2.3. specifies that the safety management system should ensure compliance with mandatory rules and regulations; and that applicable codes, guidelines and standards recommended by the Organization, administrations, classification societies and maritime industry organizations are taken into account.

Section 1.4. Functional requirements for a safety-management system. The ISM Code operates around a central concept known as the safety management system (SMS), which provides a "structured and documented system enabling company personnel to effectively implement the company safety and environmental protection policy." The functional requirements for an SMS include, among other things, instructions and procedures to ensure safe operation of ships, defined levels of authority and lines of communication amongst shore and shipboard personnel, procedures for reporting accidents and non-conformities, procedures to respond to emergencies, and procedures for internal audits and management reviews. The document used to describe and implement the SMS is known as the safety management manual (SMM). The company is required to carry out internal safety audits to verify whether safety and pollution prevention activities comply with the SMS. Periodic reviews of the SMS are to be conducted to evaluate its efficiency and audits should be carried out regularly.

Section 3. Company responsibilities and authority. This section requires the company to "define and document the responsibility, authority and interrelation of all personnel who manage, perform and verify work relating to and affecting safety and pollution prevention."

Section 4. Designated person(s). Section 4 reiterates the need to appoint a designated person to serve as a link between shipboard and shore-based management, a concept originally introduced in Res. A.680(17).

Section 5. Master's responsibility and authority. This section highlights the shipmaster's key role in implementing the SMS as well as his overriding authority in matters concerning safety and environmental protection.

Section 6. Resources and personnel. Section 6 lays out general requirements on resources and personnel. It also deals with issues such as the master's qualifications, manning, familiarization, training and information, and communication between ship's personnel.

Section 7. Development of plans for shipboard operations. According to this section, the company must ensure that shipboard operations concerning safety and pollution prevention are defined and assigned to qualified personnel.

Section 9. Reports and analysis of non-conformities, accidents, and hazardous occurrences. This section specifies that a feedback and self-improvement mechanism be integrated in the ship's SMM. Non-conformities, accidents and hazardous situations must be investigated and analyzed with the view to implementing corrective action according to documented procedures.

Aside from embodying all the characteristics of the new paradigm in maritime safety administration, the ISM Code is unique in that it is an attempt at directly regulating shipowners and operators by compelling them to identify and document their detailed safety management responsibilities. Such an explicit requirement is uncharacteristic of earlier IMO instruments.

The system of certification and periodic verification built into the Code has given the international maritime safety regulatory framework a sharper set of "teeth." Earlier statutory certificates were issued upon compliance of a prescriptive set of material requirements. In contrast, the certification process under the ISM Code gives maritime administrations the mandate to verify the adequacy and suitability of management systems.

Another unique feature of the ISM Code is the self-improvement mechanism or process provided for in sections 9, 10, and 12 of the Code. At a general level, the SMS should ensure compliance with mandatory rules and regulations as well as take into account applicable codes and guidelines. At the functional level, it must not only establish procedures to ensure the safe operation of ships but also procedures for the implementation of corrective action on all deficiencies found in order to further enhance the state of safety on board the ship. The self-improvement process requires periodic reviews of the SMS and the implementation of corrective action, as appropriate, to address non-conformities, accidents, and hazardous situations. The self-improvement process envisioned in the ISM Code is adapted from the classic Plan-Do-Check-Act (PDCA) Cycle, also known as the Shewhart or the Deming Cycle of continuous improvement.

The active implementation of the SMS entails a dynamic and positive interplay between the safety management system and the ultimate goal of maritime safety. The cycle begins with the establishment and initial implementation of the SMS that result in a particular level of shipboard safety. A review of the initial procedures and a report on deficiencies lead to revisions, amendments, or updating of procedures as well as the correction of noted deficiencies. As these actions result in enhanced safety and greater efficiency, they provide incentives and positive feedback that will encourage the continuation of succeeding cycles of reviews, reporting, updating, and execution. The process of active implementation of the SMS is aided by a number of positive factors such as a strong commitment by the shipping company to promote ship safety, a responsible flag state administration, and a competent crew that takes a serious attitude towards ship operation, maintenance, and repair. The objective is not merely to convince shipping companies of the importance of eliminating accidents or loss of life, but also of the added benefits that improved safety brings in terms of commercial viability and profitability.

THIS SUBPROJECT

A great deal of time and financial resources have been allocated in drafting and implementing the ISM Code and the industry has high expectations on the Code's beneficial effects on maritime safety. While it is too early for a conclusive judgment of failure or success, a study would be useful in confirming whether the Code is indeed a workable and enforceable regulatory framework that has the potential to achieve concrete results. This subproject aims to evaluate the Code's performance as a regulatory framework.

There is, as a matter of fact, keen interest at IMO in evaluating the ISM Code's performance. In 2002, during the 10th meeting of IMO's Subcommittee on Flag State Implementation (FSI), the Secretariat was directed to study the link between the ISM Code and port state control statistics. An Independent Experts Group was convened to study the impact of the ISM Code.

The research for this subproject was undertaken in conjunction with the research project "Safety organization, safety culture, risk management, and maritime safety – a thematic project for implementation *(Säkerhetsorganisation, säkerhetskultur, riskhantering och sjösäkerhet – ett temaprojekt för implementering)*" or MARSAF. It is a research project during the period 2002 to 2005 funded by the Swedish Maritime Administration (*Sjöfartsverket*), the Swedish Mercantile Marine Foundation (*Stiftelsen Sveriges Sjömanshus*), and the Swedish Agency for Innovation Systems (*Verket för innovationssystem, VINNOVA*).

The MARSAF Project has the following as its objectives: to develop competence and generate specialized knowledge within "management, organization, and safety culture" in the maritime context. This entails, *inter alia*, developing domain knowledge, conducting field research, and participating in international fora. In order to ensure the effectiveness of its research activities in contributing to enhanced maritime safety, MARSAF has set for itself the following goals, among which a number are more or less strategic or long-term in nature:

- assess the level of safety culture on board a number of Swedish vessels and shipping companies;
- develop a methodology as well as reference materials for analyzing safety culture in the maritime sector;
- enhance general knowledge on measures for improving safety culture;
- build competence within academe;
- gain national recognition; and
- disseminate the project's results in the international arena.

MARSAF consists of four subprojects. Subproject 1, by project manager Göran Jense (Associate Professor, Växjö University), looks at safety and occupational organization issues in the merchant marine. Subproject 2, by Bengt-Erik Stenmark (Ph.D., Luleå University of Technology), examines cultural and safety management on board cargo ships. Subproject 3, by Åsa Ek (Ph.D. candidate, Lund University), focuses on safety culture and safety management on board passenger vessels. Subproject 4, for which this report is written, evaluates ISM Code implementation and compliance. In addition, Roland Akselsson (Professor, Lund University) is also involved in both Subprojects 3 and 4.

Methodology

The research for this subproject began by posing the following questions:

- What defines the ISM Code's success or effectiveness?
- How can its effectiveness be measured?
- What are some of the criteria appropriate for assessing its effectiveness?

The subproject reviewed past and ongoing ISM research, IMO documents, and relevant scientific literature while searching for analytical tools and indicators that could be applied in evaluating the effectiveness of the ISM Code. In particular, IMO meeting documents were surveyed from as early as the 54th session (in 1987) of the Maritime Safety Committee to determine what concerns influenced the ISM Code's framers to give it the structure it has taken. The following objectives found in the review of IMO documents were identified as being relevant in the development of criteria for evaluating the ISM Code's performance:

- provide for safe practices in ship operation and a safe working environment
- to establish safeguards against all identified risks
- continuously improve the safety-management skills of personnel ashore and aboard, including preparing for emergencies related to both safety and environmental protection
- development of a safety culture in shipping

Port state control inspection statistics

Of the numerous possible indicators that manifest the achievement of the objectives of the ISM Code as listed above, this subproject has selected port state control inspection statistics for analysis. By being a random regime PSC inspections offer a candid snapshot of the actual status of operational safety aboard the vessel and, by extension, the effectiveness of the Code. The PSC inspection's random character differs sharply with announced statutory surveys where ships are notified in advance that government-appointed surveyors are scheduled to inspect the vessel for the purpose of certification. The advance notice enables operators and crews to prepare the vessel specifically for the appointed date. In contrast, PSC inspections are unannounced and therefore conducted on vessels in the normal daily mode of operations.

This subproject is a comparative analysis of the performance of different categories of vessels in port state control inspections. PSC statistics were analyzed to help reveal what effect, trend, or statistically significant changes, if any, might have resulted following the implementation of the Code. When examining PSC statistics, this subproject looks at vessel deficiencies in general; no distinction is made between ISM and non-ISM deficiencies. It does not look at vessel or company compliance with the ISM Code *per se*, but into the possible effects the ISM Code might have on ship safety. It does not focus on whether ships comply with ISM documentation requirements; rather, it looks at all deficiencies as indicators of the implementation of the SMS and a reflection of the actual state of safety on board the vessel. One could take the example of a port state control inspection where a given vessel has been noted for carrying life rafts that are overdue for maintenance and servicing. This notation not only means a deficiency in the context of the life-saving appliances regulations in SOLAS but also indicates a breach of the SMS. A properly implemented SMS should result in safer shipboard practices and, therefore, fewer findings of deficiencies. In the context of our example, a functioning SMS would have ensured that life raft servicing is scheduled and undertaken well in advance of the expiry date.

The port state control inspection process

The actual PSC inspection begins while the ship is approached for boarding. Paying attention to items that can be observed from outside the ship such as the general condition of the hull, draft marks, moorings, means of access, and cargo handling operations can give clues as to the level of safety being maintained on board. The PSC inspector(s) must carry official identification when they board the vessel and brief the ship's master or his representative on the nature of the visit. Inspector(s) verify certificates and documents that serve as *prima facie* evidence that the vessel complies with certain IMO and International Labour Organization (ILO) conventions. When a PSC inspector is satisfied that the required certificates and documents are in order and the inspector's attention has not been alerted to any deficiencies, the inspector could end the procedure at once. If suspicion is raised, however, or if someone files a report alleging that the ship does not comply with regulations, then a more detailed inspection is carried out. A more detailed inspection could lead to the identification of deficiencies that would be noted on the inspection report. If deficiencies are found, the inspector decides on the appropriate actions or sanctions. These could be on-the-spot corrections, corrective measures prior to departure from the port, corrective measures within a specified period, corrective measures prior to cargo operations, or allowing the vessel to proceed to another port for repairs. Follow-up inspections either in the same or in a future port of call are conducted to verify that the mandated correction of deficiencies has been made. When serious deficiencies are found that confirm and establish clear grounds for detention, PSC authorities can prevent the vessel from departing until those deficiencies are rectified.

All inspections are documented using a PSC inspection report. After each inspection, a copy of the inspection is provided to the ship's master. Depending on the nature of the deficiencies noted or the action taken, copies of the inspection report might have to be furnished to the vessel's flag state or classification society. They might also need to be furnished to the next scheduled port of call, MoU secretariats, or regional organizations.

DFR and DTR

In determining the ISM Code's effect on the performance of vessels at port state control inspections, the data examined in this subproject was sorted into two categories – "ISM Phase 1 vessels" and "ISM Phase 2 & ISM-exempt vessels." Phase 1 vessels include passenger ships of all tonnage including passenger high-speed craft; oil tankers, chemical tankers, gas carriers, bulk carriers, and cargo high-speed craft of 500 gross tonnage and upwards. Phase 2 vessels are all other cargo ships and mobile offshore drilling units of at least 500 gross tonnage. ISM-exempt vessels are ships that are not classified under any of the categories specified above. Phase 1 vessels were required to comply with the provisions of the ISM Code from July 1998 while Phase 2 vessels were required to be ISM compliant four years later in July 2002. ISM-exempt vessels, as the label implies, are exempt from complying with any of the Code's requirements.

By analyzing statistics from two periods, 1996-1997 and 1999-2000, vessel performance was examined during the two-year period prior to the initial implementation of the ISM Code followed by another two-year period when one group of ships, Phase 1 vessels (the test group), was covered by the Code while another, Phase 2 and exempt vessels (the control group), was not. Statistics for 1998 were excluded from the analysis because of potential distortion of data due to intense activity related to the actual year of implementation. In like manner, the years beyond 2000 were also excluded from the study in order to isolate the data from effects that might be brought about by preparations undertaken by ships for the second phase of ISM Code implementation in 2002.

The analysis was conducted with the hypothesis that the test group, by virtue of the ISM Code, would exhibit an improvement in PSC-related indicators compared to the control group. In other words, Phase 1 vessels, being vessels with a properly functioning safety management system under the ISM Code, would exhibit a relatively better performance at inspections than Phase 2 and exempt vessels during the period following the first phase of implementation of the ISM Code. Better performance can be manifested by a decreasing number of deficiencies and detentions at PSC inspections. The subproject applied two ratios to facilitate comparison. One is the deficiency rate (DFR), that is, the ratio of deficiencies to the number of vessel inspections conducted, represented by the equation,

$$DFR = \frac{df}{i}$$

where "df" represents the total number of deficiencies noted during PSC inspections and "i" denotes the number of inspections conducted. The other ratio is the detention rate (DTR) that denotes the ratio of detentions to the number of vessel inspections carried out, as shown by the equation,

$$DTR = \frac{dt}{i}$$

where "dt" represents the total number of detentions imposed as a result of PSC inspections. In other words, this subproject inquires into whether the ISM Code led to lower DFRs and DTRs for Phase 1 vessels in the post-implementation period compared to Phase 2 and exempt vessels.

The data was tested for statistical significance using either the t-test (2-tailed) or the chi-squared test. Traditionally, a p value of less than or equal to 0.05 ($p \leq 0.05$) is used as the threshold of statistical significance. In terms of this study, what the value $p \leq 0.05$ indicates is a maximum 5% probability of getting the observed value (or something more extreme) given that the ISM Code has had no real effect on the observed finding (such as an increase or decrease, for instance, in DFR or DTR values). Nevertheless, this subproject does not take a dogmatic approach to the $p \leq 0.05$ standard, and instead looks for tendencies and any positive indications in the interpretation of results.

The data

Inquiries were made with the Secretariat of the Paris MoU as well as various European maritime administrations, specifically Belgium, Germany, the Netherlands, Sweden, and the United Kingdom, regarding the availability of detailed PSC inspection statistics in digital format. All but one of the organizations approached were unable to provide the requested statistics. In most cases, the only computerized PSC data maintained by maritime administrations are the annual summaries. The actual PSC inspection reports are hard copies kept in storage; the physical volume of documents involved means that there is little chance of the historical data making it into a computer database any time in the near future. Only the Swedish Maritime Administration (SMA) has been able to provide computerized PSC inspection data of the level of detail required to facilitate the intended analysis. The data and statistics analyzed on foreign ships inspected in Swedish ports relate to a total of 6,305 inspection entries generated over 2,845 inspections conducted on board 908 foreign vessels that called at Swedish ports during the periods 1996-1997 and 1999-2000.

Foreign ships in Swedish ports

The detailed nature of each entry made it possible to sort statistics relating to foreign ships that called in Swedish ports into the categories Phase 1 vessels and Phase 2 vessels, and thereby allow a comparison of DFRs and DTRs. This part of the subproject also undertakes a further analysis of the data by examining the number of deficiencies noted for a single inspection according to vessel group and by reviewing DFR values according to different deficiency types or series. In addition to the statistical analysis, survey questionnaires were also sent to Swedish port state control inspectors to solicit their opinion on certain aspects of the ISM Code and gather their personal interpretation of the preliminary data analysis.

Swedish ships in foreign ports

DFR and DTR values were also used to compare the performance of the following categories of vessels in PSC inspections: (1) Swedish passenger vessels versus Swedish cargo vessels inspected in foreign ports, and (2) Swedish-flagged vessels versus all vessels inspected in the Paris MoU region. In total, the data on Swedish-flagged vessels calling at ports outside Sweden relate to 1,652 inspections conducted on board 305 vessels over a period of six years (1995-2000).

Regional PSC statistics

Summarized statistics were also collected from annual port state control reports generated by the Paris MoU, the Tokyo MoU, and the United States Coast Guard (USCG). DFR and DTR values are calculated for the summarized statistics that regrettably do not lend themselves to further analysis in the same manner as the detailed Swedish PSC statistics. There is a possibility that similarly detailed statistics can be available from the USCG; a request for PSC data invoking the US Freedom of Information Act has been filed. While the request has been partially obliged, key data necessary to accurately sort between Phase 1 and Phase 2 vessels inspected is still unavailable.

RESULTS OF THE STATISTICAL ANALYSIS

Below is a summary, in table format, of the results of the analysis of port state control statistics.

Foreign ships in Swedish ports

PERIOD	ISM PHASE 1 VESSELS					ISM PHASE 2 & EXEMPT VESSELS				
	Deficiencies	Detentions	Inspections	DFR	DTR	Deficiencies	Detentions	Inspections	DFR	DTR
1996-1997	1258	22	694	1.81	0.032	1026	28	664	1.55	0.042
1999-2000	886	8	548	1.62	0.015	1514	24	939	1.61	0.026

Table 1. DFR and DTR values for two groups of foreign vessels calling Swedish ports.

Table 1, above, shows a decrease in the average number of deficiencies or deficiency rate (DFR) noted on board Phase 1 vessels after the implementation of the ISM Code in 1998. Phase 2 vessels, on the other hand, exhibited an increase in the average number of deficiencies noted per PSC inspection during the same period. A t-test (2-tailed) on the data in both cases shows that the observations were not statistically significant. Additionally, an analysis of the difference between the changes in DFR values showed that the difference was not statistically significant.

Table 1, above, also shows the detention rates (DTR) for the two groups of vessels; DTR values for both groups decreased in 1999-2000. An analysis of the difference between the changes in DTR values showed that the difference was not statistically significant. Also, a calculation of the simple odds ratio (OR, that is, the ratio between the probabilities of being detained) yields a more impressive OR for Phase 1 vessels compared to the OR for Phase 2 and exempt vessels. However, a comparison reveals that the difference between the two OR values is not statistically significant.

Swedish ships in foreign ports

Table 2, below, shows an increase in average DFR values for Swedish ships as well as all other ships inspected in the Paris port state control MoU region between the periods 1996-1997 and 1999-2000. It also shows that the DTR values decreased for both categories of vessels during the same period.

When the data relating to Swedish vessels were broken down between passenger vessels and cargo vessels, the DFR values for the former category declined by 54% while those for the latter category increased by 16%. An analysis of the difference between the changes in DFR values showed that the difference was not statistically significant.

PERIOD	SWEDISH VESSELS		ALL VESSELS INSPECTED IN THE PARIS MoU REGION		SWEDISH PASSENGER VESSELS	SWEDISH CARGO VESSELS
	DFR	DTR	DFR	DTR	DFR	DFR
1996-1997	1.3	0.04	3.3	0.16	1.53	1.26
1999-2000	1.4	0.02	3.5	0.10	0.70	1.46

Table 2. DFR and DTR values for Swedish vessels calling foreign ports and for all vessels inspected in the Paris MoU region & DFR values for two types of Swedish vessels calling foreign ports.

The analysis revealed that the average DTR values for Swedish ships over the years 1990 and 2000 is 0.03, while the average DTR for all ships of all flags inspected in the region during the same period is 0.11. The average DTR for Swedish ships represents only 27% of the average value for all ships of all flags inspected in the region. The difference between these two DTR averages proved to be statistically significant.

With regards to DFR, the average value for Swedish vessels over the six-year period 1995-2000 is 1.32 deficiencies per inspection, compared to an average DFR of 3.35 for inspections conducted on all ships within the Paris MoU region. The DFR for Swedish ships represents the equivalent of 39% of the average DFR for all ships of all flags. The difference between these two DFR averages also proved to be statistically significant.

Regional PSC statistics

Table 3, below, shows a noticeable decrease in average DTR values for vessels inspected in both American and Paris MoU ports from the year 1995 to 2003, while those for vessels inspected in Tokyo MoU ports increased during the same period. DTR values decreased 71% in the case of ships inspected in American ports and decreased 36% in the case of ships inspected in Paris MoU ports, but rose 33% in the case of ships inspected in Tokyo MoU ports.

YEAR	VESSEL DETENTIONS			NUMBER OF INSPECTIONS ("DISTINCT VESSEL ARRIVALS in the case of USCG statistics)			DTR		
	USA	**Paris MoU**	**Tokyo MoU**	**USA**	**Paris MoU**	**Tokyo MoU**	**USA**	**Paris MoU**	**Tokyo MoU**
1995	514	1837	524	7846	16381	8834	0.07	0.11	0.06
1996	476	1719	689	7608	16070	12243	0.06	0.11	0.06
1997	547	1624	830	7686	16813	12957	0.07	0.10	0.06
1998	373	1598	1061	7880	17643	14545	0.05	0.10	0.08
1999	257	1684	1071	7617	18399	14921	0.03	0.09	0.08
2000	193	1764	1101	7657	18559	16034	0.03	0.10	0.07
2001	172	1699	1349	7842	18681	17379	0.02	0.09	0.08
2002	178	1577	1307	7106	19766	19588	0.03	0.08	0.07
2003	153	1428	1709	7673	20309	20124	0.02	0.07	0.08

Table 3. DTR values for vessels inspected in American ports as well as ports in the Paris and Tokyo MoU regions.

In contrast with the annual port state control reports of the USCG and the Paris MoU, the reports from the Tokyo MoU include a summary of deficiencies noted according to vessel type. This enabled the calculation of DFR values between ISM Phase 1 vessels and ISM Phase 2 and exempt vessels for the periods before and after the first phase of implementation of the ISM Code. Table 4, below, shows how DFR values decreased for ISM Phase 1 vessels and increased for ISM Phase 2 and exempt vessels.

PERIOD	ISM PHASE 1			ISM PHASE 2 & EXEMPT VESSELS		
	Deficiencies noted	Inspections	DFR	Deficiencies noted	Inspections	DFR
1996-1997	33,796	11,174	3.02	75,402	25,676	2.94
1999-2000	33,975	12,745	2.67	142,546	43,700	3.26

Table 4. DFR values for two groups of vessels calling ports in the Tokyo MoU region.

CONCLUDING DISCUSSION

The primary conclusion, based on the analyses of PSC statistics presented in this report, is that there are indications that the ISM Code has the potential to promote safer practices in shipboard operations. This conclusion is based on a number of indicators that suggest a tendency for ISM Code compliant vessels to perform better compared to non-ISM Code vessels during PSC inspections.

Foreign ships in Swedish ports

While many of the data analyzed in the subproject did not meet the test for statistical significance, there are nevertheless a number of observations that support the primary conclusion stated above. For instance, ISM Phase 1 vessels performed relatively better at PSC inspections in Swedish ports compared to Phase 2 and exempt vessels in the post-1998 period in terms of DFR and DTR values (though the observed changes did not meet the test of statistical significance). Also, inspections on board Phase 1 vessels exhibited a greater tendency, though not statistically significant, to result in clean inspection reports (that is, no deficiency noted) in the period 1999-2000 compared to Phase 2 and exempt vessels.

The survey of Swedish port state control inspectors generated responses from 19 out of the total population of 57 inspectors, representing a return rate of 33%. The inspectors responded to questions relating to personal observations made during port state control inspections regarding evidence of the ISM Code's influence on shipboard safety. Of the respondents, 58% observed evidence that the ISM Code has fostered safer shipboard practices and has resulted in considerably improved levels of safety on board Phase 1 vessels. Out of this number, 22% disagreed and 11% were uncertain. Nine out of the 19 respondents (47%) indicated that on average, ships with a functioning Safety Management System as required by the ISM Code had less findings of deficiency at port state control inspections compared to Phase 2 and exempt vessels. Only 17% of the respondents disagreed while 37% were uncertain.

Swedish ships in foreign ports

This part of the study surmises the potentially positive influence of the ISM Code on two different levels. As a flag state, Sweden introduced an accelerated implementation of the ISM Code for its ships. As a fleet, a significant number of Swedish ships were already operating with a quality and safety management system even years before the formulation of the ISM Code. The significantly better performance of Swedish flagged vessels at port state control inspections in comparison with ships of all nationalities could suggest that ships operating a safety management system in accordance with the ISM Code exhibit a higher level of safety on board. This potential is strengthened further by the fact that Swedish passenger ships (a category of Phase 1 vessels) performed better than Swedish cargo ships (a category of Phase 2 vessels). Even under Sweden's accelerated schedule of implementation, the obligation to implement the ISM Code was imposed on passenger ships earlier than it was for cargo ships.

Regional PSC statistics

The lack of detail in the summaries of PSC inspection statistics covering American, Paris MoU, and Tokyo MoU ports precluded the sorting of DTR values between Phase 1 and Phase 2 vessels from the periods 1996-1997 and 1999-2000. Nevertheless, Table 3, above, exhibits a readily apparent trend of improvement in the general performance of vessels of all types at PSC inspections in both US and Paris MoU ports from the year 1995 (three years prior to phase 1 implementation of the ISM Code) to 2003 (five years after phase 1 implementation and one year after phase 2 implementation). In fact, the improved performance is considerably pronounced in the case of the US statistics. The trend in DTR values for ships inspected in Tokyo MoU ports, however, contrasts the data collected by the USCG and Paris MoU. The summarized data for the Tokyo MoU shows a marginal increase in DTR values from the year 1995 to the year 2003, though it practically remained constant from 1998 onwards.

Since, as mentioned earlier, the data do not lend themselves to sorting between Phase 1 and Phase 2 vessels, the study has been unable to control for the effects of the ISM Code. Nevertheless, the clearly significant decreasing trend raises the issue of the Code's possible influence. While such improvements are the result of a combination of many other positive factors, detailed PSC statistics that allow sorting between vessel types would also have the potential to identify the Code's influence.

While the PSC inspection statistics covering American and Paris MoU lack the detail to enable the measurement of DFR values between Phase 1 and Phase 2 vessels from the periods 1996-1997 and 1999-2000, it was available to some extent in the Tokyo MoU annual inspection reports. The Tokyo MoU data shows that, though not statistically significant, DFR values for Phase 1 vessels decreased between the periods 1996-1997 and 1999-2000 while those of Phase 2 and exempt vessels increased.

Conclusion

The ISM Code has come to symbolize the departure from a virtually exclusive reliance on technological applications and technical standards in promoting maritime safety. Correspondingly, it also brought about a greater focus on human factors and the role of seafarers as cognitive beings. As with the introduction of any novel regime, the ISM Code's effectiveness in inducing the achievement of its stated objectives was greeted with skepticism. Measuring its effectiveness has therefore presented a challenge to researchers. This subproject hopes to contribute to efforts in taking up that challenge.

This subproject selected port state control statistics as the subject of its analyses because of the insight PSC inspections provide into safety levels prevailing on board ships in their normal mode of operations. It undertook the analyses by sorting the data between ISM Phase 1 and ISM Phase 2 vessels and comparing their respective deficiency rates (DFR) and detention rates (DTR). Phase 1 vessels were treated as the "test group" required to implement the requirements of the ISM Code by the year 1998, and Phase 2 vessels were the "control group" that would not be covered by the Code until four years later.

The analyses presented in this report show a few findings that are statistically significant and several that are not statistically significant. Nevertheless, the indications observed in the analysis point in the same direction and therefore suggest a tendency for the ISM Code to have a positive effect in terms of enhanced performance at PSC inspections.

In the course of the analysis of the data and the preparation of this report, a number of secondary conclusions and issues came to light. One such conclusion is that while the analysis of port state control statistics may suggest the ISM Code's positive potential, they do not necessarily represent adequate proof of either the Code's failure or success. This conclusion is based on the absence of statistical significance (that is, $p \leq 0.05$) in many of the tests made in the relative performance at port state control inspections of Phase 1 vessels against Phase 2 and exempt vessels. It is also based on the fact that there are many inherent weaknesses in the port state control regime and the collation of inspection statistics. One inherent weakness is the subjective nature of PSC inspections carried out by inspectors with diverse individual backgrounds, experiences, and biases. It is unlikely that two separate and independent inspections of the same vessel would replicate each other's findings.

Another weakness is that the PSC statistics analyzed for this subproject do not capture some nuances that would have been relevant to the study, such as whether a particular inspection report pertains to an initial or a follow-up inspection, whether a particular deficiency noted is a minor or a serious one, and what number of deficiencies is considered as being many. In some cases, nuances are also created that lead to confusion. For instance, the fact that PSC regimes differentiate between ISM Code and non-ISM Code deficiencies has been seen by researchers as being problematic. This subproject takes the position that basically any deficiency noted by a PSC inspector represents a breakdown in the SMS and, consequently, is an ISM Code deficiency.

The question then arises as to the suitability of analyzing PSC statistics in the context of the ISM Code. In spite of the weaknesses mentioned above, there are a number of reasons why this subproject considers PSC statistics an appropriate indicator of the ISM Code's performance. First of all, PSC is a random regime that provides port states with a snapshot of the daily status of safety on board the ship being inspected. Also, while PSC inspectors cannot escape individual bias in the performance of their duties, they are maritime professionals acting on behalf of governments. They undergo periodic training that promotes uniformity in the conduct of inspections. Inspectors are also expected to be aware of the serious implications that might result from negligence in the conduct of any given inspection. Moreover, PSC inspection reports allow the data to be sorted between Phase 1 and Phase 2 and exempt vessels. While mindful that there are numerous other factors that affect the status of safety on board ships, sorting ships required to comply with the ISM Code from ships that are not offers the possibility for the effects of the ISM Code to be detected.

PSC statistics are by no means the only appropriate indicator of the level of the ISM Code's performance. Indeed this subproject cannot emphasize enough the fact that a comprehensive assessment of the ISM Code requires a combination of quantitative as well as qualitative analysis. No single indicator can, on its own, provide a full picture of the status of ISM Code implementation. By choosing to examine PSC statistics, this subproject has applied only one among many possible criteria. At the same time, it explores the potential of random third-party inspections for providing an indication of the effectiveness of one the most important regimes in the present international legal framework for maritime safety.

Future research

Probably the most difficult challenge for the future in terms of evaluating the ISM Code using port state control statistics remains the collection of statistics containing sufficient detail as to enable meaningful analysis. There is no guarantee that more maritime administrations will be able to allocate scarce manpower to encode individual PSC inspection reports into a database for ready use by researchers. The USCG began such an exercise for PSC data from the late 1990s onwards though it seems to be encountering difficulties in merging pre-1990s data with more recent ones. When it is finally complete and made available to researchers, the USCG database could provide raw material for an interesting study, given the high and consistent number of PSC inspections conducted, the wide variety of vessels that call in US ports, and the perceived homogeneity among its PSC inspectors. It would be of particular interest, in the context of an assessment of the ISM Code, to conduct a more intensive investigation into the findings presented in Table 3, above. Table 3 suggests the year 1998 to be a watershed in terms of detention rates. Prior to 1998, DTR values stayed at an average of around 0.065 while in the post-1998 the average DTR is around 0.025, an evidently significant difference.

This subproject concentrated on isolating data related to inspections of foreign ships in Swedish ports and of Swedish ships in foreign ports for the periods 1996-1997 and 1999-2000, that is, the years that straddled the ISM Code's initial implementation in 1998. A continuation of this work might extend the coverage of the examination of PSC statistics both in terms of time and nationality, that is, by looking beyond the early years of phase 1 implementation of the Code and beyond Swedish ports and vessels. A future study could perhaps identify any trends resulting from preparations for phase 2 implementation as well as describe its effects when all vessels in the international trade (with the exception of those in the schedule of ISM exempt vessels) would have been required to comply with the Code.

The main challenge for the future in terms of general research towards assessing the ISM Code's effectiveness is to continue to explore and analyze appropriate indicators, qualitative as well as quantitative, that could contribute towards assembling as complete a picture as possible. The pioneering work in ISM Code assessment by Philip Anderson offers a number of leads that could be expanded. No matter which indicator might be selected, however, the greatest challenge would be to induce maritime administrations, shipping companies, classification societies, and other actors in the maritime industry to provide data appropriate for the type of study being contemplated. The International Maritime Organization is well placed to play a positive role in this regard. The proactive role IMO has taken in introducing a new paradigm in global maritime safety administration has given the Organization greater prestige and influence. In addition to developing regulatory regimes such as the ISM Code, IMO could aid the evaluation of such regimes by devising means to capture detailed information and statistics from member states as well as organizations with observer status.

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