Licentiate Thesis

Evaluating the ISM Code Using Port State Control Statistics

Maximo Q Mejia Jr

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Eternal Father, Strong to Save

(The Navy Hymn)
William Whiting, 1860

Eternal Father, strong to save,
Whose arm hath bound the restless wave,
Who biddest the mighty ocean deep
Its own appointed limits keep;
Oh, hear us when we cry to Thee,
For those in peril on the sea!

O Christ! Whose voice the waters heard
And hushed their raging at Thy Word,
Who walked on the foaming deep,
And calm amidst its rage didst sleep;
Oh, hear us when we cry to Thee,
For those in peril on the sea!

Most Holy Spirit! Who didst brood
Upon the chaos dark and rude,
And bid its angry tumult cease,
And give, for wild confusion, peace;
Oh, hear us when we cry to Thee,
For those in peril on the sea!

O Trinity of love and power!
Our family shield in danger's hour;
From rock and tempest, fire and foe,
Protect us wheresoever we go;
Thus evermore shall rise to Thee
Glad hymns of praise from land and sea.

Abstract

The history of modern maritime safety legislation at the international level is relatively young. Its beginnings are generally associated with the sinking of the *Titanic* in 1912, a tragedy that resulted in the adoption by an international conference of the first of what was to become a series of versions (1914, 1929, 1948, 1960, 1974) of the International Convention for the Safety of Life at Sea (SOLAS). Far from being an isolated incident, the *Titanic* was actually indicative of the unsatisfactory standards in vessel safety prevailing at the time. While the *Titanic* is best known for jump-starting the process of the global regulation of shipping, it was also 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; issues that would eventually lead to a paradigm shift in maritime safety administration at the international level occurred starting from around the late 1980s to the early 1990s.

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 new paradigm is characterized by the following: a migration from the prescriptive to the discretionary variety of administrative control; an increased focus on the human element; a wider application of macroergonomic principles; the institutionalization of third-party control; and the enrolment of a broad range of actors.

More than any other international maritime safety instrument adopted in the late 1980s, the International Safety Management (ISM) Code has come to symbolize the paradigm shift. 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.

This thesis intends to contribute to that segment of ISM Code research that seeks to evaluate the Code’s performance as a regulatory framework. A great deal of time and financial resources has 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 towards confirming whether the Code is indeed a workable and enforceable regulatory framework that has the potential to achieve concrete results.

Of the numerous possible indicators that manifest the achievement of the objectives of the ISM Code, this thesis selects port state control inspection statistics. 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.

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, this thesis 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.

The thesis 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 thesis 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 thesis 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.

PSC statistics are by no means the only appropriate indicator of the level of the ISM Code's performance. Indeed this thesis emphasizes the fact that a comprehensive assessment of the ISM Code requires a combination of numerous criteria employing quantitative as well as qualitative analysis. However, in examining PSC statistics, this thesis 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.

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Figures and tables

Abbreviations

DFR ....deficiency rate

DOC...document of compliance

DTR...detention rate

FSA ....formal safety assessment

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

ILO ....International Labour Organization

IMCO .... Inter-Governmental Maritime Consultative Organization

IMO ....International Maritime Organization

ISM Code..International Safety Management Code

ISO ....International Standards Organization

MARPOL.......................International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978, as amended

MEPC..Marine Environmental Protection Committee of IMO

MODU ....mobile offshore drilling unit

MoU...memorandum of understanding

MSC ....Maritime Safety Committee of IMO

NGO...non-governmental organization

OR ....odds ratio

P & I club...protection and indemnity club

PSC ....port state control

RoRo ....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

TQM ....Total Quality Management

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

USCG...United States Coast Guard

List of papers included in this thesis

I. Performance Criteria for the International Safety Management (ISM) Code
Max Mejia Jr. (2001), in International Association of Maritime Universities (IAMU), Proc Int Conf 2001, Kobe, Japan: Kobe University of Mercantile Marine, pp. 109-116.

II. The ISM Code in the context of Swedish port state control statistics
Max Mejia Jr., Proshanto K. Mukherjee, Roland Akselsson (undergoing review), for publication in an international academic peer-reviewed journal.

III. Actual and perceived safety on board Swedish ships
Åsa Ek, Max Mejia Jr. (2004), in International Association of Maritime Economists (IAME), Proc Int Conf 2004, Volume 1, Izmir, Turkey: Dokuz Eylül Publications, pp. 26-34.

1 INTRODUCTION

If a merchantman run against a ferryboat, and wreck it, the master of the ship that was wrecked shall seek justice before God; the master of the merchantman, which wrecked the ferryboat, must compensate the owner for the boat and all that he ruined.
– The Code of Hammurabi

The earliest recorded laws and regulations governing shipping were enacted mainly to protect the private and commercial interests of shipowners and cargo owners. The earliest surviving piece of maritime legislation is contained in the Babylonian Code of Hammurabi that was developed almost four thousand years ago. Among others, the Code "contained rules with respect to marine collisions, the practice of bottomry and leases of ships" (Gold, 1981, p. 5; Mukherjee, 2002, p. 11; Schoenbaum, 2004, p.3). It is curious that while the Code of Hammurabi[1] imposed severe penalties on the builder of an unsafe house, the same severity was not extended explicitly to the shipbuilder in respect of ships. This is perhaps an indication that, while the inherent dangers and risks of navigation were both clearly acknowledged and taken for granted, the maritime enterprise was first and foremost treated as a commercial activity. Indeed, Potter (1992, p. 608) maintains that one of the undercurrents in the Laws of Oleron, one of the most distinguished set of ancient maritime laws of medieval times, is the supremacy of commercial interests over crew safety. This is the polar opposite of one of the most important maxims in maritime safety today that specifies that in cases where, in the professional judgment of the master, there exists a conflict between safety of the cargo and the safety of the crew, the master shall give effect to those requirements necessary to maintain the safety of the crew.

It was not until the 1830s that, with the founding of the Lloyd's Register of British and Foreign Shipping, the concept of safety and risk analysis was institutionalized (Bahr, 1997). The mid-1800s onwards was a significant period in the United Kingdom and Europe in terms of the development of modern maritime safety regulation. In 1836, following a three-year period during which almost 2,000 ships were lost, a Select Committee of the British Parliament was established to inquire into the causes of shipwrecks. The inquiry led to public recognition that a systematic study of the root causes of the problem was necessary to minimize the number of shipping casualties (King, 1995, p. 470). The efforts of Samuel Plimsoll that led to the passage in 1876 of the Merchant Shipping Act represent an early attempt at promoting safety for safety's sake (Potter, 1992). Elsewhere in Europe, theoretical studies were being made that sought to add scientific bases to ship design and building.

The history of modern maritime safety legislation on the international level is quite young. Its beginnings are generally associated with the sinking of the *Titanic* in 1912, a tragedy that resulted in the adoption by an international conference of the first of what was to become a series of versions (1914, 1929, 1948, 1960, 1974) of the

[1] According to Hammurabi's Code, "If a builder build a house for some one, and does not construct it properly, and the house which he built fall in and kill its owner, then that builder shall be put to death." The punishment for causing death as a result of faulty house construction was ruled by reciprocal retribution or *lex talionis* (Parisi, 2001) – an eye for an eye and a tooth for a tooth – whereas compensation for damage to a vessel as a result of a collision, as evident in the introductory quote, came in the form of a financial disincentive.

International Convention for the Safety of Life at Sea (SOLAS). Far from being an isolated incident, the *Titanic* was actually indicative of the unsatisfactory standards in vessel safety prevailing at the time. Veiga (2002) contends that while the *Titanic* is best known for jump-starting the process of the global regulation of shipping, it was also 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; issues that would eventually lead to the development of instruments such as the International Safety Management (ISM) Code.

1.1 The international legal framework of maritime safety

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 a□auspices of the International Maritime Organization (IMO).

UNCLOS is widely regarded as the constitution of the world's oceans and is made up of "rules and principles that bind States in their international relations concerning maritime matters" (Churchill and Lowe, 1999). Among the numerous provisions in UNCLOS governing the use of the seas and its resources, the article most relevant to maritime safety is Article 94 "Duties of the flag State." The following are paragraphs 3 to 5 of Article 94:

> 3. Every State shall take such measures for ships flying its flag as are necessary to ensure safety at sea with regard, *inter alia*, to:
>
>   (a) the construction, equipment and seaworthiness of ships;
>   (b) the manning of ships, labour conditions and the training of crews, taking into account the applicable international instruments;
>   (c) the use of signals, the maintenance of communications and the prevention of collisions.
>
> 4. Such measures shall include those necessary to ensure:
>
>   (a) that each ship, before registration and thereafter at appropriate intervals, is surveyed by a qualified surveyor of ships, and has on board such charts, nautical publications and navigational equipment and instruments as are appropriate for the safe navigation of the ship;
>   (b) that each ship is in the charge of a master and officers who possess appropriate qualifications, in particular in seamanship, navigation, communications and marine engineering, and that the crew is appropriate in qualification and numbers for the type, size, machinery and equipment of the ship;
>   (c) that the master, officers and, to the extent appropriate, the crew are fully conversant with and required to observe the applicable

> international regulations concerning the safety of life at sea, the prevention of collisions, the prevention, reduction and control of marine pollution, and the maintenance of communications by radio.

5. In taking the measures called for in paragraphs 3 and 4 each State is required to conform to generally accepted international regulations, procedures and practices and to take any steps which may be necessary to secure their observance.

Article 94 provides a very broad sweep of the general obligations of party states with regard to maritime safety under UNCLOS. The details surrounding these general obligations, according to paragraph 5 of the Article, are to be provided by "generally accepted international regulations, procedures and practices" developed and adopted under the auspices of the IMO. Under the Convention on the Inter-Governmental Maritime Consultative Organization,[2] 1948, the IMO was conceived for the purpose of 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;

[2] This Convention was the basis for the establishment of the Inter-Governmental Maritime Consultative Organization (IMCO), which today is known under the name International Maritime Organization (IMO). The Organization adopted the change in name in 1982.

- 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 earliest version of SOLAS (1914) has its origins in the international negotiations that followed the sinking of the *Titanic* while the 1960 version of the convention was the first convention developed and adopted by the fledgling IMO. 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.

1.2 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. Rasmussen and Svedung portray this process as one that is multidirectional, iterative, and involves multiple levels of decision-making in safety management as shown in Fig. 1 below.

In a perfect world, the model described in Fig. 1 would operate seamlessly to ensure that regulations and work procedures are improved continuously, thereby guaranteeing maritime safety. The system, however, is not self-contained; it is a dynamic system that is exposed to stress or pressure from the external environment such as technological development, financial pressure, differing levels of competency, environmental interests, terrorist and other criminal threats, and international and national competition. It is also a system that is sensitive to adverse behavior and communication flaws by different actors with generally divergent interests.

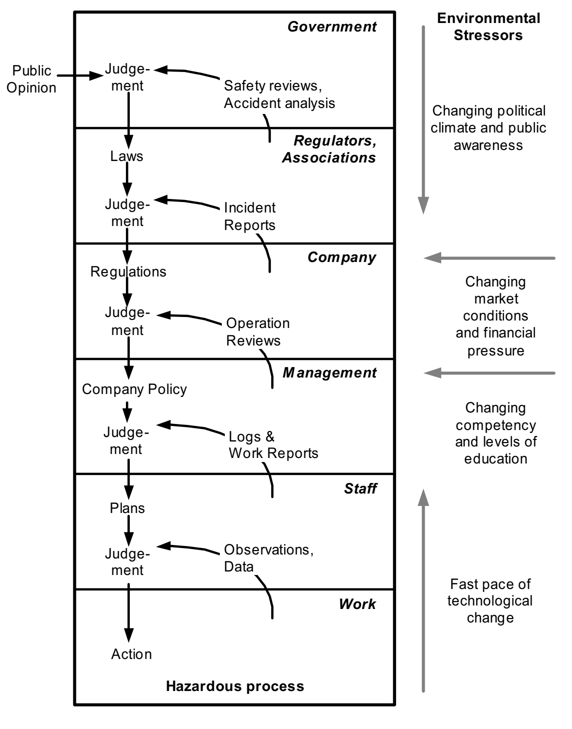
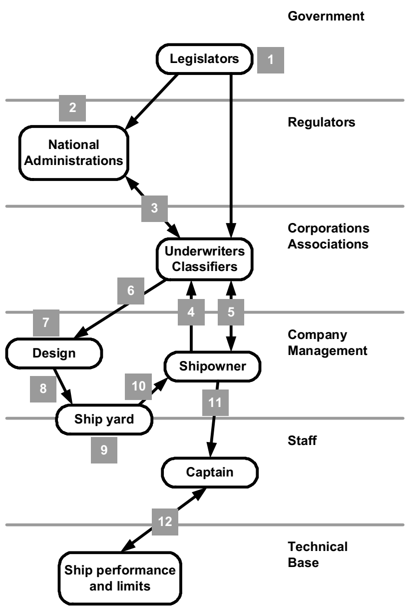


Figure 1. Many nested levels of decision-making involved in risk management and regulatory rule making to control hazardous processes. (source: Rasmussen, 1997; Rasmussen and Svedung, 2000; and Svedung and Rasmussen, 2002)

Another diagram (Fig. 2, below) by Rasmussen and Svedung is more reflective of this reality. The straightforward linear and cyclical lines in Fig. 1 are replaced by skewed ones that link different actors in complex relationships that invariably result in less than the desired level of safety. The system described in both Figs. 1 and 2 is inhabited by, *inter alia*, classification societies, flag state administrators, maritime administrations, insurers, industry associations, port state inspectors, bankers, naval architects, seafarers, ship operators, shipowners, shipyards, and trade unions. Together with a number of other actors not mentioned in the list, they represent the variegated set that need to balance maritime safety against profitable maritime operations and that find themselves in a constant tension between conflicting interests such as increasing profits versus improved ethics, controlling clients versus keeping those clients, and entrepreneurialism versus risk minimization (Bennett, 2000, p.896).



LEGEND:

1,2. The strategies for legislation appear to be inadequate during fast technological change.

3. Shipping industry's influence on legislators: Depressed shipping market of the 1980s leads to changes in its structure: Underwriters and National Administrations are neutralized by competition.

4. Shipowners influence classification societies.

5. Owners and classifiers co-operate and do not inform legislators adequately.

6. Communication from classifiers to designers is inadequate.

7. Design based on established practice inadequate during period of fast pace of change.

8. Inadequate specification and documentation from design. Shipyards rely on established practice during period of rapid technological change.

9. Quality assurance of shipyard questionable.

10. Inadequate communication between design, manufacturing and operating communities.

11,12. Inadequate guidance to captain, learning by doing inadequate during fast pace of technological change.

Figure 2. Map of conflicts among actors in shipping.
(source: Rasmussen, 1997; Rasmussen and Svedung, 2000; and Svedung and Rasmussen, 2002)

2 PARADIGM SHIFT IN MARITIME SAFETY ADMINISTRATION

Many writers and researchers (e.g., Anderson, 2003, p. 18; Chauvel, 1997; Eriksson and Mejia, 2000; Jense, 2003, p. 153; Kuo, 1998; Sagen, 1999, p. 20) agree that a paradigm shift in maritime safety administration at the international level occurred starting from around the late 1980s to the early 1990s. As in the meaning of Kuhn (1970), this paradigm shift was the result of a gradual process driven by catalyzing events – dramatic accidents at sea, particularly from the late 1980s to the mid-1990s (see Table 1, below), that occurred in spite of the growing number and stringency of international conventions[3] relating to maritime safety.

YEAR	VESSEL NAME	NATURE OF MARITIME CASUALTY	FATALITIES/ NATURE OF LOSS OR DAMAGE
1987	*Herald of Free Enterprise*	Capsizing	193 lives
1987	*Doña Paz - Vector*	Collision	4,386 lives
1988	*Piper Alpha*	Offshore oil rig blowout	167 lives
1989	*Exxon Valdez*	Grounding	36,446 tons crude oil
1990	*Scandinavian Star*	Fire	158 lives
1991	*Salem Express*	Sinking	464 lives
1991	*ABT Summer*	Explosion	260,000 tons crude oil
1992	*Aegean Sea*	Grounding	72,000 tons crude oil
1993	*Braer*	Grounding	84,500 tons crude oil
1994	*Estonia*	Capsizing	912 lives
1995	*Basanti*	Capsizing	150 lives
1996	*Bukoba*	Capsizing	869 lives
1996	*Sea Empress*	Grounding	71,000 tons crude oil

Table 1. Selected list of major casualties at sea, late 1980s to mid-1990s.
(source: Hooke, 1997)

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. This development is apparent in the following passage from a report published by the UK government:

> While casualties can never be completely eliminated there is nevertheless a growing feeling that present rates of casualty are still unreasonably high.

[3] Which in turn resulted from major shipping accidents in the 1960s and the 1970s.

> When everything else has been looked at and tried – newer designs, better technical aids, the increase in ever more sophisticated regulations and enforcement systems at every level – one thing remains about which there is, almost universally, agreement as to the underlying cause of casualties – the human factor. (Marine Directorate, Department of Transportation, United Kingdom, 1991, p.1)

Aside from disappointment over continued significant losses, the shift from the existing paradigm in maritime safety administration was also a general reaction by the world shipping community to the negative publicity and adverse reputation that seemed to increase as a result of each major accident at sea. In other words, the industry was in a crisis of confidence (Stenmark, 2003, p. 6). According to King (1995, p. 469),

> The concerns of those who see disasters looming are based on evidence that is real enough. The case of the *Estonia* has reawakened memories in Britain of the *Herald of Free Enterprise* and fuelled suspicions that ship operators will always rank profit above people; the case of the *Braer* has demonstrated that we can all be victims. The word is also abroad that seamen are incompetent, that shipping companies can never be called to account and that maritime institutions are no longer a byword for rectitude. On such grounds are reputations lost and confidence undermined.

The shift from the old to the new paradigm is better understood in the context of some of its features, such as:

- migration from the prescriptive to the discretionary variety of administrative control;
- increased focus on the human element;
- wider application of macroergonomic principles;
- institutionalization of third-party control; and
- enrolment of a broad range of actors.

2.1 Migration between varieties of administrative control

Reason (1997, p. 62) describes three varieties of administrative control that cover a wide spectrum from one that is prescriptive and allows actors little if any flexibility, to one that is discretionary and allows greater flexibility. If one were to describe these administrative controls in the context of Rasmussen's ladder model, then it could be said that Reason's models describe the dynamics within the lower four rungs of the Rasmussen ladder. In the maritime milieu this refers to the control process commencing with a shipping company's adoption of organizational standards and objectives in compliance with national and international regulations, which is then translated by management into work plans and procedures for implementation by the shipboard crew.

At one end of the prescriptive-discretionary continuum (Reason, 1997, p. 64) is the predominantly prescriptive mode of control (Fig. 3, below). Under this mode, organizational standards and objectives are translated into action through safety procedures that are set in strict detail and designed to prevent or limit deviation in implementation by individuals. It is a mainly feedforward process that does not include regular adjustment or improvement. Adjustments and modifications to the procedures are made only in reaction to occasional incidents and accidents.

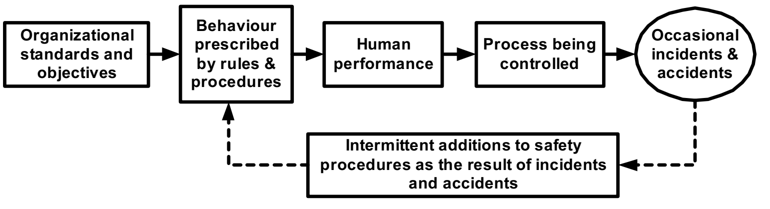


Figure 3. A mainly feedforward process control based on procedures with intermittent additions. (source: Reason, 1997)

The promise of order, predictability, rigidity, and uniformity are some of the perceived advantages of this variety of control. Also, the mechanisms against individual discretion built into this mode minimize the need for highly specialized personnel. This normally lowers labor costs for the company.

However, this variety of control does have its drawbacks. Kuo (1998, p.27) points out that because the process of prescribing rules and procedures is one that is normally long and drawn-out, by the time these are promulgated much of the primary conditions have already changed. In addition, the rigidity of this variety of control also limits the development of innovative solutions. The detailed standards do little to encourage managers and operators to push safety systems beyond the minimum requirements.

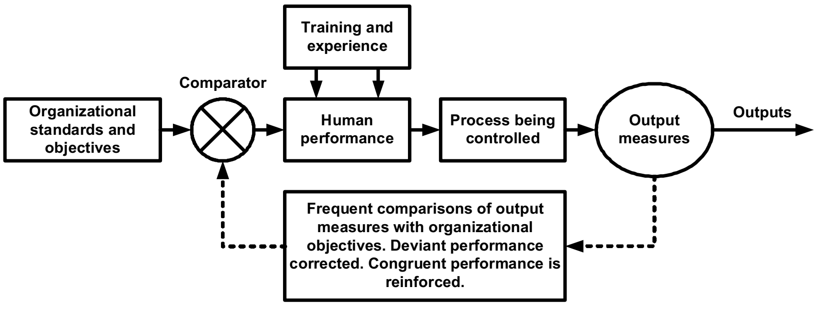


Figure 4. Feedback output control requiring frequent comparisons of performance with goals. (source: Reason, 1997)

At the opposite end of the spectrum lies the mainly discretionary variety depicted in Fig. 4 above. This variety of control presupposes a highly competent workforce with the training and experience necessary to achieve the organization's safety objectives without the benefit of detailed and rigid procedures or guidance. In contrast with the first variety, this incorporates a feedback or self-improvement mechanism that loops corrections, reinforcements, and improvements resulting from regular comparisons of output measures with organizational goals. This mode offers a great deal of latitude to managers and seafarers alike. It promotes initiative, innovation, and thinking "out of the box."

The main drawback of this variety of control for shipowners is the paucity of appropriately trained workers. Even if it were readily available, specialized skilled labor would be expensive. One obvious alternative, that is, training the existing workforce, will involve further additional cost. In the case of regulators, assessment and verification become more challenging because of the lack of uniformity in procedures between different shipping companies. As in the case of shipowners, hiring highly trained maritime administration personnel can also be an expensive proposition.

Situated between the first two varieties is a mixture of control modes shown in Fig. 5. This mixed mode is typical of organizations that are in the early stages of development where human performance in the management of maritime safety is first influenced by the experience and discretion of individuals tasked to draft and develop rules and procedures. As procedures are documented and prescribed, the role of individual discretion diminishes.

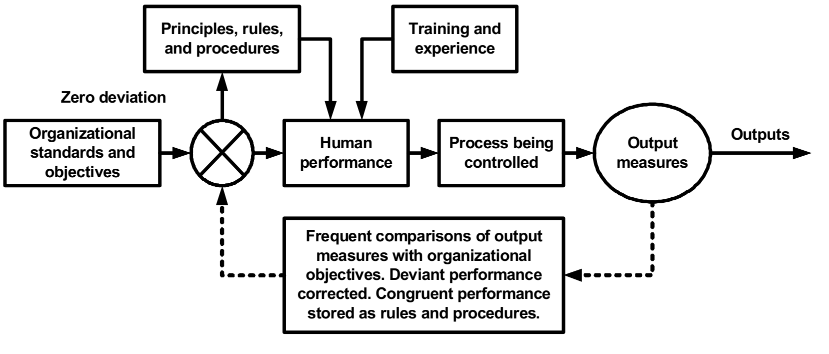


Figure 5. Mixed feedback and feedforward controls.
(source: Reason, 1997)

The mixed variety of control may also be found in organizations in transition between either ends of the continuum. Reason (1997) gives the examples of the medical profession as one that is moving from the discretionary to the prescriptive mode and rail transport and oil exploration as examples of industries moving in the opposite direction. It is also found in industries that have a mixed regime of prescriptive and discretionary regulations. One way of describing the varieties of administrative control in terms of maritime safety is by looking at it from an historical perspective.

Pre-Titanic (up to 1912). Before the sinking of the *Titanic*, the development of maritime safety regimes took place at the domestic or national level in Europe and North America. An administrative system of control on the international level was still non-existent or, at the most, in the embryonic stage. The period is nevertheless significant in that the national experiences developed up to 1912 served as the bases for the formulation of global standards.

Post-Titanic (1912 to 1959). The development of an international maritime safety regime was prompted by history's most infamous maritime tragedy. In reaction to the loss of more than 1,500 lives, the United Kingdom organized a conference attended by the world's leading maritime nations to draft a new International Convention for the Safety of Life at Sea. The Conference was held in 1914 and "took into account many of the lessons learned from the *Titanic* disaster – but more than that, it laid down internationally applicable rules for the first time" (International Maritime Organization, 2000). Among others, the SOLAS Convention of 1914 introduced international standards relating to radiotelegraph equipment, watertight and fire-resistant bulkheads, life-saving appliances, fire prevention systems, and fire fighting appliances on passenger ships. The 1914 Convention never came into force because of the First World War. Two more versions of the convention were adopted (in 1929 and 1948), each of which was considered an improvement of the previous one.

A mixture of feedback and feedforward controls (a rudimentary version of Fig. 5, above) characterized this early stage of maritime safety administration at the international level. The maritime community was in search of rules, procedures, and standards that could be globally enforced. On the one hand, nationally developed standards served as the source for feedforward control. On the other, that the Convention went through three modifications during the post-*Titanic* period indicates the application of a feedback and improvement process.

IMCO (1960 to mid-1980s). This period saw a migration from a mixed mode of administrative control towards one that is prescriptive (as in Fig. 3, above). The accelerated pace of technological development led to a maritime safety administration regime that relied heavily on preplanned control, prescriptive procedures, and technology. The establishment of a permanent international organization (the Inter-Governmental Maritime Consultative Organization or IMCO) that could coordinate the periodic revision of regulations, formulation of new conventions, as well as monitor their enforcement was also a contributing factor. By the mid-1980s, IMCO had adopted around twenty landmark, and mainly technical, conventions – almost one convention for every year that it had been in existence. The prolificacy of the IMCO in developing technical standards is also testimony to the prevalence of the prescriptive mode of control during this period.

IMO (mid-1980s to the present). The Organization went through a name change in 1982. The new label dropped the word "consultative" to manifest an intention on the part of the Organization to play a stronger and more active role in promoting safety at sea. Indeed the new name was adopted just as another migration between varieties of administrative control was underway.

In spite of the impressive collection of international conventions and technical standards in place, there was considerable frustration over the number of major accidents that still continued to occur. In many cases the lack of a safety culture, both on board ships and in shore-based management, was found to be acute. The vessel safety survey and certification process was often treated as a paper exercise, and compliance with regulations as little more than a necessary nuisance. The existing prescriptive and feedforward regime did not engender willful participation. It involved government agencies drawing up rules and regulations and the shipping industry obeying them without question (Kuo, 1998). In this sense, the maritime industry lagged behind land-based industry where the trend for many decades had been to allow "considerable freedom on the parts of the operators of hazardous technologies to identify the means" by which the required outcomes of safety management would be achieved (Reason, 1997, p. 175).

The gestalt switch (Kuhn, 1970) during this period was not a total abandonment of the prescriptive variety of control in favor of an exclusively discretionary variety. The novelty was in the acceptance of the view that technical standards are insufficient to factor out human limitations and that more effective maritime safety administration requires a combination of discretionary and prescriptive elements. Thus the prevailing variety of administrative control today is more akin to that portrayed in Fig. 5 above where feedforward and feedback controls operate side by side.

2.2 Increased focus on the human element

A study commissioned by the UK Marine Directorate in 1991 concluded that "the human element was found to be present in over 90 per cent of collisions and groundings, and over 75 per cent of fires and explosions" (Marine Directorate, Department of Transportation, United Kingdom, 1991, p.2). Indeed, public inquiries into shipping disasters in the mid-1980s repeatedly identified human error as the major contributory factor in vessel casualties and pollution incidents (Morrison, 1997, p. 19). These findings substantiated suggestions that attention to the role of shipboard as well as shore-based human resources in the promotion of maritime safety was insufficient.

The capsizing of the RoRo (roll on/roll off) ferry *Herald of Free Enterprise* (see § 3 of this thesis, below) in Zebrügge, Belgium is generally regarded as the shipping disaster that triggered international activity towards addressing the imbalance in focus between the human element and technology. As a result of that accident, which claimed 193 lives in March 1987, the United Kingdom submitted a number of proposals to IMO, one of which endorsed the development of a new Chapter II-3 to the SOLAS Convention to be entitled "Operational Procedures – Role of Management Ashore." While these did not bring about the creation of a Chapter II-3 in SOLAS, the UK proposals succeeded in introducing discussions on the human element into the regular work programme at IMO. As an initial step in this programme, IMO directed its Maritime Safety Committee (MSC) and Marine Environmental Protection Committee (MEPC) to conduct a comprehensive survey of what role the human element has played in relation to the Organization's work in general. The two Committees, in turn, gave the following instructions to each of their sub-committees (International Maritime Organization, 1990, §14.16):

- review the adequacy of requirements and recommendations for equipment and operating manuals and operational guidelines on board ships;
- consider the simplification and standardization of terminology in operating manuals and symbols and signs used on board ships;
- identify words and phrases used in IMO instruments relating to human performance criteria and determine the extent to which they can be more specifically defined;
- give appropriate consideration to a list of questions on subjects relating to human factors; and
- report to the Committees on their progress.

Since then, focus by the IMO and individual member states on the role of the human element in vessel safety has continued to increase, though Boisson (1999, p. 287) estimates that under the current international maritime safety regime about 80 per cent of available resources have been devoted “to technical and technological solutions, leaving only 20 per cent for issues related to human beings.” Indeed, there is still much in contemporary maritime affairs that point to the fact that the industry’s fascination with technical solutions is far from over (Psaraftis, 2002). The paradigm shift in maritime safety administration is not characterized by an outright rejection of the vital role of technology. Rather, it is characterized by the acceptance of the proposition that the human element is an even more significant and complex factor in preventing accidents involving what might be a highly compliant and technologically advanced vessel. The improvement of the safety levels in the maritime industry is best served by an optimal combination of human efficiency and technological innovation that works towards preventing, recovering from, or mitigating the consequences of human errors (Cacciabue, 2004).

2.3 Wider application of macroergonomic principles

The relatively new discipline of ergonomics is still under a constant process of being defined.[4] One way of defining it is the study of human behavioral and biological characteristics that influence the efficiency with which a human can interact with the inanimate components of a human-machine system[5] (Proctor & Van Zandt, 1994, pp. 2 & 499-500). Another definition of ergonomics is “the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance” (International Ergonomics Association, accessed 2005). Dzissah et al. (2001) describes it as a discipline that “seeks to design tool and tasks to be compatible with human

[4] Depending on the milieu, ergonomics is alternatively referred to as, *inter alia*, human factors, human factors engineering, or engineering psychology. Wogalter et al. (2001) discusses the challenges in defining ergonomics and its synonyms and mentions how, in an earlier study, they analyzed 190 definitions from 113 sources. After grouping together the most frequent terms they found, their study came up with the following moderate-length definitions for ergonomics: (a) designing and engineering human-machine systems; (b) applying science to people performing in working environments; (c) studying how man’s limited capabilities relate to safe job operation; (d) improving knowledge on the fit between users and tasks; and (e) the interface between people and machines in systems.

[5] In the maritime setting, the ship and its crew.

capabilities and limitations with the purpose of providing work conditions that assures safety, health, well-being and efficiency" while Wilson (2000) defines it as "the theoretical and fundamental understanding of human behaviour and performance in purposeful interacting sociotechnical systems, and the application of that understanding to design of interactions in the context of real settings."

While the design of machines and objects compatible with the anthropometric characteristics of the general population has for a long time been the staple of ergonomics, in its contemporary application it uses scientific information concerning humans also to design systems (Ergonomics Society, accessed 2005). The discipline has branched out from studying the direct level of human-machine interface (microergonomics) to the level of human interface with systems and organizations (macroergonomics). According to Kleiner (2001, p. 124),

> Macroergonomics is a sub-discipline of the human factors engineering/ ergonomics profession with the stated focus of work system analysis and design. In fact, macroergonomics and work system analysis and design are synonymous. A work system is comprised of personnel (e. g. operators) interacting with hardware and/or software (e. g. computers), an internal physical environment (e. g. illumination, humidity), external subenvironments (e. g. legal, political, technological, cultural) and organizational design, including structures, processes, and management systems. Macroergonomics has also been referred to as the ergonomics sub-discipline concerned with human-organization interface technology.

Macroergonomics adopts what is often referred to as a top-down approach in that "it begins with the relevant sociotechnical system variables in terms of their implications for the design of the overall structure of the work system and related processes" (Kleiner, 1998, p. 255; Ingelgård & Norrgren, 2001, p. 94). It does, however, involve participation at all levels. In fact, macroergonomics stresses the interdependence – rather than the hierarchical nature or independence – of different work-system components such as organizations, systems, and workers (Kleiner, 2001. p 124). The crucial point is that the process of designing the system starts at the top and trickles down to the different levels below it. Similar to the process shown in Fig. 1, the corresponding bottom-up feedback mechanism ensures the continued relevance of the system.

Under the old paradigm of maritime safety administration, the reliance on technology led to a Procrustean approach[6] to ergonomics (Osborne, 1987). The objective of maritime safety regulation became progressively associated with designing human error and discretion out of a highly technical transport system. This was evident in standards that became increasingly preoccupied with controls, dials, knobs, instrument redundancy, satellite technology, and advanced electronic and computer systems, to the detriment of adequate safe manning and crew competency. To be sure, the maritime industry would not have been able to attain the level of safety it enjoys today without the bold and constant application of technology; the role of technology should not be denigrated. As mentioned in § 2.2, above, it is the lack of a corresponding focus on organization and the human dimension that has led to

[6] In which it is proposed that since people are seen as being more adaptable than their machines and environments, it would be easier to make *them* 'fit' their surroundings.

undesirable levels of safety. Safety depends on the optimal macroergonomic combination of good technology, good management, good organization, good safety culture, and good human resources.

The mid-1980s shift towards greater attention to the human dimension also meant greater attention to the role of the cognitive process. Cognitive ergonomics is concerned with "mental processes, such as perception, human information processing and motor response, as it relates to human interactions with other elements of a system." Perception, attention, workload, decision-making, motor response, skill, memory, and learning as these may relate to human system design are among the relevant topics relevant to this sub-discipline (IEA, 2001). The departure from the traditional view that linked ergonomics to the physical aspects of work, or "below the neck" processing, as opposed to cognitive activity, or "above the neck" processing (Wogalter et al., 2001, p. 35), is reminiscent of contemporary movements along the prescriptive-discretionary continuum in administrative control discussed in § 2.1, above.

Hendrick (2002, p. 3) writes that the wider application of macroergonomics principles "increases the likelihood of microergonomic interventions having a relatively greater effectiveness than otherwise might be the case." He adds that the

> goal of macroergonomics is to optimize the work system's design in terms of its sociotechnical system characteristics, and then carry the characteristics of the overall work system design down through to the design of individual jobs and human-machine and human-software interfaces to ensure a fully harmonized work system… (W)hen this goal is achieved, the result should be dramatic improvements in various aspects of organizational performance and effectiveness.

From the late 1980s onwards, the maritime industry has focused on macroergonomic principles and underscored the importance of the human-organization interface. This has translated in a safety management system designed to influence perceptual and cognitive processes in both shore management and seafarers on the direct level, so that these actors would consistently factor safety into all their decisions and actions.

2.4 Institutionalization of third-party control

Highlighting the shipping company's[7] or the shipowner's preeminent role in promoting ship safety, Everard (2003, p. 92) writes that

> The owner is the one who chooses the flag, the insurer, classification society and to a great degree the method of operation. He or she chooses the

[7] The terms "shipping company" or "company" in this thesis is used within the context of the ISM Code which defines the term as being "the owner of the ship or any other organization or person such as the manager, or the bareboat charterer, who has assumed the responsibility for operation of the ship from the shipowner and who on assuming such responsibility has agreed to take over all the duties and responsibility imposed by the Code." The usage therefore has a wider scope than the normal commercial or legal definitions of the term.

controls, the feedback and the standard of the vessel as well as strongly influencing the morals and motivation of their employees both ashore and at sea. The buck finally stops at the owner. It is the owner who is responsible.

On the other hand the flag state administration, collectively with other states, is primarily responsible for setting up, maintaining, and enforcing the international legal framework for maritime safety. In ensuring the smooth operation of the international maritime safety framework the committed and sincere participation of the above two actors, that is, the company with primary responsibility for regulatory compliance and the flag state administration with primary responsibility for enforcement of standards, would ideally suffice. This, however, has not been the case.

The constant pressure of commercial competition exerted on shipping companies has led to the inclusion of third parties – specifically classification societies and port state authorities – as part of the global maritime safety enforcement mechanism. It is such that today these four actors are generally considered as different layers, in descending order of responsibility, of safety nets in maritime safety administration (Fig. 6).

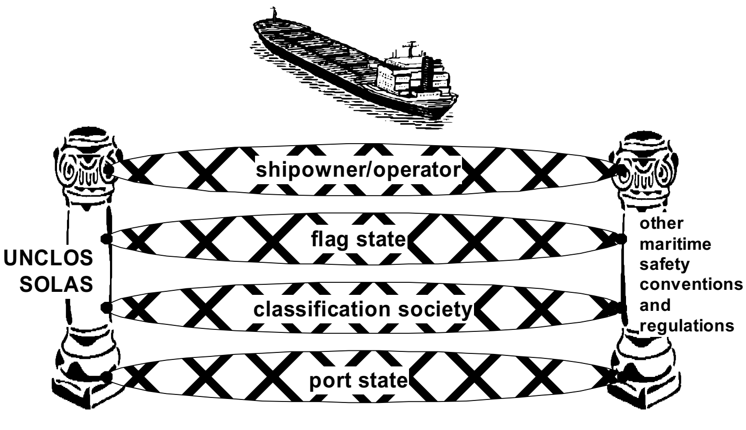


Figure 6. Safety nets in maritime safety administration.

The classification society's original role, as conceived in the late 1700s, is to provide a private service between shipowners and insurance underwriters. This service entails surveys and inspections to ensure that the ship complies with rules developed by the society relating to the structural strength of the hull and the reliability of its essential machinery and equipment. The goal of the classification survey is the issuance of a certificate that the shipowner then uses to obtain insurance at reasonable cost. In later years, however, classification societies took on a public service role particularly on behalf of many flag states that sought to offer ship registration services under the open registry type of ship registration regime. In the open registry regime, it is not uncommon for a ship to rarely visit, if ever, its port of registry in its service life. With their technical skills and extensive international network of surveyors, classification societies became a natural choice for flag states searching for agents to perform statutory certification services worldwide on their behalf. Under a delegation agreement, the flag state authorizes the classification society to carry out surveys and inspections in accordance with international maritime safety and pollution prevention conventions (Boisson, 1999, p. 119). It is in the sense of both the private and public service functions that the classification society is considered one of the safety nets in maritime safety administration.

While classification societies occasionally fill the gap in statutory survey and certification on behalf of flag state administrations, there is still a generally-held belief that many ships are unable to adequately comply with international safety standards. A fourth safety net, which came in the form of port state control, was deemed necessary to compensate for any eventual shortcomings of the shipowner, flag state, classification society, and other actors. Individual states have always had the prerogative, under national and international laws, to inspect foreign ships that call at its ports; but the establishment of the port state control regime has facilitated the coordination and harmonization of the active exercise of these rights, implied in numerous IMO and International Labour Organization (ILO) conventions, on a regional basis. Port state control was conceived as a complement, not a substitute, to effective maritime safety administration by the flag state. Herein also lays the difference between the role of the classification society and port state control. Classification societies perform a delegated flag state function *vis-à-vis* the ship, whereas port state control is conducted by authorities of states whose shores and coastal areas stand to sustain damage in the event that a visiting ship is involved in an accident.

Though port state control was originally intended as an interim measure (Özçayir, 2001), trends and developments in international enforcement indicate that it is here to stay. In the 1990s, explicit provisions in at least three of the most important conventions in the international regulatory framework for maritime safety (SOLAS, STCW, and MARPOL– see below) have institutionalized the regime of port state control.

SOLAS. On 1 January 1996 the new SOLAS Chapter XI[8] "Special Measures to Enhance Safety" entered into force under the tacit acceptance procedure. Regulation 4 makes it possible for port state control officers inspecting foreign ships to check operational requirements "when there are clear grounds for believing that the master or crew are not familiar with essential shipboard procedures relating to the safety of ships." Chapter XI also makes reference to resolution A.742(18), adopted in November 1993, which "acknowledges the need for port States to be able to monitor not only the way in which foreign ships comply with IMO standards but also to be able to assess 'the ability of ships' crews in respect of operational requirements relevant to their duties, especially with regard to passenger ships and ships which may present a special hazard'" (International Maritime Organization, accessed 2005(a)).

MARPOL. Amendments to the International Convention for the Prevention of Pollution from Ships, 1973 (MARPOL) came into force on 3 March 1996 that made it "possible for ships to be inspected when in the ports of other Parties to the Convention to ensure that crews are able to carry out essential shipboard procedures relating to marine pollution prevention." Once again, reference is made to resolution A.742(18).

[8] This chapter has since been renamed Chapter XI-1 under a recent set of amendments.

"Extending port state control to operational requirements is seen as an important way of improving the efficiency with which international safety and anti-pollution treaties are implemented" (International Maritime Organization, accessed 2005(b)).

STCW. The 1995 amendments to the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW Convention) included a revised Chapter I with enhanced procedures concerning the exercise of a port state to allow intervention in the case of deficiencies deemed to pose a danger to persons, property or the environment (regulation I/4). Such intervention can take place if certificates are not in order, or if the ship is involved in a collision or grounding, if there is an illegal discharge of substances (causing pollution), or if the ship is maneuvered in an erratic or unsafe manner (International Maritime Organization, accessed 2005(c)).

Active promotion by IMO. IMO has encouraged the establishment of regional port state control organizations and agreements on port state control (Memoranda of Understanding on Port State Control or "MoU" or "MoU on PSC"). Aside from other administrative and operational functions, the regional agreements set quotas for the minimum percentage of vessels calling within a party's jurisdiction that should be inspected. Together, the MoUs in operation today cover virtually all of the world's seas:

- Paris MoU – Europe and the North Atlantic
- Tokyo MoU – Asia and the Pacific
- Acuerdo de Viña del Mar – Latin America
- Caribbean MoU – Caribbean Sea region
- Abuja MoU – West and Central Africa
- Black Sea MoU – Black Sea region
- Mediterranean MoU – Mediterranean Sea region
- Indian Ocean MoU – Indian Ocean region
- Gulf Cooperation Council (GCC) MoU – Arab States of the Gulf

The new paradigm is characterized by a wider acceptance and application of the port state control (PSC) regime as a counterbalance against indifferent shipowners and flag states.

2.5 Enrolment of a broad range of actors

The assumption that so long as "the correct rules and organisation can be erected, the intentions of the regime will be translated into reality" has been discredited in recent decades as being overly simplistic (Bennett, 2000, p. 879). Many of the maritime accidents of the past two to three decades have shown that the participation of other actors, rather than simply "the regulator" and "the regulated," was necessary to ensure the success of a maritime safety management program. In the new paradigm, "regulators have turned to enhancing the enrolment of those actors in the regulatory process" in recognition of the fact that its "success is critically dependent upon a whole range of actors" (Bennett, 2000, p. 876).

There are a number of reasons why safety regulation can only succeed with the involvement of many actors, including private ones. According to Bennett (2000, p. 879), there is an increasing acknowledgement that modern governance entails the enrolment of non-governmental organizations (NGOs), industry, and other non-state actors; many of the actions which directly produce environmental risks are undertaken by private actors; and many of the third parties which have the potential to influence the actions of those private individuals or companies are also private organizations.

In fact the private maritime sector itself participates in the development of regulation. More than 60 non-governmental international organizations representing a broad spectrum of interests – ranging from legal to commercial, port operators to cargo owners, environmental conservation societies to nuclear energy advocates – have been granted consultative status and attend IMO meetings in an observer capacity. While these organizations do not have voting privileges, their input – by way of information, documentation, and expert advice – are taken into serious consideration in meetings of the various committees and working groups at IMO (International Maritime Organization, accessed 2005(d)). In spite of their divergent interests, representation by a wide variety of interests contributes to the adoption of standards that are as practicable as possible. The enrolment of a broad range of actors contributes to ensuring that regulations adopted are neither ineffectual nor unnecessarily burdensome.

2.6 The new paradigm manifested

The new paradigm in maritime safety administration manifested itself in a number of initiatives taken by the IMO in the 1990s. Among them were the 1995 amendment of the STCW Convention, the introduction of formal safety assessment (FSA), and the adoption of the ISM Code.

STCW. Adopted in 1978, the original version of the STCW Convention was faulted for being knowledge-based and not performance-based. Under the Convention, it was sufficient to show knowledge of a certain task through a qualifying examination but not necessarily to exhibit proof of competence through actual performance. The regulations made little or no mention "of the skills and abilities necessary to perform the tasks involved" (Morrison, 1997, p. 16). The public inquiries following each one of the numerous accidents of the late 1980s and early 1990s drew attention to the fact that prescriptive standards requiring knowledge of what to do or what must be done were no longer sufficient to promote safety. It was evident that requirements for competence or "internalized knowledge and experience" (Reason, 1997), which form the bases for discretionary control, were lacking in the regulatory framework provided by STCW 1978. The demand to raise the levels of skill, education, and competence of seafarers resulted in a migration from an exclusively prescriptive variety of control to one that is mixed prescriptive/discretionary that manifested itself in the comprehensive amendment exercise that adopted the 1995 version of the STCW Convention.

FSA. The application of formal safety assessments (FSAs) as part of the safety regulation regime was a principal recommendation contained in the report that was published at the end of the public inquiry into the *Piper Alpha* explosion[9]. The inquiry led by Lord Cullen had been tasked with establishing the cause of the accident and with formulating recommendations that would minimize the likelihood of a recurrence of similar accidents. The Cullen Report describes FSA as a process involving "the identification and assessment of hazards over the whole life cycle of a project from the initial feasibility study through the concept design study and the detail design to construction and commissioning, then to operation, and finally to decommissioning and abandonment" (Cullen, 1990, p. 275).

Formal safety assessment was introduced to the IMO's work programme to counter perceptions that the process of developing the international legal framework maritime safety is reactive in nature. While the inter-governmental nature of IMO explains the difficulty in maintaining a proactive stance, there was also agreement that to wait idly for accidents to occur before formulating new standards would be irresponsible. FSA is expected to provide the risk analysis process that would facilitate the examination of potential threats to safety and the identification of appropriate measures without having to wait for a casualty to occur. It is meant to move IMO slowly away from reliance on prescriptive standards and steer its attention towards the vessel's performance as a whole, taking into account the potential hazards that a ship faces and developing scientific methods to assess, manage, and reduce risks (International Maritime Organization, 1993a). FSA is a manifestation of the new paradigm in maritime safety administration in the sense that it is a forward looking mechanism designed to institutionalize rule-making using frequent comparisons of output measures with organizational objectives (Figs. 4 and 5, above), rather than settling for intermittent additions to safety procedures as a result of incidents and accidents (Fig. 3, above).

ISM Code. 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 thesis reviews the historical background of the ISM Code and provides a synopsis of its principal and distinctive features.

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[9] On the evening of 6 July 1988, fire and explosions caused by a gas leak destroyed the oil production platform *Piper Alpha* stationed off the coast of Aberdeen, Scotland. A total of 167 lives were lost in what so far has been the world's worst offshore disaster (Hooke, 1997, p. 488).

3 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 (Rasmussen and Svedung, 2000). 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" (Sheen, 1987).

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 maritime safety regulations. Why did it 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.

3.1 Historical background

Mainly in response to the *Herald of Free Enterprise* accident, IMO convened the Joint MSC/MEPC Working Group on the Role of the Human Element in Maritime Casualties, the principal task of which was to produce a draft "international code for the safe management and operation of ships" and "to recommend whether the code should be mandatory or voluntary" (International Maritime Organization, 1992a, p. 4). The draft code, eventually adopted as the International Safety Management (ISM) Code, was developed "to provide an international standard for the safe management and operation of ships and for pollution prevention" (International Maritime Organization, 1993b, Preamble §1).

The ISM Code evolved into its present form in different stages. The earliest version of what eventually became the ISM Code can be found in Res. A.647(16) "IMO Guidelines on Management for the Safe Operation of Ships and for Pollution Prevention" adopted in 19 October 1989, an assembly resolution that was based on the document originally proposed by the UK for inclusion in SOLAS as Chapter II-

3.[10] A.647(16) emphasized the importance of proper ship- and shore-based management to sea safety. According to the resolution, the "cornerstone of good safety management is commitment from the top" and that in "matters of safety and pollution prevention it is the commitment, competence, attitudes and motivation of individuals at all levels that determines the end result" (International Maritime Organization, 1989, § 4.1-4.2). It espouses adherence to a corporate safety and environmental policy as a departure point for safe ship operation and pollution prevention. Aside from recommending a clear and wide dissemination as well as regular review of the safety and environmental policy, the resolution strongly urges companies (shore management) to ensure that any deficiencies discovered by the master on board ship are promptly addressed. The resolution's basic theme is that management needs to be appropriately organized "to enable it to respond to the need of those on board ships to achieve and maintain high standards of safety and environmental protection" (International Maritime Organization, 1989, Preamble). A.647(16) was a non-mandatory resolution, which provided no specific courses of action, only general guidelines.

In light of the experience gained in its application and as a result of a joint MSC/MEPC review, A.647(16) was revoked two years later by another resolution – Res. A.680(17). Bearing the same resolution title, A.680(17) improved on its earlier version by introducing two of what today are important core concepts in the ISM Code, that is, the "designated person" and the "operations book." According to the resolution the designated person ashore shall have "direct access to senior management… with the responsibility for monitoring the safety and pollution prevention aspects of the operation of their ships and to ensure that adequate resources and the appropriate shorebased support are provided" (International Maritime Organization, 1991, § 4.7). Through the "operations book" on the other hand, companies are encouraged to document "guidance and instructions… to the master, officers and crew." While the form of documentation is left to the discretion of the owners, it "should also include a statement that it does not affect the master's authority to take such action and issue such orders, whether they are in accordance with its contents, that may be considered to be necessary for the safety of life, for the safety of the ship or the prevention of marine pollution" (International Maritime Organization, 1991, § 4.8). A.680(17) also includes an Appendix, not found in A.647(16), containing suggested work areas for documentation in the operations book. As in the case of A.647(16), Res. A.680(17) was not obligatory or binding in nature.

Although A.680(17) was considered an improvement, work on a third version was vigorously pursued. A correspondence group was established to address the weaknesses of A.680(17) and develop a draft safety management code in addition to tackling such issues as to whether the code should be a free-standing instrument or incorporated into SOLAS, whether compliance should be made mandatory or voluntary, and which type and size of ship should be covered by its regulations.

Finally, a new draft resolution was presented and approved at the May 1993 meeting of the MSC. The resolution, adopted during the 18th session of the IMO Assembly, came with a different title – A.741(18) "International Management Code for the Safe

[10] As discussed in § 2.2 "Increased focus on the human element," this thesis.

Operation of Ships and for Pollution Prevention," more widely known as the ISM Code. Unlike its earlier versions Res. A.647(16) and A.680(17), the ISM Code was more or less earmarked for mandatory implementation. However, just exactly how the Code was to become mandatory still evoked much debate and deliberation among members and participants of the Joint Working Group who considered four alternatives. One proposal was for IMO to adopt the ISM Code as a freestanding instrument. Another was to make it mandatory by amending SOLAS, STCW, and MARPOL. A third alternative was to amend only the STCW Convention while a fourth alternative was to amend SOLAS only (International Maritime Organization, 1992b, p. 4).

In a paper submitted to the MSC, the IMO Secretariat confirmed that the proposals to make the Code mandatory through convention amendments were viable. The Secretariat added that this would not be the first time for the Organization to make the application of a code mandatory through direct reference in a convention. The paper pointed out that the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IBC Code), for instance, was made mandatory by making the appropriate amendments to SOLAS and MARPOL. Having mentioned this, however, the Secretariat also included in its paper some perceived weaknesses and potential problems *vis-à-vis* the application of the ISM Code. One perceived weakness was that because the Code was based on general principles and objectives and because all its concepts were expressed in broad terms, there would be widely differing interpretation of its requirements. It was also foreseen that because flag States have varying requirements, situations might arise where the company responsible for operating the ship would neither be physically located in, nor be within the legal jurisdiction of, the flag State. Another potential problem mentioned in the paper involved the legal consequences of an apparent infringement being discovered. Questions as to the legal basis for a marine inspector to conduct an investigation or the legal basis for a court to ascertain the adequacy of the safety management system were anticipated to arise (International Maritime Organization, 1992b).

Another issue that evoked debate and deliberation during the proceedings of the Joint Working Group was the issue of what ships would be covered by the Code. The United States favored a voluntary regime, but would not oppose a code that would be obligatory for passenger ships and other ships above 500 gross tonnage. The United Kingdom, on the other hand, wanted the Code to apply to an even wider category of ships. Norway felt that the Code should be introduced in stages while Greece proposed that it be made totally optional (International Maritime Organization, 1992a, p. 4). Arguments in favor of making a mandatory code via the amendment of a convention eventually prevailed. The Joint Working Group invited MSC 62 to support "the recommendation that the ISM Code should be made mandatory… by means of inclusion of a new Chapter IX in… SOLAS" (International Maritime Organization, 1993c). MSC 62 endorsed the proposal to the IMO Assembly and a correspondence group, chaired by Denmark, was created to finalize the draft Chapter IX of SOLAS.

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 thesis). 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 issuing 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.

3.2 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 thesis. 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. This process is represented by the upper half of Fig. 7 ("active implementation").

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 which 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.

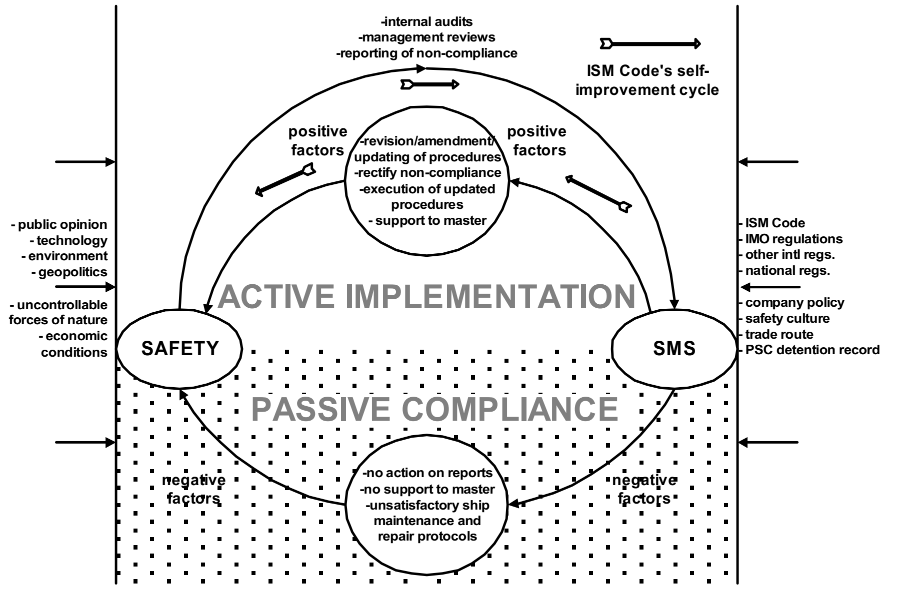

Figure 7. The ISM Code's self-improvement process.

The lower half of Fig. 7 ("passive compliance") represents the opposite of active implementation of the SMS. Passive compliance can be argued as being the stance taken by shore-based management and shipboard crew that see the ISM Code as extra expense rather than as an investment in safety. The SMS is treated as an unwelcome inconvenience that is necessary only in order to gain ISM Code certification. Minimum effort is exerted; the ultimate goal is to successfully pass the documentary exercise, not the cultivation of a true safety culture. Under such conditions, the SMS and related safety procedures are not internalized, little or no action is taken to correct deficiencies that are noted, the master is not given appropriate support to take corrective measures, and the ship maintenance and repair procedures are unsatisfactory. In other words, the SMS does not operate in the manner intended by the ISM Code.

Some of the negative factors that encourage passive compliance are unreasonably profit-centered companies, irresponsible flag state administrations, incompetent crews, and substandard ships. The feedback mechanism intended by the ISM Code is either inoperative or virtually absent.

Adding complexity to the system portrayed in Fig. 7 are external stressors that could have an effect on the content of the SMS, the level of safety, or any of the factors influencing either active implementation or passive compliance.

3.3 ISM Code literature

A number of published studies have contributed to the research corpus presenting, analyzing, and discussing various aspects of the ISM Code. Following is a review of some of them.

Cracking the Code: the relevance of the ISM Code and its impact on shipping practices (Anderson, 2003), a book published by the Nautical Institute, grew out of the need for sound, studied, and scientific evaluations of the Code. It is the result of an extensive research project conducted by P. Anderson with the objectives of establishing:

- how the ISM Code implementation was progressing;
- what issues might have come to light during the implementation process;
- the extent to which the implementation process was working; and
- whether the success could be measured.

Anderson's research involved the distribution of 70,000 questionnaires to seafarers, ship operators, and other stakeholders in the maritime industry. The response produced a collection of 3,000 completed questionnaires together with 800 pieces of individual testimony detailing personal experiences with ISM Code implementation.

Addressing the question "What evidence is there to demonstrate that the ISM Code is working?," the book identifies the most likely sources of evidence on the current status of ISM Code implementation, namely marine insurance, port state control, and individual ship operator accident and claims results. It then discusses the need for an international survey and also describes how the survey questionnaires were distributed. Anderson answers the question "Is the ISM Code working?" in both the positive and the negative. Indeed the book is filled with testimony supporting both sides. It is as much a catalogue of negative comments from those who have encountered problems with ISM implementation as it is of praise from those who bear witness to the Code's benefits.

Rather than focus on the ISM Code's success and failure, the book instead underscores its potentials. Anderson's research shows that companies that have internalized the ISM Code as a safety management system have realized gains not only in terms of safety but also in terms of efficiency and profits. Three chapters – written by Stuart Nicholls, John Wright, and Sean Noonan – buttress this point. The three chapters attest to the benefits of safety management in the offshore industry, crew resource management training, and a medium sized shipping fleet.

The way forward, in Anderson's view, is to continue support for the ISM Code, to treat it as an indispensable management tool, and to learn lessons from those who have had positive experiences in implementing it. The book documents how attitudes toward the ISM Code are evolving from skepticism and suspicion to acknowledgement and acceptance. In highlighting the ISM Code's beneficial effects, *Cracking the Code* implies that there is hope that this process of evolution would continue further towards internalization by all in the industry.

The article *New Swedish Club study confirms ISM's beneficial impact* (Swedish Club, 2001) presents the findings of a study conducted by M. Hernqvist of the Swedish (P & I) Club. The study analyzed insurance claims activity involving ships operated by Club members. Using the 1995-1996 period as the base year, Hernqvist conducted the study by comparing the insurance claims performance of vessels required to comply with the provisions of the ISM Code by July 1998 (Phase 1 vessels) against vessels required to be ISM in July 2002 (Phase 2 vessels). Table 2, below, shows the results of the analysis. Based on these findings, the Swedish study concluded that "effective implementation of ISM has a beneficial impact on claims and is a very worthwhile investment." During the 1998-1999 period, Phase 1 vessels recorded 33% less insurance claims compared to Phase 2 vessels.

PERIOD	phase 1 vessels compared to phase 2 vessels
1995-1996 (base year)	100%
1996-1997	95.5%
1997-1998	85.2%
1998-1999	67.0%
1999-2000	70.8%
2000-2001	78.0%

Table 2. Hull claims development since 1995-96 to 2000-01, for Phase 1 vessels, in relation to Phase 2 vessels (source: Swedish Club, 2001)

ISM Code: a practical guide to the legal and insurance implications is an earlier book written by P. Anderson (1998). As the title suggests, it focuses on some of world shipping's most practical concerns relating to the implementation of the ISM Code. The book begins with a presentation of the key issues and actors in ISM Code implementation and then continues to examine the Code's relevance to issues such as limitation of liability, navigation, carriage of goods, pollution, criminal liability, and insurance implications. Among others, the book analyzes the Code's potential effect on the role of the designated person and the possibility that reports of accidents and incidents would be used against shipowners in court. It then demonstrates the application of the concepts discussed by reviewing a number of actual court cases. While this book is "aimed at those who are directly concerned with… the practical operation of ships," it can also serve as a useful resource to those in insurance and in the legal profession who might be looking for "a practical view on some of the problems they may encounter."

Assessment of deficiencies in the organisation of work in shipping (Hahne et al., 2000) is a study carried out by classification society Germanischer Lloyd that analyzed survey forms filled out by 382 shipping companies. The forms contained answers to questions regarding the company's organizational structure and field of operations, safety organization, safety policy, qualification of personnel, and experience with implementation of the ISM Code. The data gathered was used to evaluate the shipping industry's attitude towards ISM and its readiness to implement the Code. Together with the survey data, Germanischer Lloyd used the ISM certification process as a mechanism to identify what safety problems found aboard ship posed a hindrance to the attainment of the Code's objectives. One of the study's central findings was the existence of widespread resistance among industry personnel against "imposing" a safety culture aboard ship and against the introduction of what was perceived as yet another regulatory and documentary burden. The study found that the shipping sector as a whole was not ready for the ISM Code. The study also identifies factors that help determine the attitudes and perceptions shore- and ship-based personnel have of the ISM Code and safety in general.

Säkerhetsstyrningens kulturella logik: ett organisatoriskt perspektiv på sjösäkerhet (Stenmark, 2003) is the author's published doctoral dissertation that had, as one of its major elements, the examination of "how the ISM Code complied with organizational culture." Referring to the SMS as the embodiment or avatar of the ISM Code, Stenmark studied and compared different safety management manuals and observed the operation of SMSs on board different ships. His study led him to conclude that a wide gulf separates the conditions described in the SMM and the reality found on board a vessel. According to Stenmark, the SMM presents a fragmented or atomistic view rather than a holistic approach. Those concerned with applying the manual do not seem to get an impression of the SMM as being a coherent system. It is seen as a somewhat diffuse collection of regulations for application in specific situations.

Säkerhetsorganisation inom handelssjöfarten: en studie av ISM-koden (Jense, 2003) is a study of the ISM Code, its background, structure, objectives, implementation, problems, and weaknesses. The study also looks at the Code's early implementation in Sweden. Aside from reviewing all available secondary sources, the study uses materials collected in interviews and informal conversations with different maritime actors – the maritime administration, class society, insurance, shipowners association, master and mates, ratings. Below are some of the study's findings with regards to the first phase of implementation of the ISM Code in Sweden:

- Seafarers, especially marine engineers, were not particularly happy with the additional administrative responsibilities brought about by the ISM Code. This was made all the more lamentable as they admitted that one major reason for choosing to live a sailor's life was to avoid paperwork!

- The abbreviated period for implementation sent everyone concerned into a panic. As it was, the Swedish Maritime Administration (SMA) had already decided on an early date for putting the ISM Code in effect for Swedish ships ahead of those of other flags. The *Estonia* disaster resulted in the further acceleration of an already accelerated date.
- A highly confused atmosphere prevailed during the first years. Many were unsure as to what was expected and whether procedures were adequate.
- Many complained that a virtually alien (ISM) culture was being imposed.
- Many received the ISM Code with studied skepticism and complained of the abundance of regulations and certificates already in existence.
- There was skepticism as to the maritime administration's competence to administer the ISM Code; because many seafarers had long-standing experience in implementing ISO standards, they were convinced that it was inappropriate for their systems to be verified by government surveyors with less experience than they.

Auditing the ISM (Chatterjee, 2004) is a "how-to" manual for ISM Code auditors. The author stresses that the desired effect of the proper implementation of the ISM Code is a movement away from "a culture of 'unthinking' compliance with external rules towards a culture of 'thinking' self regulation of safety – the development of a 'safety culture'" – which in turn means a movement towards a "culture of self regulation, with every individual – from the top to the bottom – feeling responsible for actions taken to improve safety and performance."

In writing *The ISM Code in practice* (Sagen, 1999), the author aimed to publish a book that "opens for a wider understanding and a debate of the multidisciplinary context of the ISM Code, making it possible for all shipping network participants to communicate." He claims that the "ISM Code is introducing a paradigm shift in international ship operation" but warns that its success depends on whether obstacles "such as the lack of a uniform interpretation and implementation of the Code, and the lack of an impartial international ISM Code supporting network" are hurdled by everyone involved. The book points out that while the establishment of a safety management system is the primary objective of the Code, it pays no particular attention to the personal safety, occupational health, medical care, and social welfare interests of seafarers. In spite of all the pre-enforcement hype surrounding it, certification does not represent the end of the biggest challenge in ISM Code implementation. The ultimate test lies in whether the Code succeeds in engendering a genuine safety culture among shipboard and shore-based personnel.

Managing safety and quality in shipping (Chauvel, 1997) presents itself as a practical book that reviews three concepts – the ISM Code, the International Standards Organization (ISO) 9002 series, and Total Quality Management (TQM) – and provides recommendations for implementation. Chauvel describes the ISM Code as a new approach to safety that "sets out to provide a management system which will anticipate possible contingencies and, while giving recognition to the role of people, focuses on the unique characteristics of ships as marine vehicles and the need to protect the marine environment." The book explains the ISM certification scheme in a style that is easily understood by the broad spectrum of actors in the maritime industry.

3.4 IMO Independent Expert Group

IMO recently launched an initiative to "assess the impact of the ISM Code on the safety of ships to ascertain its contribution to the enhancement of safety in the shipping industry" (International Maritime Organization, 2005). Towards this end, the IMO Secretary-General established an Independent Expert Group, comprising of experts from governments, organizations, universities and the shipping industry and the IMO Secretariat, tasked with collecting and analyzing data and preparing a report.

The Expert Group is in the process of collecting data and information from all entities in the maritime industry associated with the implementation of the ISM Code such as regional port state control MoUs, classification societies, industry organizations, and maritime administrations.

3.5 This thesis

This thesis intends to contribute to that segment of ISM Code research that seeks to evaluate the Code's performance as a regulatory framework. A great deal of time and financial resources has 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.[11]

This thesis is undertaken in conjunction with the research project MARSAF[12] that has 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:

[11] There is 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. There is mention in § 3.4 above that in 2004, an Independent Experts Group was convened to study the impact of the ISM Code.

[12] MARSAF stands for "Safety organization, safety culture, risk management, and maritime safety – a thematic project for implementation *(Säkerhetsorganisation, säkerhetskultur, riskhantering och sjösäkerhet – ett temaprojekt för implementering)*." It is a research project (2002-2005) 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*).

- 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.

4 METHODOLOGY

In Paper 1, this thesis begins by posing the following questions:

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

After an attempt to answer the above questions, Papers 2 and 3 focus on port state control data among the many possible criteria. The papers examine the ISM Code as an integral part of the enforcement mechanism applied by states to ensure that foreign vessels calling at their ports are seaworthy and do not pose a threat to the marine environment. It analyzes port state control data to determine what impact, if any, the ISM Code has had on statistics related to detentions imposed and findings of deficiencies noted.

4.1 Paper 1: Performance Criteria for the ISM Code

Paper 1 reviews 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

Paper 1 takes the position that effectiveness is measured according to the state of the achievement of the desired results (Baldwin and Cave, 1999, p.81). To ask whether the ISM Code is effective is to inquire into the extent the Code actually achieves the objectives listed above. The Paper argues that a comprehensive assessment of the Code will necessarily combine qualitative and quantitative methods. It lists a number of criteria that could measure the effects of the enforcement of the ISM Code as a regulatory regime.

4.2 Port state control inspection statistics

Of the numerous possible indicators that manifest the achievement of the objectives of the ISM Code as listed in § 4.1 above, this thesis has selected port state control inspection statistics. 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. In the same manner that Stenmark (2003) refers to the SMM as the avatar of the ISM Code, so should the SMM in turn translate into the daily work ethics and operating environment on board the ship. 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 thesis 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 thesis 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 is also indicative of 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.

Anderson (2003) contends that most, if not all, deficiencies can be seen as a failure of the ISM Code and uses the example of seized lifeboat davits and empty fire extinguishers. While PSC inspectors do not explicitly categorize such deficiencies as being ISM related, those deficiencies "clearly point to a seriously defective safety management system. If the SMS had been functioning then (the davits and fire extinguishers) would never have been allowed to fall into such a state of disrepair" (Anderson, 2003, p. 50). Sagen (2004) concurs and refers to PSC inspection statistics as "probably the most relevant factor for evaluating the effectiveness" of the ISM Code.

Fig. 8 below shows the steps typically involved in a port state control inspection. The process begins before a vessel enters port with the scheduling of the boarding of the vessel (step 1). Information on scheduled ship arrivals are obtained from port authorities, vessel traffic services, or local shipping agents. Depending on the volume of ship arrivals and the availability of PSC inspectors, a targeting system (step 2) may be applied. A targeting system allows PSC authorities to determine which ships should be given priority for inspection. Once a ship has been identified for boarding and inspection, the next step is to gather and review all available information regarding the vessel (step 3). Detailed information such as ship type, tonnage, age, and outstanding deficiencies help optimize the inspection process by establishing which areas on board the ship deserve greater focus. In addition, detailed information about the ship also helps determine the composition of the team of properly qualified PSC inspectors (step 4).

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 (step 5). 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 (step 6). Inspector(s) verify certificates and documents that serve as *prima facie* evidence that the vessel complies with certain IMO and 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 (step 7). 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 (step 8) 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.

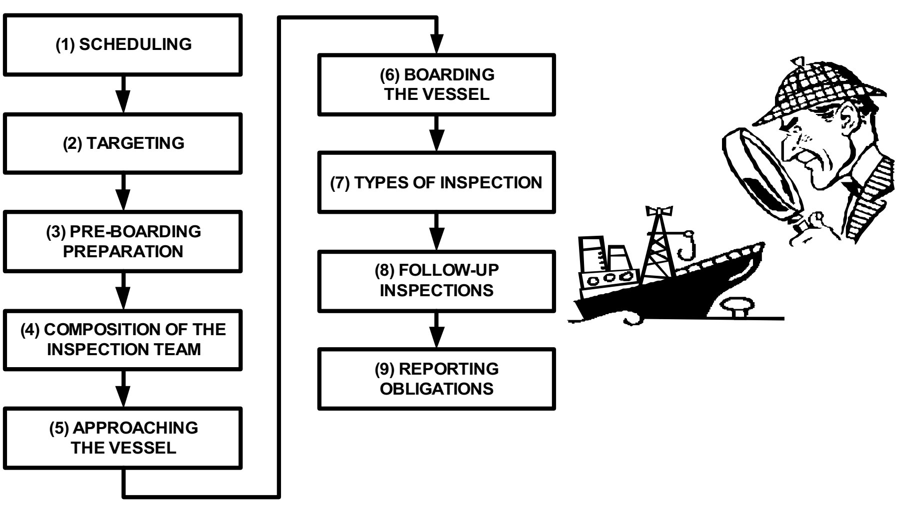

Figure 8. The port state control inspection process.

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 (step 9).

4.3 Paper 2: Foreign ships in Swedish ports

In determining the ISM Code's effect on the performance of vessels at port state control inspections, the data used in Paper 2 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. This thesis applies 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 thesis 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 thesis 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.

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 in Paper 2 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.

The detailed nature of each entry made it possible in Paper 2 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. The study 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 analysis of the data.

4.4 Paper 3: Swedish ships in foreign ports

Paper 3 uses DFR and DTR values to compare the performance of different 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).

4.5 Regional PSC statistics

To complement Papers 1 to 3, this thesis also collected summarized statistics 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.

5 RESULTS

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

5.1 Paper 2: 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 3. DFR and DTR values for two groups of foreign vessels calling Swedish ports.

Table 3, 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. For Phase 1 vessels, the t-test (2-tailed) resulted in a p value of 0.39 ($p>0.05$) and for Phase 2 and exempt vessels the p value was 0.67 ($p>0.05$). An analysis of the difference between the changes in DFR values showed that the difference was not statistically significant.

Table 3, above, also shows the detention rates (DTR) for the two groups of vessels; DTR values for both groups decreased in 1999-2000. Applying the chi-squared test to the data to measure goodness-of-fit yielded a p value of 0.052 for Phase 1 vessels and 0.066 for Phase 2 and exempt vessels. 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.

Paper 2 also includes four other tables that are not reproduced in this sub-section to avoid unnecessary duplication. One table lists the number of inspections according to the number of deficiencies that were noted per inspection. After looking at the data, it was observed that there seemed to be considerably more inspections with many deficiencies during the period 1996-1997 than the period 1999-2000 for both Phase 1 and Phase 2 vessels. Further examination of the data and application of the chi-squared test identified 13 and 14 as the boundary between “many” and “few” deficiencies. When the occurrence of 14 or more deficiencies between the two periods was considered, the chi-squared test resulted in a statistically significant p value of 0.013 ($p\leq0.05$). It is important to note, however, that since the definition of “many deficiencies" was formulated only after examination of the data, the statistical significance obtained cannot be taken at face value. That having been stated, the percentage of Phase 1 vessels with 14 or more noted deficiencies decreased from 2.6% in the period 1996-1997 to 0.7% in 1999-2000. The percentage for Phase 2 and exempt vessels, on the other hand, decreased from 1.5% to 1.2%. Applying the t-test (2-tailed) on the data for Phase 1 vessels resulted in a statistically significant p value of 0.012 ($p \leq 0.05$). On the other hand, the t-test (2-tailed) on the data for Phase 2 and exempt vessels resulted in a p value that is not statistically significant, that is, 0.111 ($p > 0.05$).

A tabulation of the number of vessels in each group that received a clean inspection report, that is, where no deficiencies were noted, shows that the number of Phase 1 vessels that had inspections where zero deficiency was noted increased between 1996-1997 and 1999-2000. In contrast, the number decreased during the same period for Phase 2 and exempt vessels. Applying the t-test (2-tailed) resulted in p values of 0.64 ($p > 0.05$) for Phase 1 vessels and 0.50 ($p > 0.05$) for Phase 2 and exempt vessels. An analysis of the difference between these observations showed that the difference was not statistically significant.

The final table in Paper 2 shows the results of the analysis of the data according to 21 types of deficiency noted in PSC inspections. Phase 1 vessels exhibited a decrease in deficiency rates for eight of the deficiency categories, six of which were found to be statistically significant ($p \leq 0.05$) after applying the t-test (2-tailed). The six categories are ship's certificates/logbooks, food and catering, fire fighting appliances, load lines, marine pollution (annex I), and SOLAS related operational deficiencies. Phase 2 and exempt vessels also exhibited a decrease in DFR values for eight of the 21 series, two of which were statistically significant ($p \leq 0.05$), namely, load lines and marine pollution (annex I). When the differences in changes between Phase 1 and Phase 2 and exempt vessels were compared, however, changes in only five categories proved to be statistically significant. These categories were food and catering, mooring arrangements, navigation, marine pollution (annex I), and MARPOL related operational deficiencies.

Paper 2 also publishes the results of the survey of Swedish port state control inspectors. The survey 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. 17% of the respondents disagreed while 37% were uncertain.

5.2 Paper 3: Swedish ships in foreign ports

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 4. 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.

Table 4, above, shows an increase in average DFR values for Swedish ships 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.

In an expanded version of the above table, Paper 3 shows 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. A t-test (2-tailed) of the average DTR of these two groups resulted in a statistically significant p value of less than 0.001.

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 t-test (2-tailed) for the two DFRs also resulted in a p value of less than 0.001.

5.3 Regional PSC statistics

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

Table 5, above, 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.

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 6, below, shows how DFR values decreased for ISM Phase 1 vessels and increased for ISM Phase 2 and exempt vessels. Applying the t-test (2-tailed) resulted in p values of 0.96 ($p>0.05$) for Phase 1 vessels and 0.52 ($p>0.05$) for 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 6. DFR values for two groups of vessels calling ports in the Tokyo MoU region.

6 CONCLUDING DISCUSSION

The primary conclusion, based on the analyses of PSC statistics presented in this thesis, 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.

6.1 Paper 2: Foreign ships in Swedish ports

While many of the data analyzed in Paper 2 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). The decline in the number of many (that is, ≥14) deficiencies noted per inspection by Phase 1 vessels proved to be statistically significant while, on the other hand, the decrease for Phase 2 and exempt vessels was not statistically significant.[13] 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.

When sorted according to specific categories of deficiencies, an equal number of DFR values decreased for Phase 1 vessels as well as with Phase 2 and exempt vessels between the period 1996-1997 and 1999-2000. However, six of the decreases for Phase 1 vessels proved to be statistically significant when subjected to the t-test (2-tailed), compared to only two for Phase 2 and exempt vessels. Additionally, for five of the changes the difference between Phase 1 and Phase 2 and exempt vessels was statistically significant, implying an effect of the ISM Code. The findings of the analysis are also reinforced in Paper 2 by the observations made by Swedish PSC inspectors regarding the difference in safety standards between Phase 1 and Phase 2 and exempt vessels.

6.2 Paper 3: Swedish ships in foreign ports

Paper 3 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 (Jense, 2003, p. 240). The significantly better performance of Swedish flagged vessels at port state control inspections in

[13] Although, as mentioned earlier, the observation cannot be taken at face value in view of the fact that the cut-off of 14 deficiencies was decided upon after examination of the data.

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.

6.3 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 5, 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.

6.4 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 thesis hopes to contribute to efforts in taking up that challenge.

This thesis 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[14] and comparing their respective deficiency rates (DFR) and detention rates (DTR).

The analyses presented in Papers 2 and 3, as well as in the summary of regional PSC statistics presented in this thesis show a few findings that are statistically significant and several that are not statistically significant. Nevertheless, the indications observed in this thesis 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 the thesis, 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[15] 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 thesis 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. Anderson (2003, p. 50), for instance, mentions how problematic it is that PSC regimes differentiate between ISM Code and non-ISM Code deficiencies. This thesis takes the position that basically any deficiency noted 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 thesis 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. As Anderson (2003, p. 44) puts it, "the intention is that port state control should confirm

[14] Phase 1 vessels being treated as the "test group" required to implement the requirements of the ISM Code by the year 1998, and Phase 2 vessels being the "control group" that would not be covered by the Code until four years later.

[15] The t-test (2-tailed), chi-squared, and the analysis of standard errors to test for difference between changes.

that there is a SMS in place and which appears to be working." 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 thesis, particularly through Paper 1, cannot emphasize enough the fact that a comprehensive assessment of the ISM Code requires a combination of quantitative as well as qualitative analysis. Though Jense (2003, p. 368) admits that quantitative indicators such as PSC statistics have their place in an assessment of the ISM Code, he is quick to point out and explain that a phenomenon as complex as maritime safety can never be fully quantified. 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 thesis 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.

6.5 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 dedicate the manpower necessary 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 5, above. Table 5 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 thesis 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 want to 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. Anderson's (2003) pioneering work in ISM Code assessment 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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ANNEX 1

Management for the safe operation of ships

Chapter IX[*] of the annex to the 1974 SOLAS Convention (International Convention for the Safety of Life at Sea, 1974, as amended)

Regulation 1
Definitions

For the purpose of this chapter, unless expressly provided otherwise:

1 *International* Safety *Management (ISM)* Code means the International Management Code for the Safe Operation of Ships and for Pollution Prevention adopted by the Organization by resolution A.741(18), as may be amended by the Organization, provided that such amendments are adopted, brought into force and take effect in accordance with the provisions of article VIII of the present Convention concerning the amendment procedures applicable to the annex other than chapter I.

2 *Company* means the owner of the ship or any other organization or person such as the manager, or the bareboat charterer, who has assumed the responsibility for operation of the ship from the owner of the ship and who on assuming such responsibility has agreed to take over all the duties and responsibilities imposed by the International Safety Management Code.

3 *Oil tanker* means an oil tanker as defined in regulation II-1/2.12.[†]

4 *Chemical tanker* means a chemical tanker as defined in regulation VII/8.2.[‡]

5 *Gas carrier* means a gas carrier as defined in regulation VII/11.2.[§]

6 *Bulk carrier* means a ship which is constructed generally with single deck, top-side tanks and hopper side tanks in cargo spaces, and is intended primarily to carry dry cargo in bulk, and includes such types as ore carriers and combination carriers.

7 *Mobile offshore drilling unit (MODU)* means a vessel capable of engaging in drilling operations for the exploration for or exploitation of resources beneath the sea-bed such as liquid or gaseous hydrocarbons, sulphur or salt.

[*] Chapter IX of the annex to the 1974 SOLAS Convention was adopted by the 1994 SOLAS Conference. It was accepted on 1 January 1998 and entered into force on 1 July 1998. The text was amended by resolution MSC.99(73) in December 2000, and these amendments were accepted on 1 January 2002. The amended text will enter into force on 1 July 2002.

[†] that is, "the oil tanker defined in regulation 1 of Annex I of the Protocol of 1978 relating to the International Convention for the Prevention of Pollution from Ships, 1973".

[‡] that is, "a cargo ship constructed or adapted and used for the carriage in bulk of any liquid product listed in chapter 17 of the International Bulk Chemical Code".

[§] that is, "a cargo ship constructed or adapted and used for the carriage in bulk of any liquefied gas or other product listed in chapter 19 of the International Gas Carrier Code".

8 *High-speed craft* means a craft as defined in regulation X/1.*

Regulation 2
Application

1 This chapter applies to ships, regardless of the date of construction, as follows:

 .1 passenger ships including passenger high-speed craft, not later than 1 July 1998;

 .2 oil tankers, chemical tankers, gas carriers, bulk carriers and cargo high-speed craft of 500 gross tonnage and upwards, not later than 1 July 1998; and

 .3 other cargo ships and mobile offshore drilling units of 500 gross tonnage and upwards, not later than 1 July 2002.

2 This chapter does not apply to government-operated ships used for non-commercial purposes.

Regulation 3
Safety management requirements

1 The company and the ship shall comply with the requirements of the International Safety Management Code. For the purpose of this regulation, the requirements of the Code shall be treated as mandatory.

2 The ship shall be operated by a company holding a Document of Compliance referred to in regulation 4.

Regulation 4
Certification

1 A Document of Compliance shall be issued to every company which complies with the requirements of the International Safety Management Code. This document shall be issued by the Administration, by an organization recognized by the Administration, or at the request of the Administration by another Contracting Government.

2 A copy of the Document of Compliance shall be kept on board the ship in order that the master can produce it on request for verification.

3 A Certificate, called a Safety Management Certificate, shall be issued to every ship by the Administration or an organization recognized by the Administration. The Administration or organization recognized by it shall, before issuing the Safety Management Certificate, verify that the company and its shipboard management operate in accordance with the approved safety management system.

* that is, "a craft capable of a maximum speed, in metres per second (m/s), equal to or exceeding $3.7\nabla^{0.1667}$ where ∇ = volume of displacement corresponding to the design waterline (m^3) excluding craft the hull of which is supported completely clear above the water surface in non-displacement mode by aerodynamic forces generated by ground effect".

Regulation 5
Maintenance of conditions

The safety management system shall be maintained in accordance with the provisions of the International Safety Management Code.

Regulation 6
Verification and control

1 The Administration, another Contracting Government at the request of the Administration or an organization recognized by the Administration shall periodically verify the proper functioning of the ship's safety management system.

2 A ship required to hold a certificate issued pursuant to the provisions of regulation 4.3 shall be subject to control in accordance with the provisions of regulation XI/4. For this purpose such certificate shall be treated as a certificate issued under regulation I/12 or I/13.

ANNEX 2

International Safety Management (ISM) Code

IMO Assembly Resolution A.741 (18) “International Management Code for the Safe Operation of Ships and for Pollution Prevention,” as amended by MSC.104(73)

PREAMBLE

1 The purpose of this Code is to provide an international standard for the safe management and operation of ships and for pollution prevention.

2 The Assembly adopted resolution A.443(XI), by which it invited all Governments to take the necessary steps to safeguard the shipmaster in the proper discharge of his responsibilities with regard to maritime safety and the protection of the marine environment.

3 The Assembly also adopted resolution A.680(17), by which it further recognized the need for appropriate organization of management to enable it to respond to the need of those on board ships to achieve and maintain high standards of safety and environmental protection.

4 Recognizing that no two shipping companies or shipowners are the same, and that ships operate under a wide range of different conditions, the Code is based on general principles and objectives.

5 The Code is expressed in broad terms so that it can have a widespread application. Clearly, different levels of management, whether shore-based or at sea, will require varying levels of knowledge and awareness of the items outlined.

6 The cornerstone of good safety management is commitment from the top. In matters of safety and pollution prevention it is the commitment, competence, attitudes and motivation of individuals at all levels that determines the end result.

PART A - IMPLEMENTATION

1 GENERAL

1.1 Definitions

The following definitions apply to parts A and B of this Code.

1.1.1 *International Safety Management (ISM) Code* means the International Management Code for the Safe Operation of Ships and for Pollution Prevention as adopted by the Assembly, as may be amended by the Organization.

1.1.2 *Company* means the owner of the ship or any other organization or person such as the manager, or the bareboat charterer, who has assumed the responsibility for operation of the ship from the shipowner and who, on assuming such responsibility, has agreed to take over all duties and responsibility imposed by the Code.

1.1.3 *Administration* means the Government of the State whose flag the ship is entitled to fly.

1.1.4 *Safety management system* means a structured and documented system enabling Company personnel to implement effectively the Company safety and environmental protection policy.

1.1.5 *Document of Compliance* means a document issued to a Company which complies with the requirements of this Code.

1.1.6 *Safety Management Certificate* means a document issued to a ship which signifies that the Company and its shipboard management operate in accordance with the approved safety management system.

1.1.7 *Objective evidence* means quantitative or qualitative information, records or statements of fact pertaining to safety or to the existence and implementation of a safety management system element, which is based on observation, measurement or test and which can be verified.

1.1.8 *Observation* means a statement of fact made during a safety management audit and substantiated by objective evidence.

1.1.9 *Non-conformity* means an observed situation where objective evidence indicates the non-fulfilment of a specified requirement.

1.1.10 *Major non-conformity* means an identifiable deviation that poses a serious threat to the safety of personnel or the ship or a serious risk to the environment that requires immediate corrective action and includes the lack of effective and systematic implementation of a requirement of this Code.

1.1.11 *Anniversary date* means the day and month of each year that corresponds to the date of expiry of the relevant document or certificate.

1.1.12 *Convention* means the International Convention for the Safety of Life at Sea, 1974, as amended.

1.2 Objectives

1.2.1 The objectives of the Code are to ensure safety at sea, prevention of human injury or loss of life, and avoidance of damage to the environment, in particular to the marine environment and to property.

1.2.2 Safety management objectives of the Company should, *inter alia*:

.1 provide for safe practices in ship operation and a safe working environment;

.2 establish safeguards against all identified risks; and

.3 continuously improve safety management skills of personnel ashore and aboard ships, including preparing for emergencies related both to safety and environmental protection.

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.

1.3 Application

The requirements of this Code may be applied to all ships.

1.4 Functional requirements for a safety management system

Every Company should develop, implement and maintain a safety management system which includes the following functional requirements:

.1 a safety and environmental-protection policy;

.2 instructions and procedures to ensure safe operation of ships and protection of the environment in compliance with relevant international and flag State legislation;

.3 defined levels of authority and lines of communication between, and amongst, shore and shipboard personnel;

.4 procedures for reporting accidents and non-conformities with the provisions of this Code;

.5 procedures to prepare for and respond to emergency situations; and

.6 procedures for internal audits and management reviews.

2 SAFETY AND ENVIRONMENTAL-PROTECTION POLICY

2.1 The Company should establish a safety and environmental-protection policy which describes how the objectives given in paragraph 1.2 will be achieved.

2.2 The Company should ensure that the policy is implemented and maintained at all levels of the organization, both ship-based and shore-based.

3 COMPANY RESPONSIBILITIES AND AUTHORITY

3.1 If the entity who is responsible for the operation of the ship is other than the owner, the owner must report the full name and details of such entity to the Administration.

3.2 The Company should 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.

3.3 The Company is responsible for ensuring that adequate resources and shore-based support are provided to enable the designated person or persons to carry out their functions.

4 DESIGNATED PERSON(S)

To ensure the safe operation of each ship and to provide a link between the Company and those on board, every Company, as appropriate, should designate a person or persons ashore having direct access to the highest level of management. The responsibility and authority of the designated person or persons should include monitoring the safety and pollution-prevention aspects of the operation of each ship and ensuring that adequate resources and shore-based support are applied, as required.

5 MASTER'S RESPONSIBILITY AND AUTHORITY

5.1 The Company should clearly define and document the master's responsibility with regard to:

.1 implementing the safety and environmental-protection policy of the Company;

.2 motivating the crew in the observation of that policy;

.3 issuing appropriate orders and instructions in a clear and simple manner;

.4 verifying that specified requirements are observed; and

.5 reviewing the safety management system and reporting its deficiencies to the shore-based management.

5.2 The Company should ensure that the safety management system operating on board the ship contains a clear statement emphasizing the master's authority. The Company should establish in the safety management system that the master has the overriding authority and the responsibility to make decisions with respect to safety and pollution prevention and to request the Company's assistance as may be necessary.

6 RESOURCES AND PERSONNEL

6.1 The Company should ensure that the master is:

.1 properly qualified for command;

.2 fully conversant with the Company's safety management system; and

.3 given the necessary support so that the master's duties can be safely performed.

6.2 The Company should ensure that each ship is manned with qualified, certificated and medically fit seafarers in accordance with national and international requirements.

6.3 The Company should establish procedures to ensure that new personnel and personnel transferred to new assignments related to safety and protection of the environment are given proper familiarization with their duties. Instructions which are essential to be provided prior to sailing should be identified, documented and given.

6.4 The Company should ensure that all personnel involved in the Company's safety management system have an adequate understanding of relevant rules, regulations, codes and guidelines.

6.5 The Company should establish and maintain procedures for identifying any training which may be required in support of the safety management system and ensure that such training is provided for all personnel concerned.

6.6 The Company should establish procedures by which the ship's personnel receive relevant information on the safety management system in a working language or languages understood by them.

6.7 The Company should ensure that the ship's personnel are able to communicate effectively in the execution of their duties related to the safety management system.

7 DEVELOPMENT OF PLANS FOR SHIPBOARD OPERATIONS

The Company should establish procedures for the preparation of plans and instructions, including checklists as appropriate, for key shipboard operations concerning the safety of the ship and the prevention of pollution. The various tasks involved should be defined and assigned to qualified personnel.

8 EMERGENCY PREPAREDNESS

8.1 The Company should establish procedures to identify, describe and respond to potential emergency shipboard situations.

8.2 The Company should establish programmes for drills and exercises to prepare for emergency actions.

8.3 The safety management system should provide for measures ensuring that the Company's organization can respond at any time to hazards, accidents and emergency situations involving its ships.

9 REPORTS AND ANALYSIS OF NON-CONFORMITIES, ACCIDENTS AND HAZARDOUS OCCURRENCES

9.1 The safety management system should include procedures ensuring that non-conformities, accidents and hazardous situations are reported to the Company, investigated and analysed with the objective of improving safety and pollution prevention.

9.2 The Company should establish procedures for the implementation of corrective action.

10 MAINTENANCE OF THE SHIP AND EQUIPMENT

10.1 The Company should establish procedures to ensure that the ship is maintained in conformity with the provisions of the relevant rules and regulations and with any additional requirements which may be established by the Company.

10.2 In meeting these requirements the Company should ensure that:

.1 inspections are held at appropriate intervals;

.2 any non-conformity is reported, with its possible cause, if known;

.3 appropriate corrective action is taken; and

.4 records of these activities are maintained.

10.3 The Company should establish procedures in its safety management system to identify equipment and technical systems the sudden operational failure of which may result in hazardous situations. The safety management system should provide for specific measures aimed at promoting the reliability of such equipment or systems. These measures should include the regular testing of stand-by arrangements and equipment or technical systems that are not in continuous use.

10.4 The inspections mentioned in 10.2 as well as the measures referred to in 10.3 should be integrated into the ship's operational maintenance routine

11 DOCUMENTATION

11.1 The Company should establish and maintain procedures to control all documents and data which are relevant to the safety management system.

11.2 The Company should ensure that:

.1 valid documents are available at all relevant locations;

.2 changes to documents are reviewed and approved by authorized personnel; and

.3 obsolete documents are promptly removed.

11.3 The documents used to describe and implement the safety management system may be referred to as the Safety Management Manual. Documentation should be kept in a form that the Company considers most effective. Each ship should carry on board all documentation relevant to that ship.

12 COMPANY VERIFICATION, REVIEW AND EVALUATION

12.1 The Company should carry out internal safety audits to verify whether safety and pollution-prevention activities comply with the safety management system.

12.2 The Company should periodically evaluate the efficiency of and, when needed, review the safety management system in accordance with procedures established by the Company.

12.3 The audits and possible corrective actions should be carried out in accordance with documented procedures.

12.4 Personnel carrying out audits should be independent of the areas being audited unless this is impracticable due to the size and the nature of the Company.

12.5 The results of the audits and reviews should be brought to the attention of all personnel having responsibility in the area involved.

12.6 The management personnel responsible for the area involved should take timely corrective action on deficiencies found.

PART B - CERTIFICATION AND VERIFICATION

13 CERTIFICATION AND PERIODICAL VERIFICATION

13.1 The ship should be operated by a Company which has been issued with a Document of Compliance or with an Interim Document of Compliance in accordance with paragraph 14.1, relevant to that ship.

13.2 The Document of Compliance should be issued by the Administration, by an organization recognized by the Administration or, at the request of the Administration, by another Contracting Government to the Convention to any Company complying with the requirements of this Code for a period specified by the Administration which should not exceed five years. Such a document should be accepted as evidence that the Company is capable of complying with the requirements of this Code.

13.3 The Document of Compliance is only valid for the ship types explicitly indicated in the document. Such indication should be based on the types of ships on which the initial verification was based. Other ship types should only be added after verification of the Company's capability to comply with the requirements of this Code applicable to such ship types. In this context, ship types are those referred to in regulation IX/1 of the Convention.

13.4 The validity of a Document of Compliance should be subject to annual verification by the Administration or by an organization recognized by the Administration or, at the request of the Administration, by another Contracting Government within three months before or after the anniversary date.

13.5 The Document of Compliance should be withdrawn by the Administration or, at its request, by the Contracting Government which issued the Document when the annual verification required in paragraph 13.4 is not requested or if there is evidence of major non-conformities with this Code.

13.5.1 All associated Safety Management Certificates and/or Interim Safety Management Certificates should also be withdrawn if the Document of Compliance is withdrawn.

13.6 A copy of the Document of Compliance should be placed on board in order that the master of the ship, if so requested, may produce it for verification by the Administration or by an organization recognized by the Administration or for the purposes of the control referred to in regulation IX/6.2 of the Convention. The copy of the Document is not required to be authenticated or certified.

13.7 The Safety Management Certificate should be issued to a ship for a period which should not exceed five years by the Administration or an organization recognized by the Administration or, at the request of the Administration, by another Contracting Government. The Safety Management Certificate should be issued after verifying that the Company and its shipboard management operate in accordance with the approved safety management system. Such a Certificate should be accepted as evidence that the ship is complying with the requirements of this Code.

13.8 The validity of the Safety Management Certificate should be subject to at least one intermediate verification by the Administration or an organization recognized by the Administration or, at the request of the Administration, by another Contracting Government. If only one intermediate verification is to be carried out and the period of validity of the Safety Management Certificate is five years, it should take place between the second and third anniversary dates of the Safety Management

Certificate.

13.9 In addition to the requirements of paragraph 13.5.1, the Safety Management Certificate should be withdrawn by the Administration or, at the request of the Administration, by the Contracting Government which has issued it when the intermediate verification required in paragraph 13.8 is not requested or if there is evidence of major non-conformity with this Code.

13.10 Notwithstanding the requirements of paragraphs 13.2 and 13.7, when the renewal verification is completed within three months before the expiry date of the existing Document of Compliance or Safety Management Certificate, the new Document of Compliance or the new Safety Management Certificate should be valid from the date of completion of the renewal verification for a period not exceeding five years from the date of expiry of the existing Document of Compliance or Safety Management Certificate.

13.11 When the renewal verification is completed more than three months before the expiry date of the existing Document of Compliance or Safety Management Certificate, the new Document of Compliance or the new Safety Management Certificate should be valid from the date of completion of the renewal verification for a period not exceeding five years from the date of completion of the renewal verification."

14 INTERIM CERTIFICATION

14.1 An Interim Document of Compliance may be issued to facilitate initial implementation of this Code when:

.1 a Company is newly established; or

.2 new ship types are to be added to an existing Document of Compliance, following verification that the Company has a safety management system that meets the objectives of paragraph 1.2.3 of this Code, provided the Company demonstrates plans to implement a safety management system meeting the full requirements of this Code within the period of validity of the Interim Document of Compliance. Such an Interim Document of Compliance should be issued for a period not exceeding 12 months by the Administration or by an organization recognized by the Administration or, at the request of the Administration, by another Contracting Government. A copy of the Interim Document of Compliance should be placed on board in order that the master of the ship, if so requested, may produce it for verification by the Administration or by an organization recognized by the Administration or for the purposes of the control referred to in regulation IX/6.2 of the Convention. The copy of the Document is not required to be authenticated or certified.

14.2 An Interim Safety Management Certificate may be issued:

.1 to new ships on delivery;

.2 when a Company takes on responsibility for the operation of a ship which is new to the Company; or

.3 when a ship changes flag.

Such an Interim Safety Management Certificate should be issued for a period not exceeding 6 months by the Administration or an organization recognized by the Administration or, at the request of the Administration, by another Contracting Government.

14.3 An Administration or, at the request of the Administration, another Contracting Government may, in special cases, extend the validity of an Interim Safety Management Certificate for a further period which should not exceed 6 months from the date of expiry.

14.4 An Interim Safety Management Certificate may be issued following verification that:

.1 the Document of Compliance, or the Interim Document of Compliance, is relevant to the ship concerned;

.2 the safety management system provided by the Company for the ship concerned includes key elements of this Code and has been assessed during the audit for issuance of the Document of Compliance or demonstrated for issuance of the Interim Document of Compliance;

.3 the Company has planned the audit of the ship within three months;

.4 the master and officers are familiar with the safety management system and the planned arrangements for its implementation;

.5 instructions, which have been identified as being essential, are provided prior to sailing; and

.6 relevant information on the safety management system has been given in a working language or languages understood by the ship's personnel.

15 VERIFICATION

15.1 All verifications required by the provisions of this Code should be carried out in accordance with procedures acceptable to the Administration, taking into account the guidelines developed by the Organization.

16 FORMS OF CERTIFICATES

16.1 The Document of Compliance, the Safety Management Certificate, the Interim Document of Compliance and the Interim Safety Management Certificate should be drawn up in a form corresponding to the models given in the appendix to this Code. If the language used is neither English nor French, the text should include a translation into one of these languages.

16.2 In addition to the requirements of paragraph 13.3, the ship types indicated on the Document of Compliance and the Interim Document of Compliance may be endorsed to reflect any limitations in the operations of the ships described in the safety management system.

PAPER 1

Performance Criteria for the International Safety Management (ISM) Code

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Performance Criteria for the International Safety Management (ISM) Code

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ABSTRACT

There is an obvious need to conduct research and to gather and analyze data that could provide a sound, scientific, and objective evaluation of the ISM Code. The first step in organizing such a research effort is the identification of performance criteria. In this connection, the proposed paper poses and attempts to answer the following questions: What performance criteria are appropriate for assessing the ISM Code's effectiveness? How can "effectiveness" be defined and measured? The paper reviews past and ongoing ISM research, IMO documents, and relevant scientific literature to identify what analytical tools and indicators could be applied in evaluating the ISM Code. An argument is made that the application of a synthesis approach in the research, i.e., a combined qualitative-quantitative methodology, would provide the most comprehensive picture of the Code's effectiveness. The study concludes by proposing two sets of performance criteria – under the categories "output" and "outcome" – suitable for the assessment of the ISM Code.

1. Introduction

The first three years of the first phase of ISM Code implementation have elicited mixed reviews and conflicting verdicts – success ("The ISM Code's beneficial impact"), failure ("ISM: the bulb that failed to bloom"), and skepticism ("The ISM Code – is it working?") – have been heralded in the shipping news. Such assessments, however, seem to be largely based on oral testimony and anecdotal evidence. There is an obvious need to conduct research and to gather and analyze data that could provide sound, scientific, and objective evaluations of the Code. One of the first steps in such a research effort is identifying appropriate performance criteria, i.e., indicators that provide specific measures of safety and reveal how well the Code and its different components are doing in meeting its objectives (Osborne and Gaebler, 1992). Osborne and Gaebler (1992) give four good reasons why the performance of regulatory regimes such as the ISM Code should be measured and assessed:

- What gets measured gets done
- If you don't measure results, you can't tell success from failure
- If you can't see success, you can't learn from it
- If you can't recognize failure, you can't correct it

The objective of this paper is to offer criteria that might be applied in a research project evaluating the effectiveness of the ISM Code. It will pose and attempt to answer the following questions: How can the Code's "success" or "effectiveness" be defined? How can it be measured? What are some of the criteria appropriate for assessing its effectiveness? The study will commence by reviewing IMO meeting documents as well as past and current research on the ISM Code. The purpose of the review would be to identify what standards, explicit or implicit, have been or may be applied in evaluating the Code. The paper will also survey literature in the fields of policy analysis and safety science to identify analytical tools and frameworks that could be relevant in a scientific assessment of the ISM Code. With the reviewed literature as reference, the paper will then define effectiveness and propose a set of performance criteria.

2. Completed and ongoing ISM research

Albeit very small, there is a body of research focusing on the ISM Code. One study (Hahne et al., 2000) carried out by classification society Germanischer Lloyd analyzed survey forms filled out by 382 shipping companies. The forms contained answers to questions regarding the company's organizational structure and field of operations, safety organization / safety policy, qualification of personnel, and experience with implementation of ISM. The data gathered was not used to directly evaluate the effectiveness of the Code. It was used instead to evaluate the shipping industry's attitude towards ISM and its readiness to implement the Code. Together with the survey data, Germanischer Lloyd used the ISM certification process as a mechanism to identify what safety problems found aboard ship posed a hindrance to the attainment of the Code's objectives. One of the study's central findings was the existence of widespread resistance among industry personnel against "imposing" a safety culture aboard ship and against the introduction of what was perceived as yet another regulatory and documentary burden. The data also confirmed that the shipping sector as a whole was not ready for the ISM Code. Nevertheless, the German study is relevant to this paper in that it identifies factors that help determine the attitudes and perceptions shore- and ship-based personnel have of ISM and safety in general.

Another study (Hernqvist, 2000) was conducted by the Swedish (P & I) Club. Using insurance claims activity as a criterion for evaluating the Code's effectiveness, the Swedish study indicated that "vigorous application of the ISM Code can significantly reduce claims exposure."

One on-going study (Anderson, 2001) intends to "consider the perceived conflict between the requirements under the ISM Code to produce… reports as a part of its SMS (safety management system)… on the one hand, and, on the other hand, the consequential production of potentially self incriminating evidence which could be used against those who produced that evidence: the ships master, or other seafarer… and the ship operator who will stand exposed to civil or criminal liabilities." Anderson's study focuses on the willingness of seafarers to submit reports of deficiency and non-compliance and how readily shore management acts upon such reports. Since this system of reporting is a novel concept in shipping and is the key to the SMS's self-perfecting mechanism, the level of activity in this area would also reflect upon the effective operation of the ISM Code.

3. IMO documents

IMO meeting documents were reviewed from as early as the 54th session (1987) of the Maritime Safety Committee (MSC) to determine what concerns influenced the framers to give the ISM Code the structure it has taken. Unfortunately, the review revealed a lack of detail in documented background information on the formulation process. This corroborates the difficulties referred to by Stenmark (2000), who headed a number of Swedish delegations to IMO and who mentioned in his study that the "preparatory work on the Code took place in working groups that, though officially constituted, employed unconventional work methods." Stenmark added that "minutes were not recorded... The meeting reports produced within IMO's different committees and subcommittees, where the Code was formulated, are summaries and reflect only decisions and contains proposals and drafts for whichever text may be under review at the moment." Nevertheless, there are at least two IMO documents that provide some indication of the Code's framers' expectations. One is an earlier version of the Code, the Guidelines on Management for Safe Ship Operation and Pollution Prevention (IMO, 1988), which had the purpose of providing "elements that can be used to gauge safety management and to develop and implement safety management." According to the document, the objectives of the guidelines were "to ensure safety, prevent human injury or loss of life, damage to the environment, particularly marine pollution, and damage to property." The other document, a submission by the Nordic maritime administrations (IMO, 1991), contains recommendations for revising the 1988 guidelines. According to the Nordic countries, the objectives of safety and environmental protection management should be the promotion of safe practices in ship operation, safe working conditions aboard ship, and the capability to handle whatever emergencies may still occur. They also offer the following criteria to determine whether the above objectives have been met: compliance with mandatory rules and regulations; observation of applicable codes, guides, and standards worked out by IMO, administrations, class societies, and industry organizations; and identification of risks not covered by the above sources and establishment of adequate safeguards (IMO, 1991). Though broad and general, the two documents give at least an indication of the Code's framers' expectations.

Examining the ISM Code itself gives us the same broad results. The Code states that its purpose is to provide an international standard for the safe management and operation of ships and for pollution prevention (IMO, 1993). Its objectives are "to ensure safety at sea, prevention of human injury or loss of life, and avoidance of damage to the environment, in particular to the marine environment, and to property." Section 12.2 of the ISM Code also requires the shipping company to "periodically evaluate the efficiency" of the SMS. In keeping with the general language of the Code, no detailed guidelines or standards are provided for this periodic evaluation of the SMS's efficiency. The Code only mandates that the review of the SMS be conducted "in accordance with procedures established by the (shipping) company." This is made clearer in Resolution A.788(19) which contains implementation guidelines to the ISM Code. Section 2.1.3 of the guidelines recommends administrations "not to use criteria in the form of prescriptive requirements as these may result in companies implementing solutions prepared by others. This may then result in difficulty for a company to develop the solutions which best suit that particular company, that particular operation or that specific ship" (IMO, 1995). In assessing an SMS's compliance with the Code's requirements, section 2.1.4 of the guidelines further recommends that administrations "ensure that these assessments are based on determining the effectiveness of the SMS in meeting specified objectives, rather than conformity with detailed requirements." In specifying objectives, companies are meant to consider the ability of the SMS to meet the following general safety management objectives (an improved version of the Nordic submission):

- 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 both to safety and environmental protection

There is one more objective worth adding to the above list that is found in the introductory paragraphs of A.788, i.e., that "the application of the ISM Code should support and encourage the development of a safety culture in shipping." As far as a review of IMO documents go, the above summarize the maritime sector's expectations of the ISM Code. However, because the Code is designed to be non-prescriptive the challenge for this exercise is to translate these broad objectives, in addition to those that have been applied in the body of ISM research, into criteria that lend themselves to analysis and evaluation. There are at least two research disciplines that could provide us with analytical tools and concepts that could help us in developing these criteria – policy analysis and safety science. We shall look to policy analysis for analytical framework while we look at safety science literature to see how safety and safety policy is evaluated in other industries.

4. Policy analysis

Policy analysis is an "applied discipline or field" of political science "concerned with the evaluation of public policy." It has its origins in the 1960s when, during the US presidency of Lyndon Johnson, "social-scientific policy research and evaluation were widely celebrated as the proper basis for decision making in public policy" (Fischer, 1995). Perhaps the biggest debate in the discipline today is the relative preponderance of quantitative methods – such as, *inter alia*, microeconomics, econometrics, decision analysis, and statistics – in policy analysis. One classic example of the application of quantitative analysis in safety policy is Viscusi's 1979 study of the impact of occupational safety and health regulation. The study looked at the impact of the early years of the implementation of the Occupational Safety and Health Act of 1970 in the US by analyzing "pooled time series and cross section data on industry health and safety investments and injury rates for the 1972-1975 period" (Viscusi, 1979). The econometric analysis showed no significant effect of OSHA on workplace safety, mainly because the financial incentives were weak. A follow-up study was conducted in 1986 using an expanded series of data from 1973 to 1983 (Viscusi, 1979). Although the follow-up study showed an improved positive effect compared with the earlier one, the data was still inconclusive on the issue of OSHA's overall effectiveness and relevance to worker safety. Another quantitative study, "Direct and indirect effects of regulation: a new look at OSHA's impact," was completed by Bartel and Thomas (1985) by developing and testing "a three-equation model of workplace injuries, industrial noncompliance with OSHA safety standards, and OSHA enforcement." Like Viscusi, Bartel and Thomas did not find their empirical data conclusive. Nevertheless, their study concluded that OSHA had commendable, if indirect, effects on safety.

At the same time, there seems to be a rising tide against an exclusively empirical approach in policy analysis. There is, as it were, more than meets the statistical eye. Yanow (2000) sees the debate as being between analysts who believe "that it is not only necessary but also actually possible, to make objective, value-free assessments of a policy from a point external to it" (the positivist, empirical, or quantitative school) and those who believe that it is impossible "to stand outside of the policy issue being studied, free of its values and meanings and of the analyst's own values, beliefs, and feelings" (the interpretative, naturalistic, or qualitative school). Fischer emphasizes, however, that it is not a question of choosing one approach to the exclusion of the other. The quantitative approaches still play an important role in policy analysis but only as long they are applied "within the normative frameworks that give its empirical data meaning" (Fischer, 1995), in a methodology John (1998) prefers to call the "synthesis approach."

Baldwin and Cave (1999), Viscusi et al. (1996), Weimer and Vining (1999) offer introductions to the subject of policy analysis while Yanow (2000), Fischer (1995), and John (1998) offer methodologies that combine the qualitative and quantitative approaches.

5. Safety science

Safety Science is a multidisciplinary field of research into the science and technology of human safety. "It extends from safety of people at work to other spheres, such as transport, leisure and home, as well as every other field of man's hazardous activities." It covers, *inter alia*, the "physics and engineering of safety; its social, policy and organizational aspects; the management of risks; the effectiveness of control techniques for safety; standardization, legislation, inspection, insurance, (and) costing aspects" (Elsevier Science, 2001).

Kjellén et al. (1997) studied the economic effects of implementing a precursor to the ISM Code known as internal control (IC). In force in Norway since 1992, IC is a key regulatory strategy designed to ensure that companies comply with the country's safety, health and environment (SHE) legislation. It operates within Norwegian industry in very much the same way as the ISM Code does in international shipping. Kjellén et al. compared retroactive data covering ten years at an aluminum plant and calculated how much of the expenses incurred in implementing IC was offset by benefits in Q-SHE (quality, safety, health, environment). The study also determined IC's effect on Q-SHE related losses. The reported LTI-rate (number of lost-time injuries per 1 million hours of work) was used as the central criterion for measuring the safety program's Q-SHE effects. Kjellén et al. found that a significant reduction in the plant's operational (variable) expenditures was accomplished in parallel with significant improvements in Q-SHE related results.

Mitchison and Papadakis (1999) conducted a study on safety management systems under the European Union's Seveso II Directive (96/82/EC) which is the Union's equivalent of the ISM Code for certain establishments holding hazardous substances. Like ISM, the central feature of Seveso II is the implementation of a safety management system or SMS. Mitchison's and Papadakis' conclusions and guidance on SMS assessments are relevant to this study in that they conclude that the SMS under Seveso II is no different from those in other industries. Most SMS guidance are, as a rule, very general in nature and give emphasis to flexibility in structure and details. Mitchison and Papadakis (1999) warn against the adoption of an industry-wide safety performance rating system on the grounds that "the results will not in general be comparable across different establishments, and because the desire to perform well in the rating may prevail over the real objective, which is to improve overall safety… We remain sceptical as to the usefulness of rating systems based on simple and uniform formulae."

There are a number of safety science studies that adopted a particular safety criterion in order to identify a sampling of industrial plants that could be investigated for attributes that result in greater occupational safety. Cohen at al. (1975) was a questionnaire study "in which safety program practices of matched pairs of low and high accident rate plants were compared to determine factors that might account for the difference in safety performance." Smith et al. (1977), a companion study to the above, conducted on-site surveys "of a sample of 7 pairs of the questionnaire respondents in order to expand on the results of Cohen et al.." The findings confirmed the results of the questionnaire study and identified additional factors "in safety program practices that could account for plant safety performance." Simonds and Shafai-Sahrai (1977) used work injury frequency rates as their criterion for studying eleven pairs of industrial firms and identified ten positive factors that could be related to higher safety levels.

In his study, Hurst (1997) shows that findings from research activity could form the basis for developing practical tools to assess safety management and safety attitudes. In particular, Hurst describes how research work commissioned by the Health and Safety Laboratory (UK) were crucial to the development of STATAS (Structured Audit Technique for the Assessment of Safety Management Systems) and PRIMA (Process Risk Management Audit), analytical tools that have been employed for the assessment of management arrangements, risk control systems, safety management performance, safety attitudes, and safety culture.

6. Performance criteria for the ISM Code

After a broad sweep of some of the relevant literature, this study will now consolidate the information reviewed within the context of the ISM Code and translate them into criteria for assessing the Code's performance. Before moving on, it might be relevant to review Mitchison's and Papadakis' skepticism as to the usefulness of industry-wide safety performance rating systems. Mitchison and Papadakis actually qualified this viewpoint by conceding that such a rating system may be useful in evaluating changes. This was borne out by the industry-wide studies of Cohen et al., Smith et al., and Simonds and Shafai-Sahrai. This present study does not intend to propose performance criteria for an industry ratings system or to identify specified objectives for the ISM certification process. Rather, the criteria to be proposed in this paper are intended to be applied in evaluating the performance of the ISM Code as a regulatory framework. The rate of change in accident frequency in a given year relative to previous years, to take an example, could be one such indicator. In addition, while the Mitchison and Papadakis study is mathematical and theoretical, the authors themselves argue that a purely quantitative approach is inappropriate in evaluating an SMS. A qualitative system such as the SMS must also be evaluated qualitatively.

6.1 Effectiveness

One of the questions posed in the introduction to this paper was "How is 'effectiveness' defined?" Baldwin and Cave (1999) define effective regulation as one that addresses "the issue of whether desired results are actually achieved (irrespective of costs)." They contrast this with "efficiency" which takes into consideration the ratio of benefit to the cost to government of implementation and enforcement of regulations.

Viscusi (1979), on the other hand, draws a link between effectiveness and cost, not to government but to the industry being regulated. After comprehensive econometric calculations, he concludes in his study that the "conceptual analysis indicated that the effectiveness of job hazard regulations hinges critically on the economic incentives created." Adapted to the ISM Code, effectiveness could depend on the willingness of ship owners to run the risk of expensive delays due to ISM-related detentions or other activities.

According to Sagen, the effectiveness of the ISM Code does not hinge upon the compliance by shipping companies with mandatory instruments (a key objective of the Code) because this is already taken for granted through the issuance of statutory certificates. Instead, the true measure of the ISM Code's success is how effective enforcement is by administrations (Sagen, 1999).

The common thread between these three definitions is that effectiveness is measured by the positive results resulting from the enforcement of the regulatory regime. For purposes of this study, effectiveness is given the meaning from Baldwin and Cave, i.e., the state of the achievement of the desired results. To ask whether the ISM Code is effective is to ask whether it actually achieves the desired results it was designed to achieve, i.e., safer ships and cleaner seas. This leads us to the next question: "How can the Code's 'effectiveness' be measured?"

6.2 Dichotomy

To facilitate identification of performance criteria within a combined qualitative-quantitative framework, it would be useful to adopt the policy analysis concept of output and outcome. In the field of policy analysis, outputs are alternatively referred to as "policies" while outcomes may also be referred to as "goals." The dichotomy between output and outcome is a device employed in policy analysis that enables the researcher "to find out if policy intentions turn into reality, and when policies are successes or failures. The procedure allows the researcher to ask some pertinent questions about the effectiveness of the policy process" (John, 1998). Weimer and Vining (1999) offer this succinct distinction between the two concepts: "goals are the values we seek to promote and policies are the alternatives and strategies for promoting them." Examples of outputs/policies in the context of the ISM Code are the regime of port State control inspections and the system of SMC (safety management certificate) and DOC (document of compliance) certification. Examples of outcomes/goals are the promotion of ship safety, protection of the marine environment, and the development of a safety culture in shipping.

The designation of an item as either output or outcome is not necessarily set in stone in every case. Goals, perhaps reworded, occasionally become policies at another level as new goals are set. In other words, the divisions are not necessarily always clear-cut. Weimer and Vining (1999) advise that one should "start by formulating goals as abstractly as possible and policy alternatives as concretely as possible." The dichotomy also reminds researchers of the complementary nature of the quantitative (concrete policy alternatives) and qualitative (abstract and normative goals) methodologies.

6.3 Proposed criteria

The following objectives that were identified in the review of IMO documents will be used to form the basis for developing 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 both to safety and environmental protection
- development of a safety culture in shipping

The task now is to identify performance criteria under the headings "output" and "outcome" as defined above.

6.3.1 Output

If output can be defined as the set of alternatives and strategies for promoting the safety values we seek to promote, then the performance criteria to be proposed under this heading will relate to activities that ensure that the ISM Code is in place as a safety regulatory framework. Following are the proposed criteria:

- *Port State control detentions related to ISM deficiencies or non-conformities.* The Secretary-General of IMO has directed the collection of "information on, for example, any significant drop, or otherwise, in the number of detention of ISM-certificated ships together with any information or action taken by port State control authorities in respect of ISM Code deficiencies" (IMO, 2001).
- *ISM-related spot inspections requiring demonstration*. Under the ISM Code, the maritime administration is expected to carry out controls to ensure that the SMS is functioning. An inspection that involves requiring ship's crew to demonstrate competence is normally a sign that there is reason to believe that the SMS might not be functioning properly. A high number of spot inspections could be linked to a lower level of safety.
- *Re-inspections related to ISM deficiencies or non-conformities*. A high number of re-inspections reflects on the number of inspections that led to deficiencies being noted for rectification. The data could be compared over time to see if there is a down- or upward trend, particularly involving major non-conformities.
- *Reporting of ISM deficiencies and non-compliance by shipboard staff.* The main criterion employed in the on-going study by Anderson. The willingness and actual use of this important mechanism gives an indication that the Code is functioning as it should.
- *Annual review and interim surveys results*. Non-compliance and deficiencies detected by auditors during annual reviews and interim surveys, particularly those categorized under major non-compliance, could be compared over time.

The above indicators or criteria could be observed by comparing a series of data over time to not only to gather absolute values but also to detect the rate of change, a technique used regularly in safety science. Quantitative criteria are highly desirable "because they facilitate more precise ex ante comparisons of effects" (Weimer and Vining, 1999), yet they need to be tempered by normative analysis.

6.3.2 Outcome

If goal/outcome can be defined as the set of safety values we seek to promote, then the performance criteria to be proposed under this heading will relate to measures that indicate whether the ISM Code is producing its intended results. Following are some proposed criteria:

- *Accident rate* and *injury frequency*. Cohen, et al. (1975) employed accident rate as the criterion in their study while Simonds & Shafai-Sahrai (1977) considered injury frequency. An effective ISM Code should result in a downward trend in accident rates and injury frequency not only in terms of personal injuries to seafarers but of vessels involved in marine casualties. It is worthy to note that accident and injury rates are commonly employed in safety science but does not seem to have been used in an evaluation of the ISM Code.
- *Mortality rate*. Nielsen (2000) estimates that 2,595 seafarers die every year while serving at sea. Observing the number of accidental deaths at sea over a period of time will give an indication of the Code's impact.
- *Safety culture*. A number of studies provide methodologies and criteria for assessing safety culture in the maritime sector. Ek and Akselsson (1999) evaluated the safety culture on board a passenger vessel in the Baltic Sea. Hahne et al. (2000) surveyed the attitudes and perceptions of shipping personnel. Stenmark (2000) aimed at "finding a workable definition of safety culture within a framework of organizational psychology." Sagen (1999) discusses the four columns of safety culture in the maritime field.
- *Lost-time injuries (LTI)*. Defined in safety science as "injury at work leading to unfitness for work and absence beyond the day of the accident," LTIs could be costly to shipping companies particularly in cases where the injured seafarer has to be flown out and replacement crew have to be flown in.
- *Vessel off-hire/delay*. Shipping companies incur losses for every day that a vessel is not engaged in loading, unloading, and transporting cargo. Delays could be caused by, *inter alia*, port State control detentions, accidents, accident investigations, vessel casualties, and vessel emergency repairs.
- *Crew repatriated or sent ashore for retraining*. An effective ISM Code should result in a decline in the number of crew sent ashore for retraining or repatriated for carrying invalid professional documents or for other ISM Code non-conformities.
- *Insurance premiums and claims level*. The Swedish Club study showed a link between the ISM Code and the number of insurance claims while Häkkinen (1995) confirms the link between safety levels and insurance premiums.
- *Active commitment of management to safety*. Kjellén et al. (1997), Cohen et al. (1975), and Smith et al. (1978) showed the positive link between greater safety and a management team that is actively involved in safety issues.

The two lists above do not claim to be complete and comprehensive sets of criteria for evaluating the ISM Code's effectiveness. The principal aim of this study is to show one way of learning lessons from other industries and disciplines that have had decades of experience in the assessment of regulatory frameworks and safety management systems.

While the ISM Code requires that shipping companies develop an SMS with a built-in self-perfecting mechanism, the Code itself is not equipped with the same type of mechanism. This is where research could be useful in identifying some criteria and overall industry goals that could give an indication of the state of the ISM Code, and provide a more scientific basis for drafting amendments. It might be difficult to attach minimum, maximum, or ideal values (whether numerical or normative) to the performance criteria until an initial study is conducted. However, scientific research into the ISM Code's performance could eventually lead to the development of practical assessment systems similar to those available to safety management in other industries.

7. Conclusion

During the February, 2001 session of the IMO Sub-Committee on Flag State Implementation, the Secretary-General of IMO made the following admonition: "We should not allow (the ISM Code) to become merely a paper exercise." This is in reaction to fears expressed by some sectors of the maritime industry that the physical trappings of a safety management system we now see in vessels and shipping companies are testimony to nothing more than just another cumbersome international maritime documentary exercise. This is why a studied basis should be made for giving any verdict on the Code's performance. If studies indicate that the Code is indeed achieving its intended results, then the fear is baseless. If studies indicate that the Code does not seem to make a significant dent in the accident statistics, then the research could also give clues as to how the situation may be improved. Mitchison and Papadakis (1999) emphasize that while safety performance measurement is useful in describing the present state of a safety management system, it is even more useful as a basis for improving the system's performance, i.e., by identifying weaknesses and targeting necessary interventions.

On the one hand, the non-prescriptive nature of that Code ensures that each SMS is tailor-fitted to the particular shipping company. On the other, it presents a challenge for assessment and evaluation. The dilemma facing the analyst is how to gather measurable and quantifiable data without intentionally causing the transference of prescriptive values to any ISM Code amendment exercise. This is the reason this paper advocates a mixed approach to evaluation. After reviewing ISM Code research, IMO documents, policy analysis literature, and safety science research, this study has proposed that a combined quantitative-qualitative approach of research be conducted. The paper has also offered the following criteria, under two broad headings, for evaluating the ISM Code's performance:

OUTPUT

- Port State control detentions related to ISM deficiencies or non-conformities
- ISM-related spot inspections requiring demonstration
- Re-inspections related to ISM deficiencies or non-conformities
- Reporting of ISM deficiencies and non-compliance by shipboard staff
- Annual review and interim surveys results

OUTCOME

- Accident rate and injury frequency
- Mortality rate
- Safety culture
- Lost-time injuries (LTI)
- Vessel off-hire/delay
- Crew repatriated or sent ashore for retraining
- Insurance premiums and claims level
- Active commitment of management to safety

Criteria could be added and deleted from these lists and a combination of any number of them could be applied in different studies. The above criteria are naturally subject to debate and are best assessed, justified, or rejected by the results coming out of any study that would apply them. In proposing these criteria it was shown that there is much that the field of maritime studies could learn from the experience in policy analysis and safety management in other industries.

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PAPER 2

The ISM Code in the context of Swedish port state control statistics

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The ISM Code in the context of Swedish port state control statistics

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Abstract

This article presents the results of a study evaluating the International Safety Management (ISM) Code's effects on vessel performance in port state control (PSC) inspections in Swedish ports. PSC statistics are compared and analyzed between vessels that were required to implement the Code by 1998 and vessels that were not. Additionally, the results of a survey and interviews of Swedish PSC inspectors are considered and discussed. The paper concludes that a number of indicators suggest that ISM has the potential to positively impact vessel performance in PSC inspections.

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Key words: ISM Code, port state control, safety management, maritime safety.

1. Introduction

In 1993 the International Maritime Organization (IMO) added a new chapter to the International Convention for the Safety of Life at Sea (SOLAS) which provided for a set of new regulations relating to the safety management of ships. The new Chapter IX entitled "Management for the Safe Operation of Ships" established the International Management Code for the Safe Operation of Ships and for Pollution Prevention, commonly referred to as the International Safety Management (ISM) Code, as a requirement for ships in the international trade.

At the time of its adoption the ISM Code was, for a number of reasons, perceived to be a "radical change or a paradigm shift of the general safety and quality management standard in ship operation."[1] One reason is that it departs from the traditional IMO activity of formulating technical and prescriptive regulations. Instead of specifying detailed standards, the Code is "based on general principles and objectives"[2] and espouses the following broad safety management goals:

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- provide for safe practices in ship operation and a safe working environment;
- establish safeguards against all identified risks; and
- continuously improve safety management skills of personnel, including preparing for emergencies.

Evaluating the ISM Code's effectiveness is a complex task, and one that has been complicated by the fact that right from its inception it has drawn an equal number of sceptics and critics as it has proponents and champions in the shipping press. The objective of this study is to evaluate the ISM Code's effectiveness as a regulatory mechanism for maritime safety by examining, through port state control inspection statistics, whether ships that implemented the ISM Code exhibited a higher level of safety in their daily operations. This is done by taking into account the fact that the ISM Code was implemented in two phases, July 1998 for one group of vessels and July 2002 for the other. This four-year gap in implementation provides a unique opportunity to determine, by comparing performance between the two groups of vessels at port state control inspections, whether the ISM Code has indeed had an impact on the operational safety of ships.

1.1. The ISM Code

Since 1959 when its first meeting was held, IMO's work on promoting maritime safety and marine environmental protection has been heavily concentrated in two areas. One was the development of technical standards in ship design, construction, and equipment and the other was the formulation of minimum standards for certification of seafarers. By the mid-1980s, however, the international community registered considerable disappointment over the significant number of major maritime casualties that continued to occur despite the stringent technical standards developed at IMO. Studies revealing that human factors figured significantly in a vast majority of maritime casualties led many to wonder if perhaps excessive weight and emphasis have been placed on technical standards for both ships and seafarers as mechanisms to promote safety at sea. In the wake of a number of serious maritime accidents, it became apparent to the IMO membership that after "everything else has been looked at and tried – newer designs, better technical aids, the increase in ever more sophisticated regulations and enforcement systems at every level – one thing remains about which there is, almost universally, agreement as to the underlying cause of casualties – the human factor"[3] in daily ship operation and ship management.

A series of maritime accidents starting with the capsizing of the *Herald of Free Enterprise* that claimed 193 lives in March 1987 followed by, *inter alia*, the *Doña Paz-Vector* collision that led to a loss of more than 4,000 lives in December 1987, the fire on board the *Scandinavian Star* that killed 158 in 1990, the grounding of the *Braer* that resulted in the spillage of 84,500 tons of crude oil in 1993, and the sinking of the *Estonia* where 912 were confirmed or presumed to have died in 1994,[4] alerted the IMO to the need to factor human performance, in both shipboard and shore-based management, more vigorously into the maritime safety equation. With most casualties being linked to varying levels of human error, the need to fill the gap between advanced technical standards and better, more responsive, safety-conscious management became self-evident. Even with a technologically advanced vessel, highly qualified crew, and world-class managers, a company's casualty record still stood or fell on the presence of a safety culture among all personnel, both shipboard and shore based. The issuance of a certificate of competence presupposes that the seafarer has both the knowledge and skill to perform specific tasks onboard ship; it does not guarantee, however, that the seafarer would exhibit an attitude of safety at all times. It is the development of this attitude or culture of safety that the application of the ISM Code seeks to stimulate, support, and encourage.[1, 2, 5]

According to its preamble, the ISM Code was developed "to provide an international standard for the safe management and operation of ships and for pollution prevention." It 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."[2, 6] The functional requirements of an SMS include, among other things, instructions and procedures to ensure the safe operation of ships, maintenance of the ship and its equipment, procedures for reporting accidents and non-conformities, procedures to respond to emergencies, and procedures for internal audits and management reviews. The documentation that describes and implements the SMS is referred to as the safety management manual (SMM). Once the requirements of the ISM Code are met, and upon determination that the company and its shipboard management are operating in accordance with the approved SMS, the flag state administration or its duly authorized organization issues a document of compliance (DOC) to every company and a safety management certificate (SMC) to every ship. The ISM Code's mandatory character together with the system of certification and periodic verification give the international maritime safety regulatory framework a sharper set of "teeth."

The ISM Code heralded a paradigm shift in international maritime safety rule-making not only because of its emphasis on human factors and a safety culture as integral parts of promoting safer ships and cleaner seas, it was also seen as a unique attempt to directly regulate shipowners and operators by requiring them to identify and document their detailed safety management responsibilities. The imposition of direct responsibilities on the shipowner or operator, referred to in the Code as the shipping company, is uncharacteristic of earlier IMO instruments. In fact the usage of the word "company" is itself unique in that it was an entity that was never directly referred to in IMO instruments prior to the ISM Code.[1] As such the Code has a considerable impact on commercial shipping activities.

Additionally, the ISM Code's non-prescriptive character put IMO's work programme in line with the way safety rule making has evolved in land-based

[1] "Company" in this article is used within the context of the ISM Code which defines the term as being "the owner of the ship or any other organization or person such as the manager, or the bareboat charterer, who has assumed the responsibility for operation of the ship from the shipowner and who on assuming such responsibility has agreed to take over all the duties and responsibility imposed by the Code." The usage therefore has a wider scope than the normal commercial or legal definitions of the term.

industry in recent decades. Reason describes this evolution in the following terms: “instead of rules that prescribe the precise steps to be taken by individuals or organizations, leaving little or no discretion for deviation, the current trend is towards rules that emphasize the required outcomes of safety management, allowing considerable freedom on the parts of the operators of hazardous technologies to identify the means by which these ends will be achieved.”[7]

1.2. ISM Code research

Among the commentaries, papers, and books written on the ISM Code,[2] at least two studies evaluating the Code’s performance have attracted the attention of the wider shipping community. The first study, conducted by Martin Hernqvist under the auspices of the Swedish (Protection & Indemnity) Club, uses insurance claims activity as a criterion for evaluating the Code. Hernqvist compared insurance claims involving two groups of ships, that is, ships required to comply with the ISM Code and ships that were not. The study reviewed insurance claims entered with the Swedish Club from mid-1996 to mid-1999 and “noted that the claims development during the period was 30 per cent better”[8] for ISM compliant ships. The Swedish Club study gave the ISM Code an overall positive rating, indicating that “vigorous application of the ISM Code can significantly reduce claims exposure.”[9]

The second study is the doctoral research initially designed by Philip Anderson to assess the effectiveness of the ISM Code by focusing on the willingness of seafarers to submit reports of deficiencies and non-compliance as well as shore management’s readiness to act upon such reports. However, after processing and analyzing 3,000 completed questionnaires together with 800 individual testimonies that detailed personal experiences with ISM Code implementation, Anderson expanded the scope of his study. In his initial findings, Anderson found the question “Is the ISM Code working?” too complex for a definitive answer and focused instead on its potential. In particular, he inquired into common denominators and best practices shared by survey respondents that testified to the ISM Code’s beneficial effects. His study concludes that “the ISM Code, properly implemented, will not only lead to safer ships and cleaner seas, but also more efficient ships and profitable companies.”[10, p. 5]

1.3. Port state control statistics

This article compares the performance of two groups of vessels using statistics from the Swedish Maritime Administration (SMA) database relating to port state control (PSC) inspections conducted in Swedish ports. Port state control is a regime of unannounced shipboard safety inspections conducted by designated authorities in a port or offshore terminal. PSC was developed in the early 1980s

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2 Two websites are a must for the ISM Code researcher. The first is an IMO website that maintains an excellent bibliography of works related to the ISM Code. Entitled “Information Resources on the International Safety Management Code (ISM Code)” the bibliography can be accessed by opening IMO’s website at www.imo.org and clicking on “information resources.” The second website, www.ismcode.net, was created to serve as an international focus for ISM research and debate. This website is maintained by Philip Anderson and is designed to act as an authoritative reference source of information and data about the ISM Code and related issues.

to complement existing international maritime safety enforcement mechanisms. This was in reaction to the generally-held belief that many flag states are unable to adequately perform their mandated duties of ensuring that ships flying their flag comply fully with international safety standards formulated under the auspices of the IMO and the International Labour Organization (ILO). Under the open registry type of ship registration regime it is not uncommon for a ship to rarely, if ever, visit its port of registry in its service life, thereby keeping it effectively beyond the reach of surveyors and inspectors of the flag state.[3] It was this irregularity that port state control was mainly designed to address.

A typical port state control inspection begins with a visit by one or more properly qualified PSC inspectors on board a foreign vessel to verify certificates and documents that serve as *prima facie* evidence that the vessel complies with certain IMO and 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 aroused, 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. 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.

The incorporation of the ISM Code into Chapter IX of SOLAS, one of the IMO conventions covered under PSC inspections, brings the operation of a ship's SMS evenly within the ambit of port state control.[11, 12] This means that PSC inspectors do not only verify that the vessel carries valid DOCs and SMCs but also whether its SMS is indeed functional.

2. Method

This study is a comparative analysis of the performance in PSC inspections of foreign vessels that have called at Swedish ports during the years 1996-2000. Swedish PSC statistics were selected for this study because of the comprehensiveness of the SMA database. The database consists of all the information found on hardcopy PSC reports but transcribed and tabulated in Microsoft ® Excel to facilitate analysis. In contrast, corresponding digital data was not available from other administrations and port authorities that were approached. The Swedish 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. PSC inspection statistics were selected as an indicator to measure the effectiveness of the ISM Code because by being a random regime, PSC inspections offer a candid snapshot of the actual

[3] Although it should be noted that the more conscientious open flag states have an inspectorate system under which flag state surveyors and inspectors are stationed or appointed in strategic locations around the world to visit ships under their flags.

status of operational safety aboard the vessel.[4] This is in contrast to announced statutory surveys[5] 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. PSC inspections, on the other hand, are unannounced and therefore conducted on vessels in the normal daily mode of operations. As such PSC statistics can be a powerful tool to establish the ISM Code's effectiveness in constraining, to paraphrase Rasmussen and Svedung, the behaviour of seafarers in a manner that increases safety in the daily operation of ships.[13]

When examining PSC statistics, this study looks at vessel deficiencies in general; it does not distinguish between ISM and non-ISM deficiencies. Neither does it focus strictly on whether ships comply with ISM documentation requirements. It looks at all deficiencies as indicators of the status of implementation of the SMS and the actual state of safety on board the vessel. Take for instance 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 indicative of 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.

It should also be mentioned as a caveat that a study of PSC statistics is not in itself sufficient to draw definitive conclusions on the effectiveness of the ISM Code; rather, vessel performance at PSC inspections is but one among a number of important indicators necessary for a comprehensive assessment of the Code.[14]

2.1. Port state control statistics

The data and statistics analyzed in this study relate to all PSC inspections undertaken by SMA inspectors on foreign vessels calling at ports in Sweden over two periods that straddle the ISM Code's first phase of implementation. Examined were the two years prior to first phase implementation (1996 and 1997) and the two years that followed (1999 and 2000). The data for the two periods were compiled by the SMA on a monthly basis and, in total relate to 2,845 inspections conducted on board 908 vessels. 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

[4] Most states are parties to a regional organization, known as a Memorandum of Understanding on Port State Control (PSC MOUs), which, aside from other administrative and operational functions, sets quotas for the minimum percentage of vessels calling within a party's jurisdiction that should be inspected.

[5] Statutory surveys emanate from international conventions and are conducted by or on behalf of flag states; also includes statutory inspections which normally relate to domestic regulations rather than international conventions; surveys and inspections are distinguished from each other in some jurisdictions depending on the level of detail involved and the qualification of the inspecting officer.

effects that might be brought about by preparations undertaken by ships for the second phase of ISM Code implementation in 2002.

Every PSC inspection generates an inspection report. As a minimum, each report contains the following information:

- ship's name;
- flag of registry;
- date of registry;
- call sign;
- IMO vessel number;
- vessel type;
- gross tonnage;
- year built;
- date of inspection;
- place of inspection;
- nature of deficiencies noted; and
- action taken by the inspecting authority.

Regardless of whether deficiencies are found on board a vessel during inspection, a minimum of one notation or inspection entry related to the nature of deficiencies is generated. A vessel with no noted deficiency would only have one inspection entry, represented by the notation "none" (code 0000). A vessel found to have one or more deficiencies, on the other hand, would be given an inspection entry for each deficiency discovered. As an example, a certain vessel might be noted for the following deficiencies: launching arrangements for rescue boats (code 0635), fire fighting equipment (0720), hull-corrosion (0983), or control of discharge of oil (1720), or a total of 4 inspection entries for this fictional vessel. Around 25 different types or series of deficiencies, indicated by the first two numerals in each deficiency code, are employed by the regional PSC regimes.

The SMA data analyzed in this study comprise a total of 6,305 inspection entries which were then sorted into the two following groups: "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. As mentioned earlier, 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 are, as implied by the label, exempt from complying with any of the Code's requirements. By analyzing statistics from two periods, 1996-1997 and 1999-2000, the study is able to examine vessel performance during the two-year period prior to initial implementation of the ISM Code followed by another two-year period when one group of ships, Phase 1 vessels (the test group), were covered by the Code while another, Phase 2 and exempt vessels (the control group), was not.

To determine whether the ISM Code affected the performance of vessels during port state control, the two groups of data were processed to compare the number of deficiencies found per group of vessel during inspections. The study was conducted under 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, should perform relatively better at inspections than Phase 2 and exempt vessels during the post-implementation period of 1999-2000. This improvement in the level of safety should be indicated by exhibiting a decreasing number of deficiencies and detentions at PSC inspections after the introduction of the ISM Code. To facilitate this comparison two ratios are introduced in this study. One is the deficiency rate (DFR), that is, the ratio of deficiencies to the number of vessel inspections conducted,[15] represented by the following 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) which 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 ordered as a result of PSC inspections. The data was subjected to various tests of statistical significance. Traditionally, a p value of less than or equal to 0.05 ($p \leq 0.0.5$) is used as the threshold of statistical significance. This value indicates that there is a 5% or less probability that the observed findings are the result of chance and that the correlations observed or surmised are false.

The study 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.

2.2. Survey of PSC inspectors and existing studies on the ISM Code

As a complement to the analysis of PSC statistics, questionnaires were also sent to Swedish port state control inspectors to solicit their opinion and interpretation. This was undertaken to determine how the preliminary findings drawn from the analysis of the statistics compare with the observations of the inspectors whose PSC inspections generated those statistics. Survey questionnaires were sent to the 57 inspectors based in the three inspection regions in Sweden, namely Stockholm, Gothenburg, and Malmö.

The survey showed the inspectors the preliminary results of the statistical analysis and requested their views on the results. The survey questionnaire also asked the PSC inspectors about their perception of the Code's practicability and effectiveness and requested them to identify what results they expected to observe from the Code's implementation. It inquired what trends they had observed in terms of the number of deficiencies noted between different groups of vessels at PSC inspections; in other words, whether their observations corresponded with their expectations. In asking them for their personal assessment of the ISM Code, the survey also sought to determine what significant variations in perception prevail among inspectors by asking them for the reasons why they believe the Code has succeeded or failed in promoting safer shipboard practices. Follow-up interviews and consultations with selected inspectors were also undertaken to complement understanding of the survey results as well as the inspection process itself.

3. Results

As shown in Table 1 below, the DFR values calculated for the period 1996-1997 was 1.81 for Phase 1 vessels and 1.55 for Phase 2 & exempt vessels. For the period 1999-2000, it was 1.62 for Phase 1 vessels and 1.61 for Phase 2 & exempt vessels. These values show a decrease in the average number of deficiencies noted on board Phase 1 vessels after the implementation of the ISM Code in 1998; applying the t-Test for the data on Phase 1 vessels resulted in a p value of 0.39 (p>0.05). Phase 2 vessels, on the other hand, exhibited an increase in the average number of deficiencies noted per PSC inspection during the same period. Subjecting the data to the same test also revealed that the increase was not statistically significant, with a p value of 0.67 (p>0.05).

Table 1
DFR values for two groups of vessels during the periods 1996-1997 and 1999-2000

	ISM Phase 1 vessels			ISM Phase 2 & exempt vessels		
Period	df	i	DFR	df	i	DFR
1996 & 1997	1258	694	1.81	1026	664	1.55
1999 & 2000	886	548	1.62	1514	939	1.61
t-Test	p=0.39			p=0.67		

Table 2 below shows the data sorted according to how many inspections, for each group of vessel and period, generated a particular number of noted deficiencies. More than half of the inspections under each period for both vessel groups were concluded with no deficiencies noted; perhaps predictably, the number of times a certain number of deficiencies was discovered (occurrences) during inspection generally decreased as the number of deficiencies increased.

Table 2
Number of deficiencies noted per inspection for two groups of vessels during the periods 1996-1997 and 1999-2000

Total number of deficiencies noted during a single inspection	Number of occurrences in the database			
	ISM Phase 1 vessels		ISM Phase 2 & exempt vessels	
	1996-1997	1999-2000	1996-1997	1999-2000
0	386	321	389	525
1	111	62	81	116
2	65	41	70	100
3	38	33	36	61
4	26	26	23	35
5	14	20	12	21
6	15	16	11	19
7	6	5	9	17
8	4	2	6	7
9	4	6	8	8
10	3	4	2	3
11	2	3	1	5
12	–	3	3	3
13	2	2	3	8
14	4	–	3	5
15	2	1	1	–
16	–	–	–	2
17	–	–	2	1
18	–	–	1	–
19	2	–	1	1
20	–	–	–	1
21	–	1	–	–
22	1	–	–	–
23	1	–	1	–
24	–	1	–	–
26	1	–	–	1
28	1	–	–	–
30	1	–	–	–
34	1	–	–	–
35	3	–	–	–
39	–	–	1	–
43	–	1	–	–
59	1	–	–	–
TOTAL	694	548	664	939

Further observation shows that the 10 to 15 range constitutes a zone where occurrences start to become sparse for both groups of vessels and periods. For the purpose of further analysis the midpoint of this zone, that is, between 13 and 14 noted deficiencies was selected arbitrarily as a point of separation between occurrences of what might be considered, for lack of more accurate labels, “more” or “fewer” deficiencies. The data was analyzed between inspections that generated greater than 13 noted deficiencies and inspections with less than or equal to 13 noted deficiencies. The results of this analysis are shown in Table 3 below.

Table 3
Inspections with greater than, and less than or equal to, 13 noted deficiencies; for two groups of vessels during the periods 1996-1997 and 1999-2000

	Number of occurrences in the database							
	ISM Phase 1 vessels				ISM Phase 2 & exempt vessels			
	>13 deficiencies noted	≤13 deficiencies noted	i	Percentage of inspections with >13 deficiencies noted	>13 deficiencies noted	≤13 deficiencies noted	i	Percentage of inspections with >13 deficiencies noted
1996-1997	18	676	694	2.6%	10	654	664	1.5%
1999-2000	4	544	548	0.7%	11	928	939	1.2%
t-Test	p=0.012				p=0.111			

For Phase 1 vessels, the percentage of inspections that generated greater than 13 noted deficiencies decreased from 2.6% in 1996-1997 to 0.7% in 1999-2000. The decrease proved to be statistically significant with a p value of 0.012 ($p \leq 0.05$). The percentage for Phase 2 and exempt vessels, on the other hand, decreased from 1.5% to 1.2%. The decrease in the case of Phase 2 and exempt vessels was not statistically significant, the p value being 0.111 ($p > 0.05$).

Table 4
Inspections with zero noted deficiency; for two groups of vessels during the periods 1996-1997 and 1999-2000

	Number of occurrences in the database					
	ISM Phase 1 vessels			ISM Phase 2 & exempt vessels		
	Zero deficiency noted	i	Percentage of inspections with zero deficiency noted	Zero deficiency noted	i	Percentage of inspections with zero deficiency noted
1996-1997	386	694	56%	389	664	59%
1999-2000	321	548	59%	525	939	56%
t-Test	p=0.64			p=0.50		

A further analysis of Table 2 within the context of how many vessels in each group received a clean inspection report, that is, where no deficiencies were noted, resulted in Table 4 above. The number of inspections where zero deficiency was noted increased between 1996-1997 and 1999-2000 for Phase 1 vessels. In contrast, the number during the same period decreased for Phase 2 and exempt vessels. Applying the t-Test shows that the changes are not statistically significant. P values were 0.64 (p>0.05) for Phase 1 vessels and 0.50 (p>0.05) for Phase 2 and exempt vessels.

Table 5 shows the detention rates, DTR, for the two groups of vessels. In 1996-1997, the DTR was 0.032 for Phase 1 vessels and 0.042 for Phase 2 and exempt vessels. Both DTR values decreased in 1999-2000 to 0.015 for Phase 1 vessels and 0.026 for Phase 2 and exempt vessels. Applying the chi-squared test to measure goodness-of-fit yielded a p value of 0.052 (p≤0.05) for Phase 1 vessels and 0.066 (p>0.05) for Phase 2 and exempt vessels.

Table 5
Detention rates for two groups of vessels during the periods 1996-1997 and 1999-2000

	ISM Phase 1 vessels			ISM Phase 2 & exempt vessels		
	dt	i	DTR	dt	i	DTR
1996-1997	22	694	0.032	28	664	0.042
1999-2000	8	548	0.015	24	939	0.026
Chi-squared test	p=0.05			p=0.07		

As mentioned earlier, deficiencies noted in PSC inspections are grouped into 21 series, each of which covers a specific area of work and safety on board ship. These areas can range from working spaces (series 0500) and accident prevention (series 0800) to alarm signals (series 1000) and mooring arrangements (series 1300). Table 6 below presents DFR values for the two vessel groups sorted according to 21 series of deficiencies. Aside from DFR values, Table 6 also has columns indicating the nature of the change in DFRs between the periods 1996-1997 and 1999-2000, as well as the corresponding p values. Phase 1 vessels experienced a decrease in deficiency rates for eight of the deficiency categories, six of which were statistically significant (p≤0.05). An increase was registered for four of the series while nine showed no change. Phase 2 and exempt vessels also exhibited a decrease in DFR values for eight of the 21 series, of which only two proved to be statistically significant (p≤0.05). In contrast, there was an increase in seven of the series while there was no change in six of them.

Table 6
Deficiency rates, sorted according to deficiency types, for two groups of vessels during the periods 1996-1997 and 1999-2000

		ISM Phase 1 vessels				ISM Phase 2 & exempt vessels			
		DFR				DFR			
Deficiency type		1996-1997	1999-2000	nature of change	p-value	1996-1997	1999-2000	nature of change	p-value
100	ship's certificates / logbooks	0,13	0,09	*decrease*	*0,02*	0,06	0,10	increase	0,03
200	crew	0,01	0,01	no change	0,08	0,03	0,02	decrease	0,11

300	accommodation	0,03	0,03	no change	0,08	0,04	0,02	decrease	0,11
400	food and catering	0,05	0,03	*decrease*	*0,01*	0,03	0,01	decrease	0,11
500	working spaces	0,01	0,01	no change	0,07	0,03	0,01	decrease	0,11
600	life saving appliances	0,22	0,23	increase	0,02	0,18	0,21	increase	0,05
700	fire fighting appliances	0,42	0,36	*decrease*	*0,05*	0,30	0,28	decrease	0,06
800	accident prevention	0,03	0,03	no change	0,08	0,02	0,02	no change	0,11
900	safety in general	0,40	0,41	increase	0,04	0,27	0,36	increase	0,08
1000	alarm signals	0,01	0,01	no change	0,08	0,02	0,01	decrease	0,11
1100	cargo	0,02	0,01	decrease	0,08	0,02	0,02	no change	0,11
1200	load lines	0,15	0,09	*decrease*	*0,02*	0,17	0,14	*decrease*	*0,04*
1300	mooring arrangements	0,01	0,01	no change	0,08	0,01	0,01	no change	0,11
1400	propulsion and auxiliary machinery	0,07	0,07	no change	0,08	0,07	0,09	increase	0,03
1500	navigation	0,05	0,06	increase	0,08	0,10	0,10	no change	0,03
1600	radio (odd codes are for ships equipped for GMDSS)	0,01	0,01	no change	0,08	0,02	0,03	increase	0,11
1700	marine pollution - annex I	0,12	0,08	*decrease*	*0,02*	0,13	0,10	*decrease*	*0,04*
1800	tanker:	0,00	0,00	no change	0,07	0,00	0,00	no change	0,11
1900	marine pollution - annex II	0,01	0,00	decrease	0,08	0,00	0,00	no change	0,11
2000	SOLAS related operational deficiencies	0,05	0,02	*decrease*	*0,01*	0,02	0,03	increase	0,11
2100	MARPOL related operational deficiencies	0,01	0,02	increase	0,08	0,01	0,02	increase	0,11

The survey of Swedish port state control inspectors generated responses from 19 out of the total population of 57, representing a return rate of 33%. Of the respondents, 58% indicated from observations made during port state control inspections that it was evident 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.

Asked whether in their work as inspectors they had noticed a difference in safety standards between Phase 1 and Phase 2 and exempt vessels, 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. 17% of the respondents disagreed while 37% were uncertain.

The respondents were also asked which types of deficiencies they expected would be influenced strongly by the ISM Code at port state control inspections. 32% believe that the number of deficiencies across all deficiency types should in decrease as a result of proper ISM Code implementation. On the other hand, 63% expect deficiencies in the 0100 series (ship's certificates/logbooks) to be most affected while 42% believe that it would be the 0600 series (life saving appliances). 42% believe that series 0700 (fire fighting appliances) deficiencies would most likely decrease and 37% said it would be series 0800 (accident prevention). 32% indicated 0200 (crew), 1700 (marine pollution by oil), and 2000 (SOLAS related operational deficiencies).

4. Discussion and conclusions

The analysis shows that Phase 1 vessels exhibited improved performance at PSC inspections in Swedish ports compared to Phase 2 and exempt vessels, thereby suggesting the ISM Code’s potential in enhancing safety. However, not all of the above analyses resulted in statistically significant changes in respect of the test group. Thus, it would be difficult to interpret the above results as incontrovertible proof of either the ISM Code’s failure or success. Instead, the results should be examined in light of contending views of the beneficial effects of the ISM Code.

4.1. An addition to the administrative workload

The results of the above analyses could be interpreted as being indicative that the ISM Code has simply had no significant positive effects because the shipping industry in general has treated it with scepticism. In their survey responses, a number of the Swedish inspectors provided some insight into why some sectors in the maritime industry are unconvinced of the ISM Code’s beneficial effects. To begin with, there is general agreement that a number of years will need to pass before the ISM Code becomes an accepted and normal approach to managing safety on board ships. As already mentioned earlier, the Code is considered a radical departure from the usually prescriptive character of IMO safety rules. Some suggest that the transition period to the new regime of the ISM Code could cause difficulties and confusion as it clashes with the existing management system.[1] Another factor mentioned by survey respondents are the concerns expressed by ship’s crew that reporting deficiencies, non-conformities, accidents and near-misses in accordance with the ISM Code will only result in self-incrimination, punishment, and penalty. Although the voluntary reporting of non-conformities is an integral part of the SMS improvement process, it is still viewed with suspicion by ship operators and seafarers alike because of potential legal implications and possibly adverse effects on employment.

Another explanation offered why the ISM Code might not positively affect safety standards on board vessels is that many ship’s crews and shipping company staff treat the ISM Code as a documentary requirement or a paper exercise rather than a useful tool for promoting safe shipboard practices. 63% of the survey respondents imply that whatever significant effects might have resulted from the Code could have been dampened by relaxed attitudes on the part of all concerned after overcoming the anxiety of initial implementation and certification in 1998. This tendency was identified in a study conducted prior to ISM Code implementation by Hahne et al.[16] where one of the central findings was the existence of widespread resistance among maritime industry personnel against "imposing" a safety culture on board ships. The Hahne study found that the respondents perceived the ISM Code as yet another regulatory burden and treated it as an unwelcome addition to the already heavy administrative workload on board ships. An alternative explanation could be found in the phenomenon in which it is shown that "as the quality… of the work environment provided by the firm is increased, workers will diminish their level of safety-enhancing actions… that affect the probability of an accident."[17] Within the context of the ISM Code this implies that as the SMS gains wider acceptance as a tool to promote safety and as greater management support results in higher quality in the workplace, there is also a risk that complacency in safety matters would set in among the crew. In other words, while it might sound ironic, it is conceivable that the ISM Code could generate a false sense of safety and result in a diminished, instead of increased, safety awareness among shipboard personnel.

The results may also be attributable to the nature of the PSC statistics. The process of generating inspection statistics is highly subjective. Each PSC inspector that comes on board to inspect a ship possesses a unique personal, professional, and cultural background. The outcome of each inspection depends heavily on the inspector's individual judgment and perceptions. Nevertheless, PSC inspectors maritime professionals acting on behalf of governments and who undergo periodic training that promote uniformity in the conduct of inspections. Additionally, they are expected to be aware of the serious implications that might result from negligence in the conduct of any given inspection. Unnecessary or unwarranted ship delays or detentions can have significant legal and financial consequences as was demonstrated in the *Lantau Peak* case.[6] Port state control is an integral part of the international maritime regulatory regime for determining the status of safety on board ships. When analyzing port state control statistics, a researcher can only hope that the data has gained enough critical mass to negate the impact of any irregularities related to the subjective nature of the inspection process.

4.2. Tool to promote safe practices in ship operation

On the other hand, there is much in the foregoing analysis of Swedish PSC statistics that suggests that the ISM Code has had a positive impact on vessel safety. This is substantiated by a number of indicators showing that the test

[6] See *Budisukma Puncak Sendirian Berhad and Maritime Consortium Management Sendirian Berhad v. Her Majesty the Queen in right of Canada, B.S. Warna and D.A. Hall.* In its April 2004 ruling, the Federal Court of Canada found Canadian port state control authorities "negligent in the conduct of their duties with respect to the inspection and detention of the ship" and awarded Cdn$4.35M in damages and Cdn$1.62M in prejudgment interest to the owner/operator of *Lantau Peak.*

group's (Phase 1 vessels) performance in PSC inspections was consistently better than that of the control group (Phase 2 and exempt vessels) during the period following the first phase of ISM Code implementation.

The deficiency rate for Phase 1 vessels decreased 11% in the period 1999-2000 compared to the DFR from 1996-1997. In contrast, the DFR for ships that were not required to comply with the ISM Code increased 4% during the same period. The analysis of the number of inspections that yielded more than 13 deficiencies showed that the occurrences decreased for both groups of vessels. However, the decrease for Phase 1 vessels was statistically significant compared to that of Phase 2 and exempt vessels. The test group exhibited a 73% decrease compared to the more limited 20% decrease experienced by the control group.

The number of inspections that yielded zero deficiency is an even more telling indicator. There was an increase of 5% in the number of Phase 1 vessels that showed zero deficiency in the post ISM Code implementation period. In contrast, there was a 5% decrease for Phase 2 and exempt vessels. Looking at detention rates, the DTR for Phase 1 vessels exhibited a more statistically significant decrease (53%) between the two periods examined than Phase 2 and exempt vessels (38%). When sorted according to specific deficiency series, the statistics show that Phase 1 vessels also performed better, exhibiting more statistically significant improvements over the two periods compared with Phase 2 and exempt vessels.

While the above imply the positive effects of the ISM Code, a number of the indicators do not meet the test of statistical significance as presented in the results section of this study. The maxim "absence of proof is not proof of absence" should be kept in mind and prudence should be exercised in order to avoid interpreting the foregoing analyses solely on the basis of the standard $p \leq 0.05$. The absence of statistical significance does not automatically nullify any of the positive indicators. The traditional $p \leq 0.05$ definition of statistical significance is a pre-set and arbitrary level that is not designed to be the be-all and end-all. In fact this issue is challenged and debated in disciplines such as the medical, health, and sports sciences, and psychology[18, 19] where the suggestion has been made that "whereas significance testing is important and helps to determine the likelihood of a true treatment-related effect, it… does not confer magnitude, importance, or the clinical meaning of the results,"[20] It is argued that the importance of findings are determined not exclusively by statistical significance, but by clinical or practical significance.[21]

The observations of Swedish PSC inspectors regarding the difference in safety standards between Phase 1 and Phase 2 and exempt vessels also reinforce the findings of the statistical analysis. Nine of the 19 respondents, or 47%, observed that ships with a functioning SMS as required by the ISM Code exhibit a decreasing trend in the number of deficiencies found or noted compared to Phase 2 and exempt vessels. Of the 19 respondents, 37% were uncertain while only 17% disagreed. The survey also revealed that the majority of inspectors are of the view that the ISM Code is fostering safer shipboard practices evident in the development of improved safety routines, the implementation of better maintenance plans, and the promotion of a safety culture among shipboard crew.

Indeed, 58% of the inspectors surveyed expressed full confidence in the ISM Code's beneficial effects.

The positive performance of Phase 1 vessels, relative to Phase 2 and exempt vessels during the period 1999-2000, is in line with the objectives under section 1.2 of the ISM Code stating that the "safety-management objectives of the Company should, inter alia, provide for safe practices in ship operation and a safe working environment…" These results are also compatible with Hernqvist's findings of a 33% drop in insurance claims for the same vessels [8] and Anderson's conclusion that the ISM Code, employed effectively, can be a catalyst for promoting a safety culture within any shipping company.[10]

4.3. Conclusion

This study sought to evaluate the ISM Code's effectiveness as a safety regulatory policy by analyzing a set of port state control statistics. The analysis was undertaken by comparing the performance of two groups of vessels – a test group that was required to implement the requirements of the Code by the year 1998 and a control group that would not be covered by the Code until four years later – in PSC inspections conducted in Swedish ports. The result is a number of indicators showing a positive correlation between ISM Code compliance and enhanced performance at PSC inspections. The results also complement earlier studies of the ISM Code's effectiveness as well as observations made by Swedish PSC inspectors.

The analysis of port state control statistics alone does not offer a definitive assessment as to the effectiveness of the ISM Code. As mentioned earlier, no single indicator can, on its own, provide a full picture of the status of ISM Code implementation. This study has applied only one among numerous possible criteria and, in so doing, has attempted to shed light on a tiny area of an immense and complex picture. Care should be taken not to replicate the folly of the six blind men of Indostan,[7] each of whom ventured to describe the appearance of the elephant by touching a specific part of the massive mammal's anatomy in isolation. As expected, each of the blind men arrived at a different conclusion.

What this study has attempted to illuminate is only one aspect of the ISM Code's effectiveness. It might constitute one part of the truth but should not by any means be construed as being the complete truth. Even though Swedish PSC inspectors agree that better performance at PSC inspections is one of the anticipated effects of the ISM Code, many other indicators need to be examined to arrive at a comprehensive assessment. Nevertheless, this study concludes that there is strong evidence within the context of PSC statistics to show that the ISM Code has potential to positively influence vessel safety. The challenge that lies ahead is the development of measures that will encourage full utilization and recognition of the Code as a beneficial factor in the management and operational culture in shipping.

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[7] John Godfrey Saxe's classic poem "The Parable of the Blind Men and the Elephant" tells the tale of six blind men whose conclusions as to the appearance of an elephant varied wildly depending on which part of the pachyderm they happened to touch.

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PAPER 3

Actual and perceived safety on board Swedish ships

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ACTUAL AND PERCEIVED SAFETY ON BOARD SWEDISH SHIPS

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ABSTRACT
This paper aims to examine the status of safety on Swedish ships by looking at the following two aspects: the performance of Swedish ships in port state control (PSC) inspections and the perception of safety culture (SC) on selected Swedish passenger vessels. The methodology applied in the first part of the study involves the analysis of PSC statistics (vessel deficiency rate and detention rate) related to Swedish ships inspected in foreign ports. The second part employs a method for SC assessment including a standardized questionnaire filled out by crew members of five Swedish passenger vessels in the international trade. The two sets of data were used to make a comparison between the perceptions of safety/perceptual audit and the behavioral sampling (i.e., the PSC statistics). The preliminary results showed some indications of better SC being manifested in a higher level of safety indicated by exhibiting fewer deficiencies at PSC inspections.

Keywords: Maritime safety, Safety assessment, Port state control, Safety culture, Safety management, Safety perception

ACTUAL AND PERCEIVED SAFETY ON BOARD SWEDISH SHIPS

1. INTRODUCTION

This study is part of a research project on maritime safety focusing on safety culture, safety management, port state control and cultural management in the shipping domain in relation to the ISM Code. The project, based in Sweden, is divided into four sub-projects looking at the following topics: 1) safety organization and organization of work in cargo shipping; 2) cultural management and safety management in cargo shipping; 3) safety culture and safety management in passenger shipping; 4) ISM Code implementation and compliance. The present study is a combination of the last two of the above topics and is an initial attempt to investigate the status of safety on Swedish ships by looking at the following two aspects: the performance of Swedish ships in port state control (PSC) inspections and the perception of safety culture (SC) on selected Swedish passenger vessels.

An efficient and successful safety management depends largely on the attitudes and the commitment to safety that exist in the organization especially on the management level (O'Toole, 2002; Clarke, 1999; Kirwan, 1998). The existing safety culture has a central role and encompasses the basic values, norms and attitudes concerning safety that exist in the organization. One of the most widely used definitions is the following: "The safety culture of an organization is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organization's health and safety management" (Health and Safety Commission, 1993). Most investigators agree that an SC includes elements such as good communication, organizational learning, senior management commitment to safety and a working environment that rewards identifying safety issues (Sorensen, 2002). Reason (1997) adds that an SC is an informed culture, i.e., a culture in which those who manage and operate the system have current knowledge about the human, technical, organizational and environmental factors that determine the safety of the system as a whole.

The existing SC within an organization has a significant impact on how proactive the approach to safety management will be. An efficient safety management probably demands integration with the general management system of the organization, but also as far as possible coordination with the areas of quality, health and environment. A good SC manages to create motive powers for safety within the organization itself.

The range of tools to be used in measuring SC is essential to ensuring the accuracy of the result, and in most cases this involves the use of different and complementary methods. We can measure human attitudes and norms in safety matters and perceptions of SC dimensions using questionnaires. But the safety management system as a framework also has to be investigated to determine whether policies and routines for safety are in place, whether the technology matches human cognitive abilities, etc. The study of safety behavior, including how safety rules are being followed, is another important area that requires investigation and is one where PSC inspection data can offer revealing information.

National governments as well as supranational bodies such as the International Maritime Organization (IMO) have developed a framework of maritime safety conventions and regulations that seek to promote greater safety behavior among seafarers and ship operators. These regulations serve as "behavior shaping mechanisms" that set work system constraints and delineate boundaries of acceptable performance (Rasmussen, 1997; Rasmussen and Svedung, 2000). PSC is a system of inspections that helps states assess the enforcement of applicable safety regulations and thus establish the status of safety on board ships that visit their ports (Bell, 1993; Kasoulides, 1993; Payoyo, 1994; Ozcayir, 2001). PSC inspections may involve, among others, verification of documents, certificates, equipment, and even demonstration of skill by the crew.

The aim of this paper is to investigate actual and perceived safety on board Swedish vessels by combining an analysis of PSC statistics with the results of SC assessments. A hypothesis is that a better SC is manifested in a higher level of safety indicated by exhibiting fewer deficiencies at PSC inspections.

2. METHOD

The methodology applied in the first part of the study involves the analysis of PSC statistics related to Swedish ships inspected in foreign ports. The second part employs a method for SC assessment using standardized questionnaires filled out by crew members of selected Swedish passenger ships. The two sets of data are used to make a comparison between the perceptions of safety by shipboard crew and the behavioral sampling from the PSC statistics.

2.1. Analysis of port state control statistics

This part of the study involves an analysis of the performance of Swedish ships at PSC inspections in foreign ports. PSC inspection statistics were selected as an indicator of the level of safety because PSC employs a regime of random inspections that offer a candid snapshot of the actual status of operational safety on board a vessel. PSC inspections are unannounced and therefore conducted on vessels in the normal daily mode of operations.

PSC inspections are directed by the maritime authorities of a port state and are conducted on board approximately one out of every four foreign-flagged vessels that call in that state's ports. These port states, through their maritime authorities, are in turn members of a regional PSC agreement, known as a Memorandum of Understanding (MoU). The MoU is organized to ensure uniformity in PSC inspection standards and procedures in all ports within the region. The MoU also serves the important function of collection and analysis of data related to PSC inspections. The sources of the PSC inspection data processed in this study are the Swedish Maritime Administration (SMA) and the European regional MoU on port state control. The PSC agreement in Europe was signed in Paris in 1982 and is thus referred to as the Paris MoU.

The data relate to all PSC inspections undertaken on Swedish-flagged vessels while calling at ports outside Sweden during the period 1995 to 2000. The data was compiled on a monthly basis and, in total, relate to 1,652 inspections conducted on board 305 vessels over six years.

Every PSC inspection generates an inspection report. Regardless of whether deficiencies are found on board a vessel during inspection, a minimum of one notation or "inspection entry" related to the nature of deficiencies is generated. A vessel with no notable deficiencies would only have one inspection entry, represented by the notation "none" (code "0000"). A vessel found to have one or more deficiencies, on the other hand, would be given an inspection entry for each deficiency discovered. As an example, a certain vessel might be noted for the following deficiencies: launching arrangements for rescue boats (code "0635"), fire fighting equipment ("0720"), hull-corrosion ("0983"), or control of discharge of oil ("1720"), or a total of 4 inspection entries for this fictional vessel. Around 25 different categories or series of deficiencies, indicated by the first two numerals in each deficiency code, are employed by the regional PSC regimes.

This study employs two ratios, namely deficiency rate (DFR) and detention rate (DTR), to compare the performance of different categories of vessels, i.e., Swedish versus non-Swedish, and passenger versus cargo, in PSC inspections. DFR values represent the ratio of deficiencies noted during PSC inspections to the number of vessel inspections conducted. DTR values represent the ratio of vessel detentions to the number of vessel inspections conducted.

2.2. Methods for safety culture assessment

The SC assessments on board passenger vessels normally include the following five techniques (Ek & Akselsson, manuscript): 1) observations on board vessels; 2) open interviews with crew members concerning their experiences in daily work; 3) standardized questionnaires; 4) standardized interviews with crew members from different work levels in the deck, engine and catering departments; and 5) collection of facts and statistics about the vessel and its operations.

This part of the study is concerned with the questionnaire part of the SC assessment. The questionnaire consisted of a total of 97 items representing the nine SC dimensions given below. A majority of the questions were answered using a five-point scale (1-5, e.g., 'not at all, barely, a little, much, very much', or 'never, seldom, sometimes, often, very often'), where a 'better' SC score had a higher value on the scale. The questionnaires were filled in anonymously by all crew members.

Following are the nine dimensions included in the SC assessment (Ek & Akselsson, manuscript): *Working situation* - concerns cooperation, support and appreciation; *Flexibility* - ability to transform the work organization to changing demands; *Communication* - good communication within and between work levels; *Reporting* - willingness to report incidents and anomalies; *Justness* - just judgments of human errors; *Learning* - willingness to learn and to introduce changes; *Safety-related behaviors* – comprising, e.g., discussions about and encouragement of increased safety; *Attitudes towards safety* - commitment to safety from both management and staff; *Risk perception* - perceived risk of harming others or oneself and one's own influence on safety at work.

This paper presents preliminary results from safety culture studies conducted on a total of five passenger vessels from three different shipping companies in international traffic. In two of the companies one HSC vessel (high speed craft) and one ROPAX vessel (roro-passenger) were studied, and in the third company one ROPAX vessel was studied. The vessels operate routes in northern Europe, i.e., the Baltic Sea and its environs.

For each SC dimension, each sample vessel's average score was calculated using the questionnaire items belonging to the respective dimension. Furthermore, in order to investigate differences between officers and crew in average SC scores, the t-test (2-tailed) was used.

3. RESULTS

3.1. Port state control data

Table 1 below is a comparative table of deficiency rates and detention rates of Swedish ships vis-à-vis all ships inspected in the European PSC inspection region. The second and third columns show the detention rates, DTR, of Swedish ships inspected in foreign ports compared to the average detention rates of all ships inspected within the Paris MoU. The period covered is between the year 1990 and the year 2000. Column 4 lists the total number of deficiencies that were noted on all Swedish ships inspected in foreign ports through the years 1995 to 2000. Column 5 shows the number of inspections that were conducted on Swedish ships during the same period. Column 6 gives deficiency rates

(DFR) which are the ratio between columns 4 and 5. These values can be compared with column 7 which correspond to the DFR for ships of all flags inspected within the European region. Columns 8 to 13 break the data related to Swedish ships between passenger and cargo vessels. The DFR for Swedish passenger ships are shown in column 10 while those for Swedish cargo ships are in column 13.

Table 1: Comparative table of deficiency rates (DFR) and detention rates (DTR) of Swedish ships vis-à-vis all ships inspected in the European PSC inspection region.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Year	DTR Swe-dish ships	Average DTR ships inspected by Paris MoU	Total nr. of defici-encies noted Swedish ships	Nr. of inspec-tions Swedish ships	DFR Swe-dish ships	DFR ships inspect-ed in Paris MoU ports	Swedish PASSENGER SHIPS			Swedish CARGO SHIPS		
							Defi cien cies	Inspe ctions	DFR	Defi cien cies	Inspe ctions	DFR
1990	0.02	0.04										
1991	0.02	0.05										
1992	0.02	0.06										
1993	0.06	0.08										
1994	0.06	0.15										
1995	0.03	0.17	251	259	0.97	3.32	27	42	0.64	224	217	1.03
1996	0.03	0.17	405	305	1.33	3.36	50	30	1.67	355	275	1.29
1997	0.05	0.15	338	274	1.23	3.17	39	28	1.39	299	246	1.22
1998	0.02	0.14	402	251	1.60	3.28	20	31	0.65	382	220	1.74
1999	0.03	0.09	381	276	1.38	3.30	24	28	0.86	357	248	1.44
2000	0.01	0.10	404	287	1.41	3.65	11	22	0.50	393	265	1.48

Table 2 below shows the results of a more detailed processing of the PSC data to determine how the two types of ships, passenger and cargo, performed in specific deficiency categories or series during PSC inspections. The deficiency series were selected on the basis of how indicative they are likely to be of the level of safety culture on board ships. 600 series deficiencies relate to life saving appliances; 700 series deficiencies relate to fire fighting appliances; 800 series deficiencies relate to accident prevention; 900 series deficiencies relate to safety in general; 1000 series deficiencies relate to alarm signals; 1100 series deficiencies relate to cargo; 1200 series deficiencies relate to load lines; 1400 series deficiencies relate to propulsion and auxiliary machinery; 1500 series deficiencies relate to navigation; and 2000 series relate to operational deficiencies related to SOLAS (International Convention for the Safety of Life at Sea).
Columns 2 to 7 show the ratio between the number of deficiencies related to the selected deficiency series and the total number of all deficiencies found on board passenger vessels, for the years 1995 to 2000. Columns 8 to 13 show the corresponding values for cargo vessels.

Table 2: Comparative table of deficiency rates (DFR) according to selected deficiency series for passenger and cargo vessels, 1995-2000.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	PASSENGER						CARGO					
DEFICI-ENCIES	Year 1995	Year 1996	Year 1997	Year 1998	Year 1999	Year 2000	Year 1995	Year 1996	Year 1997	Year 1998	Year 1999	Year 2000
TOTAL	27	50	39	20	24	11	224	355	299	382	357	393
600 series	0.33	0.10	0.13	0.10	0.29	0.27	0.21	0.23	0.23	0.22	0.18	0.18
700 series	0.22	0.12	0.18	0.30	0.17	0.18	0.12	0.10	0.11	0.12	0.10	0.10
800 series	0.04	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.01	0.01	0.01
900 series	0.07	0.14	0.36	0.20	0.08	0.36	0.08	0.14	0.13	0.11	0.13	0.06
1000 series	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1100 series	0.00	0.00	0.05	0.00	0.00	0.00	0.02	0.01	0.00	0.01	0.01	0.02
1200 series	0.00	0.14	0.00	0.00	0.13	0.09	0.08	0.06	0.03	0.07	0.03	0.06
1400 series	0.04	0.04	0.00	0.00	0.13	0.00	0.05	0.03	0.03	0.07	0.08	0.06
1500 series	0.07	0.06	0.05	0.05	0.13	0.00	0.13	0.13	0.17	0.11	0.09	0.12
2000 series	0.04	0.04	0.03	0.00	0.00	0.00	0.01	0.01	0.00	0.03	0.02	0.01

3.2. Safety culture assessment

The average scores for each SC dimension for the five vessels are presented in Figure 1. Generally, the studies yielded positive evaluations for the separate SC dimensions on all vessels, in the sense that all had an average value of above 3.00.

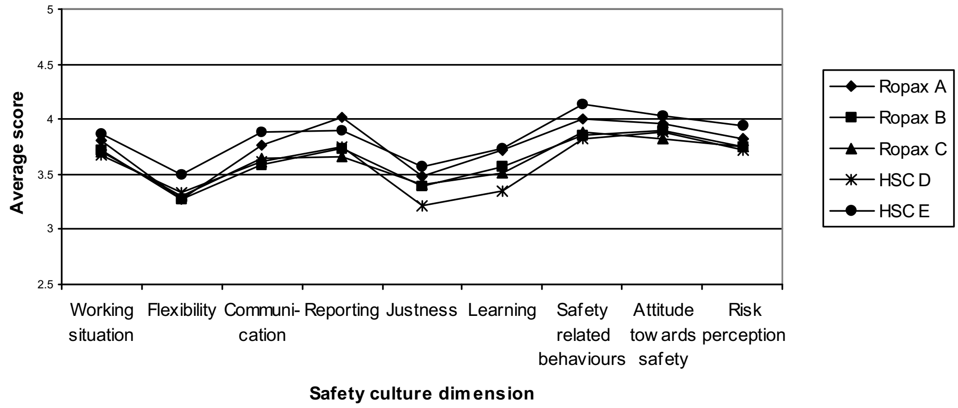

Figure 1: Average score for each safety culture dimension for five Swedish passenger vessels.

As shown in Figure 1, a similar SC pattern emerged for the five separate vessels. The SC dimensions Flexibility, Justness and Learning received somewhat lower scores while the rest of the SC dimensions received somewhat higher scores.

To determine whether differences existed between officers and crew in the reporting of SC dimensions, Table 3 below shows comparisons between these two groups for each individual vessel and for the three departments (deck, engine, catering). A symbol in a cell in Table 3 denotes that a difference existed between officers and crew in the perception of SC dimensions. Cases where officers generally gave more positive perceptions of SC dimensions than did the crew are denoted with the symbol "o." Where the opposite was observed, i.e., where crew generally gave more positive perceptions of SC dimensions than did the officers, the cell is denoted by the symbol "x."

In almost all the cases where a difference in perception was detected, the observations showed that officers had more positive perceptions of the SC dimensions than did the crew. The one exception found was in the results of the study on board HSC E, where the crew in the engine department exhibited more positive perceptions of certain SC dimensions compared to the officers.

Table 3: Comparisons between officers and crew concerning perception of safety culture (SC) dimensions ("o" - officers had more positive perceptions than crew, "x" - crew more positive than officers).

	Vessel																			
	Ropax A				Ropax B				Ropax C				HSC D				HSC E			
SC dimension	T	D	E	C	T	D	E	C	T	D	E	C	T	D	E	C	T	D	E	C
Working situation	o	o			o				o	o			o				o	o	x	
Flexibility	o	o			o				o	o		o	o	o	o				x	
Communication	o				o															
Reporting	o				o				o	o							o	o	x	
Justness				o	o								o							
Learning	o				o				o	o										
Safety related behaviors	o				o					o										
Attitudes towards safety	o				o				o	o		o								
Risk perception	o				o					o			o					o		

Group differences are significant at p<.05, 2-tailed
Ropax=RORO-passenger, HSC=High Speed Craft vessel
T=Total, D=Deck, E=Engine, C=Catering department

4. DISCUSSION

An analysis of columns 2 and 3 of Table 1 provides a general impression of how Swedish flagged vessels compare, in terms of detention rates, with the average for all ships inspected in the Paris MoU region. This offers one indication of how safety on board Swedish ships could be perceived in the wider world. The average value of the DTRs for Swedish ships over the years 1990 and 2000 is 0.03, as opposed to the average DTR of 0.11 for all ships of all flags inspected in the region during the same period. A comparison of the average values of these two groups using the t-test reveal that the differences between the groups are statistically significant ($p<.001$, 2-tailed). Columns 4 to 7 of Table 1 show that as an average, 0.97 deficiency was noted in 1995 for every occasion that a Swedish ship was inspected by port state control authorities. This value increased to 1.33 in 1996 and stayed more or less within an average value of 1.5 into the year 2000. The average value of the DFRs for the six years is 1.32 deficiencies per inspection. In comparison, the average DFR for inspections conducted on all ships within the Paris MoU region was 3.35 for the same period. A comparison of the average values of these two groups using the t-test also reveal that the differences between the groups are statistically significant ($p<.001$, 2-tailed). In terms of both DTR and DFR, there is scope to conclude that Swedish ships have shown to operate at a higher level of safety compared to the international average.

The result from the questionnaire part of the SC assessment revealed generally good safety cultures on board the five passenger vessels, in terms of the average scores that were received on SC dimensions. The two dimensions Safety related behaviors and Attitudes towards safety received especially high scores on all vessels. Safety related behaviors involve perceived individual and organizational behaviors concerning safety priorities, risk taking, encouragement of orderliness and level of pressure to take short cuts. Attitudes towards safety involve perceived individual and organizational attitudes concerning the importance of safety, distribution of work and responsibilities, and encouragement toward safe practices. In combination with the above discussion of positive Swedish DTR and DFR results, there is scope to believe that the SC on board the five Swedish vessels is at a reasonably high level and that the prevailing SC has had an effect on the actual behavior concerning safety. Of course, as the SC study involves only five vessels, a more general conclusion cannot be drawn, but we believe a tendency towards this result exists.

Taking the data related to Swedish vessels and breaking them down between the two types, passenger vessels showed an average DFR for the years 1995 to 2000 of 0.95, that is, less than one deficiency per inspection for passenger vessels the entire period. The lowest DFR for passenger vessels was 0.50 in 2000 while the highest was 1.67 in 1996. It should be noted, however, that the number of inspections was low especially in the year 2000, making these values uncertain. The DFR for Swedish cargo vessels, on the other hand, averaged 1.37 during the same 6-year period, that is, an average of almost one and a half deficiencies per port state control inspection. The lowest DFR for cargo vessels was 1.03 in 1995 while the highest was 1.74 in 1998. When comparing the average DFR values of these two groups over the 6-year period, calculations found no statistical significance. Nevertheless, the values show a tendency for passenger ships to perform better than cargo ships. This result gives added strength to the findings of good SC on Swedish passenger vessels. However, we lack corresponding SC data from cargo vessels that hypothetically could have revealed less positive perceptions of SC compared to passenger vessels.

This paper has presented the results of a first attempt to investigate actual and perceived safety on board Swedish vessels using a combination of PSC statistics and SC assessments. The results of the study need to be interpreted in more detail to obtain a clearer picture of the complex relationships between PSC statistics and SC questionnaire results. The challenge for the next phase of this study is developing a model that will clarify the relationships that can hopefully identify the relevant factors and methods for improving safety. This could include a parallel SC assessment on board a series of passenger vessels in other countries that can then be compared with the SC assessment on board Swedish ships.

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