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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.

Key words: maritime safety, safety assessment, port state control, safety culture, safety management, safety perception.

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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. 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.

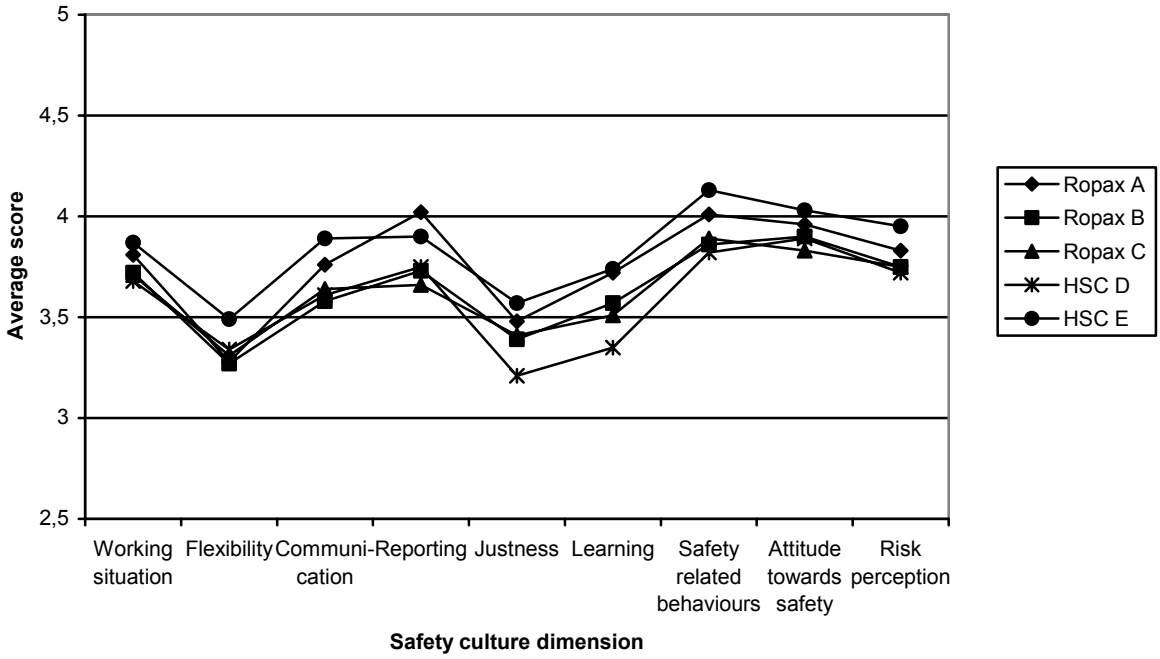

Figure 1: Average score for each safety culture dimension for five Swedish passenger vessels.

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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