

## **“A Critical Assessment of Human Element Regarding Maritime Safety: Issues of Planning, Policy and Practice”**

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### Abstract

In this paper, we will present the findings, derived from a structured questionnaire, that cover various aspects of the relation between human factor and maritime safety. In general, human element holds a very important share compared to the ensemble of marine-accident causes. This fact renders human behaviour and performance as potential leading components in relative safety surveys. Moreover, it must be noted that marine industry is surely between the less documented sectors, as far as human element is concerned. Nevertheless, IMO is constantly aiming at an adequate incorporation of human factor in numerous of its actions and regulations. Hence, numerous key enhancements of human behaviour and performance could be regarded as possible future standards and specifications, for certain safety-driven procedures of maritime transport. Then, we describe and analyse an original human-related questionnaire, which focuses on depicting the current practice of human factor, mainly through the implementation of the International Safety Management Code. The specific questionnaire, which comprises of an adequate sample of interviews and surveys, is presented in detail, in order to set off all fields of included data and its corresponding potential for informative and exploitative usage. Thus, the selected results are clearly human-oriented and they assay to portray a number of human aspects (crew training, acceptance etc), relatively to safe management and naval accidents. Finally, we close this paper with some interesting and revealing conclusions, derived from the aforementioned process. This way, we plan to show the importance of human factor in the evolving outline of the contemporary marine industry.

Keywords: human factor, marine safety, International Safety Management, accidents.

### Introduction

The issue of marine safety should be regarded as the key priority concerning the planning and practice of maritime transport procedures, in a worldwide scale. Since the vast majority of world trade is being conducted through sea-borne ways, maritime safety should be viewed as a factor that needs extreme caution, detailed planning, self-commitment and obligatory enforcement. The term marine safety has a multi-fold content, with a serious impact on numerous aspects of the maritime transport chain; more specifically, it involves the aversion of human losses and injuries, the

preservation of marine and coastal environment and the protection of vessels and their cargoes. Hence, safety topics are not to be simply pinpointed and addressed in the aftermath of a significant, or a mass media-adduced, naval accident. On the contrary, these matters should be dealt proactively, in order to provide for an efficient, profit making and environment-friendly maritime transport network.

There are several causes that can rupture the aforementioned transport chain, with undesired consequences. This can be resulted from unsolved mechanical or electrical problems, hazardous external conditions (such as severe weather), poor human factor behaviour or performance (e.g. inadequate bridge resource management), accidental events (like an unpredictable hull problem) etc. However, it is a fact that human element is the basic and by far the most frequent reason that leads towards marine accidents (Ventikos, 2002). Each involved player (e.g. crew, shore management, classification societies etc) has been recorded as the responsible component for numerous verified mishaps, which could have been averted under different circumstances. Thus, the correct way to respond to casualties and exploit its knowledge potential is to analyse the “mistakes” (mainly human errors) that caused them and assay to prevent them from appearing ever again.

The corresponding literature contains several examples than can depict the significance of human factor in relation to safe maritime management, even from a high level point-of-view. The case of the collision between the passenger vessel *Noordam* and the loaded bulk carrier *Mount Ymitos* could be considered as a typical example of documenting the involvement of human element in marine accidents (Atkinson, 1995). This accident happened near the Southeast Pass in the Gulf of Mexico, and both vessels were moderately damaged. The human errors that were pinpointed by the corresponding investigation were, the failure of officers on the *Noordam* to maintain a vigilant watch, the preoccupation of *Noordam* bridge crew with arrival activities and a certain lack of communication betwixt the two ships. Another similar example is the collision between the supply vessel *Galveston* and the Panamanian bulk carrier *Atticos* in the Lower Mississippi River near Venice, Louisiana (Atkinson, 1995). This accident resulted into the rapid sinking of *Galveston* and the loss of three of its crewmembers. The detected human errors were the failure of the *Galveston* crew to maintain a proper lookout (either visually or by radar), the insufficient time to adapt to the darkness and the failure to establish a proper passing agreement.

The International Maritime Organization (IMO) has developed prominent activities (guidelines, circulars etc) concerning the combination of human factor with safe navigation and management issues. Its focus is primarily on manning, qualification and licensing (STCW 95); safety procedures (ISM, which is the chosen vehicle of this paper); automation design (integrated bridges, human-machine interfaces (HMI), etc); communications; organizational practices and structures. All the above, target to the amelioration of human interference, in the context of an enhanced and more safe maritime transport framework.

The structure of this paper is as follows: the next section includes some findings concerning the involvement of human element in marine accidents. The following one gives a current view on IMO's actions and guidelines regarded human factor and safety. Thereupon, the introduced questionnaire on human aspects – regarding marine

safety and management – is presented in adequate detail. The penultimate section gives some original and revealing results coming from the analysis of the questionnaire feedback and the last one closes the paper with insights and conclusions on various points of the aforementioned topics.

### Human Element Statistics Regarding Marine Safety

The effort of allocating various forms of human error as verified accident causes is surely not a trivial task. Moreover, this difficulty is augmented in the case of maritime transport, since the respective monitoring and documentation is usually lacking of adequacy and excellence. Nonetheless, marine industry can be exemplified from other sectors of industry (e.g. civil aviation, nuclear plants etc), where considerable load of attention is already given in pinpointing and revealing various involved aspects of human element. Accident investigators in these industries do not simply cover the chronic events of an accident from a high-level point of analysis, but they actually try to efficiently incorporate in each methodology framework, the human factor in all of its subsequent forms. In this manner, risk assessment acquires solid and complete settings that can ascertain for realistic and useful results. The following short list gives some of the human-driven causes implemented for airborne accidents (ICAO, 1987):

- Failed to obtain/maintain flying speed, follow approved procedures, directives;
- Unsuitable selected area for take-off, landing, taxing;
- Inadequate pre-flight preparation etc;

Therefore, human behaviour and performance can be the prevailing factors that prescribe the level of safety for numerous maritime transport procedures and practices of management. This means that they can also influence, in a considerable degree, the protection of marine and coastal environment. Thus, a feasible way to reduce the frequency and severity of naval accidents is, by identifying the contributing factors to the so-called human error, and by investigating for methods, which will either eliminate or mitigate these mistakes.

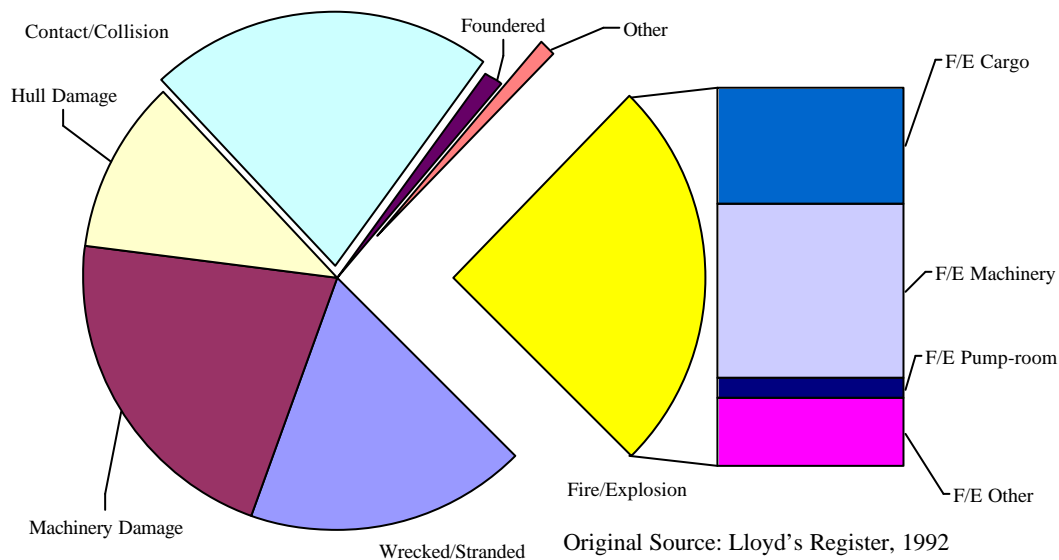


Figure 1: Analysis by Category of Casualty, 1977-1991 (Tankers, 6000+ GRT).

Figure 1 depicts the distribution of tanker casualties per accident category, for the time period 1977-1991 (IMO, 1992). It is evident that mishaps such as Fire/Explosions, Contact/Collisions and Groundings, are mainly responsible for the recorded tanker casualties. However, this analysis is in no position to reveal the actual causes that led to the aforementioned accidents and to come up with conclusions concerning the active involvement of human factor. This crucial weakness can be remedied with the dynamic incorporation of human element in the process at play. Hence, both human errors and error producing conditions can be assessed formulating a realistic approach to the actual event chain that constitute each incident.

A preliminary survey concerning the combination of human element and naval accidents is shown in Table 1. It must be noted that the implemented data are derived from the Transportation Safety Board (TSB), and they cover multiple vessel type casualties, for the time-period 1981-1992.

Table 1: Analysis of Causes (including HE) for Marine Accidents (1981-1992).

Cause	%	Contributing Cause	%
Outer Conditions	4		
Port/Harbour	2		
Navigational Reasons/Aids	1		
Other (Vessel)	3		
Vessel "Hardware"	16		
<i>Human Element</i>	74	Misjudgement (Captain)	11
		Misjudgement (Pilot)	34
		Communication Problems	10
		Misunderstanding	9
		Attention Problems (Pilot & Officers)	23
		Other Human Errors	13

Table 1 gives human element as the major cause for sea accidents, with a percentage of 74%. Therewithal, the problems of misjudgement (45%) and lack of attention (23%) are presented to be the most important ones from human factor point-of-view. The term "hardware" refers to vessels hull, main engine etc.

In general, human error is considered to be the preponderant cause for the majority of naval accidents. Relative studies come up with percentages from 70% to 95% (with an average value of about 80%) for accidents in the maritime transport chain. Crew costs correspond to about 10% of the total running costs (Welling, 1995). However, it this specific ship-cost category that is usually pressed down, in order to "balance" economically each vessel. This can be interpreted into e.g. cheaper labour, smaller crews, inadequate training; all these are constituents that enhance the probability for marine accidents.

Closing this section, Cpt. Ken Fullwood's words are mentioned: "The well known 80% of all marine casualties are caused by human error, is flat wrong. I believe human error – or poor judgement, which is the same thing – is a factor in 100% of accidents, or very close to it".

## Current IMO Perceptions on Human Element: Visions & Guidelines

As already mentioned, in the majority of maritime transport accidents, human behaviour and performance were the key factors that led to their beginning, escalation and conclusion. This means that the lack of various human-related aspects can and actually did play a burdensome role, regarding the various phases of a hazardous incident (Karydis & Vasilakos, 2000). Thus, it is imperative that all involved players should deal efficiently with the specific problem, aiming at the mitigation – if not at the prevention – of circumstances that foster the occurrence of accidents.

Nevertheless, IMO – many times in cooperation with other units, e.g. the International Labour Organization (ILO) – tries to formulate an operational and legal framework, to find solutions covering the manifestation of human element, in management issues and accidents that threaten either the ship, the cargo, human life or the marine environment. This denotes that IMO implements various state-of-the-art techniques, aiming at an enhanced survey on human element; some of these efforts are sententiously and indicatively presented below.

*International Safety Management (ISM) Code*: this is the international management code for the safe operation of vessels and for pollution prevention, which was adopted by IMO with resolution A.741(18) (IMO, 2001). Table 2 shows the ratified time schedule for the ISM Code. This effort scopes to apply structured human-oriented procedures (e.g. in management, documentation, training etc), in order to achieve enhanced safety for international shipping and alleviate consequent injuries, life losses and damages to the environment. So this Code poses human factor in the center of safety operations assigning to it what IMO refers to as “safety culture”: a self-willing commitment for every individual to contribute in “safer shipping and cleaner oceans”. This paper mainly utilizes the findings from the implementation of this Code, as the proper vehicle to pinpoint and analyse various human-driven aspects, in relation to marine safety.

Table 2: Ratified Time Schedule for the ISM Code.

Vessel Type	Date
Passenger Ships (incl. High-Speed Crafts)	1 July 1998
Oil & Chemical Tankers, Gas & Bulk Carriers, Cargo High-Speed Crafts (all above 500 GRT)	1 July 1998
Other Cargo Vessels, Mobile Offshore Drilling Units (all above 500 GRT)	1 July 2002

*Seafarers Training, Certification and Watchkeeping (STCW) Code*: this was adopted on 7 July 1995, entered into force on 1 February 1997 and it constitutes the attachment No 2 to the Final Act of the Conference of Parties to the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (IMO, 1996). This Code comprises of 2 parts:

**Part A.** It is the mandatory part of the Code that describes the minimum standards that fulfil the provisions of the STCW Convention.

**Part B.** It the recommended part/guide targeting to the unimpeded enforcement of the STCW Convention.

STCW addresses the issue of crew competence. Hence, it handles matters of fatigue, training, survival functions, occupational safety, watchkeeping etc – e.g. Chapter VIII, Section A-VIII/1, *Fitness for duty*, Chapter VI, Section A-VI/3, *Mandatory minimum training in advanced fire fighting* etc. Furthermore, STCW provides for certain characteristics/qualifications for the corresponding assessors – e.g. Chapter I, Section B-I/6, *Guidance regarding training and assessment* etc. It must be noted, that the STCW Convention does not deal with manning levels; Chapter V, Regulation 14, of the new International Convention for the Safety of Life at Sea (SOLAS), covers this topic along with resolution A.890(21), adopted by the IMO Assembly in 1999.

*Formal Safety Assessment (FSA) & Human Reliability Analysis (HRA)*: IMO has introduced FSA, which is “... a structured and systematic methodology, aimed at enhancing maritime safety, including protection of life, health, the marine environment and property by using risk and cost/benefit assessments” (IMO, 2000). Under this perspective, the human element can be incorporated in the specific process by implementing HRA, mainly in Step 1 (*Identification of Hazards*), Step 2 (*Risk Assessment*) and Step 3 (*Risk Control Options*) of FSA. More specifically, HRA consists of the following stages (IMO, 2000):

1. Identification of key tasks;
2. Task analysis of key tasks;
3. Human error identification;
4. Human error analysis;
5. Human reliability quantification.

Hence, IMO proposes to quantify the relative contribution of human factor, in order to evaluate its realistic value concerning mainly the escalation of marine accidents.

*Human Element Vision, Principles and Goals for IMO*: in November 1997, resolution A.850(20) was adopted regarding human factor matters; this resolution is focused on human-driven activities concerning the safe operation and management of commercial ships, and the adequate protection of coastal and marine environment. The endmost vision of this effort, is to improve the performance and behaviour of human element, whereas at the same time it is aiming at simpler regulations, better dissemination of relative information, effective remedial actions, involvement of the entire operational spectrum (e.g. shore personnel, crew, shipowners etc), enhanced training, better working conditions etc. *Inter alia*, resolution A.850(20) attempts to record and handle issues capable to denote numerous Performance Shaping Factors (PSFs), which are parameters that can have either negative or positive effect on human behaviour/ascription; these factors may be experience, situational stress, HMI etc (IACS, 2002). In particular, HMI cover a very promising and significant area, which can ameliorate human behaviour, especially in cases of navigational problems and mishaps (also vide ISO 13407, *Human Centred Design Specification*).

#### Human-Related Questionnaire: Introduction & Presentation

The presented questionnaire was initially developed and utilised, in order to evaluate potential trends, perspectives and difficulties faced by companies – that is mainly from a human factor point-of-view – when implementing the ISM Code (IMO, 1994).

The first phase of ISM implementation, as already known, started in July 1998 and it was the milestone for all companies, dedicated to transport dangerous goods, bulks and passengers. After 4 years of continuous updating of the questionnaire database, the gathered data were considered adequate enough, primarily to evaluate the success of this IMO instrument, in improving operations within companies. At this point it must be noted, that the working sample size comprises of about 100 company/ship questionnaires; this can be translated personnel-wise, into a rather rich sample, coming e.g. from crewmembers of tankers, bulk carriers, general cargo vessels, RoRos etc (mainly selected with port state control criteria). Hence, it is able to draw a general picture concerning the resultant improvement in maritime safety and the consequent reduction of marine pollution. The interest in the ISM Code and its achievements (including human factor, administration and marine safety amelioration) is justified, because of the deep concern of the maritime community on safety and management measures and policies.

Prior to the detailed presentation of the aforementioned questionnaire and the subsequent analysis of its results, this paper describes sententiously the definition, the objectives and the provisions of the ISM Code.

Thus, the ISM Code is an international management code for "...the safe operation of ships and for pollution prevention" as adopted by IMO through an amendment to the SOLAS Convention, Chapter IX (IMO, 1997).

Within this context, every ship owner should establish a safety (and environment-friendly) policy that describes how the various safety-management objectives of each company will be achieved. Additionally, this management manual should be approved by the selected Administration. The adopted policy should ensure the compliance with mandatory rules and regulations, guidelines and standards recommended by IMO, national administrations, classification societies, shipping community etc. Under these premises, every company should develop, implement and maintain a safety-management system (SMS), which should include proper directives/guidelines, in order to ensure adequate administration, safe operation for ships and satisfactory protection of marine and coastal environment. In few words, such a scheme should comprise the following actions:

- Provide for safe practice in ship operations and for a safe working environment;
- Establish numerous safeguards against all identified risks;
- Continuously improve safety-management skills of personnel ashore and on-board ships, including awareness for emergency situations (including safety and environmental hazards).

The company must show to the Administration – or to any other authorised organisation responsible to assess compliance with the Code – that all of its policies and procedures are being implemented in a practical and harmonized way. Only then, the Administration can and will issue the Document of Compliance (DOC – for the company) and the Safety Management Certificate (SMC – for the vessel). Since July 2002, all shipping companies are obliged to have SMSs in place, aiming at safe vessels and clean seas.

Continuing with the presented questionnaire, it must be noted, that it was initially submitted – for approval – to the members/participants of the European Thematic

Network, THEMES. More specifically, Spanish, Portuguese and French partners sent the inception draft to a few selected shipping companies for testing purposes. After receiving and evaluating the feedback information, the final version was approved and eventually sent out to a wider sample of companies all over Europe.

The structured questionnaire comprises of five major parts (Martínez de Osés et al, 2001):

**Part A.** Company identification data;

**Part B.** Management;

**Part C.** External input;

**Part D.** People;

**Part E.** Possible results from adopting the “safety culture”.

More specifically, part A was intended to obtain information on each interviewed company, in order to set its input in the proper context; e.g. concerning the kind of the selected company, if it is a ship-owning or a ship-managing one, the kind of ships operated and the existing date of certification, indicating the quality and standards of the utilized certifying organisation. Some of the most representative questions included in part A, are presented below:

- *It is your company primarily a: Shipowner, ship manager or ship manning?*
- *Which type of vessels does your company operate?*
- *What is the number of vessels of your fleet?*
- *Was your company certified by: Directly by the Maritime Administration, Classification Society or other?*

The second question was addressed, in order to focus on the type of traffic that the interviewed company was involved into, and then to quickly identify if the company was obliged to develop and maintain a SMS, at the specific date (prior to July 2002). The third one was included in the context of classifying the company by its own size and the last question was embodied in the questionnaire, so as to receive more qualitative and exploitable information, as far as the company certification status is concerned.

Part B was developed to identify the trends and prospects “behind” the implementation of the ISM Code. It assays to shed some light on whether the companies have adopted the guidelines of ISM Code forced from the fact that it was made compulsory, or because it fitted into the company strategy and would have been implemented, irrespective of the circumstances. Part B also intended to find out whether the company was already ISO certified, at the time of the ISM Code implementation.

One of the key questions of part B is whether “*ISM implementation process led to changes into the company policies*”. At this point it must be noted, that a significant number of answers to the questionnaire, were obtained from oil-related companies, e.g. D’Amato di Navigazione, Naftomar etc. Therefore, a critical mass of the incoming answers indicated that the implementation of ISM was not equivalent to a new line of responsibility. On the contrary, it led more towards a structured reinforcement of their safety measures and to an upgraded concern for the responsibilities inherent in every rank and functions of the shore staff and vessel crew.



Another set of questions made in the context of part B, was in reference to quality systems, such as the following one:

- *Is your company also certified according to ISO standards (e.g. ISO 9000)?*

The intention for the above question was to know how many respondents wanted to take advantage from the compulsory application of the ISM Code and with some extra effort from their part, to acquire a certification in quality, in order to improve the commercial image of their company.

Part C of the questionnaire, aimed at obtaining information regarding the support provided from the Flag States during development, implementation, testing, auditing and certification, as far as the application of the ISM Code, and the corresponding human element compliance are concerned. Questions posed in this part were in the line of:

- *Have the Flag States, where your vessels are registered, communicated any initial certification 'threshold'?*
- *Have the Flag States, where your vessels are registered, supported and encouraged the improvement of safety management skills?*

The recorded answers to this part of the questionnaire were expected to depend mostly on the "quality" of the Flag State, in which the ship was regularly flagged. Indeed, in the case of traditional maritime nations (e.g. UK, Greece etc), the state was supporting the implementation of the ISM Code, with the occasional aid from classification societies; whereas for flags of convenience (e.g. Honduras, Bahamas etc), it was the classification societies, the endorsed and authorised vehicle to carry out the necessary processes.

Part D intended to obtain information on the levels and practices of training, both for shore and sea personnel; it should be noted that this set of questions are focused exclusively on human factor behaviour and performance. Hence, the questionnaire feedback for part D is extremely important for depicting the strong points, the weaknesses, the opportunities, the techniques and the possible improvements of human element. This part is very closely related to STCW 95 and its recorded implementation, in case of monitoring and evaluating the crew.

The provided questions of this part of the questionnaire were formulated to investigate, whether ISM implementation and additional human factor issues were encountered, as a fruitful occasion to check upon and improve the existing qualifications of crews. This could be done taking into account, e.g. the quality assurance and responsibility distribution among the shipping company personnel, prefixed standards concerning human element behaviour, predetermined procedures for on-board operations etc. In line with the above, the following questions were posed regarding the measures and practices that were adopted by companies, in order to ensure the proper level of training. Actually, training can be handled as one of the main constituents of human factor performance, but at the same time, it cannot always give the desired results. Thus, the questions below can indicate part's D generic direction:

- *Has the implementation of the ISM Code obliged to an increase in the checking of seafarer's qualifications and certification before being enrolled in the company's vessels?*

- *Did new type of training for shore based personnel had to be established as result of the implementation of the ISM Code? – Could you specify the new type of training that was put in place?*
- *Did new type of training for sea based personnel (vessel crew) had to be established as result of the implementation of the ISM Code? – Could you specify the new type of training that was put in place?*
- *What new information is being sent to the vessels as result of the implementation of the ISM Code?*

Additionally, the questions of part D aimed at whether the companies, according to the spirit of STCW 95, had already developed some kind of private and supplementary training, or everything were simply driven by the enforcement of ISM. The key point is the determination of numerous shipping companies to improve their training standards, through a voluntary and highly efficient approach, regardless of IMO efforts to introduce ISM.

In part E, the questionnaire intended to obtain information on any available result related to the implementation process, addressing human factor reaction, compartment and ratings. It is recorded that even though more than 4 years have elapsed since July 1998 (first phase of the ISM Code), it is still soon to determine and evaluate the real effects of this IMO instrument, mainly on human factor and managerial procedures. Nevertheless, there are some areas that can already provide certain and valuable trends and conclusions. Accordingly, this part targeted to obtain information on:

- Number of accidents;
- Number of incidents or reported near misses;
- Economic effects, such as insurance premiums or costs of repairs.

The comments coming from this part of the questionnaire were the most valuable in qualitative terms, because of the broad spectrum of possible answers for the interviewed companies and personnel. The provided answers were proven significant on depicting company results, practices, comprehensive human behaviour and consequent gained experience. Indicatively, one of the questions included in part E, was the following quantitative one:

- *Please give the number of deaths and personnel injuries, the number of commercial contracts, the volume of the company fleet, the number of vessel accidents, possible insurance premium bonuses and the number of reported near misses since the date that the company adopted its Safety Management System.*

The above question assays to evaluate any possible changes on various patterns and tendencies concerning marine accidents (possibly with human factor as a mishap cause), or any commercial benefits arisen from the implementation of a SMS. The last question of this questionnaire cluster provides an opportunity to each of the interlocutors to state their feelings and opinions regarding the implementation of SMS and its real effect on the benefits and difficulties of all relative maritime transport segments. This yields to a special focus on human element behaviour and performance, in order to probe, all interconnected causes and relations that lead to marine accidents. The rest of part E questions were addressed to investigate whether the introduction of the ISM Code improved the work conditions and load in the company/vessel; and to pinpoint any specific difficulties encountered within the

working practices in the company/vessel. At the same time, the questionnaire is checking on the maintained communication between shore-management and the ship; this provides the necessary means for reporting deficiencies and non-conformities related to safety and management issues.

### Questionnaire Results: Human Aspects Concerning Maritime Safety

The results yielded from the examined questionnaire cover an extensive spectrum of topics that actually can reflect numerous human aspects and various regulatory practices related to maritime transport. In particular, the questionnaire addresses human factor, either through a structured bypass approach, such as is the ISM Code, or in a direct manner, e.g. marine accidents, workload, working environment etc.

In this context, the provided results depict a generic attitude of a rather large, yet “quiet”, number of respondents, particularly seafarers, who believe that the systems currently in place are generating far too much paperwork, and they are requiring additional administration and resources onboard ships. Nevertheless, an important fragment of them appear to be prepared to give ISM a real chance, even if they have already been overtaken by mountains of paper. Moreover, a certain number of individuals have used a very similar language, in order to allude towards the same consequence; that is the failure of relative efforts, if something is not done to reduce the paperwork and administration. Questionnaire data reveal that the filling of ISM checking sheets, is a time consuming task and most of the times done quickly, with no special attention to the actual process. The questionnaire also shows that seafarers have informed, their shore management, of the pressure that they feel, in order *‘to complete the paperwork within the time frame, under STCW rules’* (Martínez de Osés et al, 2001). Hence as the answers manifest, this may resort to filling in forms and writing reports on watch, at the expense of maintaining a proper lookout and attending to the navigation of the vessel. Such a practice can be considered as a potential contributing factor to marine accidents that are usually characterized as human-driven accidents. Accordingly, Phil Anderson warns: *“... this is not only an ill-advised, highly dangerous practice, but has to be the ultimate irony as far as the whole philosophy of ISM is concerned”* (THEMES meeting, Brussels, Feb-2002).

Many of the comments recorded in the survey, suggests that a significant number of seafarers, who perhaps started off with enthusiasm for ISM and other safety related issues, are now losing faith concluding that there is a gap in this area. Phil Anderson stated on this matter: *‘clearly this is very serious and we need to consider whether such a conclusion is warranted’* (THEMES meeting, Brussels, Feb-2002).

The above findings are depicted in Figure 2, which shows a generic view concerning the acceptance of crewmembers for the ISM Code and other novel safety-oriented initiatives. Thereby, according to the existing feedback of the specific questionnaire, only the 40% of the examined cases seem to be positive towards the guidelines and practices arisen from this IMO instrument. The rest 60% holds a negative position, mainly because of the extra paper work, which is time and cost consuming. It must be noted that the aforementioned percentages reflect the opinions of experienced and active sea personnel who have to deal with such issues on a daily basis. This does not mean that they oppose in any way, to the enhancement of marine safety, but on the contrary they criticize some side effects of the specific effort (particularly concerning

its first years of practice), in order to augment safety and secure all stakeholders at play. From human element point-of-view, extra paper work can point to additional workload (which can mean fatigue, ennui etc), or even negligence of prescribed duties; circumstances that are able to lead to marine accidents attributed to human-related aspects.

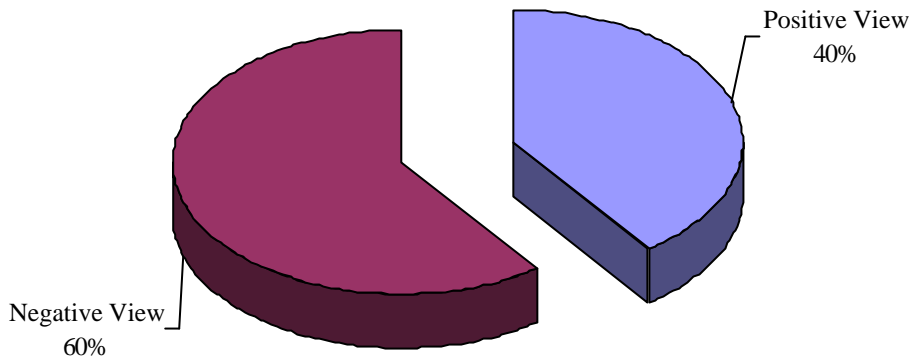


Figure 2: Human Response towards ISM Implementation & Other Safety Initiatives.

Howbeit according to the questionnaire feedback, there are ship operators, masters and seafarers who seem to have passed through the “pain barrier” and can see the light at the end of the tunnel. They are describing systems, where the paperwork and administration are under control, there is full support and commitment from shore personnel (company) and profits are augmenting. The above-described picture also indicates a substantial potential for future decrease of marine accidents that are related to human behaviour and comportment. In this context, Table 3 gives tentative, yet revealing, results on some basic human-centred causes that, according to the answers from the questionnaire, led to marine accidents. In general, the indicative figures included in Table 3 are in line with other similar efforts (e.g. MAIB, DNV etc), but at the same time it must be underlined, that the evaluation of human-related results need extreme caution and prudence.

Table 3: Distribution of Human-Oriented Causes for Marine Accidents.

Basic Events	Percentage (%)
Wrong speed & Incorrect use of radar	15,5
Inadequate performance of Officer on Watch	32,0
Wrong use of equipment	2,0
Misunderstanding due to language problems	1,0
Misunderstanding due to lack of training	1,0
Procedural problems	2,0
Incorrect decisions & actions due to stress, fatigue & training	30,0
HMI problems	0,5

As it can be seen in Table 3, according to the presented questionnaire, the inadequate performance of officers on watch constitutes the most frequent type of human-driven marine accident; this failure applies mainly for the categories of collision/ramming, power grounding and foundering, in various types of vessels. It seems, that the introduction of STCW 95 has not yet resolved all issues concerning the proper way of

watchkeeping, posing the implementation of STCW regulation/guideline, Chapter VIII, Section A-VIII/2, Part 3-1 and Section B-VIII/2, Part 3-1, *Navigational watch*, in question. More specifically, the most common violations recorded are the following ones:

- Bridge unattended or under manned;
- Limited visibility;
- Unexperienced officers;
- Officers non-familiarized with the vessel.

All these components should be mitigated, as result of company policy, crew motivation and efficient regulatory regime. STCW provides a detailed list of watchkeeping duties and obligations, in the outline of safe vessel navigation. However it is evident, that the success of this task lies entirely on human factor and its aspects. Therefore, the element of motivation or the avoidance of tedium/stress situations for the crewmembers should be considered as possible ways out, with the desired results.

Table 3 also shows that a very large portion of human-driven causes for marine accidents has to do with incorrect decisions and actions due to stress, fatigue and lack of training. It should be noted, that these parameters are allocated to all types of vessels and sizes, but they are mostly related with types of accidents such as, powered grounding, collision/ramming, fire/explosion and mechanical problem. Once more, a rather complete regulatory regime is not capable to fill the inadequacy of human behaviour and performance. STCW in Chapter VIII, Section A-VIII/1, *Fitness for duty*, gives the respective standards (e.g. 10 hours of rest per day), in order to eliminate the possibility of fatigue during watchkeeping. Moreover, SOLAS in Chapter III, Regulation 19 *Emergency training and drills*, and Regulation 35, *Training manual and on-board training aids*, and ISM Code in Chapter 6, *Resources and personnel*, and Chapter 8, *Emergency preparedness*, cover adequately the issue of training with multiple guidelines on the specific topic. Nevertheless in all cases, the key factor is again the performance of human element, even in the form of company management policy; motivation, training, workload, working environment, fatigue, stress-free situations, alcohol-free practices, attention, leadership etc are important constituents towards the enhancement of marine safety, from human factor point-of-view.

Another human-oriented problem included in Table 3, is the misunderstanding due to language problems; the specific questionnaire has recorded maritime accidents that were at least, partially attributed to such difficulties. This is another example of human failure leading to accident, even if the corresponding regulatory framework exists. In particular, the ISM Code in Chapter 6, *Resources and personnel*, provides for a common working language on-board the vessel to avoid similar problems and consequent mishaps. Only it is the crewmembers that are called to follow these guidelines, and make sure that such problems will not affect the safe voyage of the vessel.

The implementation of novel safety-oriented schemes is in position to enhance the standing benchmarks of maritime transport, as far as safety and productive management are concerned. ISM can be viewed as a typical to-be example for the aforementioned perspective. Thus, the elimination of a number of known accident

causes – related to the human factor component, e.g. extra workload, distraction of attention etc – may lead to safer and error-free voyages. Figure 3 depicts the questionnaire feedback concerning seafarer views on the number of vessel accidents in conjunction with ISM and relative IMO guidelines. The majority of these answers point towards positive trends; that is, at least the preservation, or even more, the enhancement of marine safety and consequently, the decrement of the number of vessel accidents.

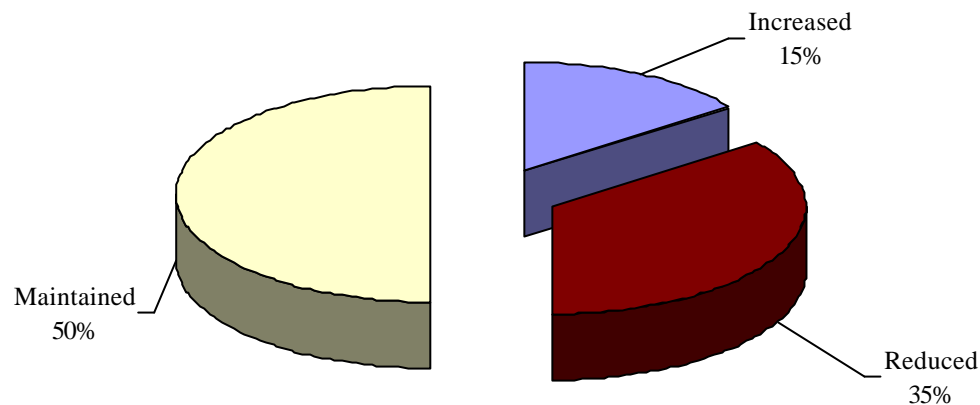


Figure 3: Quantitative Trends of Accidents as a Result from ISM Implementation.

According to Figure 3, seafarers seem to support that ISM has the potential to enhance accident wise maritime safety, in a certain degree. *Inter alia*, they focus on ISM, Chapter 9, *Reports and analysis of non-conformities, accidents and hazardous occurrences*, which manifests that the implemented SMS should ensure that all problems will be apart from reported to the company, thoroughly monitored and investigated, in order to improve safety and prevent pollution. Likewise, ISM Chapter 7, *Development of plans for shipboard operations* and Chapter 8, *Emergency Preparedness*, are believed to pay an important role into vessel safety, whereas ISM Chapter 10, *Maintenance of the ship and equipment*, settles the maintenance topic in a structured and efficient way. Moreover, ISM Chapter 12, *Company verification, review and evaluation* covers all the actions necessary to uphold an adequate SMS. Seafarers perceive that the common point of all these guidelines is the allocation of responsibilities to shore (company), which is considered a rather fruitful step towards a realistic approach to the risk exposure matrix. Shore personnel should take their actual share of responsibility, in the outline of an effort aiming at safe vessels and clean seas.

The negative trend in Figure 3 (15%) is based on the opinion of few of the interviewees, who seem to believe that human involvement in marine accidents can be increased, due to the implementation of ISM. These crewmembers feel that problems such as extra paperwork, augmented workload, lack of initiative etc will overcome the benefits from ISM and lead to maritime accidents. It should be mentioned that this type of answers were acquired mainly from European Union (EU) crews.

The common belief should be that ISM can work and strengthen the safety framework of maritime transport procedures. It is in a position to aid human performance in a multi-fold manner, in order to mitigate its critical involvement in the vast majority of

marine accidents. IMO and the rest of the maritime community need to look very carefully at what several shipping companies have achieved in this area. More specifically, they should focus on how they have overcome the paperwork and administration problems, and how they have motivated their staff to persevere with the implementation and maintenance of their SMSs. According to the questionnaire, shipping companies have increased the screening of potential crewmembers – based on their qualifications and certifications – during their enrollment phase, as a result of ISM implementation. Indeed, Figure 4 shows that about 73% of the interviewees state that ISM has ameliorated the recruitment procedures targeting to well-trained and motivated crews. The specific upgrade of sea personnel results to better human behaviour and performance practices and to the enhancement of maritime safety levels.

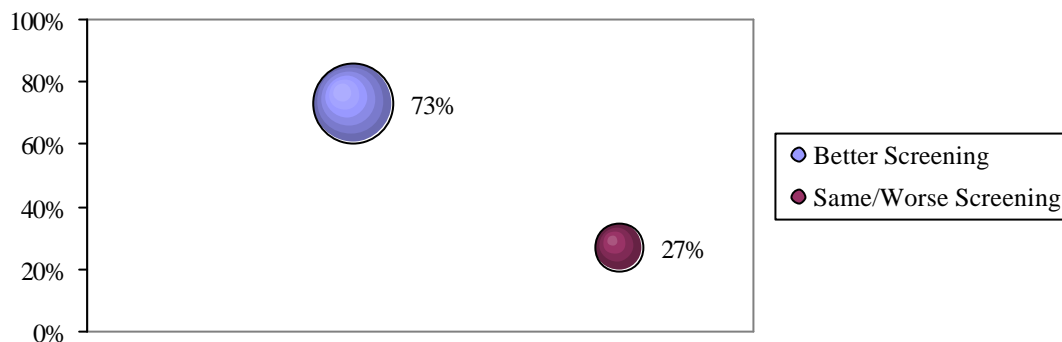


Figure 4: Enhancement of Crew Recruitment Standards due to ISM Implementation.

ISM Chapter 6, *Resources and personnel*, creates the generic framework for the results included in Figure 4. The key point arises from its structured approach, which includes the corresponding STCW standards. This means that the implementation of ISM forces the shipping companies to document their screening procedures, in order to prove that they comply with STCW 95 (e.g. Chapter II, Regulation II/3, Section A-II/3, *Deck department: Minimum mandatory requirements for officers in charge of navigational watch*). Hence, it is expected that the recruitment standards will improve, resulting to qualified crews on-board vessels.

Another important finding derived from the presented survey was the contradictory views and perceptions concerning human element matters, between EU crews and personnel and those coming from shipping labour countries (e.g. Philippines, Ukraine etc). In particular, seafarers from economically advanced nations are mainly holding the middle ground, if not leaning towards a rather negative attitude towards the role of ISM and the consequent amelioration of human behaviour and comportment. However, when the opinions of other nationalities are also taken into account, then an enormous shift is recorded towards a positive stand; provided that all paperwork and practical problems can be solved, in order to diminish relative accident causes (e.g. distraction, boredom, etc). Thus, a significant cultural issue can be identified from the aforementioned observation. Masters and officers from western cultures believe that they derive from old, established shipping companies or traditions, where safety was already being effectively managed. To these people, this IMO instrument was neither wanted nor needed and has not contributed to increased safety standards or reduced rate of accidents – especially for the types related to human errors. On the other hand,

it maybe the case that some of the “non-western” nationals, who do not come from such traditions, have found indeed that the ISM Code provides them with a good and sound structure to manage maritime safety; proving a *de facto* valuable and useful tool. Under the umbrella of a SMS, they feel that they are given a more productive and friendly working environment, while at the same time they enjoy the absence of certain human-oriented contributing factors to marine accidents.

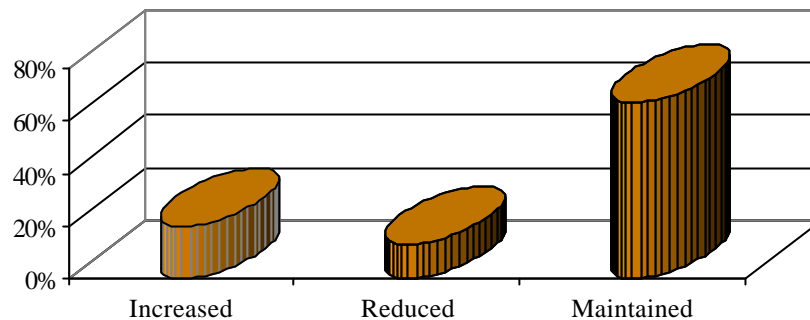


Figure 5: Insurance Fees and Maritime Safety Scheme (ISM) Implementation.

The questionnaire reveals that most surveyed individuals think, more or less, in the same manner, when the insurance premium is concerned; they hold a rather conservative stance regarding the implementation of various safety schemes, like ISM and the transition of insurance fees. Figure 5 shows the results that are derived from the questionnaire feedback, where it is evident that the majority of the answers give a neutral view for insurance costs in the maritime industry. Only about 13% of the questionnaires support the line of reduced insurance fees, as result of IMO guidelines for human factor and safety (ISM); fact that should be addressed in depth.

### Conclusions

Safety is a crucial attribute relating to maritime transport; more specifically, it has many facets and it is difficult to deal with – even more in a proactive sense. At the same time, marine safety is considered to be indispensable for a viable and “attractive” maritime transport network. Its deficiencies can have an important impact on various maritime transport stakeholders (e.g. crewmembers, passengers, cargo, shipping companies, sea and coastal environments etc), as well with damages to third parties. The development of a full proof structure from safety point-of-view is definitely not a trivial task, yet an efficient approach should be configured in order to achieve the best possible results.

Statistics show that the most common accident types for commercial vessels are, fire/explosions, mechanical problems, collisions, groundings and hull damages. Moreover, the pivotal cause for the occurrence of these accident lies on human behaviour and performance; that is on human element. Its interference can militate on various procedures and event chains, causing more problems and provoking unpleasant consequences, or on the other hand improving difficult situations and even preventing the escalation of threatening incidents. The term human factor is an umbrella that covers various human-related aspects, such as training issues, problems on watch, lack of concentration, communication problems, fatigue etc. Additionally,



marine safety can be enhanced through management practices, knowing that a suitable framework can relief certain difficulties encountered in the maritime transport system.

Under this perspective, IMO has issued several regulations focusing on human element and maritime safety; ISM is one of the most important of them. It was developed to enforce, through predetermined and established guidelines, safety practices on board ships targeting to the protection of human lives and the preservation of the corresponding environment. Hence, ISM is considered a prime vehicle to introduce solid safeguards and acknowledge useful practices for the *day-to-day* ship and company routine. ISM addresses the responsible party for every task, brings forward structured checklists for every action done onboard vessels and generally creates a safety net for the sea and shore personnel. The key issue for a fruitful implementation of ISM is, the success of a well-balanced equilibrium between extra workload and safety motivation (safety culture) for crew and shore personnel. SMS should not allow, in any case, the crew (which could be stressed, under manned etc) to focus on the relative paperwork and not to pay attention to fundamental duties during a sea voyage, e.g. keep a proper look out, avoid a main engine black out etc.

The presented questionnaire has to do with marine safety and safety management (ISM) issues, from human element point-of-view. Its development, in a structured way, aimed at presenting the true consequences derived from ISM implementation and the impact of human factor on marine safety. As already mentioned, the documentation regarding the involvement of human element in accidents (for the maritime industry) is poor up-to-date; therefore similar efforts should be viewed as useful instruments in formulating the generic safety component, in the outline of maritime transport. Recapitulating, the following findings from the specific original questionnaire can be highlighted:

- Shipping companies have placed their attention mostly on safety-related aspects, such as prevention and training, which are mainly, if not exclusively, human factor aspects. Marine safety has been understood to be the main goal of ISM, dragging other related questions behind its wake.
- The implementation of ISM has made documentation and report management much more complicated. For instance, the corresponding extra paperwork (justification of every action) has brought the crew to a boring situation, which can increase the possibility of marine accidents due to human errors; this is a fact that should be efficiently dealt with. Authorities, companies etc should not permit to some possible weaknesses of the SMS approach to overshadow its numerous safety-driven advantages; a crucial fact is that human factor can be adequately positioned in a broader maritime framework, in an objective sense.
- There are certain cultural issues that lead seafarers from labour supplying countries to a favourable opinion for the ISM Code. The real reasons can only be assumed, but it is completely understandable that labour-force providing countries do not possess a deep culture in safety aspects; like within their educational process. Thus, they perceive SMS as a good guide of procedures and liabilities, in order to succeed adequate performance and enhanced safety.
- In case of an accident, the use of ISM guidelines improves specific points of the action/event chain that finally concludes with the unfortunate mishap. However, there are a lot “deeper” topics, such as personal motivation, crew attitude and predisposition, or even the subject of crew honesty towards a necessary investigation, that still need to be addressed. Questions as fundamental as log

book disappearance after an accident (e.g. in the case of the single hull M/T PRESTIGE) should be considered essential from safety point-of-view, and non-existent within a proper SMS approach.

- It seems that an important portion of human-driven marine accidents can be attributed to inadequate performance of officers on watch. IMO has already addressed strongly this matter with the introduction of STCW. Another big part of human related accidents comes from incorrect actions and choices due to fatigue, improper training, stress, boredom etc. Other significant human-centred accident causes is related to the improper usage of radar and the incorrect choice of vessel speed or to language problems etc.
- The interviewees believe that the implementation of safety-oriented schemes, such as is the SMS approach, can at least maintain, and hopefully reduce the number of ship accidents on a yearly basis. This is done because this effort handles efficiently human factor issues and therefore, assays to neutralize a basic player/cause concerning the occurrence and escalation of maritime accidents.
- The general view concerning the implementation of the Code is negative to a percentage of 60% of the recorded answers. This occurs because seafarers strongly believe that ISM is equivalent to extra paper work, increased workload, worst working conditions and time and cost consuming tasks in expense of marine safety. Whereas, the rest 40% maintain a positive attitude, pinpointing the numerous advantages of this instrument and conscious that there are changes taking place regarding the philosophy of shipping companies and the mentality of their shore and sea personnel.

It is obvious, that the passage towards safer ships and cleaner seas crosses the sector of human behaviour and performance; the reduction of human faults should be viewed as the key achievement, in the context of such an effort. Fewer human errors can be safely translated into less accidents, fewer fatalities and oil spills and enhanced levels of safety concerning all maritime transport practices and procedures.

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