Safety Culture, the Cure for Human Error: A Critique

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Abstract

Since the initial adoption of maritime safety standards, the focus was always on the ship's design and equipment; nevertheless, many studies have revealed later that human factor and human error are the main reasons contributing to marine accidents.

By the mid 1980's the International Maritime Organization (IMO) gave attention to the role of human factor in the maritime accidents. IMO have adopted the concept of implanting the safety culture in shipping industry.

The most significant instruments which were introduced to create safety culture are the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW 78/95) convention and the International Safety Management (ISM) code.

After five years of implementing the two instruments, important questions which raise themselves now are: have ISM Code and STCW convention achieved their initial objectives related to the improvement of human performance in ship operations. Moreover, is safety culture rooted in the shipping industry?

Keywords: Maritime safety, human factor, human error, marine accidents, safety culture, ISM Code, STCW convention, human performance.

1. Introduction

The Sinking of SS 'Titanic' on 1912 was the initial incentive for the international maritime community to set up safety standards in order to reduce accidents at sea, and that resulted in the adoption of SOLAS convention and later led to the establishment of IMO.

Initially, the main focus was on enhancing the technology of ship design and operation, as well as introducing regulatory system on international basis to ensure safety at sea and preservation of the marine environment, over and above, the adherence of ships crew and operators to such regulations.

However, there was a lake of attention to the human/system interface, the so called human factor, and the role of the human in maritime accidents. Factors such as sophistication of modern ships, multinational crew, the lack of proper competency, education and training system and many others resulted in the increase of the number of maritime accidents as a result of human errors, which has establish the need for improving the performance of human element, by studying the causes of human error and how to overcome it.

Salvendy (1997) has defined Human factor as a discipline regarding human abilities and limitations in relation to the design of systems, organizations, tools etc. Important parameters are safety, efficiency and comfort.

Human error is defined as a result of observable behavior originated from psychological processes on different levels such as, perception, attention, memory, thinking, problem solving, decision making, evaluated against some performance standards, initiated by an event in a situation where it was possible to act in another way considered to be right (Senders & Moray , 1991).

2. The factors effects the role of human in shipping

The human role is vital in the shipping industry; ships require well trained and motivated crew in order to operate safely and efficiently. Recognizing that most of the accidents are preventable and normally occur following unsafe action or failure to correct procedure, seafarers need to be provided with the appropriate tools and be properly trained to perform their duties safely and efficiently. In other words the quality of output mainly depends on the quality of input.

According to Squire (2006), the personal output of the seafarer is dependent of seven needs:

2.1. **Competence**: the seafarer's level of competence will depend not only on good and effective education and training and realistic competencies, it also on the ability to absorb knowledge and to understand the subject and his own skill and proficiency.
2.2. **Attitude**: the seafarer's attitude towards education and training will be given by his mental ability, intelligence, personality, character and sensitivity. Self-awareness and self-evaluation are the key drivers.
2.3. **Motivation**: motivation is driven by good communication, direction, teamwork, empowerment and character building in order to provide the seafarer with a sense of leadership, interoperability and adaptability.
2.4. **Happy and healthy life style**: a happy and healthy life style through the encouragement of a balanced diet, good hygiene, exercise, rest and recreation, together with acceptable standard of habitability and regular medical screening, including drug and alcohol testing, will ensure that the seafarer has the energy, physical fitness, physical strength, stamina and a sense of wellbeing to enable him to do the job.
2.5. **Safe and secure working environment**: good ergonomics, safe working practice, the provision of protective equipments, together with the proper physical security will lead to an improved safety culture and greater security awareness.
2.6. **Self-actualization**: personal ethics, conscience, cultural integration and leadership, together with proper supervision and adequate remuneration can generate a sense of pride and purpose, identity, conviction, trust, expectation, realization, belonging, loyalty, esteem, fellowship and personal security.
2.7. **Moral values**: Moral values are equally important; an awareness of the various religious beliefs, together with one's personal faith and self-discipline are driver towards cultural awareness.

It's the role of maritime administrations to ensure that many of the above mentioned needs are satisfied, such as the establishment of good maritime education and training (MET) system, living conditions onboard, the working environment, working and rest hours, and

most of all, verifying that the ship is complying with all the national and international regulations related to safety, environmental protection and seafarer's rights.

On the other hand, ships-owners are responsible for providing safe and secure working condition, decent working and living conditions, and reasonable terms of employment among other needs. Subsequently, it's the duty of seafarers themselves to use all the available tools to satisfy their needs.

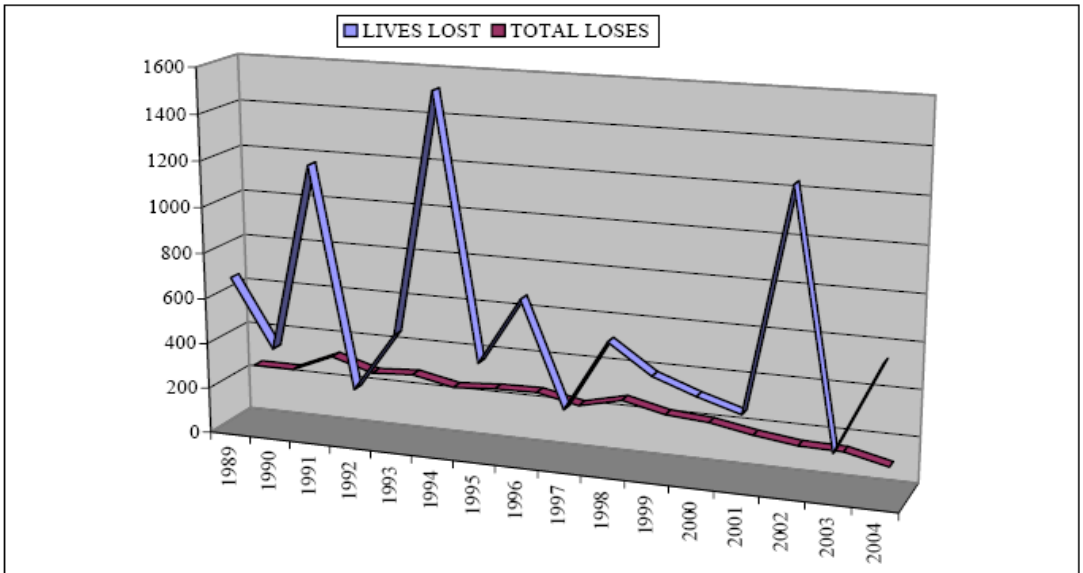
3. **The role of human factor in maritime accidents**

Accidents are unplanned and unintentional events that result in harm or loss to personnel, property, production, or nearly anything that has some value. Consequently, these losses increase the operating costs.

The IMO's Code for Investigation of Marine Casualties and Incidents defines marine accidents as, an occurrence or event being caused by, or in connection with, the operation of a ship by which the ship or any person is imperiled, or as a result of which serious damage to the ship or structure or the environment might be caused.

Talley (2002) has classified the main causes for maritime accidents as follow:

3.1. Flag of convenience
3.2. Doubts about the vessel safety enforcement performance of classification societies
3.3. Shirking crew size
3.4. Vessel maintenance
3.5. The aging of world fleet of dry cargo vessels
3.6. Insufficient fire protection and instability of ferry vessels
3.7. Human factor



	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
LIVES LOST	688	389	1204	246	504	1552	419	710	257	566	439	373	317	1274	197	589
TOTAL LOSES	244	244	321	266	278	240	254	257	219	263	220	206	173	148	144	101

Figure (1): Statistics on total loses of ships of 100 GT and above and losses of lives as a consequence to the total losses (source: IMO causality statistics and investigations, very serious and serious casualties for the year 2003)

It seems to be common knowledge that a majority of accidents are actually caused by human factors or human error. Recently, an analysis of 187 instances of groundings and collisions carried out by IMO's Sub- Committee on Flag State Implementation (FSI) indicates that in 150 cases 80 per cent the human element was a contributory factor (E.Mitropoulos, 2006); the analysis indicates also that there are fewer accidents are caused by technical failure.

According to O'Neil (2000), the shipping industry cannot go on this way, with over 1000 deaths from accidents among seafarers every year. The authors believe that perhaps the causes of 100 percent of marine accidents are related to the influence human factor, taking into considerations the human factor aspects also from other parties than the seafarers.

Nevertheless, when considering maritime safety it is necessary to address both the human element and the technical solutions, taking into consideration that human error may be due to an error in the equipment design, ship design, the lack of proper maintenance on board or the way the ship's management is operating. Many aspects of ship design that have a direct impact on human performance, such as ship motions, accessibility, lighting and noise levels and basic habitability.

According to UK P&I club, human error costs the maritime industry $541 million a year. From their own analysis of 6091 major claims (over $100,000) spanning a period of 15 years, the Club has established that these claims have cost their members $2.6 billions, 62% of which is attributable to human error.

A number of studies were conducted in the recent years in order to study the role of human factor in marine accidents, in particular, why people do mistakes? Off course not all authors and researches agreed on every cause, but there was a great deal of harmony on the results of why people do mistakes in the maritime industry.

The UK P&I club stress that latent failures frequently stem from decisions higher up and such failures can be hidden in one or more of 11 categories: Procedures, Hardware, Design, Maintenance Management, Error Enforcing Conditions, Housekeeping, and Incompatible goals, Communication, Organization, Training and Defenses.

Probably, there are many lessons to be learned from the experience of other industries, to prevent the marine industry learning the same lessons the hard way. Most of analysis of human error has been aimed at improving understanding, and its remedial value has not been fully exploited.

The American Bureau of Shipping (ABS) acquired 150 accident reports from the web site of the Australian Transportation Safety Bureau (ATSB), attempting to codify the causal factors of each accident. Based on that review figure (2) presents the database over the period 1992 to 2001, which suggests that human error was primarily responsible for approximately 85% of maritime accidents.

Figure (3) presents accident data for accidents and incidents cited as being primarily caused by human error. Shown in the figure is the top-level breakdown of near root causes for the human error category. The figure shows that the situation awareness and situation assessment are the primary area of human error, with over 50% of human errors falling into this category.

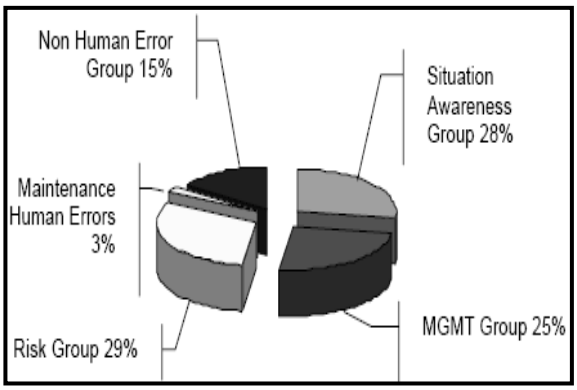


Figure (2): Accident Causation by Qualitative Groupings for ATSB Data (Source: ABS Review and analysis of accidents Databases: 1991–2002 Data)

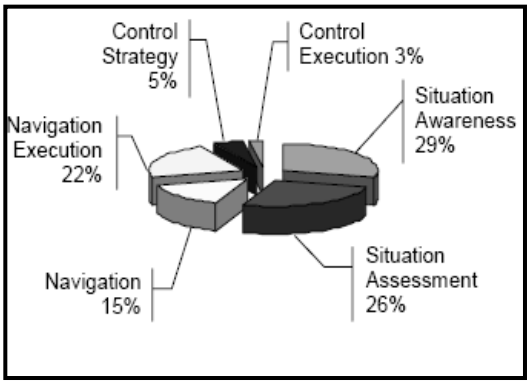


Figure (3): Top-Level breakdown of near root causes for human error induced accidents (Source: ABS Review and analysis of accidents Databases: 1991–2002 Data)

Numerous other causes of marine accidents were identified and categorized into human, environmental, including job, task, equipment, organization and management. The common human causes of accidents include: stress, isolation, fatigue, carelessness, operator error, calculated risk, improper loading, lack of training, cultural differences, lack of communication, lack of motivation, error in judgment, lack of knowledge and physical impairment.

4. The human factor in the work of IMO

By the mid-1980s, the international maritime community became anxious about the number of major maritime accidents continued to occur despite the IMO's stringent technical standards. Studies revealed that the human element was present in a vast majority of maritime casualties. Accordingly, IMO gave attention to the human element of daily ship operation and ship management.

In 1991, Maritime Safety Committee (MSC) / Marine Environment Protection Committee (MEPC) working group was established on the role of the human element in maritime casualties and since then several Assembly resolutions have present "the human element vision, principles and goals for the Organization" (resolution A.850 (20) updated by A.947 (23)) and requested the IMO Committees to focus their attention on "shifting emphasis onto people" (A.900 (21)).

The working group continues to meet annually. In 2006 the working group approved a checklist for considering human element issues by IMO bodies; strengthening of human element input to the work of IMO; framework for IMO consideration of ergonomics and work environment; and the Organization's strategy to address the human element, which includes a related action plan.

In addition to the key human element regulations include the STCW Convention and the ISM Code, IMO has also developed guidelines for the investigation of human factors in marine casualties and incidents, included in the IMO Code for the Investigation of Marine Casualties and Incidents, and comprehensive guidance on fatigue mitigation and management has been published.

The STCW Convention requires that all seafarers to be properly qualified for the position that they hold on board. Meanwhile, MSC agreed that a comprehensive review of the STCW Convention and STCW Code is needed, in order to ensure that the convention meets the new challenges facing the shipping industry including, the rapid technological advances today and in the future.

The ISM code was developed to provide a framework for the proper development, implementation and assessment of safety and pollution prevention management. Additionally, the ISM Code requires that ship-owners define the responsibility, authority and level of competence required of each crew member. Moreover, the ISM Code, is an 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

Meanwhile, MSC/MEPC working group is studying the impact and effectiveness of the ISM Code, based on the data collected, the report concludes that where the ISM Code had been embraced as a positive step toward efficiency through a safety culture, tangible positive benefits were evident; and ISM Code compliance could be made easier through a reduction in the administrative process (Sekimizu, 2006).

5. Safety culture in shipping

Kuo (1998) define safety as a perceived quality that determines to what extent the management, engineering and operation of the system is free of danger to life, property and the environment. In the other hand, Oxford dictionary defines safety as the freedom from danger. Moreover, safety can be defined as the freedom from unacceptable risks/personal harms, additionally, safety can also be defined as, measures and practices undertaken to prevent and minimize the risk of loss of life, injury and damage to property and environment.

Culture is a way of life; the customs, beliefs and attitudes that people in a particular group or organisation share. Perhaps, culture is behind the reason why certain group of people or nationality behave in a similar manner, or prefer particular type of food and certain way of life, for instance, occasionally it's possible to guess somebody's nationality from his body moves the so called body language.

A safety culture means that safe and proper methods of shipping and doing business in the maritime industry are not only economical, but a way of life. Moreover, safety culture of an organization is the product of individual and group values, attitudes, perceptions, competencies and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization's safety management (O'Neil, 2002).

In addition, safety culture can be defined as a subset of the organizational culture, organisational culture is the product of multiple interactions between people (Psychological), jobs (Behavioural) and the organisation (Situational). It therefore becomes evident that an effective safety culture requires the active collaboration between management and the workforce.

Individual seafarer must believe that safety is important; it is not possible to create a strong safety culture if people do not believe that safety is everyone concern. Safety culture often involves changing the way people think, it's important that the management behave in ways

which demonstrate 'Safety Comes First' example is the most effective way of creating a strong Safety Culture.

The goal of everybody must be making the working condition safe. Bearing in mind that, safety is not a problem which can be solved and then put aside. It is permanent feature of how everyone on board works and lives. O'Neil (2002) has emphasized that the crew members on board a ship will observe and be sensitive as to whether the company not only complies legally with all the appropriate safety and environmental requirements, but also the manner in which compliance is approached.

Creating a good company culture goes beyond compliance with regulations. It goes well beyond looking for the last dollar in profits. It requires a company vision of keeping the goals of each individual at a higher priority than the sole pursuit of profits (Chawla, 2004). There are perhaps three components to introduce genuine safety culture, commitment from top, measuring the scale of the problem, and finally changing the behavior.

IMO have realized the importance of promoting safety culture concept in shipping, despite the significant differences of IMO member States, particularly in their abilities to make the necessary institutional change as well s developing their human resources. IMO instruments and standards will be effective only, if the safety oriented attitude is established. Among the instruments and standards adopted by IMO, STCW convention and ISM code.

The ISM Code were designed to influence the process aboard ships and within shipping companies and contribute to the mental attitude necessary for the promotion of a safety culture in shipping. According to IMO resolution A.788 (19), the application of the ISM Code should support and encourage the development of a safety culture in shipping. Success factors for the development of a safety culture are, inter alia, commitment, values and beliefs.

6. An overview on the impact of introducing safety culture concept in shipping

Its nearly five years since the date of the full implementation of STCW convention and ISM code in 2002, perhaps it's time to review and assess the impact of those two instruments in establishing the safety culture in daily routine work onboard ships, in order to establish realistic and valid safety management standards, taking into consideration the nature of humans as well as the factors influence the role of human in shipping and the potential incompatible goals between safety and productivity.

Two questions raise themselves now:

- Have ISM Code and STCW convention achieved their initial objectives related to the improvement of human performance in ship operations?
- Has safety culture rooted in the shipping industry?

Many shipping statistics show some positive and negative signs, which appear in the annual shipping causality statistics of different causes. In some cases, difficulty in coping with international conventions and instruments were the main reason behind the failure of implementing genuine safety management system in some shipping companies, probably because of the huge administrative work which have be done by the tiny crew.

It has been recognized that there have been marked improvements in the casualty records and that fewer ships and fewer lives are being lost at sea than was the case a decade ago. The records also show that there has been a concurrent decline in the amount of pollution entering the marine environment from vessels transiting the oceans (O'Neil, 2002).

Madsen (2000) believe that the present trend of increased mobility of crew members and reduced contact between the shore-based organization and the seafarers makes it more demanding to build a genuine safety culture. The whole industry is engaged in a fight for talent, showing that experienced and competent crew is in strong demand.

In 2006 The Norwegian classification society (DNV) has performed a survey among 4,000 seafarers based on a questionnaire imitated from the aviation industry by the Danish Maritime Institute, University of Texas, Risø National Laboratory and DNV. The survey shows that:

- 50 per cent of the seafarers confirm that they break safety procedures frequently.
- The top 25 shipping companies have an accident frequency of only 15 per cent compared to the bottom 25 companies.
- The average ship operator has a potential of 70 per cent reduction in accident frequency measured against the best performers.

Concurrently, the DNV has verified 300 training providers globally as part of a quality improvement project, and revealed that more than 50 per cent under-perform according to best practices regarding facilities, course content and instructor qualifications. This demonstrates that lack of relevant qualifications represent a serious safety risk in shipping.

According to the chief executive of DNV, International requirements for qualifications and training can only make shipping safer if all parties perform in line with the intentions. Our findings show that there is a gap between documented and actual qualifications, for instance when it comes to basic safety skills, and a need for much more focus on building a safety culture (Madsen, 2006).

Table (1): Reported total loses by month 1997-1999 for merchant ships of 500 GT and over

Month	No. of ships	**1997** 1000 gt	1000 dwt	No. of ships	**1998** 1000 gt	1000 dwt	No. of ships	**1999** 1000 gt	1000 dwt
January	12	96	167	9	49	79	6	73	109
February	8	105	191	8	40	67	2	44	56
March	10	88	141	1	1	2	8	16	14
April	8	18	20	6	39	54	3	19	38
May	4	35	9	5	26	31			
June	6	61	94	6	49	75			
July	3	42	77	4	30	48			
August	6	15	22	6	87	79			
September	6	72	120	4	48	58			
October	7	48	64	15	60	92			
November	13	94	93	7	43	70			
December	5	87	158	9	47	73			
Total Monthly Average	88 **7**	761 **63**	1157 **96**	80 **7**	519 **43**	726 **61**	19 **5**	151 **38**	217 **54**

Source: Institute of Shipping Economics and Logistics

Table (2): Reported total loses by month 2003-2005 for merchant ships of 500 GT and over

Month	No. of ships	**2003** 1000 gt	1000 dwt	No. of ships	**2004** 1000 gt	1000 dwt	No. of ships	**2005** 1000 gt	1000 dwt
January	12	103.6	146.3	8	26.3	38.5	8	25.4	20.5
February	13	37.7	50.9	12	90.7	134.6	10	52.8	68.1
March	3	4.3	7.4	3	13.5	20.7	4	34.7	54.6
April	7	45.9	52	4	13.8	19.5	8	27.1	33.4
May	9	65.2	113	5	52.2	31.4	3	17	22.4
June	12	53.7	86	5	16.7	19.7	6	34.2	54.4
July	6	59.5	103.2	11	45.4	64.1			
August	4	23.4	31.6	3	22.4	34.4			
September	7	67.1	102.1	6	20.1	21.8			
October	6	31.5	50.2	3	23.9	27.4			
November	4	23.1	35.9	9	39	55.9			
December	8	24.6	26.8	5	54.2	94.9			
Total Monthly Average	91 **8**	539.7 **45**	806.4 **67.1**	74 **6**	418.1 **34.8**	562.9 **46.9**	39 **7**	191.3 **31.9**	253.3 **42.2**

Source: Institute of Shipping Economics and Logistics

Figure (4) and figure (5) presents the average monthly total loss of ships due to accidents for three years prior to the full implementation of both STCW convention and ISM code, and three years after their implementation. The authors see no significant change or drop in the number of totally lost ships.

They hoped to raise the safety culture through the use of lengthy procedures and checklists, which did not bode well with those who were supposed to use them. Some companies then changed their strategy by first soliciting feedback and participation from those using the manuals and then writing concise, user friendly procedures and improved transparency between the vessel and the office removed the blame culture (Sivasundram, 2006).

Probably one reason behind the failure in establishing genuine safety management in many companies was the production of large volumes of manuals, which clouded or failed to address key issues.

Conclusions

Perhaps the idea of building the safety culture in shipping through the enforcement of rules and regulations may not persuade the individuals to comply with and adhere to, seeing that, the individual's attitude to the rules that really determines the culture, do they comply because they want to, or because they have to.

The authors believe that safety culture involves moving beyond compliance to external rules to a culture of self regulation; "want to" attitude can be effective in achieving the objectives of establishing safety culture in shipping.

Probably, IMO's member States are required to review and amend their safety management, maritime education and training, as well as their manning legislation to ensure the effective and practical implementation of genuine safety management system onboard ships. IMO is required to establish more effective instruments to assist the member States in doing so.

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