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SAFETY CULTURE IN THE MANAGEMENT SYSTEM OF SAFE EXPLOITATION OF THE SHIP AND POLLUTION PREVENTION

ABSTRACT

One of the most important aims of this paper is to identify the current idea of safety culture, and to present authors' understanding of safety culture, how it may be comprehended and perceived, and what benefit it can bring for improving safety at sea.

This article discusses the human role in this aspect, namely, who fulfils their responsibilities (work, service, duty) which are connected in a wide understanding of maritime Industry (both at sea and on land).

The preliminary analysis of the concepts of safety culture, which has been carried out, points clearly to the **human factor** (which has a direct impact on the shape and meaning of safety culture) as one of the main links which connects multidimensional maritime safety, environmental protection and safety of life at sea.

Key words:

safety of navigation, safety of sea areas, maritime accidents, **safety culture**, maritime accidents prevention.

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INTRODUCTION

The tragedy of the most famous Passenger Royal Mail Steamer R.M.S. 'Titanic' in 1912 is not one of the most tragic marine catastrophes in human history because there had been many before and after 'Titanic', however, it became a wake-up call for action to introduce new regulations and make massive moves, to improve safety of life at sea [19].

International Safety Conference at sea which was held in London one year after the 'Titanic' tragedy prepared the first version of International Convention of Safety of Life at Sea, which was published in 1914.

Over the years this Convention has been improved (in 1929, 1948, 1960 and 1974), and its present version has been enacted in London on 1st November 1974 by International Maritime Organization — IMO¹, which is known as International Convention for the Safety of Life at Sea 1974, and its Protocol of 1988, articles, annexes, and certificates — SOLAS, 1974 [9–11, 14].

In its chapters, the Convention determines among other issues: safety operational standards of vessels (indicating requirements about documents, certificates, construction, structure, equipment, operation, communication, surveys, crew exercises and trainings onboard, carriage goods — including carriage dangerous goods), safe operation of vessels and special measures to enhance maritime safety and security.

The Convention has become a 'tool' in the IMO hands, which may regulate broadly defined and understood issues-safety at sea.

DISASTERS AT SEA AND FOLLOWING ACTION TO IMPROVE SAFETY OF NAVIGATION

Cargo and passenger transport by sea, and running maritime exploration and mining business of sea resources, have been subjected to a risk of dangerous situations or accidents which may occur and include human loss of life. These could be the effects of the power of sea, inadequate operation of vessels and ocean-engineering objects and human errors [7, 8, 12, 19, 20].

Those statements are nothing new and generate numerous prevention activities by providing modern technical equipment solutions which may improve safety

¹ IMO — International Maritime Organization.

of navigation, installing integrated monitoring systems probing ocean and sea areas and tracking ship traffic, and introducing new or updated regulations. Assuring safety and raising its level has been a goal of a broad spectrum of activity on widely understood sea areas.

The tragedy and accidents occurring at sea have indicated how much there is still to do and improve about the safety level. It can be stated that despite human endeavor, International Organizations and all, having a broad outlook on maritime industry, the shipping system and its supervision is still defective and conditioned by action of both human and marine environment, and almost always its results are felt by decades and never really eliminated entirely [19].

To mention but a few most significant tragedies taking into account:

- **numbers of transported passengers:** Steamer 'Kianga' (1948), 'Admiral Nachimow' (1986), 'Herald of Free Enterprise' (1987), 'Dona Paz' (1987), 'Jan Heweliusz' (1993), 'Estonia' (1994);
- **environmental contamination due to leaks from tankers:** 'Amoco Cadiz' (1978), 'Exxon Valdez' (1989), 'Erika' (1999), 'Prestige' (2002);
- **accidents on Mobile Offshore Drilling Units (MODU):** 'Piper Alpha' (1988), 'Deepwater Horizon' (2010), 'Kolskaja' (2011).

Additionally, the accidents and disasters which happened as a result of human activity during destructive warfare should not be discounted and these involved: 'Lusitania' (1915), 'Athenia' (1939), 'Wilhelm Gustloff' (1945), or USS 'Cole' bombed in Gulf of Aden, Yemen (October 2000).

Taking into consideration the above mentioned tragedies and accidents, a question arises if there are any steps to eliminate marine accidents from our life. At present stage of human development, the answer is straight — **NO**, but any possible effort should be put into minimizing them.

Accidents are often a sequence of adverse events proceeding slowly (indirectly and imperceptibly over a long period of time) or occurring suddenly without any preceding warning signals.

The accidents and tragedy at sea mentioned so far, in which human life was lost and natural environment deteriorated for many years [19], provided the possibility for drawing far-reaching conclusions and gave rise to introducing amended regulations and actions.

Such actions illustrate the following examples:

1. Adopting the conviction that one of the best ways to improve safety at sea is unification of safety standards.

2. Providing 24 hour radio monitoring (connected with navigational and meteorological services and warnings), equipping ships with modern means of satellite communication and radio devices (e.g. GMDSS — Global Maritime Distress and Safety System, Emergency Position Indicating Radio Beacons, Search and Rescue Radar Transponders, Handheld GMDSS Radios, Emergency Radio Messages).
3. Equipping ships with adequate amount of life-saving appliances (e.g. rescue boats, life rafts, immersion suits, and safety personal protection suits and equipment, life jackets, life buoys, life belts, Marine Evacuation Systems — MES, different means for recovering people from water, thermal protective aids, signaling equipment, pyrotechnics and life throwing appliances and other).
4. Adjusting the terms connected with the construction and opening of vessel gates on different types of ships.
5. Developing International Management Code for the safe operation of ships, pollution prevention and implementation of the International Safety Management (ISM) Code by Administrations [2].
6. Introducing Goal Base Standards (among others construction of double hull ships) for oil tankers and bulk carriers, which would specify ships' design and construction so that they stay safe and friendly to the environment throughout their life in the case when they remain intact, operated and maintained properly while in exploitation and under certain environmental conditions, as well as in defined damage conditions.

A new SOLAS regulation II-1/3-10 on Goal-based ship construction standards (GBS) for bulk carriers and oil tankers was adopted by IMO's Maritime Safety Committee (MSC), in May 2010, by resolution MSC.290(87).

This regulation, which entered into force on 1 January 2012, requires that all oil tankers and bulk carriers of 150 m in length and above, for which the building contract is placed on or after 1 July 2016, satisfy applicable structural requirements conforming to the functional requirements of the International Goal-based Ship Construction Standards for Bulk Carriers and Oil Tankers (GBS Standards) (resolution MSC.287(87)).

Under the GBS Standards, construction rules for bulk carriers and oil tankers of classification societies which act as Recognized Organizations or National Administrations will be verified, based on the Guidelines for verification of conformity with goal-based ship construction standards for bulk carriers and oil tankers (resolution MSC.296(87)) (GBS Guidelines). Deadline for the receipt by IMO of initial verification requests from classification societies was 31 December 2013 [11].

7. Creating European Maritime Safety Agency — EMSA in Lisbon Portugal, and many other such agencies, after debates on protection of seaside and sea waters around Europe after the 'Erica' tanker disaster in year 1999 near the coast of Spain. The main goal of this agency is to strive for the improvement of safety at sea, environmental protection by arranging training and upgrading technical requirements for ships.

The systematic action outlined above is only a part of human efforts which are undertaken to ensure safety at sea.

A very important factor in prevention of accidents on ships may be near-miss reporting which should be bringing attention of people responsible for proper exploitation of ships to potential dangers and giving enough time for adequate correction to be implemented. In author's opinion the goals of near-miss reporting are not always properly understood by both ship's crew, and the Company/Ship-owner who commits ship's crew to excessive mandatory reporting. In fact, as a result ship's crew may see it as a superfluous obligation which contributes nothing to a better safety at sea. The examples of near-miss reports show that there is a lack of commitment and understanding of the true meaning of this vital document.

Company/Ship-owner imposes the obligation of sending a number of reports, and the person responsible for their making and conveying is lost with the massive amount of information coming in and, not realizing what exactly to report often tries to find their 'favorite situation' to report repeatedly. The question arises if this is the right way of improving safety on sea areas and ensuring safety of ship's exploitation in its entire extent. The answer that comes to mind says that it does not seem to be the way forward.

The strenuous efforts of International Organizations, working on boosting safety on sea areas, are aimed at implementing regulations appropriately to the changing reality. However, the foundation to the efficiency of the undertaken actions, is execution and compliance with the regulations. Also application of the regulations should be constantly monitored and verified, against their effectiveness and usefulness before any accident or emergency situation occurs.

Figure 1 presents dependence between dangerous activities/nonconformities and significant accidents according to some sources.

All activities towards amendment of the regulations are a multi-level process beginning with preparation of a document, and its evaluation, further approval and implementation at every level of a competent organization, institution or Company, involved in ensuring safe exploitation of the ship, as well as concerned crew members participating in the process.

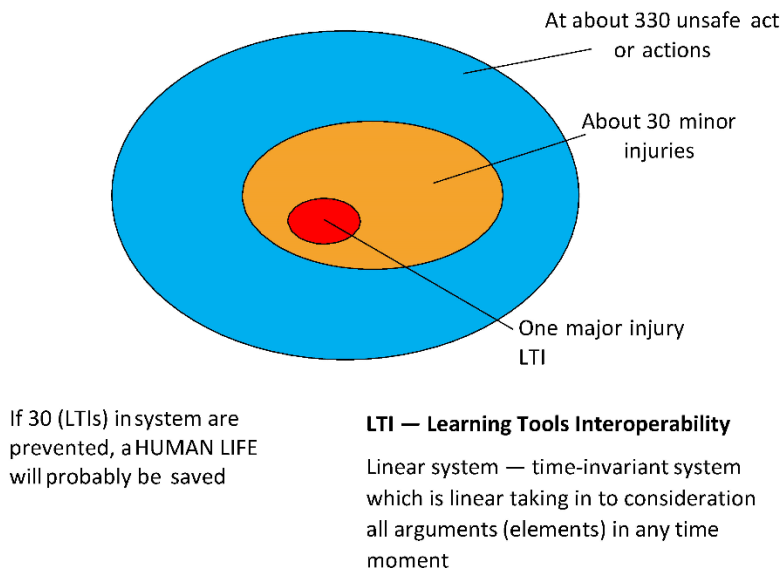


Fig. 1. Dependence between dangerous actions/nonconformities and major accidents
Source: *International Chamber of Shipping, IMO Symposium on the future Ship Safety, 2013.*

SAFETY CULTURE ON SEA AREAS AS A PRIORITY OF CONSOLIDATED PREVENTION ACTIVITIES

Nowadays, as the intensity of shipping is increasing, there is a wide spectrum of work being carried out in exploration of natural resources [12], and there emerges a well-grounded need for codification of elements having both direct and indirect influence on improving safety at sea. **The solution could be putting safety culture into practice** [2, 3].

The question is what exactly safety culture is. **Safety culture is the provision of greater knowledge and better understanding about ensuring safety of the ship in operation and the safety of exploration of sea and ocean resources and their exploitation in the well-understood human interest.**

It can be stated that safety culture already starts with the construction design process of ships and oceanic objects [7] and their building, and continues throughout operation until decommissioning (including scrapping) safe for the natural environment.

The elements of safety culture are presented in figure 2.

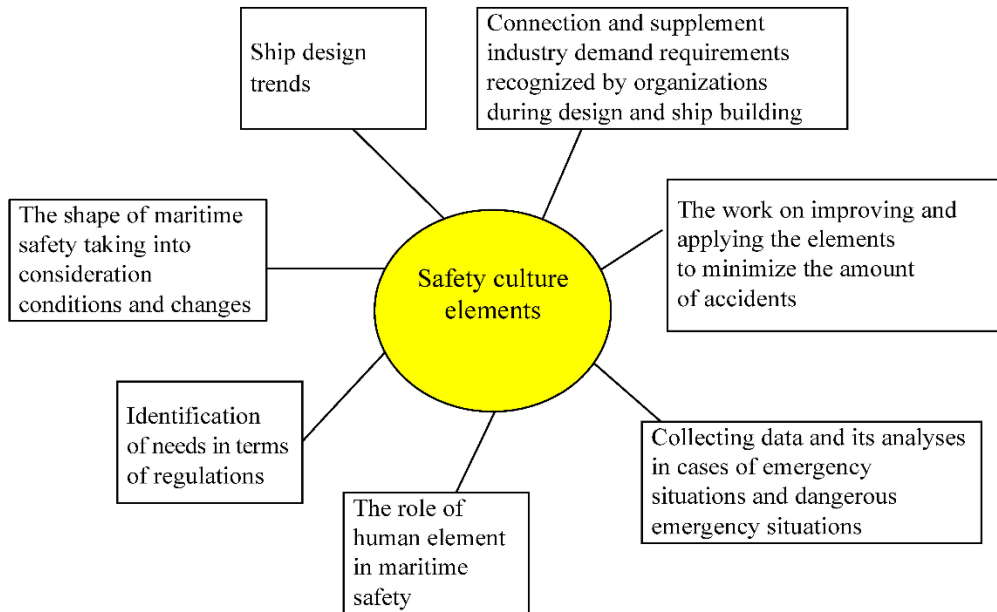


Fig. 2. The elements shaping safety culture [own work]

These are the aspects, that constitute an integral and indivisible whole, characterized by a strong mutual interaction. Introduction of these elements to life means not only involvement of specific entities, but the whole maritime community, all the same enhancing legitimacy of safety culture [2, 3].

The role of safety culture to protect against accidents at sea is illustrated by figure 3. This diagram shows clearly, that Safety Management System should consist of coherent layers (elements) preventing formation of weak points which might pose a danger [3, 4].

In the case of a 'very strong' system under threat, when the operational consistency, compliance with the regulations and further implementation are present, it stays substantially protected against accidents. Whereas the faulty system, having a lot of 'holes' — weak points, permeates threats through these 'holes' in effect leading to emergencies and dangerous situations.

Another question is how to apply the Ideal System Solution into practice, if possible at all, throughout Company's activity to protect the system against all possible situations. The starting point may be looking into the issue of **HUMAN FACTOR** and **HUMAN ERROR** which directly influences human activity in sea and ocean areas [1, 5, 6, 11, 18].

The role of safety culture in preventing accidents

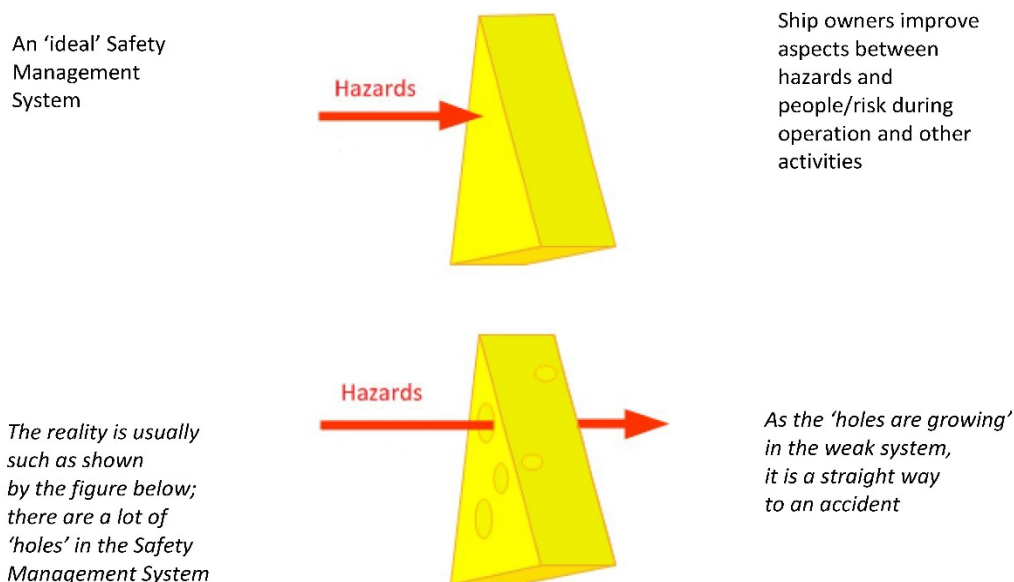


Fig. 3. The faulty and the 'ideal' Safety Management System in action

Source: prepared under international chamber of shipping materials (IMO Symposium).

HUMAN FACTOR INCLUDING PERSONAL ASPECT IN SAFETY CULTURE

Human is the link between the multiple layers of safety in sea areas. Figure 4 presents the network of some causes of ship accidents, including warship, all linked by the **HUMAN FACTOR**. Applying gained experience, knowledge and competency, humans perform their given tasks and duties [9, 11, 15, 16, 18].

The data gathered on sea accidents show that human is responsible on 50 percent² of dangerous situations and accidents. Human error may be either intentional

² Z. Kopacz, W. Morgaś, J. Urbański, *Metody oceny bezpieczeństwa morskiego*, 'Zeszyty Naukowe', Akademia Morska w Szczecinie, 2006, No. 11, pp. 151–160 [*Methods for assessing marine safety* — available in Polish]; J. Girtel, S. Kuzmider, L. Plewiński, *Wybrane zagadnienia eksploatacji statków morskich w aspekcie bezpieczeństwa żeglugi*, WSM, Szczecin 2003 [*Selected issues in operating seagoing ships relating to safety of navigation* — available in Polish]; Z. Korczewski, A. Powłędzio, R. Wróbel, *Analiza ilościowa wypadków i awarii technicznych na okrętach marynarki wojennej RP w latach 1985–2004*, 'Przegląd Morski', 2005, No. 2, pp. 33–42 [*Quantitative analysis of accidents and technical failures recorded in Polish Navy ships between 1985–2004* — available in Polish]. These are only a few publications which indicate human error as a significant contributing factor in causing accidents.

when the activities are carried out purposefully and to achieve the desired effect, or unintentional, when the activities performed are influenced by such factors beyond human power as: weather conditions, rapid failures and breakdowns of mechanisms, and other unidentified circumstances. Apart from that, some mistakes may be a result of human activity characterized by a lack of due awareness while carrying out given duties, owing to poor knowledge and experience, and inadequate qualifications and predispositions to the position held. Examples of the factors which determine and generate human error are depicted by figure 5.

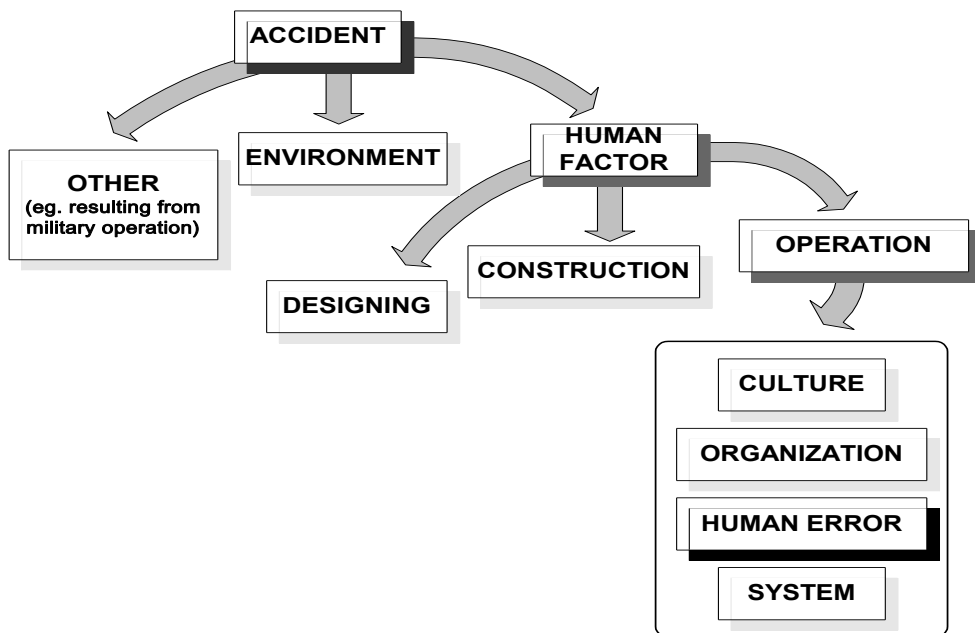


Fig. 4. The causes of ship accidents at sea including warship [own work]

At this stage, it is well justified quote the following example from SOLAS,74 Convention, Regulation 14 of Chapter V. Regulation 14 (ship's manning) oblige the ship crew to be manned each ship with qualified, competent, certified and medically — fit seafarers, which is described in point 1: *Contracting Governments commit, each for their national ships, to maintain, or, if it is necessary to adopt, the measures, for the purpose of ensuring that, from the point of view of safety of life at sea, all ships shall be sufficiently and efficiently manned.* Point 2 of this Regulation states, that: *[...] every ship, to which Chapter 1 applie, shall be provided with a document stating the appropriate minimum level of safe manning document*³.

³ SOLAS Convention, chapter V: *Safety of Navigation.*

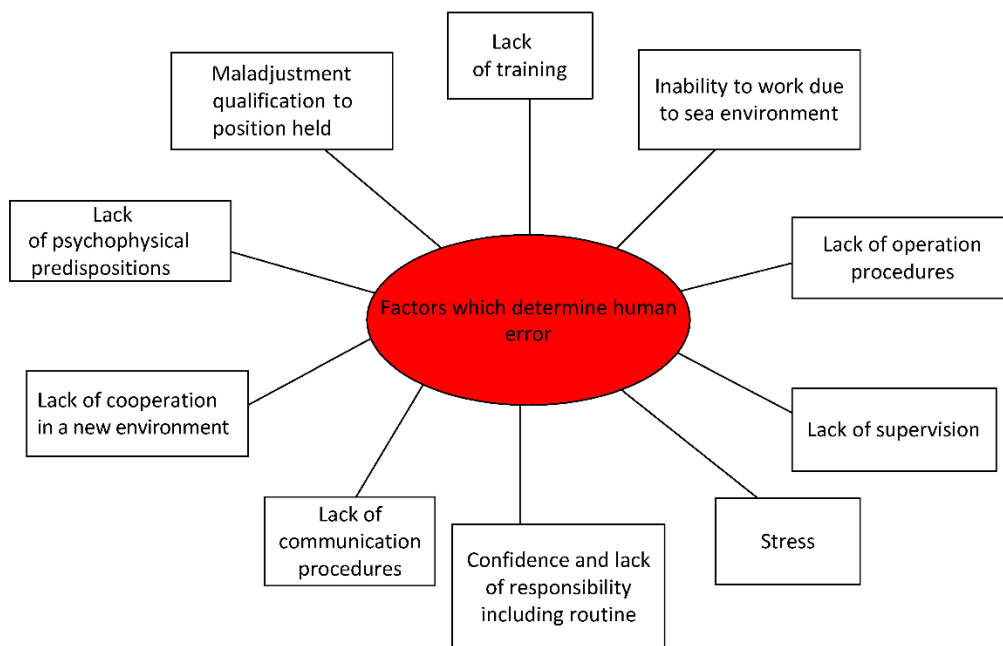


Fig. 5. Deterministic elements of mistakes which are committed by human [own work]

In this paper at first, the focus has been on regulations of SOLAS Convention and on STCW Convention (International Convention on Standard of Training, Certificates and Watch keeping for Seafarers with amendments), and so far has paid less attention to International Convention for the Prevention of pollution from ships, 1973, as modified by the 1978 and 1997 Protocols — MARPOL 1973/1978. However MARPOL Convention may be one of the ‘pillars’ of safety at sea [4]. The lay out of fundamental documents on ensuring maritime safety is presented by figure 6.

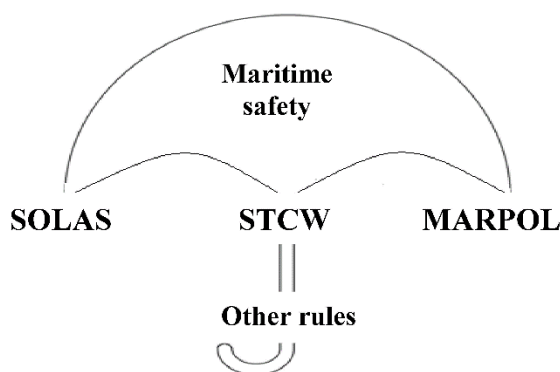


Fig. 6. Fundamental documents on ensuring safety of life at sea [own work]

STCW Convention regulates requirements for every ships' crew member to keep duty (work) on ships. STCW 'watches over' regular practice training, and e.g. points to terms and conditions to be fulfilled by ships' crew for further improvement.

Revisiting SOLAS Convention and highlighting its practical application of information included in Minimum Safe Manning Document Certificate, there is a concern raised if it is not an obvious way to **'human fatigue'**.

Ships' manning has been reduced to minimum and any attempts of its reinforcement usually leads to failure, or if it happens at all either after a long delay or an accident occurrence.

Understandably Company/Ship-owners try to find savings, but the true challenges to preserve the balance between savings and good practice. The issue for further investigation is if there is a relation between manning reduced to a minimum and safety at sea, priceless health and human life, not to mention multi-million losses caused by failure, lost cargo or environment contamination.

In the case of manning being reduced to a minimum the requirements for seafarers regarding hours of rest and work on ships were often not fulfilled, which quite recently ILO Convention, 2006 has regulated. These regulations have been implemented and their application is under special supervision during all Port State Control inspections on ships.

A good practice is arranging meetings between Company organizations/ Ship-owners representatives and crew members/workers. Thanks to these meetings both sides can exchange experience on ships' operations and support each other knowing specific working conditions; also any current issues may be solved. Just that can be the key to promote **safety culture** on sea areas — that way seafarers identify with their Company and the good work for the Company instead of next posts to seaman's book hunting for new and better offers or being hired by other flag flaying vessels often substandard.

THE STRUCTURE OF COMPETENCE

It should be taken into consideration that the issues of coping with stress are expending in terms of both day-to-day operation and emergency and dangerous situations. Good skills and abilities to coordinate activities in a variety of environments are very important, even more so in a dangerous environment where human may not adapt as quickly to take proper decision and action.

Being under constant stress in the same ship environment both at work and free time causes a lot of strain to a human body. Perhaps the new crew members should be keeping their watch under supervision of much more experienced crew members until their duties are mastered. It might be a good idea to start discussions on the subject with Ship-owners and Companies in order to protect their ships against **human errors**.

The authors believe that, by giving these topics adequate attention, these problems could be solved internationally in the near future. Ensuring safety at sea, STCW Convention introduces competence standards at different levels of responsibility [7, 9, 12, 17], ranging from ordinary seaman to the Captain. The structure of competence in this context is presented in figure 7.

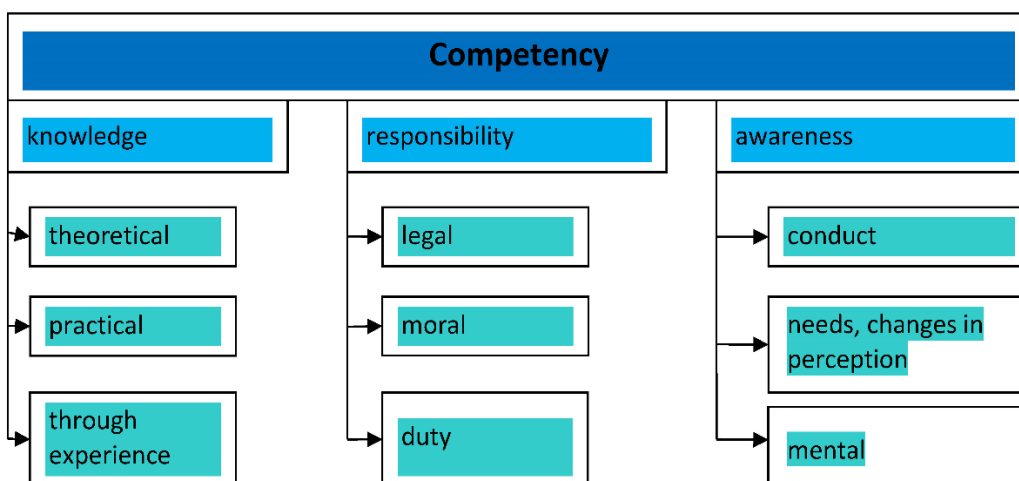


Fig. 7. The structure of competence [own work]

Competence is a much wider concept because it embraces not only theoretical and practical knowledge gained by a human, but also (perhaps primarily) the responsibility for given tasks, decision making and outcomes, as well as awareness of performed action with the use of knowledge, and taking full responsibility for carrying out work.

Identifying with so to say oneself is a very and difficult process of gaining **full competence** at keeping duty/service. Knowing one's own predispositions for work and duty on ships can be extremely useful both in everyday work and in extraordinary situations.

THE PRINCIPLES OF SAFETY CULTURE

When it comes to safety culture the cost should not matter, and the investment pays back in the future. Competent and well trained and adequately prepared crew will be a solid foundation of safety at sea.

One of the most important principles of safety culture is that crew members and supporting land service should identify with their Company, asking workers (crew members) how they can contribute to the Company, what is their outlook on the Company's operation how to improve the functioning of the Organization and what is the key to solving problems (when they has been occur), all the same improving and perfecting existing system.

Company/Ship-owner representatives should always inform their crew members what the Company is going to do and ask the crew possible improvement at the time.

Another principle is upgrading Safety Management System implemented by the Company by arranging meetings expecting explanations from (all the crew and workers) suggesting solutions leading to a better operation of the system, so called: **CONTINUOUS REFLECTION AND FOCUS ON SAFETY CULTURE. This approach may awake active discussion** and invite experts of various specializations to cooperate.

The advantage of such approach is that it can have the following effects:

1. Reduction in the amount of accidents.
2. Preventing personnel from rotation.
3. Reduction in the cost of training and exercises.
4. Reduction of sick leave and the cost of medical expenses and compensation payments.
5. Increase in motivation, enthusiasm, communication, and quality of decision making.
6. Significantly reduction in costs concerning loss or damage of cargo.

The examples presented above aim at improving the functioning of **Safety Management System**, which can have a great influence on the functioning of the system as a whole in a given Company active within Maritime Industry.

Exchange of information concerning Company's operation is a **step in the direction of** improved mutual trust between the workers and ship's crew members.

CONCLUSION

This paper is an attempt to identify safety culture which seems to be a very contemporary issue. Taking a look at the most recent accidents on the sea areas like the one involving crew members of Polish Flagged flying vessels (sinking of Tug 'Kuguar' in Świnoujście Harbour, sinking of yacht 'Down North' (in which one life was lost), sinking of fishing boat 'MIZ 20' near Świnoujście Harbour (one person missing), or rescue operation from the water flooding the yacht 'ZJAWA IV' on the Baltic Sea where twelve women sailed from Gdynia to Sweden 'fight the cancer' action (all women have been rescued and safely transported on land), it has been confirmed that the weather conditions had not had any significant impact on the course of events and it is evident that the weakest link of the whole navigational safety system and its supervision is **HUMAN**. It can be stated that despite substantial efforts of people and International Organizations and many other who have a broad outlook on the worldwide shipping, the is still weak and depends on people's activity and maritime environment, and at the same time with the accompanying lack of imagination, negligence, even nonchalance it nearly always ends up in a tragedy or accident.

The tragedy at sea will probably never be entirely eliminated, but seeking how to minimize it and drawing conclusions in order to prevent it from re-occurring should never cease.

SUMMARY

This paper is an attempt to identify the current meaning of safety culture in a wide understanding of maritime industry, and to show authors' understanding of safety culture at sea and how it should be comprehended. What is more, the authors indicate the benefits that has been taken into consideration in terms of improvements that safety culture may bring for navigation, pollution prevention and protection of safety of life at sea.

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KULTURA BEZPIECZEŃSTWA W SYSTEMACH ZARZADZANIA BEZPIECZNĄ EKSPLOATACJĄ OKRĘTU I ZAPOBIEGANIEM ZANIECZYSZCZENIOM

STRESZCZENIE

Jednym z najważniejszych celów artykułu jest ustalenie obecnego poglądu na kulturę bezpieczeństwa, przedstawienie stanowiska autorów na ten temat, a także korzyści, jakie ta kultura może przynieść dla bezpieczeństwa na morzu.

W artykule rozważana jest rola człowieka realizującego zadania (praca, służba) związane z szeroko rozumianym przemysłem morskim (na morzu i na lądzie).

Wstępna analiza koncepcji kultury bezpieczeństwa wyraźnie wskazuje na **czynnik ludzki** (który ma bezpośredni wpływ na kształt i znaczenie kultury bezpieczeństwa) jako jeden z elementów łączących wielowymiarowe bezpieczeństwo morskie, ochronę środowiska oraz bezpieczeństwo życia na morzu.

Słowa kluczowe:

bezpieczeństwo żeglugi, bezpieczeństwo obszarów morskich, wypadki morskie, kultura bezpieczeństwa, zapobieganie wypadkom morskim.