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Fatigue leading to human error: a study based on marine accidents

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Abstract. The maritime field is, like many other fields, an interrelationship between technology and the human factor. And as it is predictable, the human factor holds the leading role. As Dr. Anita M. Rothblum says, ‘The maritime system is a *people* system’, and human errors are often the starting point for different accidents. Among the large array of factors leading to human errors when facing a situation or a decision onboard ship, fatigue is one of the main disruptive cause. The present work aims to analyze the impact of fatigue on crew members in situations leading to accidents.

Key words: Marine accidents, human factor, fatigue, error

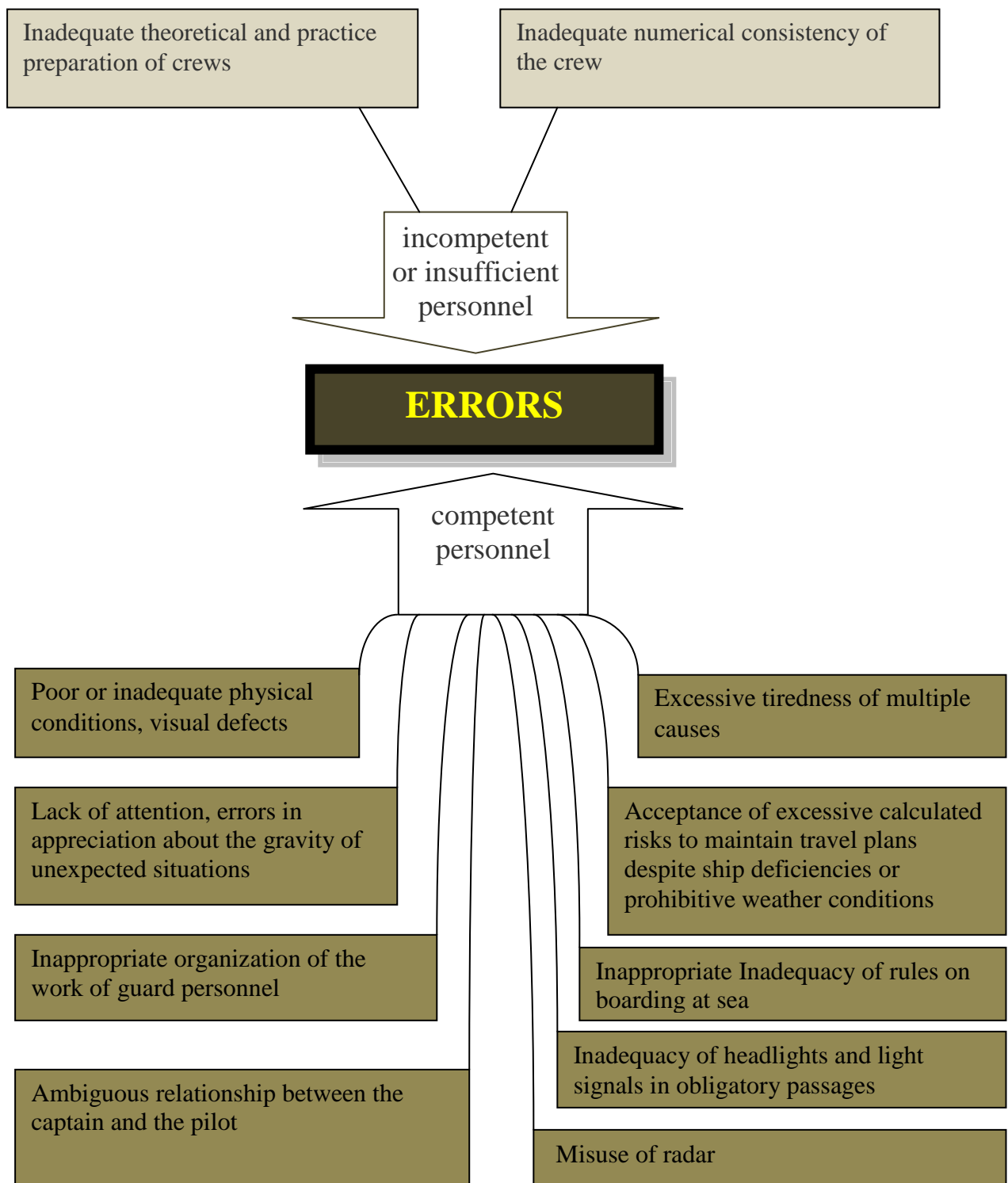
The maritime transport system is a very complex and large-scale *socio-technical environment (STE)* system consisting of 2 entities (people and vessels) and the interaction between them. The human factor is the base of the system, being the one that designs, builds, operates and manages the vessels, port facilities, and inter-human relationships.

Past studies conducted by different bodies have reached the conclusion that almost 80% of the maritime accidents had developed on human errors. The number seems very large, but if we take into consideration that people are the central pillar of the system and each and every interaction may lead to an accident of any kind, the technological advancement doesn’t seem that important. The development of the maritime field led to comprehensive systems of surveys and analyses that could enlighten and explain the causes of accidents and prevent them from happening again.

Lorenzo Spinelli, general director of the Italian Naval Registry, and a prominent figure of IMO at its beginnings, was one of the first to observe and then analyze the impact of human factor in naval accidents. He was the one who put the human error in relationship with concepts like “Just culture” (aspects of cultural background that permit the lack of sanctions against people who make omissions, little mistakes in taking decisions or taking actions based on their experience or field development, without being tolerant towards big mistakes or grave negligence, breaking international laws or actions leading to severe damage to ships, installations or endangering peoples’ lives), “safety culture” (the product of individual and group values, opinions and perceptions, knowledge and skills, behavioural models, leading towards self emerging into managing a healthy and safe working environment. Implementing the concept of “safety culture” means a prior conscience regarding evaluation and action in matter of safety along with an open communication style in the organization.), “human factor”(the study of interactions between machinery, places and working environment, and the

worker). When talking about the human factor, it is compulsory to relate it with human error and fatigue.

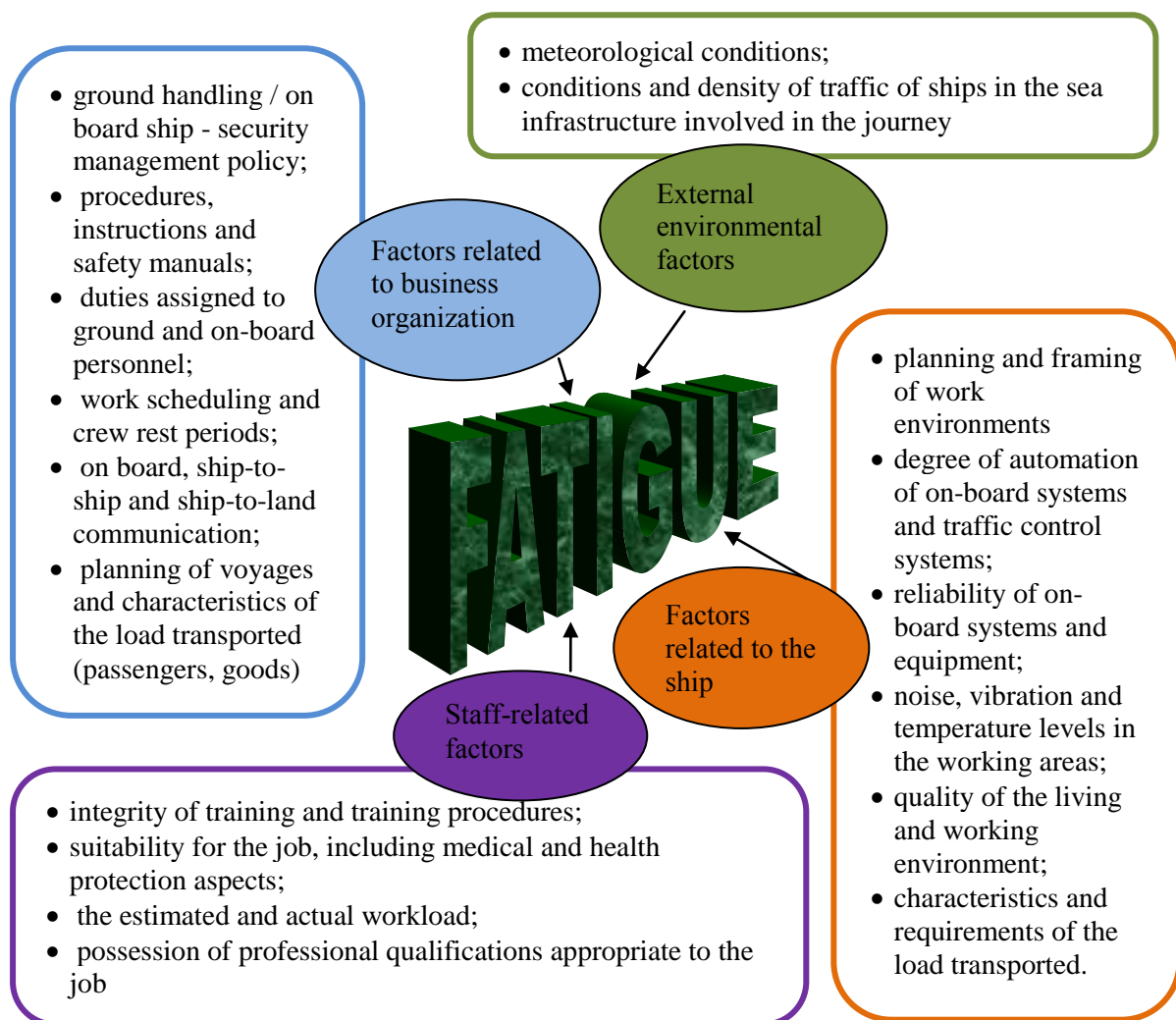
Errors come into life of both competent and incompetent personnel based on different insufficiencies, inequities, ambiguities, and excess.



To prevent the potential risk situations that can involve maritime accidents, a parameter that is certainly fundamental to take into consideration during investigations is also represented by the "Fatigue" factor. Fatigue is at the base of the decrease in the operator's work performance, by manifestations like slowing down of physical and mental reflexes and cutback in making rational evaluations. The direct consequence is a steep increase in the occurrence of accidents and a concurrent decrease in security level of the transport system. Fatigue increases, on one hand, the probability that the operator makes mistakes and, on the other hand, alters the performance of the operator, especially when dealing with tasks that require:

- The ability to conduct the means of transport and to take immediate and good decisions, including rapid reactions in dangerous or emergency situations
- The diligence to monitor and supervise instruments, appliances, machinery, situations
- The recognition and the understanding of the actions to be taken.

In the rough, the most commonly known and documented causes of fatigue are deficient training with respect to the duty to be performed, diminished or limited duration and quality of rest, excessive tasks to be performed-especially in terms of duration, excessive noise in the workplace and wrongly conducted interpersonal or communication relationships between the various operators. If we are to group the main factors of "fatigue", we could do that as follows:



In documents of HTW 3/8 “Revision of the Guidelines on Fatigue”, presented in the 3rd meeting of the IMO Human Element, Training and Watch keeping, kept in 2016 in London, UK, the subject “Fatigue” was discussed and the first matrix of risk assessment related to fatigue was completed. It has 6 criteria for the risk factor “Number of working hours vs. periods of rest”. According to the various situations/cases of potential risks caused by fatigue, the situations/cases were classified into low risk situations (0 points, illustrated in light green), medium risk situations (2 points, illustrated in orange), and high risk situations (4 points, illustrated in red).



The cases we considered for study are taken from the UK Marine Accidents Investigation Branch. We took into consideration only some of the many cases that have fatigue as one of the roots of the accident stipulated as such in the final official investigation report. The recorded accidents could be categorized into 3 main types: grounding, collision, and man overboard.

Grounding

General cargo vessel *Fri Ocean* ran aground

At 0322 on 14 June 2013, at a speed of 10.5 knots, the general cargo vessel ran aground at about 2 miles south of Isle of Mull. The investigation identified that the second officer, who was alone on watch, fell asleep, probably caused by lack of stimulation associated with fatigue, shortly after making a course alteration at 0256. None of the alarms fitted to the GPS2 and ECS3 were loud enough to wake the sleeping officer, and a bridge navigational watch alarm system (BNWAS) that could have alerted the crew to the second officer sleeping was probably not in use. The incident ended up in damaged vessel's bow shell plating and frames causing a flood in the bow thruster room.

General cargo vessel *Danio* ran aground

At 0330 on 16 March 2013, the general cargo vessel ran aground in the Farne Islands nature reserve, off the east coast of England. The chief officer, who was the officer of the watch, had fallen asleep. . The chief officer had been on board *Danio* for 3 months period in which, besides supervising cargo work operations in port, he worked in a 6 hours on / 6 hours off watch keeping routine at sea with the master, who was the only other deck officer. This incident showed the impressive workload carried out by the two deck officers and the fact that this situation is common on many coastal vessels trading in European waters. Despite the fact that *Danio* was equipped with a fully functional Bridge Navigational Watch Alarm System, it was permanently switched off. Moreover, there was no lookout posted on the bridge as required by international rules.

Collision

Bulk carrier Huayang Endeavour and oil tanker Seafrontier collision

At 0304:40 on 1 July 2017, the bulk carrier Huayang Endeavour and the oil tanker Seafrontier, both registered in Hong Kong, collided in the Dover Strait approximately 5 nautical miles to the west of Sandettie Bank. The investigation identified as the root of the accident the VHF radio conversation between the two vessels about which vessel should overtake the other. The radio conversation displayed the conflictual views of the 2 bridge teams. Even if it had been agreed upon Huayang Endeavour overtaking Seafrontier, the bridge team on the latter vessel did not make sure there was sufficient sea room astern before altering course, ending in a collision between the two vessels. The incident report underlined the fact that the master of Seafrontier, the vessel that made the alter course movement, had been on the bridge for more than fourteen hours prior to the manoeuvre that led to collision, and for sure, his ability to take the best decision was altered by fatigue.

Golden Promise fishing vessel and Self Elevating Barge (SEB) Buzzard collision

At about 0010 on 10 April the fishing vessel Golden Promise was at sea involved in fishing for 5 days. The skipper and the single crew member had been fishing around the clock from the moment they left Whitehaven. The rest period was spent repairing a winch. While the deckhand was resting in the mess room, the skipper was on the bridge. As the main engine lubricating oil pressure gauge sited in the wheelhouse started to fluctuate violently and the wheelhouse main engine monitoring panel, had been defective for some time, the skipper had to go to the engine room to look for the problem. He let the vessel in auto-steering, towing at a speed of 2.5 knots in a position where it should not be in the first place- about 0.8 mile away from the SEB. The tidal stream set the vessel on a course directly

towards the SEB and, at 0028; Golden Promise collided with the hull of the SEB which was elevated and involved in wind farm survey work. The high tide prevented the fishing vessel from being driven under the SEB's hull. The investigation recorded as the main accident leading factors both the disregard of the skipper of the navigation warning, advising vessels to keep a wide berth from the working SEB, and the accumulated fatigue.

Man overboard

Motor tug *Endurance*

At about 0005 on 5 February 2013, a crewman from the motor tug *Endurance* fell overboard in rough seas about 2.3 miles west-south-west of Beachy Head on the south coast of England. The crewman fell while attempting to jump to the unmanned motor cruiser *Sirius M* that they were towing, with a replacement towline after the original towline connecting the two vessels had broken. The motor tug's skipper made some efforts to recover the sailor, but, because of the heavy seas, he couldn't and the sailor body was found 11 days after the accident. The investigation report found several factors that led to the unfortunate situation of losing the crewmember's life: the skipper was not qualified in towing operations, his decision making was affected by fatigue (being in rough seas for almost a day after a 10 hours shift as a deckhand on another vessel on River Thames and operating a vessel that was not certified to sail in such sea conditions), the sailor was not wearing a lifejacket.

Given the above examples, we can sum up that the maritime system as a constant mixture and synergy between people and machinery/ devices, is always going to be affected both by machinery failure and human error. Further studies should be made in order to identify and underline such failures, and a continuous drawing and implementation of the rules that could set the general and particular lines should be brought up in the system as a whole and its sub-systems.

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