

# Identification and reduction of seafarers' cognitive and behavioral fatigue impacts for effective MET policy development

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**Abstract:** The analysis of the interviews, conducted among the crewing agencies representatives, active seafarers and cadets, review of the instruments, developed by the International Maritime Organization (IMO), evaluation of the accidents' database, collected by the International Transport Workers' Federation (ITF) display fatigue as one of the leading factors greatly influencing upon the seafarers and effectiveness of their performance, especially due to the COVID-19 pandemic. Therefore, the aim of the proposed paper is to share the results of the implemented research, related with identification of cognitive and behavioral markers prioritization and inclusion of fatigue detection and decrease into Maritime Education and Training (MET) policy development aimed at improvement of seafarers' performance and safety of navigation.

*Keywords:* fatigue; cognitive, behavioral impact; reduction

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## 1. Introduction

Fatigue is a threat significantly influencing the safety of navigation and considerably damaging both mental and physical health of seafarers. According to the International Transport Workers' Federation (ITF) data, fatigue results in no less than 25% of the whole number of casualties-resulted accidents at sea [1].

Therefore, both the International Maritime Organization and the International Labour Organization pay special attention to fatigue prevention issues. The applicable regulations of the International Convention on Standards of Training Certification and Watchkeeping for Seafarers (STCW), 1978, as amended, the International Safety Management (ISM) Code, the Maritime Labour Convention (MLC), 2006, and the IMO Assembly resolutions provide a background for fatigue reduction. The above-mentioned instruments are aimed to apply the principles of minimum safe manning, to arrange watchkeeping schemes ensuring the balance between minimum rest and the safe watches periods, to provide occupational safety and health, suitable hygienic conditions at cabins and recreational spaces on board, etc. The analysis of the seafarers' interviews, based on the mentioned above resolutions, also displays fatigue as one of the leading factors, greatly influencing the seafarers and effectiveness of their performance, especially due to the COVID-19 pandemic.

## 2. Fatigue causing factors detection

The researches, dealing with fatigue related issues, are generally focused on the following matters, such as the prevention and management of fatigue among seafarers [4], health and safety in seafaring [5], studies of the international regulations on labor health and safety among seafarers involved in fishing [6], review of measuring methods of seafarers' fatigue, sleepiness and sleep behavior [7].

Thus, as the first step of our research, identification of the main factors, causing fatigue among the seafarers was conducted on the basis of the IMO developed resolutions [2].

The interview analysis resulted in detection of the chain of interrelated seafarer-vessel-environment factors, mainly causing and strengthening fatigue among the interviews' participants.

The seafarers were also asked not only to name the main fatigue causing factors, but also to range fatigue causing sub-factors in priority sequence.

The interviewed seafarers arranged the following priority sequence of the seafarer-related factors, mainly causing fatigue on board:

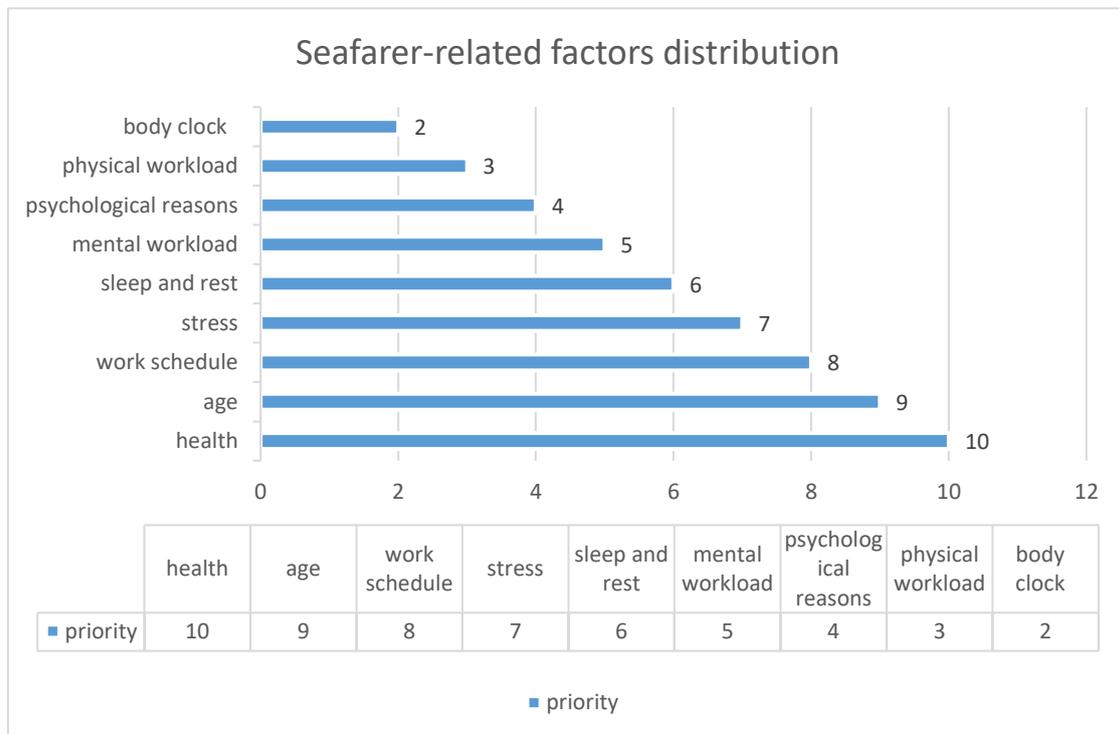


Table 1. Prioritization of seafarer-related factors.

According to the interviewed seafarers, the following priority sequence of the vessel-related factors was arranged:

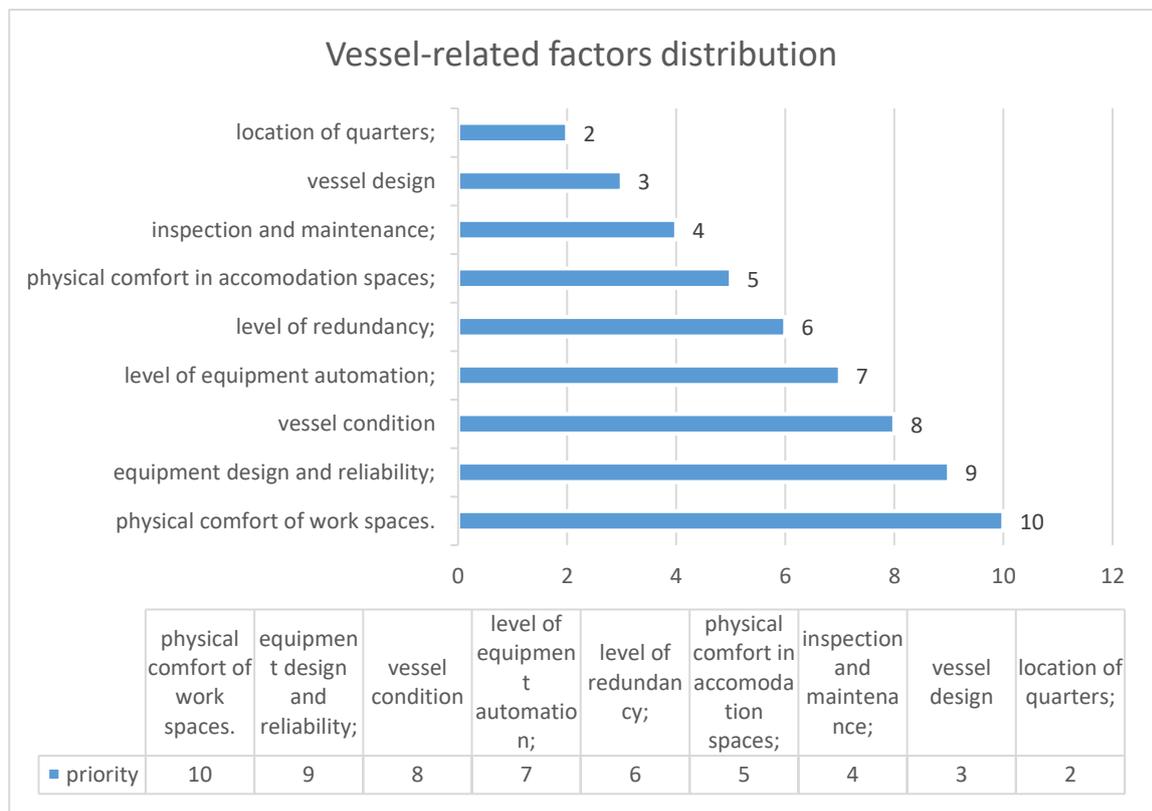


Table 2. Prioritization of vessel-related factors.

Thus, according to the interviewed seafarers, the following priority sequence of the environmental-related factors mainly causing fatigue on board:

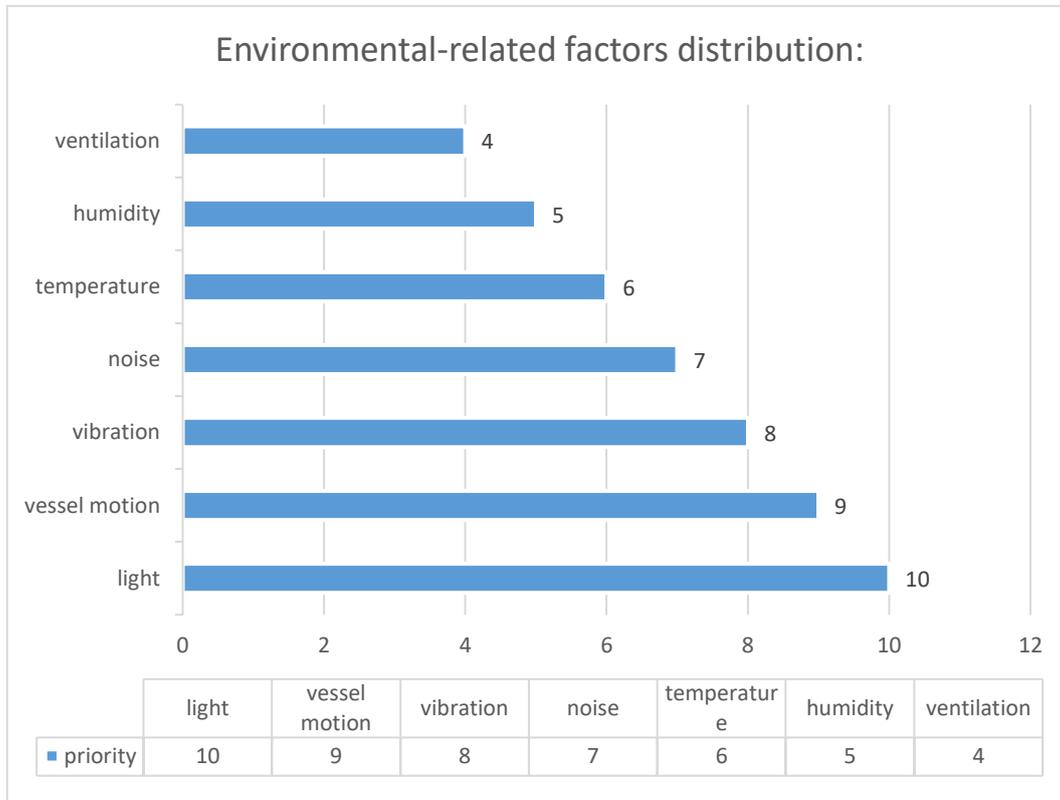


Table 3. Prioritization of environmental-related factors.

### 3. Detection of physical, cognitive and behavioural markers of fatigue

At the next step of the research development, markers of fatigue influences on physical, cognitive and behavioural performance of the seafarers are presented.

Physical effects of fatigue are typically displayed by uncontrolled wish to sleep, often followed by sluggish eyelids closure, irritated eyes, sudden napping, and difficulties keeping awake.

Physical markers are characterized by impediment of hand-eye coordination and slow speech with difficulties to apply a correct word. Other physical markers include headaches, faintness, difficulties with breathing, digestion, sleeping, and appetite.

Naturally, physical effects present a risk to seafarers' safe and effective performance, but at the same time, they are relatively easy for detection and identification.

In their turn, behavioural mood and attitude shifts are presented with the markers of unusual manner of ineffective communication, increased irritation and decreased tolerance.

Therefore, the seafarers feel depression, ignore dangers and are prone to risky decision. Lost motivation often results in habitual negligence and reckless disregard.

Thus, behavioural effects present a considerable risk for safe shipping, but may be detected by the crew members of fatigue suffered seafarers, who can't evaluate their own ineffective performance.

Therefore, mentioned above physical and behavioural signs and markers may be more or less easily and clearly detected and recognized, but cognitive signs are quite difficult to be identified, therefore they present significant safety problems.

The conducted interviews' analysis resulted in prioritization of three following fatigue caused cognitive problems detection and ranging of their effects.

1. Difficulties with concentration, presented with the following prioritization:
  - Decrease habitual vigilance
  - Gaps in attention
  - Problems with multitasking
  - Inability to ensure a chain of activities
  - Prioritization of a single-task
  - Mainstreaming of a simple task, ignoring more significant ones
  - Reduction of solving compound tasks
  - Application of habitual unsuccessful actions
2. Reduced decision making has also been detected as the critically dangerous impact of fatigue, followed with:
  - Inability to evaluate importance of the situation
  - Improper assessment of distance, speed, and time
  - Taking risky decisions
  - Unusual uncertainty
3. Decreased memory results in:
  - Brain fade
  - Problems with remembering the chain of actions and procedures
  - Problems to fix the series of assignments or its components
  - Problems with assignment or its components completion

Slackening of cognitive processes is also detected through slow responds to routine or emergency situations.

## **Conclusion**

Consequently, fatigue, its symptoms and results present a vivid threat for safe shipping. It shall be taken into consideration that behavioral and especially cognitive impacts of fatigue are difficult to be detected and identified by untrained person suffering from fatigue.

So, it is not enough to deliver currently recommended trainings, mainly covering general fatigue related issues, but prospective fatigue-resistant policy of Maritime Education and Training, in line with Global Maritime Professional concept development, shall plan the ways to educate persons involved in safe shipping provision with appropriate skills of fatigue identification, prevention, detection, and management.

Thus, fatigue-resistant industry shall ensure a circle of fatigue-resistant seafarers, companies, vessels and the environment.

Fatigue resistant company shall constantly track fatigue signs and take appropriate corrective measures.

Fatigue resistant seafarer shall be able to detect not only his or her own, but also colleagues' physical, behavioral and cognitive signs of fatigue, be able to apply the modern trends of fatigue reduction, including self-massage and breathing techniques in line with traditional measures of fatigue reduction.

Fatigue resistant MET shall not only identify but also shall predict and provide a long-range fatigue resistance policy, including analog ship handling in expected augmented and mixed reality and operation of unmanned vessels in near future.

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