

Effects of Fatigue on Navigation Officers and SWOT Analyze for Reducing Fatigue Related Human Errors on Board

O. Arslan & I.D. Er

Istanbul Technical University, Istanbul, Turkey

ABSTRACT: Maritime industry is still a human-centered industry in spite of latest technologies which has developed for reducing marine accidents. Human based errors cause marine accidents more than equipment based problems. These accidents cause catastrophic consequences about human life and marine environment. Fatigue of navigation officers plays effective role on these human-based errors and marine accidents. Fatigue can be defined as temporary loss of strength and energy resulting from hard physical or mental work. There are several factors that effect navigation officer's fatigue. Fatigue is associated with poor quality sleep, negative environmental factors, high job demands and high stress. In this study, relationship between fatigue of navigation officers and marine accidents examined; Factors which are affecting fatigue of navigation officers determined with SWOT (strength, weaknesses, opportunities and threats) analysis method. SWOT analysis is an established method for assisting the formulation of strategy. With this analysis, efforts were made to explore the ways and means of converting the possible threats into opportunities and changing the weaknesses into strengths. Consequently strategic action plans were developed for minimizing fatigue related human errors on-board.

1 INTRODUCTION

Human based errors are causing marine accidents more than equipment based problems. Human error had started to be recognized as the major cause of maritime incidents such as collisions, groundings and spills. According to the many of research studies and analysis it has also been recognized that almost 70 to 80% of maritime incidents are caused by human errors (Shea&Grady, 1998). Violation of rules, mistakes, slips and lapses are causing accidents. The categories of human errors can be summarized in Figure 1. Fatigue can be defined as temporary loss of strength and energy resulting from hard physical or mental work. There are several factors that effect navigation officer's fatigue. Fatigue is associated with poor quality sleep, negative environmental factors, high job demands and high stress Fatigue is playing important role on especially these slips and lapses.

SWOT analysis method is used in this study to analyze factors which is affecting fatigue level of navigation officers in order to make strategy formulation for reducing human errors and reducing maritime causalities respectively. SWOT is an acronym for strengths, weaknesses, opportunities and threats. Every program including operational process, management plan and development characteristics have its strengths and weaknesses, opportunities and threats. Considering these strengths, weaknesses, opportunities and threats (SWOT), several strategies derived for converting

the threats into opportunities, and off-setting the weaknesses against the strengths. This SWOT is intended to maximize both strengths and opportunities, minimize the external threats, and transforms the identified weaknesses into strengths and to take advantage of opportunities along with minimizing both internal weaknesses and external threats (Saaty, 1987).

The present investigation is attempted to examine the strengths and weaknesses affecting fatigue level of navigation officers, as well as the opportunities and threats in the external working environment for ships and her officers who are in charge of navigation are taken into account. The intention of this study is to develop strategy action plans for shipping companies and seafarers through SWOT analysis with a view to make safer navigational operations.

2 OVERVIEW OF HUMAN FACTOR ASPECT IN MARITIME INDUSTRY

In maritime domain human error is classified in major three categories. The first category is operational based human errors, the second category is the management based human errors and the third category is the combination of the first and second category that might cause a considerable accident or disaster by triggering error chains (Arslan&Er 2006). In this respect the terminology of incident might be described as a triggering event, such as a

human error or a mechanical failure that creates an unsafe condition that might cause result in an accident. Human errors are categorized in Figure 1. Violation of rules, mistakes, slips and lapses are causing accidents. Low employee satisfaction and fatigue of seafarers play effective role on slips and lapses (Er&Celik, 2005).

Human Factor is the body of scientific knowledge about people and how they interact with their environment, especially when working. A simple way to view human factors is to consider three main aspects: the person, the job (task, environment and equipment), and the organization and management and how they interact among them. The following definitions are utilized for the clear understanding of expectation survey methodology:

- Human Factors Engineering: The comprehensive integration of human characteristics into the definition, design development, and evaluation of a system to optimize Human – Machine performance under specified conditions.

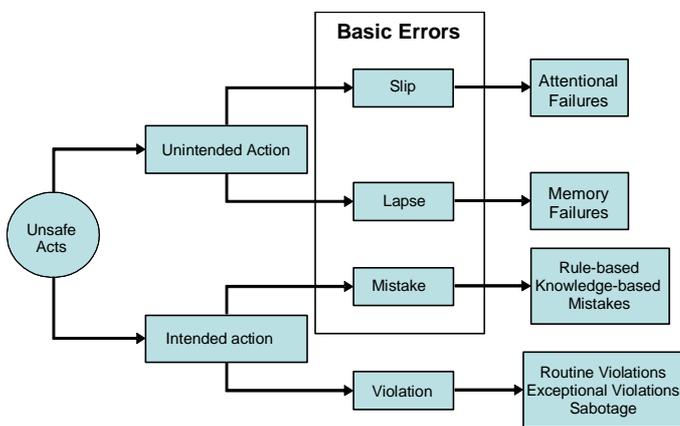


Fig. 1. Classification of human errors

- Health hazards: The identification, assessment and the removal or reduction of short or long-term hazards to health occurring as a result of normal operation of a system.
- System Safety: The human contribution to risk when the system is functioning in a normal or abnormal manner.
- Human resources management: HRM defines the most important resource of organizations, the human, for accomplishing their service and production tasks.

3 METHODOLOGY FOR SWOT ANALYSES

The methodology that is used to enable the SWOT analysis for reducing fatigue related human errors on board includes the identification of relevant factors in terms of SWOT groups (namely strengths group,

weaknesses group, opportunities group and threat group). These are fixed with pair-wise comparisons in order to increase the rapidly of decision making process in multi-variable parameters that have transient characteristics in shipboard operations (Saaty, 1987; Kangas, 1994). Firstly the activity worksheet is utilized for reducing fatigue related human errors on board to sort the activities in terms of SWOT groups. The activity worksheet mainly concentrates the purpose of SWOT with its four quadrants of the coordinate according to their categories as shown in Figure 2. While utilizing activity work-sheet approach strategic action plans are developed for reducing fatigue related human errors and safer shipboard operations.

4 PROPOSED SWOT ANALYSIS APPLICATION FOR REDUCING FATIGUE-RELATED HUMAN ERRORS ON BOARD

4.1 The probable strengths for reducing fatigue related human errors could be the following:

- *Equipping of ships with new technologies:* New innovations or technologies such as ECDIS and AIS reduce navigation officer's workload and they have been developed to lighten considerably the navigation workload with enforcing reduced human errors. Automated control of loading/discharging systems especially on tankers and machinery area reduce officer's and other rating's workloads and they have been developed to lighten considerably the port operation workload with enforcing reduced human errors. *Increasing team awareness and contribution:* Increasing team awareness reduces both phyysiological and physical fatigue on board.
- *Application of ISM system and increasing safety culture on board:* Safety on board has become a critical issue in the last decades. Application of ISM system regularly reduced workloads of seafarers and increased safety culture on board (Er, 2000).
- *Increasing communication facilities:* Being far away from family is the most common problem for seafarers on board (Arslan 2006). This reality increases seafarer's phsychological fatigue level on board. Increasing communication facilities on board reduces psychological fatigue on board.
- *Increasing nutrition possibilities on board:* Regular and sufficient nutrition reduces fatigue level. Nutrition possibilities and quality of nutrition increased on ships when compared with before.

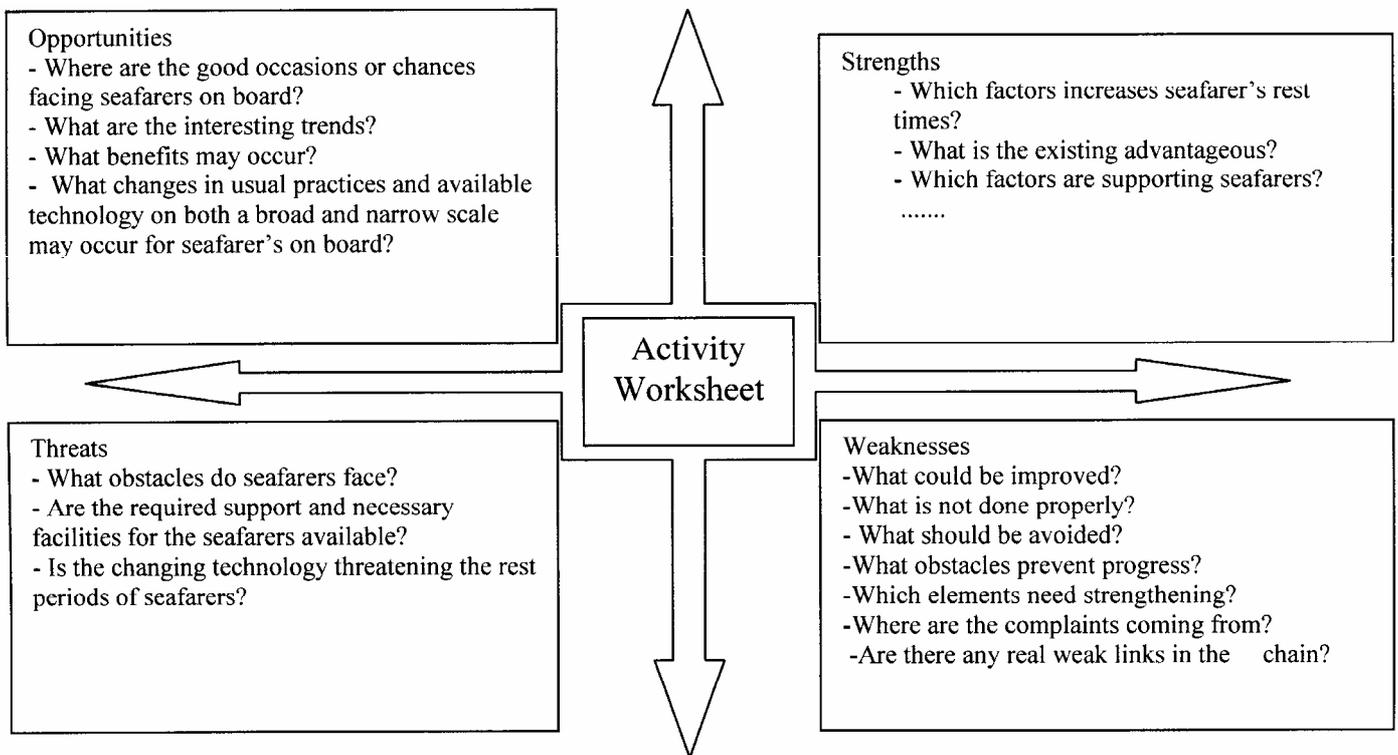


Fig. 2. Activity Worksheet for SWOT Analysis

4.2 *The probable weaknesses that increasing fatigue-related human errors could be the following:*

- *Commercial pressures of ship management companies:* There have been commercial pressures on seafarers such as arriving next port faster, making unnecessary maintenance during voyage, preparing cargo area in bad weather conditions and etc.
- *New technology needs new skills and educations:* Every new technology which thought to increase navigational safety has brought new skills and new compulsory training such as ARPA Radar and ECDIS training.
- *New procedures bring more paper work on board:* New procedures which though to increase ship safety and such as ISM and ISPS procedures, they naturally have brings extra workload for navigation officers.
- *Poor quality sleep, long working hours, insufficient rest between work periods, excessive workloads, noise and vibration, working at nights:* These factors are directly related with the nature of job (Cardiff University).
- *Sleeping duration and low quality of sleep:* Less than seven hours of a day is associated with poorer health and fatigue level.
- *Low satisfaction of seafarers about their occupation and on board comfort:* Seafarers who act and display care and loyalty are less likely

to produce claims. Ship owners and operators can achieve a high level of crew continuity and competence by providing seafarers with secure employment and taking human factors into account including recruitment, health, training and general awareness of shipboard best practice and by monitoring satisfaction in terms of monitoring expectation of seafarers.

4.3 *The probable opportunities for reducing fatigue related human errors on board*

- *High maneuvering capability of new building ships and new manoeuvring equipments:* World merchant fleet is renewing and new-built ships have high maneuvering capabilities when compared with the last decade built ships. This reality reduces manoeuvring times of ships.
- *Shortening of seafarer's contract durations:* Contract durations of seafarers' shortened especially in world's leading ship management companies. This situation reduces chronic fatigue of seafarers taking into account the fatigue close of STCW Code (STCW, 1995).
- *Ergonomic bridge and accommodation design of new-building ships:* Ergonomic issues have become more popular in ship-building sector. Ergonomic bridge design arranges safe look out and reduces workload of masters and navigation officers. Ergonomic design of accommodation places also increases seafarers' satisfaction and

arranges acceptable living conditions (Pomeroy & Jones, 2002).

- *Improvements on technologies:* New technologies about navigation or ship construction reduce navigation officer's workloads. They are assisting tools for them to enable efficient maneuvering and offering more comfortable navigation infrastructure.

4.4 *The probable threats that are increasing fatigue related human errors on board*

- *Intensive ship traffic:* There are around 48500 ships in service at sea, and number of ships is increasing 1% per annum. Increasing the number of ships and new-built faster ships causes collision risks. Watch conditions are closely related with ship traffic. In intensive traffic condition, an extra watchman should look out in navigation bridge (Akten, 2004).
- *Trend of decreasing seafarer number on board:* One another commercial pressure appears as decreasing number of seafarers to minimum standards as it is mentioned in the Minimum Safe Manning Certificate of ship. This reality increases workload and fatigue of seafarers.
- *Extra workloads for navigation officers:* New procedures which though increase ship safety, such as ISM and ISPS procedures and their record keeping process brings extra workload for navigation officers.
- *Port stay days and continual inspections on restricted port days:* Stay in port for ships decreased due to the developed cargo handling facilities. Also, port state and flag state inspections are increased on this restricted port days. Shortened port days and increased inspections directly cause seafarers' fatigue and response.
- *Construction of new ports far away from city centers:* New-constructed ports and terminals are generally constructed far away from city centers. On restricted port days, seafarers can't go outside from ship for relaxation.
- *Terror threats and ISPS application:* Terror threats for ships and related ISPS application tasks restrict seafarers' social life during stay at port.
- *Bad weather conditions:* Bad weather conditions such as gales and dense fog situations increase workload of navigation officers and master. Also, seasickness is a factor that increases mental and physical fatigue that directly reduces job satisfaction.

- *Currents, tides, and darkness:* Currents and darkness are the two dominant factors causing marine casualties especially in coastal traffic area and narrow channels (Akten, 2004).

5 STRATEGIES DERIVED FROM SWOT PROFILE

While considering the overall factors of strengths, weaknesses, opportunities and threats mentioned in the section 4 of this study, the following strategies are proposed. Besides the risk assessment of each process can easily be handled if the threats or weaknesses are identified properly. It should also be taken into account that a human factor has a great significant impact on threats or weaknesses as it is identified in section 4 of this study.

When the overall contribution of SWOT analysis is examined the following comments can be interpreted for reducing fatigue level of seafarers and fatigue related human errors on board.

Workload management should be applied on board because of fatigue plays important role on human errors. Precautions which will increase seafarer's satisfactions should be taken by ship management companies. Loyalty of seafarers should be provided by ship management companies by taking several precautions. On board procedures should be shortened that officers will need less time for paper works. New training programs about new technologies should be developed. New rules should bring into force for reducing fatigue of seafarers. Sea and sea life must be encouraged. Social facilities about seafarers at port should be developed. Navigation bridges and accommodation places should be designed taking into account ergonomic aspect. Widespread use and equipping new technologies such as ECDIS and automated loading-discharging systems on board should be maintained.

6 CONCLUSION

In maritime industry, human errors causing still accident and incidents in spite of latest navigational technologies and fatigue is playing important role on these errors. In this study, it is aimed to identify the positive and negative factors that affecting the fatigue level of seafarers by applying SWOT (Strength, Weakness, Opportunities and Threats.) analysis. Taking into account above mentioned strengths, weaknesses, opportunities and threats, several practical solutions are proposed for reducing fatigue related human errors on shipboard operations.

REFERENCES

- Akten N., (2004). Analysis of Shipping Casualties in the Bosphorus, *Journal of Navigation* 57, 345-356.
- Arslan O., Er I.D., (2006). Human Factor Aspect for shipboard operations, *Maritime Transport 3*. Barcelona, pp. 871-878.
- Er D., (2000). Integration of Quality Based Management Standards into International Maritime Training and Education, *International Association of Maritime Universities Journal*, 1, 45-53.
- Er Z., Celik M., (2005). Definitions of Human Factor Analysis for the Maritime Safety Management Process, *IAMU AGA-6*, Malmö.
- Kangas J., (1994). An Approach to Public Participation in Strategic Forest Management Planning. *Forest Ecological Management* 70, 75–88.
- Pomeroy R.V., Sherwood Jones B.M., (2002). Managing the Human Element in Modern Ship Design and Operation, *Human Factors in Ship Design and Operation Conference*.
- Saaty R.W., (1987). The analytic hierarchy process and SWOT analysis– what it is and how it is used. *Mathematical Modeling* 9, 161–178.
- Shea I.P., Grady N., (1998). Shipboard Organisational Culture in the Merchant Marine Industry, *Proceedings of the Safe Navigation Beyond*, Gdynia.
- STCW, Seafarers Training, Certification and Watchkeeping (STCW) Code - Part A - Mandatory Standards Regarding Provisions of the Annex to the STCW Convention - Chapter VIII - Standards Regarding Watchkeeping - Section A-VIII/1 Fitness for duty, 1995.
- Seafarer Fatigue: Cardiff University Research Programme, 2006. Cardiff.