A method of assessing the impact of a human factor on the risk of a marine accident during maneuvers in a restricted water.

SUMMARY

The systematic approach to the evaluation of human factor influence on the risk of maritime accidents is based on the formal human-ship-environment system definition including the relationships between human, technology, environment and organization.

There are three categories of factors having an impact on human reliability considered in the anthropotechnical systems. The social and organizational factors are included in the IMO (International Maritime Organization) regulations; the individual factors still need investigations. There are few examples of the research on human factor influence on navigational error committed by the navigator considering the selected features of a psychological profile.

This research should include both the psychological assessment, carried out by the authorized psychologist and properly prepared research program in the field of maritime traffic engineering, using the advanced methods and research tools.

The combination of psychological studies and technical operation of sea-going ships gives a big opportunity to use the human factor assessment in rule-making process and decision support systems development. The necessity of research results from the documents published by IMO, maritime administrations, agencies and maritime safety comities. In particular, it is related to the navigation in restricted waters.

The problem considered in the thesis concentrates on human factor influence on the risk of maneuvering accident, in particular on the not presented in the known literature influence of human susceptibility to stress, risk-taking motivation and basic features of human personality relationship with the correctness of a complex maneuvering task performance.

The main scientific goal of the dissertation was the development of the method for the assessment of human factor influence on the risk of maneuvering accident in restricted waters, based on the research within the area of technical ship operation and using the results of psychological analysis of personality profile carried out by the authorized psychologist.

The developed method includes the identification of stress factors affecting human performance on the bridge and development of a fuzzy model of human factor influence on the risk of maneuvering accident.

The model is based on the quantitative human factor model developed by the authorized psychologist comprising personality traits, vulnerability to stress and risk approach. The investigations were carried out with two groups of participants: 32 experienced Ship Masters and 42 students performing the complex maneuvering task on Full Mission Ship Handling Simulator and man manned physical models of ships.

The selection of two groups of participants and dedicated experimental conditions allowed assuming the features of psychological profile as the main elements influencing the risk of maneuvering accident. The statistical survey of results was based on the correlation analysis, Bayesian networks and fuzzy logic. The multidimensional dependencies between variables of the psychological profile and risk of an accident resulting from maneuvering errors were implemented into the Mamdani fuzzy model. The calculations were performed using Fuzzy Logic Toolbox of MatLab computing environment. The model was verified for the selected risk levels of the linguistic risk scale for the groups of Ship Masters, students and group combined of both Ship Masters and students. The model was verified for the high-risk level using Bayesian network.

The result obtained by Mamdani model were compared with calculations done using self-tuning Sugeno model available in MATLAB/Simulink environment.

The developed model allows conducting various experiments and risk assessment in dependence on the selected personality profile features. These features can be measured using psychological questionnaires and then the risk of accident due to the maneuvering error can be calculated for a captain or marine pilot in order to improve human resource management.

The resulting accident risk value can be implemented in the general risk assessment models in waterborne transport.