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METHODS OF RESEARCHING THE HUMAN FACTOR IN THE MARITIME INDUSTRY

This study examines the methodological approaches employed by contemporary researchers in the maritime domain, with particular emphasis on human factors. The aim is to provide guidance for graduate students and early-career scientists in selecting appropriate and effective research methods for their own investigations. By analyzing current methodological trends, the study seeks to discourage reliance on outdated or limited techniques – such as simple percentage-based analyses – and to promote the adoption of more advanced and rigorous approaches.

The research is based on a review of 50 articles published in Scopus-indexed journals. The analysis reveals several prominent methodological tendencies in recent studies, including the use of advanced data analytics, case study approaches, field research conducted during maritime voyages, and the application of author-developed questionnaires with thorough validation procedures. The findings indicate that studies focusing on human factors predominantly employ psycho-diagnostic methods, surveys and questionnaires, observational techniques, and experimental designs.

Among experimental approaches, navigation simulators are widely utilized due to their ability to replicate realistic maritime conditions, including variable weather, traffic density, technical failures, and emergency scenarios. Additionally, archival methods play a significant role by enabling retrospective analyses of maritime incidents and human performance under authentic operational circumstances.

Overall, data analysis emerges as a central component of modern maritime research on human factors, facilitating the transition from descriptive observations to evidence-based conclusions. This approach supports the identification of patterns and causal relationships, thereby enhancing the scientific rigor and practical relevance of contemporary studies.

Key words: *human factor, methodology, marine psychology, surveys, data analysis*

Introduction. Human factor at the current stage of development of the maritime industry is increasingly being integrated into the regulatory and legal framework of international shipping. A key role in this process is played by the documents of the International Maritime Organization (IMO), primarily the International Convention on the Training and Certification of Seafarers and Watchkeeping (STCW, 1978 as amended, in particular the Manila Amendments of 2010). In these standards, the psych-pedagogical aspects of seafarers' professional activity are considered as a component of seafaring safety and the reliability of the human factor. IMO has consistently emphasized that most maritime accidents are not due to technical failures, but to human error. In this regard, in modern IMO documents, the emphasis shifts from formal mastery of technical skills to the development of non-technical skills, which include situational awareness; decision-making in conditions of uncertainty; stress and fatigue management; communication and team interaction; leadership and responsibility. These elements actually form the subject of research in marine field; they are related to cognitive processes, emotional regulation, interpersonal interaction and psychological resilience of seafarers. In IMO documents, marine psychology is in fact integrated into the broader concept of human element /human factor. Within this concept, psycho-pedagogical factors are considered as: the key link of the "man - technology - environment" system; source of both risks and security resources; object of management through training, selection, training and mental health support. Marine psychology provides scientific tools for the analysis of human errors, the development of training programs, the assessment of the psychological readiness of seafarers to watch and actions in emergency situations.

In practical terms, research in human factor contributes to: improvement of the system of professional selection of seafarers; development of training on stress and fatigue management; increasing the efficiency

of teamwork of crews; reducing accidents and occupational burnout; formation of a safety culture on the ship. Thus, research in marine psychology acts not only as a scientific discipline, but also as a tool for the implementation of international IMO/STCW standards, ensuring the psychological component of maritime safety. Unfortunately, marine psychology is not developed as a separate branch of science, but there are some well-known books which started the development of this field. Malcolm MacLachlan is an international specialist in marine psychology and his main works: *Maritime Psychology: Research in Organizational & Health Behavior at Sea*, Springer, 2017 - the first comprehensive scientific collection on maritime psychology, which includes an overview of psychological, social and behavioral aspects of the life and activities of seafarers in maritime transport (organizational, mental and behavioral component).

The essence of the contribution: systematizes psychological research of seafarers' work, mental health, adaptation to the conditions of long-term stay at sea and the human factor as a key factor in safety. Also, we would like to mention Michelle Rita Grech, Tim Horberry, Thomas Koester and their book "Human Factors in the Maritime Domain". Main aspects in its content are psycho-physiological aspects of seafarers' activities; situational awareness, fatigue, navigational errors; communication in a team, human-technician interaction; analysis of human errors in maritime accidents.

The purpose of this article. The purpose of the article is to provide an analysis of modern methods of human factor research in marine field, which are used by modern scientists.

Relevance of the study.

The study was aimed at studying the methodology used by contemporary scientists specifically in the marine field. This research will help graduate students and young scientists choose the right scientific methods for their own research developments. The analysis of modern methodologies aims to prevent the use of irrelevant methods and discourage researchers from limiting themselves to simple percentage-based analyses, encouraging instead the use of more advanced approaches.

Methods

The purpose of the research is to analyze the most popular methods used in the recent works of the scientists, who study the role of human factor in the maritime field.

For the research we used the following journals:

1. "Journal for Maritime Research", focuses on the historical enquiry of maritime history, particularly British maritime experience within a global context.
2. "Journal of Maritime Research", focuses on the technical, engineering, and social aspects of the maritime sector.
3. "Maritime Studies", focuses on social dimensions, coastal management, and marine policy.
4. "Promostro", published by the Faculty of Maritime Studies Rijeka, covering nautical science, engineering, and logistics.
5. "Maritime Policy and Management", focuses on management, policy, and operations in the shipping industry.
6. "European Journal of Maritime Research", an open-access journal covering engineering, scientific, and technical maritime research.
7. "Maritime Economics and Logistics", focuses on economic issues.
8. "Transactions on Maritime Science", focuses on maritime research from South-East Europe, particularly the Mediterranean area.
9. WMU Journal of Maritime Affairs covers a wide range of maritime-related subject areas, such as maritime administration and management, maritime safety and sustainability, maritime law and regulations, 'maritime education and human resources.

We analyzed 50 articles from these journals, found out some tendencies of methods, used in the recent studies, such as: deep data analyses, case studies, research during the voyages, authors' questionnaires with deep analysis of their validity etc.

Results of the study

Summarizing the studied articles, we emphasize that the researchers use various scientific methods adapted to the specifics of the seafaring profession.

Psycho-diagnostic methods: tests for attention, memory, reaction, observation, stress resistance.

An important psycho-physiological factor for the suitability of a seafarer for professional activity is attention. To measure the various dimensions of attention, we recommend follow-up tests: focus, Response Rate and Distraction Test (Schultz Monsters/Eyeballs Test), attention to colors (Stroop task Kagan test), visual attention to objects (Cancellation Tasks), multitasking ability Dual-task test, memory measurement (Digit Span, Forward and Backward, Corsi Block-Tapping Test), etc.

We note that tests for psychomotor abilities and coordination are especially important for navigators, engineers, and captains. For instance, the research conducted by Mengjiao Guo and Haonan Zheng (2025) utilizes several established instruments: “Connor-Davidson Resilience Scale (CD-RISC): A widely used 25-item self-report scale that assesses the ability to cope with stress. It has good reliability and validity for measuring changes in psychological resilience. Perceived Stress Scale (PSS-10): A 10-item scale assessing the degree to which situations in one’s life are appraised as stressful over the past month. Profile of Mood States (POMS), Pittsburgh Sleep Quality Index (PSQI): Evaluates sleep quality over the past month”. The use of validated psychometric instruments is also evident in other research, such as the study by Oldenburg et al. (2018). In their cross-sectional study, 251 seafarers were surveyed regarding demographic data and job-related stressors. Particularly, the Emotional Exhaustion (EE) subscale of the Maslach Burnout Inventory (MBI) and the Epworth Sleepiness Scale (ESS) were used to assess the respective risks of job-related burnout and daytime sleepiness. The statistical analysis was carried out using multiple logistic regressions.

Questionnaires and surveys

To realize the goal of the study, it is not enough to use only existing recognized tests. And all modern researchers use questionnaires of subjects. Questionnaires are important empirical research methods in marine psychology that allow studying mental states, behavioral manifestations and interpersonal relationships of crew members in real conditions of professional activity. The specificity of the maritime service, involving collective work in confined spaces and increased responsibility for safety, makes these methods particularly valuable for the analysis of group processes and psychological climate on ship. Questionnaires and surveys are widely used to assess subjective perceptions of psychological states and working conditions. With the help of specially developed instruments, researchers investigate the crew's psychological climate, job satisfaction levels, relations with management and colleagues, as well as the perception of living and working conditions at sea. Such data make it possible to identify factors that contribute to or, on the contrary, hinder effective professional activity. A special place is occupied by questionnaires for assessing the level of anxiety and emotional tension. They allow you to detect a tendency to stress reactions, internal tension, emotional exhaustion and the risk of developing psychological disorders. The advantage of the questionnaire is the possibility of covering a significant number of respondents in a relatively short time, as well as obtaining standardized data for further analysis.

The method described by the researchers of human factor was like that. “... a group of experts made a list of adjectives. Then, a sample of 141 Officers was asked to give their opinion about the importance of each adjective in Seafarer’s behaviour. Exploratory Factor Analysis and Confirmatory Factor Analysis through Structural Equation Modeling techniques were applied to the data” (Cordon et al.,2017).

Observation

Observing the behavior of the crew during real or educational navigation makes it possible to obtain objective information about the peculiarities of professional interaction, discipline, the level of coordination of actions and the emotional reactions of sailors in standard and stressful situations. A psychologist or trained specialist analyzes the style of communication between crew members, the ability to work as a team, manifestations of leadership, conflict or emotional tension. During educational navigation, observation allows you to assess the readiness of sailors to perform professional tasks, their behavior in conditions of modeling emergency or non-standard situations.

An important advantage of the observation method is the possibility of recording natural behavior without direct intervention in the crew's activities. This allows you to identify hidden problems of adaptation, decreased motivation or impaired mutual understanding, which are not always realized by the sailors themselves. Observation results are often used to correct management style, improve team interaction, and improve maritime safety.

Interviews

This method of research was described by in the article of McVeigh et al., 2018. “The first interviews were conducted ... via telephone and Skype as participants were on-board at the time of interview. The officers’ focus group was subsequently conducted by the primary researcher at the Shell International Fleet Officer Conference, London, UK, in December 2015, as an event separate to the main conference meeting. The superintendents’ interviews were also conducted by the primary researcher at this conference”.

Experimental research methods in marine psychology

Experimental methods occupy an important place in marine psychology, as they allow purposeful study of mental processes, behavior and decision-making of seafarers in controlled but close to real conditions. Unlike observation or questionnaires, the experiment makes it possible to actively change the conditions of activity and analyze how these changes affect the psychological state and professional efficiency of marine industry specialists.

One of the most common experimental methods is the use of simulators of navigation. Such simulators reproduce real navigation conditions, including weather factors, vessel traffic volume, technical malfunctions and emergency situations. In the process of the experiment, the behavior of boat masters in extreme or non-standard conditions, their ability to maintain self-control, concentration of attention and effectively interact with other crew members is investigated. The advantage of this method is the possibility of repeated reproduction of complex and dangerous situations without risk to life and the ship.

An important variety of experimental methods are simulation exercises aimed at evaluating decision-making processes under stressful conditions. During such exercises, participants are offered simulated problem situations that require quick analysis of information, selection of the optimal strategy of actions and forecasting of the consequences of decisions. The speed and reasonableness of decision-making, the level of psychological tension, the tendency to risk and the effectiveness of team interaction are analyzed. Such experiments are particularly valuable in assessing the professional reliability of marine professionals. The article “Modeling and simulating processes in optimizing port activities – literature review” published in the Scientific Bulletin of Naval Academy in 2022 was authored by a team of six researchers. Their “paper aims to provide a systematic literature review in the field of process modeling and simulation for process improvement in seaports”

In modern research, computer simulation models are widely used, which allow analyzing human behavior in complex dynamic systems. As part of the experiment, a virtual environment is created where all objects (such as ships) are generated in advance with specified parameters, such as arrival time, service duration, or driving conditions. This provides the same starting conditions for different experimental scenarios and makes it possible to objectively compare the effectiveness of different behavior strategies. Limiting the number of random factors allows you to reduce the impact of random deviations and increase the reliability of results.

At the same time, it is important to take into account that under experimental conditions, not all information that objectively exists in the system may be available to the subjects. This makes it possible to model situations of uncertainty specific to real maritime activity, where decisions are taken under conditions of incomplete or delayed information. This approach allows for deeper exploration of cognitive processes, prediction strategies, and psychological mechanisms of adaptation. Consequently, experimental methods in marine psychology provide a scientifically based study of behavior and mental processes in complex and stressful conditions. They are an effective tool for assessing professional readiness, improving the quality of maritime training, and enhancing maritime safety systems.

Archive methods

Archival methods represent an essential component of contemporary research in the study of human factors within the maritime domain. They provide access to extensive historical datasets that enable researchers to examine long-term trends, patterns of incidents, and the evolution of safety practices over time. Unlike primary data collection, which is often limited in scope and duration, archival research allows for the analysis of large-scale, real-world evidence derived from official records, institutional reports, and documented case studies.

The importance of archival methods lies in their ability to support retrospective analysis of maritime accidents and human performance under authentic operational conditions. Such methods make it possible to identify recurring causal factors, assess the impact of organizational and regulatory changes, and validate theoretical models of human error. In this context, the use of diverse and credible archival sources is critical, as it enhances the reliability and comprehensiveness of the research findings. Moreover, modern archival research increasingly integrates digital databases and online repositories, which significantly expand access to information and facilitate more sophisticated data analysis.

Therefore, archival methods should not be viewed as merely descriptive or supplementary. When applied systematically and in combination with advanced analytical techniques, they constitute a powerful methodological approach that contributes to evidence-based conclusions and supports the development of effective safety strategies in maritime operations.

The archive method is actively used in recent research. Thus, researchers (Carter et al., 2023) indicate that "the main information sources used to identify ship casualties and human fatalities were, first, a complete series of Lloyd's Register of Shipping's Shipping Casualties/Wreck Returns..., Board of Trade investment Wreck Reports, searches of the leading shipwreck website (wrecksite.eu), The British Newspaper Archive and Welsh Newspapers Online.

Data analysis

Data analysis constitutes a fundamental component of contemporary research into human factors in the maritime domain. It enables researchers to move beyond descriptive observations toward evidence-based conclusions, supporting the identification of patterns, causal relationships, and risk factors that directly affect safety and operational performance. In this context, relying solely on basic statistical procedures—such as calculating percentages or simple averages—is insufficient. While such methods may provide an initial overview, they do not capture the complexity, uncertainty, and interdependence inherent in human and organizational systems.

Modern research requires the application of advanced analytical approaches capable of handling multidimensional data and modeling human behaviour under varying operational conditions. Among the most widely used tools are statistical software packages such as SPSS, R, and Python-based analytics libraries, which support regression analysis, multivariate analysis, and predictive modeling. In addition, specialized methodologies for human factors analysis are essential. Techniques such as the Human Factors Analysis and Classification System (HFACS) enable systematic identification and categorization of human errors, while Cognitive Reliability and Error Analysis Method (CREAM) allow for the quantification of human error probabilities. Furthermore, contemporary studies increasingly incorporate Bayesian networks, fuzzy logic, and evidential reasoning to address uncertainty and to model complex interactions between common performance conditions (CPCs).

Thus, modern data analysis is not merely a supportive element of research but a core methodological foundation. Its proper application ensures the validity, reliability, and practical relevance of findings, particularly in high-risk domains such as maritime operations, where understanding human factors is critical for improving safety outcomes.

Here we cite some examples of how researchers describe the tools for data analysis. «Quantitative studies were appraised using a slightly modified version of the AXIS tool» «Studies using retrospective analysis of existing health data were appraised using the nine questions in the MetaQAT Critical Appraisal Tool» (Brooks S. K., Greenberg N., 2022). While studying human factors, scientists use techniques for human organizational analysis (HOFs). «The most widely used modeling technique for human error identification is the Human Factors Analysis and Classification System (HFACS). Moreover, Cognitive

Reliability Error Analysis (CREAM) is the most widely used technique for human error probability quantification, and fuzzy, evidential reasoning and Bayesian networks are often incorporated for common performance condition (CPC) quantification and synthesis processes» (Fan et al., 2020).

Development prospects

In the context of the further digitalization of shipping, autonomous vessels and the increasing cognitive burden on seafarers, the role of marine psychology within the IMO/STCW standards will continue to grow. Increased attention is expected to: psychological adaptation to automated systems; maintaining situational awareness; mental health support in isolation; integration of psychological criteria into the certification and training system.

Conclusion.

By summarizing the studied articles, we identified the most prevalent methods for investigating the role of the human factor in the maritime domain.

1. Psycho-diagnostics methods. Tests for attention, memory, reaction, observation, stress resistance are the most frequently used.

2. Questionnaires and surveys are widely used to study subjective assessments of psychological state and working conditions. With the help of specially developed questionnaires, the psychological climate in the crew, the level of job satisfaction, relations with management and colleagues, as well as the perception of living and working conditions on the ship are investigated.

3. Observations. An important advantage of the observation method is the possibility of recording natural behavior without direct intervention in the crew's activities. Observation results are often used to correct management style, improve team interaction, and improve maritime safety.

4. Experimental methods. One of the most common experimental methods is the use of simulators of navigation. Such simulators reproduce real navigation conditions, including weather factors, vessel traffic volume, technical malfunctions and emergency situations. The advantage of this method is the possibility of repeated reproduction of complex and dangerous situations without risk to life and the ship.

5. Archive method. The importance of archival methods lies in their ability to support retrospective analysis of maritime accidents and human performance under authentic operational conditions.

6. Data analysis. Data analysis constitutes a fundamental component of contemporary research on human factors in the maritime domain. It enables researchers to move beyond descriptive observations toward evidence-based conclusions, supporting the identification of patterns, causal relationships, and risk factors that directly affect safety and operational performance.

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МЕТОДИ ДОСЛІДЖЕННЯ ЛЮДСЬКОГО ФАКТОРУ У МОРСЬКІЙ ГАЛУЗІ

Дослідження спрямоване на вивчення методології, яку застосовують сучасні вчені в морській галузі. Отримані результати сприятимуть обґрунтованому вибору наукових методів аспірантами та молодими науковцями для власних розробок. Аналіз сучасних підходів дозволяє запобігти використанню не релевантного інструментарію та спонукає дослідників виходити за межі простого кількісного підрахунку відсотків.

На основі аналізу 50 статей з журналів, що індексуються в базі даних Scopus, визначено провідні тенденції: глибокий аналіз даних (data mining), тематичні дослідження (case studies), польові дослідження під час рейсів, а також розробка авторських опитувальників із ретельною перевіркою їхньої валідності.

Встановлено, що ключовими методами вивчення людського фактору є психодіагностика, анкетування, спостереження та експериментальні методи. Серед останніх найпоширенішим є використання навігаційних тренажерів, які відтворюють реальні умови: погодні чинники, інтенсивність руху суден, технічні несправності та надзвичайні ситуації. Важливу роль відіграють також архівні методи, що дозволяють здійснювати ретроспективний аналіз морських аварій та ефективності роботи екіпажу в автентичних умовах. Сучасний аналіз даних є фундаментальним компонентом досліджень, оскільки дозволяє перейти від описових спостережень до доказових висновків, виявлення закономірностей та причинно-наслідкових зв'язків.

Ключові слова: людський фактор, людський фактор, методологія, морська психологія, опитування та опитування, аналіз даних