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Research Article

Psychopedagogical features of the formation of stress resilience of future seafarers: Readiness to overcome the challenges of life activity at sea

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Abstract

This research aims to define and substantiate the core psychopedagogical features comprising specific content, methods, and criteria that are essential for effectively integrating stress resilience training into the professional curricula of future seafarers. A number of adapted psychodiagnostic methods were used to address the tasks related to the stress resilience of future seafarers: 1) Connor-Davidson Resilience Scale (CD-RISC); 2) Perceived Stress Scale (PSS); 3) authors' questionnaires "Resilience of future seafarers" and "Readiness to overcome stress situations while working at sea". It was identified that future seafarers' stress resilience is not only a personal trait but is also heavily influenced by the special conditions of their professional environment. Three most significant factors were identified: 1) the extremity of the profession (the possibility of emergency situations and the need for quick decision-making); 2) communication in a limited space (avoidance and resolution of conflict situations, lack of access to the Internet and other means of communication); 3) physical living conditions (limitation of personal space).

1. Introduction

A strategic, holistic approach to the well-being of seafarers is the key to retaining experienced personnel and attracting a new generation of professionals in the maritime industry. People who enable global trade should not remain isolated with their problems- neither onboard nor ashore. The problem of the decline in the attractiveness of the seafaring profession, and its impact on the morale, motivation, and professionalism of crews, is addressed in this study. Harsh working conditions, long periods away from home, economic instability, competition from the IT industry, and a number of other factors reduce the interest of young people in maritime careers. To ensure a resilient and sustainable workforce in the evolving maritime industry, it is crucial to refine maritime education by balancing physical, mental, and vocational competencies with comprehensive sustainability training (Barasa et al., 2025). Seafarers are often exposed to a variety of stressors, including social isolation, high-pressure situations, and the demands of maritime operations, which can significantly affect their mental health and performance. In light of today's global challenges, such as climate change, the growing complexity of maritime operations, and the impact of long voyages on mental health, the formation of stress resistance in future seafarers is gaining critical importance. All these factors are significant sources of stress and anxiety for seafarers. Therefore, developing stress resistance, emotional resilience, and coping strategies is crucial for their mental health and effective performance. It should be mentioned that there is a difference between stress and anxiety. Stress is a

response to external pressure or a challenge. It is often short-term and can disappear once the stressful situation is resolved. Anxiety is a persistent feeling of worry, fear, or unease, even when there is no immediate threat. It is often ongoing and not tied to a specific event- it can continue even after the stressor is gone (in anticipation of future problems). If the above-mentioned factors mostly cause chronic anxiety (anticipation of future problems), accidents such as collisions, shipwrecks, piracy attacks, sexual abuse, or racial harassment are definitive sources of acute stress and potential trauma for seafarers.

Thus, supporting the well-being of seafarers is not only about their emotional comfort; it is also about their mental and physical health and their survival. Furthermore, there is a difference between stress reliance and stress resistance, though they sound similar. Stress resistance refers to an organism's (or person's) ability to withstand or minimize the negative effects of stress. Stress reliance means depending on stress to function well or achieve optimal performance. In psychology or performance science, it means that some individuals rely on a certain amount of stress (or pressure) to stay motivated, focused, or productive.

The International Maritime Bureau (IMB) reported statistics on global maritime incidents and maritime piracy in 2024. The report recorded 116 incidents against ships in 2024, down from 120 in 2023, but up from 115 in 2022. Although the overall number of incidents reported by the IMB remains relatively stable, the escalation of maritime piracy in the first quarter of 2025 (recording 45 incidents) underscores the continuing and immediate risk faced by seafarers. The report stated that 94 ships were boarded, 13 reported attempted attacks, six were hijacked, and three of them were fired upon. The IMB recorded 45 incidents of maritime piracy in January-March 2025, a significant increase compared to the same period in 2024 (ICC ITALIA, 2025). In the context of a pirate attack, seafarers should be stress-resilient, not just stress-resistant. They must be stress-resilient to cope with high-pressure situations such as pirate attacks, ensuring they remain calm, follow safety procedures, and recover quickly after the incident. Researchers also note the presence of sexual harassment, which has deep cultural roots associated with historically male occupations, gender stereotypes, and an isolated environment onboard, and this problem in the maritime industry remains acute despite increased demands for corporate responsibility and the well-being of crew members. However, victims often do not report incidents for fear of retaliation or career impact, which creates a culture of silence. (Ukrainian Shipping Magazine, 2025). In this situation stress resistance implies being "unaffected" or "impervious" to stress, which is not realistic during a violent, life-threatening event. Stress resilience captures the ability to stay composed during these situations and bounce back afterwards- emotionally, mentally, and operationally.

Therefore, when educators train future seafarers, they should teach them to overcome any possible stress situations. Psycho-emotional resilience plays an important role in ensuring quality performance of professional tasks, maintaining the safety of navigation, and preserving the overall well-being of the crew. Considering that the professional activity of seafarers is often associated with prolonged stays in limited space, limited social contacts, and a high risk of physical and psychological stress, the formation of stress resistance and stress resilience becomes an integral part of their training.

Given the critical necessity of this psycho-emotional resilience for both personnel survival and operational safety, this research aims to define and substantiate the core psychopedagogical features- comprising specific content, methods, and criteria- essential for effectively integrating stress resilience training into the professional curricula of future seafarers. Despite the growing body of research on seafarers' mental health and stress resilience, most existing studies focus either on experienced seafarers or on clinical indicators of stress and well-being. Far less attention has been paid to future seafarers at the stage of professional education, particularly from a psychopedagogical perspective. Moreover, previous studies rarely link empirical data on stress-related perceptions with concrete educational recommendations for curriculum design. This study addresses this gap by exploring stress resilience among maritime students and translating empirical findings into practical psychopedagogical training recommendations.

2. Literature review

In psychology, stress resistance is defined as the ability of an individual to effectively adapt to stressful conditions while maintaining emotional and mental stability. Medical science investigates the physiological aspects of stress resistance, such as the impact of stress hormones like adrenaline and cortisol which keep the body in a state of high alert, and also develops methods of maintaining physical and mental health in conditions of increased workload. In sociology, stress resistance is considered as an individual's ability to interact with society under conditions of stress. Educational science emphasizes the formation of stress resilience in the learning process, using training, simulations, and psychological exercises to develop adaptation skills.

2.1 Stress resilience and mental health of seafarers

Some researchers define their work as “a foundational step in maritime mental health research, emphasising accident prevention aboard ships. It does also highlight the need to raise awareness from the very first steps into the profession, from the Maritime Education and Training stage.” (Sánchez-González et al., 2024, p. 7). Identified psychological factors of seafarers' activities provide a conceptual foundation for measuring future seafarers' readiness to cope with stressful situations in their professional life at sea. Three defined factors are: 1) psychological well-being; 2) interpersonal and environmental challenges; 3) social isolation and communication difficulties (Arslan et al., 2025, p. 42).

2.2 Psychopedagogical approaches to stress resilience training

This study supports the proposal to “to integrate stress management and diversity training in intercultural communication in the higher education of future superiors on board” (Jensen & Oldenburg, 2020, p. 178). The content of stress resilience can be integrated into many disciplines such as “Survival at sea”, “Intercultural communication and Leadership”, “Psychology for professional purposes”, etc.

Some studies provide detailed recommendations on how to develop the mechanisms of psychological resilience in the case of seafarers living in isolation and uncertainty during their voyages (Toygar, 2025), and how to “endure the isolation, stress, and homesickness inherent in their profession” emphasizing the discipline as a cornerstone of resilience (Abadicio et al., 2025, p. 153). Kakon et al. (2025) describe human rights violations against seafarers. This she present study states that a violation of human rights on board a ship can definitely cause stress and, in many cases, it can also lead to serious psychological harm, including anxiety, depression, and trauma.

2.3 Gaps in maritime education for future seafarers

Most researchers state that the development of soft skills is crucial to the professional competence of future seafarers, particularly concerning their mental health support and sustainability integration. They prove that effective education of future seafarers should come “through integrated physical and mental health, sustainability, and vocational training. This ensures cadets are not only technically proficient but also resilient, healthy, and equipped for a sustainable maritime future” (Barasa et al., 2025, p. 10).

The same ideas are expressed by other researchers. “The findings indicated that although maritime education effectively develops technical competencies, there are significant gaps in the integration of sustainability and health management. Both lecturers and graduates emphasized the need for more practical sustainability training and enhanced mental health support.” (Cahyadi et al., 2025).

3. Methods

The issue of developing stress resilience in future seafarers has become increasingly important for Ukrainian educational institutions. Ukrainians constitute a substantial proportion of the global

merchant fleet's personnel; according to the Seafarer Workforce Report 2021 by BIMCO and the International Chamber of Shipping, more than 76,000 Ukrainian seafarers are employed by international shipping companies. Since the onset of the war, many Ukrainian crew members have been unable to depart the country, while others remain onboard vessels for extended periods due to the challenges of returning home. These circumstances heighten the need to strengthen psychological preparedness and stress resilience skills among seafarers in training.

3.1 Research design

The study employed a cross-sectional exploratory research design with descriptive and correlational components. Data were collected at a single point in time using standardized psychometric scales and author-developed questionnaires to explore stress resilience and perceived stress among future seafarers.

3.2 Participants

The sample for quantitative analysis consisted of 40 undergraduate students (second- and third-year) enrolled in navigation and technical systems programs at the Kyiv Institute of Water Transport. Participation was voluntary and anonymous.

The sample consisted of the students of one educational institution, of the same specialties (navigation, technical systems), and of one age range (2 - 3 courses); this meant that the sample was homogeneous, and therefore: response variance was lower, fewer participants were able to provide stable psychometric indicators, and statistical errors were reduced. In psychology, 30 - 50 people are acceptable for: correlation studies with an average effect; primary psychometric assessment; pilot testing of original tools; and factor analysis under the condition of a small number of variables. The participants of the research had only educational shipboard practice, meaning that they did not have real work experience of work at sea. The qualitative research included individual discussions, feedback after testing, and approbation of practical recommendations on how to develop stress resilience in the form of training.

3.3 Instruments

Research methods used were documentary review (study of the conventions of the International Maritime Organization, study of requirements for seafarers on the websites of local and European crewing companies), empirical (observation, questionnaires, interviews, testing, and evaluation), and Statistical and Mathematical Data Processing (scaling, internal consistency of scales estimated by calculating the alpha-Cronbach coefficient, Spearman correlation coefficient (ρ), factor analysis to identify the main factors that affect the formation of stress resistance). To analyze the received data, IBM SPSS Statistics software was used. A number of adapted psychodiagnostic methods were used to address the tasks related to the evaluation of general individual stress resilience of respondents: 1) Connor-Davidson Resilience Scale (CD-RISC); 2) Perceived Stress Scale (PSS) and the evaluation of specific stress resilience connected with the work at sea; 3) authors' questionnaire "Resilience of future seafarers"; 4) authors' questionnaire "Readiness to overcome stress situations while working at sea".

4. Results and discussion

4.1 Connor-Davidson Resilience Scale (CD-RISC)

This test is a widely used psychological instrument that measures resilience- a person's ability to cope with stress and adversity (see **Appendix 1**). The purpose of the test is to assess the ability of respondents to adapt to stressful situations (deal with stress). The tasks are to calculate 1) the mean item score (weighted average per question); 2) the total average CD-RISC score per respondent; 3) the overall interpretation of resilience level for the group. Reliability statistics: alpha- Cronbach 0,

839 (N = 25 elements). The statistic results: number of respondents- 40; total possible score- 100; group mean score- 65; average per item- 2,6/4; resilience level- moderate.

The mean CD-RISC score of 65 points suggests a moderate overall resilience level among the participants. Most respondents (over half) exhibited high resilience characteristics, indicating strong coping mechanisms, optimism, and adaptability. A smaller segment (around one in ten) displayed low resilience, suggesting potential areas for psychological or stress-management support.

Overall, the results suggest a relatively good potential for adaptation by the majority of respondents, while highlighting the importance of further psychological preparation for the conditions of the future profession. 55 % of respondents had a high level of stress resilience, which indicates their ability to quickly adapt to changes, maintain internal balance in critical situations, and make thoughtful decisions without succumbing to emotions. Such indicators are a positive marker of readiness for future professional challenges in the maritime environment. Moderate levels of stress resilience was demonstrated by 36 % of respondents, which corresponds to average resilience; generally adaptive, but vulnerable to prolonged stress. Only 9 % of respondents showed a low level of stress resilience, which indicates difficulties in adaptation, increased anxiety, rapid exhaustion, and a tendency to disorganize in difficult situations. This indicates the need to carry out preventive measures and trainings to increase the level of self-regulation and develop adaptation skills.

4.2 Resilience of future seafarers

The questionnaire consisted of 10 questions. Answers to questions were in a text form that allowed the obtaining of more reliable information. For example: Question 1. How do you usually behave during a long stay in a limited space (for example, on a ship)? Answer options: (a) I feel comfortable, I find an occupation. (b) I feel a certain discomfort, but over time I adapt. (c) I feel considerable stress and a desire to leave this place. All answers were interpreted as a) positive, b) moderate, or c) negative. The purpose of testing was to identify the level of readiness of future sailors to cope with stressful situations in a professional environment. Reliability statistics: alpha- Cronbach 0, 799 (N=10 elements).

Table 1 Results according to the questionnaire “Resilience of future seafarers”.

No.	Questions	Answers		
		High	Moderate	Low
1.	How do you usually behave during a long stay in a limited space (for example, on a ship)?	50 %	45 %	5 %
2.	How do you react to conflict situations (for example, between fellow students- potential crew members)?	60 %	30 %	10 %
3.	How do you feel when you need to make quick decisions in conditions of danger?	35 %	50 %	15 %
4.	How would you feel during long sea crossings, when there would be difficulties with communication with relatives?	40 %	50 %	10 %
5.	How do you perceive uncertainty about future working conditions on a ship?	35 %	50 %	15 %
6.	How would you behave during adverse weather conditions on the ship?	45 %	50 %	5 %
7.	How do you respond to limitations in your personal space and the necessity constant communication with other crew members?	35 %	55 %	10 %
8.	How do you perceive the long-term lack of access to the Internet and other means of communication?	25 %	55 %	20 %
9.	How would you react to the possibility of emergency situations on the ship?	35 %	55 %	10 %
10.	How would you like to spend time after a hard day's work on a ship?	75 %	25 %	0 %

Interpretation of the test score:

High level- high self-confidence, a sense of comfort; willingness to act under stressful circumstances; the ability to adapt to changing circumstances; focus on work regardless of stressful situations; the ability to cope with anxiety; the ability to make a balanced decision.

Moderate level- anxiety is present, but there is a willingness to act under stressful circumstances; a need for personal space, but the ability to adapt; a feeling of anxiety, but the ability to focus on work; a feeling of anxiety, but the ability to cope with it; a feeling of anxiety is present, but there is an effort to remain calm; remain calm and seek compromise; feel stressed, but try to make a balanced decision.

Low level- there is discomfort; unwillingness to act according to circumstances; the need for personal space and the inability to adapt; a feeling of anxiety, without the ability to focus on work; a feeling of anxiety, without the ability to cope with it; do not look for a compromise; feel stress, but do not try to make a balanced decision.

According to the results of the authors' questionnaire "Resilience of Future Seafarers" (N = 40), it was established that 43.5 % of respondents had a high level of resilience, 46.5 % a moderate level, and only 10 % a low level. High resilience includes confidence, the ability to adapt, and find effective solutions in stressful conditions. Moderate resilience means that there is a feeling of anxiety, but a willingness to act, and the ability to adapt is preserved. Low resilience means pronounced discomfort, difficulties with adaptation, and a need for psychological support. Consequently, most future seafarers exhibit adaptive behavioral mechanisms in conditions of limited space, stress, and isolation. The highest indicators are observed in issues related to the reaction to conflicts and rest after a load, which indicates the formed strategies for overcoming tension. The lowest results were in the aspects of digital isolation and uncertainty regarding working conditions, which requires further development of psychological preparedness for the realities of maritime service.

To sum up, the survey results show that the majority of respondents demonstrated a high level of self-confidence, even in conditions of predicted stress. This can be explained by the lack of real-life experience at sea, as well as characteristics of the nervous system and character. At the same time, the biggest concern was the opinions about the future working conditions of the seafarers. With this in mind, the feasibility of implementing special exercises and trainings aimed at developing stress coping skills in extreme working conditions is seen (Dohrmann & Leppin, 2016). In general, the positive perception of future professional activity is explained by the high motivation to work at sea.

4.3 The Perceived Stress Scale (PSS)

Perceived stress is a person's subjective feeling of how strong and uncontrollable he considers stress in his life. This is not necessarily the real level of stressful events, but how a person perceives, evaluates, and experiences them. This scale allows assessment of how often a respondent has felt overloaded, irritated, or unable to cope with events over the past month. The PSS (Cohen et al., 1983) is the most common technique for assessing the extent to which life situations are perceived as stressful, reflecting a subjective feeling of tension, overload, and loss of control. The questionnaire consists of 10 questions. The main goal is to determine: 1) the level of subjective perception of stress in everyday life, which can affect professional efficiency in the future; 2) psychological factors that cause internal tension, anxiety, or insecurity, and which require further attention or correction. The results of the survey you can see in the **Table 2**.

Average total score of the group = 18.45 out of 40 possible; the level of stress is moderate; most experience periodic tension, but not critical; control over emotions is preserved. Estimated distribution of respondents by type of answers and average value: low- 25 %; moderate- 60 %; high- 15 %. In a sample of 40 respondents, the average level of perceived stress is 18.5 points (moderate level). Most respondents adequately cope with the load, although some demonstrate increased emotional stress, which may require measures to reduce stress (psychohygiene, relaxation techniques, support of the social environment). Model Summary: measurement 1. Cronbach's alpha- 0, 848;

measurement 2. Cronbach's alpha- 0, 793; mean 0.823 (Average Cronbach's alpha is based on the average eigenvalue).

These results are also associated with the lack of direct work experience in the marine environment and the peculiarities of individual personal resources. At the same time, in order to increase stress resilience in the real conditions of future professional activity, it is advisable to implement training programs for adaptation to extreme situations.

Table 2 Results according to Perceived Stress Scale (PSS).
 Perceived Stress Scale (PSS)- 10 questions, N = 40

No.	Questions	Answers				
		Never	Almost never	Sometimes	Fairly often	Very often
1.	In the last month, how often have you been upset because of something that happened unexpectedly?	20 %	35 %	35 %	10 %	0 %
2.	In the last month, how often have you felt that you were unable to control the important things in your life?	5 %	35 %	35 %	15 %	10 %
3.	In the last month, how often have you felt nervous and stressed?	15 %	15 %	30 %	35 %	5 %
4.	In the last month, how often have you felt confident about your ability to handle your personal problems?	10 %	20 %	35 %	35 %	0 %
5.	In the last month, how often have you felt that things were going your way?	0 %	40 %	50 %	10 %	0 %
6.	In the last month, how often have you found that you could not cope with all the things that you had to do?	5 %	25 %	45 %	20 %	5 %
7.	In the last month, how often have you been able to control irritations in your life?	0 %	25 %	45 %	30 %	0 %
8.	In the last month, how often have you felt that you were on top of things?	5 %	10 %	40 %	45 %	0 %
9.	In the last month, how often have you been angered because of things that happened that were outside of your control?	10 %	25 %	30 %	20 %	15 %
10.	In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	20 %	55 %	20 %	5 %	0 %

4.4 Exploratory factor analysis to determine the main areas for stress resilience training

The purpose of conducting an exploratory factor analysis is to identify which aspects of future life at sea most concern respondents. This will allow focus on a practical approach to the formation of stress resilience of future seafarers.

The factor analysis was conducted using the Principal Component Analysis (PCA) extraction method with the questionnaire “Resilience of future seafarers” (the questions can be seen in **Table 1**). The sample size of 40 respondents met the minimal methodological requirements for pilot psychometric testing of short questionnaires (10 items) and allowed for conducting reliability analysis (Cronbach’s alpha) and exploratory factor analysis (KMO, Bartlett test). All calculations were performed using SPSS Statistics. Analysis of the 40 respondents` answers: KMO and Bartlett's test Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy- 0.558; Bartlett's test of sphericity:

Approximate Chi-square: 151.965; Std. 45; Significance < 0.001. Cronbach’s alpha is 0, 799. Exploratory factor analysis was conducted despite the small sample size (N = 40). The KMO value (0.558) and significant Bartlett’s test (p < 0.001) indicated marginal but acceptable sampling adequacy. Therefore, the factor solution was interpreted cautiously, and it is planned to confirm it in future studies with larger samples.

This method was selected because it effectively reduces a large set of interrelated variables to a smaller number of underlying components, while retaining as much of the total variance as possible. The criteria for factor retention included: Eigenvalues greater than 1 (Kaiser’s criterion), and visual inspection of the Scree Plot, which indicated a distinct break after the fourth component. Based on these criteria, four components were extracted for further interpretation. The extracted components were subjected to Varimax rotation with Kaiser normalization, an orthogonal rotation method. Varimax rotation was chosen because it simplifies the interpretation of factors by maximizing the variance of loadings on each factor. This yields a clearer separation, ensuring that each variable loads highly on one factor and minimally on others, thereby enhancing interpretability. The rotation converged in 8 iterations. Quantitative data of variance explanations are given in the **Table 3**.

Table 3 Variance explained.

Component	Eigenvalue	% of Variance	Cumulative %
1	2.85	28.5 %	28.5 %
2	2.02	20.2 %	48.7 %
3	1.47	14.7 %	63.4 %
4	1.11	11.1 %	74.5 %

Interpretation of factors according to high-loading items.

Factor 1. Emergency and Danger Resilience (Q3, Q9). Reflects emotional stability and ability to act effectively in high-pressure or emergency situations.

Factor 2. Adaptation to Environmental and Communication Challenges (Q4, Q6, Q8). Represents adaptability to external stressors such as poor communication, isolation, and adverse weather.

Factor 3. Coping with Uncertainty and Interpersonal Conflict (Q2, Q5, Q10). Measures cognitive-emotional flexibility and the ability to handle conflict and uncertainty constructively.

Factor 4. Tolerance for Confinement and Social Proximity (Q1, Q7). Indicates comfort with limited space and continuous interaction with others in confined environments.

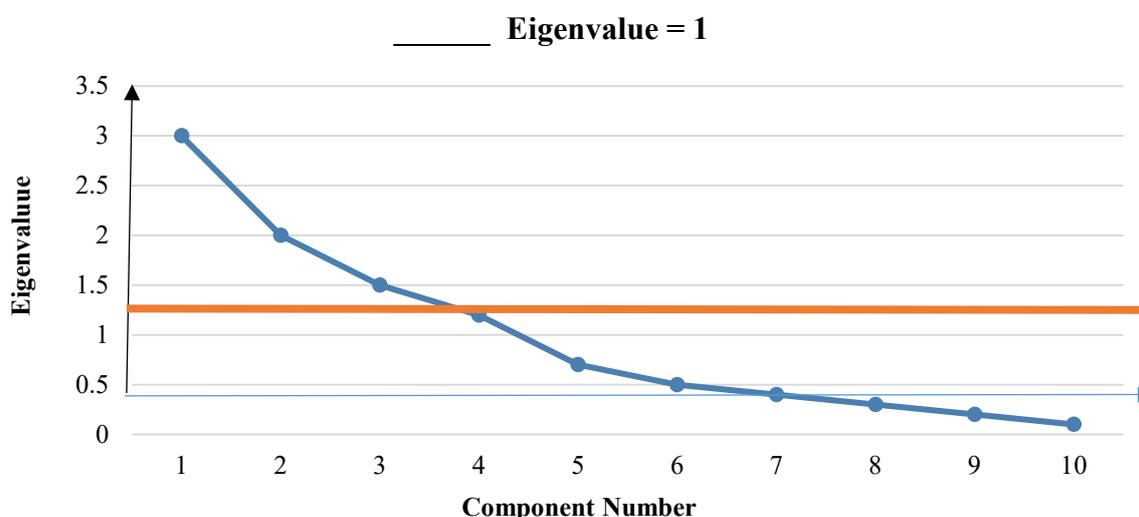


Figure 1 Scree Plot. Significance of factors.

Figure 1 shows the eigenvalues for each component; the “elbow” after the fourth component can be seen, which supports retaining four factors in the analysis. The PCA with Varimax rotation revealed four interpretable factors, accounting for approximately 74.5 % of the total variance. These factors collectively describe key psychological and behavioral dimensions of individuals in maritime conditions- crisis resilience, adaptability, coping flexibility, and social tolerance- all essential for successful adjustment to long-term life and work aboard a ship.

Although the principal component analysis extracted four statistical factors, conceptual interpretation revealed that these loadings cluster meaningfully into three broader dimensions: (1) Extremity of the profession- reflecting emergency readiness and rapid decision-making; (2) Communication in a limited space- encompassing conflict management, adaptation to isolation, and lack of communication tools; and (3) Physical living conditions- indicating tolerance for confined personal space. These three dimensions were emphasized when developing pedagogical recommendations for preparing students for maritime work. From the rotated component matrix, four components emerged statistically, but their meaning can overlap conceptually:

Factor 1. Emergency and Danger Resilience match Extremity of the profession (Q3- quick decision in danger; Q9- emergency situations). Factor 2. Adaptation to Environmental and Communication Challenges matches Communication in a limited space (Q4- limited communication; Q6 - adverse weather; Q8 - no internet. Factor 3. Coping with Uncertainty and Interpersonal Conflict matches Communication but here with conflict dimension (Q2 -conflict situations; Q5- uncertainty; Q10- coping/free time). Factor 4. Tolerance for Confinement and Social Proximity matches Physical living conditions (Q1- limited space; Q7- personal space and constant contact).

Thus, statistical (PCA) result separates environmental adaptation and social tolerance into distinct factors, but the offered conceptual result merges overlapping factors into broader, practical categories. So, while PCA technically extracted four components, the offered three-factor summary is conceptually justified and is more interpretable for practical application- especially when translating results into recommendations for teachers.

4.5 Readiness to overcome stress situations while working at sea

The questionnaire consisted of 10 questions. The questionnaire was about respondents' perception of own readiness to overcome stressful situations in future work at sea. The results of the survey can be seen in the **Table 4**. The respondents did not have real work experience; they answered according to their inner feelings and expectations. The purpose of the survey was for qualitative research: to obtain feedback about 1) the level of readiness of future sailors to cope with stressful situations in the professional environment, and 2) which aspects caused concern among respondents and required careful correction. After the survey, group discussions were conducted and psychological training on how to cope with stress were given.

The interpretation of the survey results showed that the majority of respondents demonstrated a high level of self-confidence, despite the predicted stressful situations. Psychologically, this is explained by the lack of real life in the sea and the features of the type of nervous system and character traits of the respondents. Therefore, the need to conduct stress management exercises under extreme working conditions is predicted. The issue of lack of successful communication has also become an important aspect of waiting for stress (Canımoğlu et al., 2023). In general, the rather positive results of the survey are explained by the high level of motivation to work at sea.

4.6 Comparison of stress resilience indicators

The study assessed stress resilience among respondents using two methods:

1. The Connor–Davidson Resilience Scale (CD-RISC)- to measure general resilience.
2. The authors' test “Resilience of Future Seafarers”- to measure occupation-specific resilience related to the challenges of life and work at sea.

Both tools use a three-level scale, allowing for comparison between general and specific resilience indicators.

Table 4 Results according to the questionnaire “Readiness to overcome stress situations while working at sea”.

No.	Questions	Answers		Interpretation
		Yes	No	
1.	Could you keep calm in difficult situations on board the ship?	72.2 %	27.8 %	High level of self-confidence
2.	Do you feel anxious when you are away from family and friends for a long time?	50.0 %	50.0 %	Moderate level of need for private communication
3.	Are you able to make quick decisions under stress or danger?	72.2 %	27.8 %	High level of self-confidence
4.	Do you try to avoid conflicts in the team even when it threatens your comfort?	77.8 %	22.2 %	High level of conflict avoidance
5.	Would it be difficult for you to adapt to constant changes in the work schedule and rest on the ship?	61.1 %	38.9 %	High level of fear of working conditions
6.	Can you easily distract yourself from work and completely relax after a hard day's work?	83.3 %	16.7 %	High level of self-confidence
7.	Would you be concerned about limitations in personal space during long sea crossings?	55.6 %	44.4 %	Moderate level of fear of working conditions
8.	Are you able to maintain high motivation and work productivity even under stress?	61.1 %	38.9 %	High level of motivation to work at sea
9.	In your opinion, would you feel very stressed about the lack of access to the usual means of communication on the ship?	55.6 %	44.4 %	Moderate level of need for communication
10.	Do you feel confident in emergency situations and ready to act according to the instructions?	72.2 %	27.8 %	High level of self-confidence

A Spearman’s correlation coefficient (ρ) of 1.000 was obtained, indicating a perfect linear relationship between the two measures. According to the Cheddock scale, this means the relationship is extremely strong. Although the exact critical value of the Spearman test (F) was uncertain, the results show that ρ for general resilience is greater than ρ for specific resilience, and the relationship between variables is statistically significant ($p < 0.05$). Therefore, the study concludes that the unique characteristics of seafaring work significantly influence levels of stress resilience. This means that, while general psychological resilience (as measured by a standard test) is important, occupational factors specific to seafaring- such as isolation, long voyages, and environmental challenges- shape how individuals respond to stress.

The strong correlation ($\rho = 1.000$) suggests that those who scored high on general resilience also tended to score high on seafarer-specific resilience, but the differences between the two indicate that contextual, job-related conditions add an important dimension. General resilience (CD-RISC): 55 % high, 36 % moderate, 9 % low. Most respondents are well-adapted and capable of maintaining composure under stress.

Seafarer-specific resilience: 43.5 % high, 46.5 % moderate, 10 % low. This reflects good adaptability, but some vulnerability, to uncertainty and isolation. The majority of future seafarers demonstrate solid potential for adaptation and psychological readiness for maritime work. Still,

preventive psychological training and resilience-building programs are advisable- especially to address digital isolation and uncertainty regarding working conditions. Future seafarers' stress resilience is not only a personal trait but is also influenced by the special conditions of their professional environment.

4.7 Discussion

Scientists recognize three types of stressors that significantly contribute to mental health problems: (1) environmental factors (e.g., vibration), (2) social problems (e.g., bullying, working alone), and (3) health problems (e.g., physical injuries, viruses, and diseases). Stress and mental health problems determine the motivation of seafarers for their work and their consideration of leaving the maritime industry. Factors contributing to seafarers' reasoning about leaving the industry are also indicated; these factors are mainly related to social stresses, such as isolation from family and friends, cultural differences at work, demands of managers, and bullying. Factors such as bad weather, work shifts, the duration of the employment contract, or the ban on leaving ports are considered less important. (Svetina et al., 2024). In recent research, it was recognized the factors that also significantly contribute to mental health problems include: (1) the extremity of the profession; (2) communication in a limited space and (3) physical living conditions which differ from the above mentioned. The present study did not focus on the physiological aspects of seafarers' life. Researchers stress that health status, directly and indirectly, affects seafarers' satisfaction with life. (Baygi et al., 2022; Jonglertmontree et al., 2021; Carter & Jepsen, 2014). Researchers connect job satisfaction with psychiatric symptoms and state that "when respondents thought they were unhealthy, they tended to show higher scores in psychoticism, somatization, depression, anxiety, and phobic anxiety" (Kim et al., 2016).

Furthermore, a very high positive Spearman's correlation was found between general and professional resilience ($\rho \approx 1.000$, $p < 0.05$), indicating that individuals with higher general resilience also demonstrate greater occupational stress resistance. However, a perfect correlation suggests potential overlap between the measures or limitations due to the small sample size.

5. Training recommendations and practical exercises for formation of stress resilience in future seafarers

Training seafarers for emergency situations involves a number of safety training exercises, such as regular drills and strict instructions, according to international standards (SOLAS, STCW). When a ship is underway, such dangers as storms, fire, equipment failure, pirates (in some regions), and diseases are possible. Thus, situations may arise where a quick decision must be made.

In order to prevent a stressful state if it is necessary to make quick decisions, the technique of deep breathing is appropriate. This can "restart" the mind. Inhale- 4 counts, delay- 2, exhale- 6. This activates the parasympathetic nervous system, which is responsible for calming down.

Instead of panicking over all possible options, it is necessary to quickly determine what is most important in this situation, and which option will bring the least harm or the most benefit. It helps to make decisions that are not perfect, but good enough to move on. Not every solution will be perfect, and that is okay. Remind yourself: "I'm doing the best I can in this situation." This reduces pressure and fear of making the "wrong" choice.

Communication in confined spaces also leads to stress- and this is supported by both psychological research and everyday experience. It is natural for a person to have a "comfort zone"-physical and psychological. In a cramped room (cabin, cabin, engine room, etc.), this area is disturbed: sailors may feel "gasping", pressure, or an inability to "stand aside".

Even small stimuli (noise, smell, other people's emotions) can cause a strong reaction of irritability, even if no one is directly in conflict. In a limited space, it is more difficult to "retreat" in cases of conflict or disagreement. Also, in a closed space, sailors are constantly in each other's field of vision. This reinforces nonverbal cues (gestures, facial expressions, glances) that can be

misinterpreted, especially in international crews due to cultural differences. Advice is as follows: (1) take small pauses- even a few minutes alone (even in the toilet) can relieve tension; (2) create a psychological space, listen to music in headphones, close your eyes for a minute, imagine yourself in nature- all this “expands” the inner space.

The development of stress resilience is the development of the ability to manage, adapt, and recover from challenges. It is a skill that can be developed over time through intentional practices and based on different factors that might influence overall health, including mental-physical health and well-being (e.g., satisfaction with life) of seafarers at sea (Baygi et al., 2022).

The following techniques will help develop stress resilience:

1. Understand and manage your stress triggers. Identify triggers: think about situations, people, or tasks that cause you stress. Awareness-raising tools: use journaling or stress-tracking tools to mark patterns. Cognitive reappraisal strategies should be applied to reinterpret stress-inducing situations as opportunities for learning and growth.

2. Strengthen emotional stability. The cultivation of emotional stability may be achieved through evidence-based practices such as mindfulness meditation, controlled breathing techniques, and yoga. Emotional regulation: learn how to pause before a reaction; methods such as the 5-4-3-2-1 grounding method can help. Positive self-talk: replace negative thoughts with constructive ones.

3. Create a powerful support system. Communicate with others: spend time with friends, family, or a mentor who can offer perspective and encouragement. Seek professional help: a therapist or counselor can teach stress management strategies.

4. Practice problem solving skills. Break down tasks into smaller steps: big problems seem less difficult if solved gradually. Emphasis should be placed on distinguishing controllable from uncontrollable factors and allocating resources accordingly.

5. Develop healthy coping mechanisms. Engage in hobbies: creative activities, sports, or other interests can serve as a source of stress relief. Laugh more: humor helps reduce stress and improve mood. Empirical evidence indicates that a supportive and pleasant environment moderates the relationship between job demands and turnover intention (Gu et al., 2020).

6. Learn relaxation techniques: try progressive muscle relaxation or guided visualization. Gradually expose yourself to difficulties. Additionally, gradual exposure to manageable stressors can facilitate incremental increases in stress tolerance.

7. Learn from failure: Treat failure as a learning opportunity to become stronger. Adopt a growth mindset. Accept challenges: believe in your ability to adapt and grow through adversity. Celebrate progress: celebrate even small victories to build confidence in dealing with stress.

8. Develop gratitude and optimism. Keeping an Appreciation Diary: write down three things you are grateful for every day. Focus on the positive: look for advantages in difficult situations.

9. Set boundaries and prioritize self-care. Learn to say no: avoid excessive commitments to reduce unnecessary stress. Plan downtime: rest and recharge to prevent exhaustion. Scheduled periods of rest and recovery should be integrated into regular routines to maintain psychological and physiological balance.

6. Conclusions

The analysis of the results leads to the conclusion that the development of stress resistance in future sailors should be considered as a complex process that includes not only professional training, but also the formation of personal qualities necessary for successfully overcoming stress factors. Professional training should take into account the psychological characteristics of the individual and contribute to the development of emotional stability, flexibility, and adaptability.

Thus, the formation of a high level of stress resilience in future seafarers is the result of the interaction of various psychological factors and the conditions of professional activity. Three of the most significant factors were identified that the study emphasized when developing recommendations for teachers on how to work with students, namely:

1) the extremity of the profession (the possibility of emergency situations and the need for quick decision-making); 2) communication in a limited space (avoidance and resolution of conflict situations, and lack of access to the Internet and other means of communication); 3) physical living conditions (limitation of personal space).

This highlights the need for a systematic approach to seafarer training, covering both professional skills and the development of personal resources capable of ensuring the successful performance of professional duties under stress.

Declaration of generative AI in scientific writing

The authors confirm that no generative artificial intelligence (AI) or AI-assisted technologies were employed during the writing or production process of this manuscript. The authors are fully responsible and accountable for the content and originality of the work.

CRedit author statement

Olena Tyron: Conceptualization; Methodology; Software; Validation; Formal analysis; Investigation; Resources; Data Curation; Writing - Original Draft; Writing - Review & Editing; Visualization; Supervision; Project administration; Funding acquisition. **Larysa Hatsenko:** Conceptualization; Methodology; Software; Validation; Formal analysis; Investigation; Resources; Data Curation; Writing - Original Draft; Writing - Review & Editing; Visualization; Supervision; Project administration; Funding acquisition. **Svitlana Kaminska:** Conceptualization; Methodology; Software; Validation; Formal analysis; Investigation; Resources; Data Curation; Writing - Original Draft; Writing - Review & Editing; Visualization; Supervision; Project administration; Funding acquisition.

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Appendixes

Appendix 1

The Connor-Davidson Resilience Scale (CD-RISC)

No.	Questions	Answers				
		Not true at all	Rarely true	Some-times true	Often true	True nearly all the time
N = 40		0 points	1 point	2 points	3 points	4 points
1.	I am able to adapt when changes occur.	0 %	0 %	15 %	55 %	30 %
2.	I can deal with whatever comes my way.	0 %	0 %	25 %	40 %	35 %
3.	I try to see the humorous side of things when I am faced with problems.	30 %	0 %	60 %	5 %	5 %
4.	Having to cope with stress can make me stronger.	0 %	0 %	20 %	40 %	40 %
5.	I tend to bounce back after illness, injury, or other hardships.	0 %	0 %	25 %	30 %	45 %
6.	I believe I can achieve my goals, even if there are obstacles.	0 %	0 %	50 %	40 %	10 %
7.	Under pressure, I stay focused and think clearly.	5 %	0 %	35 %	60 %	0 %
8.	I am not easily discouraged by failure.	5 %	5 %	40 %	35 %	15 %
9.	I think of myself as a strong person when dealing with life's challenges.	5 %	0 %	25 %	50 %	20 %
10.	I can make unpleasant or painful feelings go away.	5 %	0 %	25 %	65 %	5 %
11.	I can handle unpleasant feelings.	5 %	5 %	40 %	35 %	15 %
12.	When I have a problem, I can usually find a solution.	20 %	5 %	55 %	20 %	0 %
13.	I have a strong sense of purpose in life.	10 %	0 %	20 %	45 %	25 %
14.	I take pride in my achievements.	0 %	5 %	25 %	50 %	20 %
15.	I am able to handle unpleasant emotions.	10 %	0 %	40 %	35 %	15 %
16.	I can stay focused under pressure.	0 %	0 %	50 %	40 %	10 %
17.	I prefer to take the lead in problem-solving.	15 %	5 %	50 %	25 %	5 %
18.	I am able to adapt to change.	25 %	0 %	55 %	20 %	0 %
19.	I can recover quickly from stress.	0 %	5 %	35 %	50 %	10 %
20.	I am able to keep going when things seem hopeless.	10 %	0 %	30 %	50 %	10 %
21.	I have a tendency to see the positive side of things.	10 %	5 %	35 %	25 %	25 %
22.	I am not easily discouraged by failure.	0 %	5 %	30 %	55 %	10 %
23.	I can think clearly under pressure.	15 %	0 %	50 %	35 %	0 %
24.	I have a strong belief in my capabilities.	10 %	0 %	25 %	45 %	20 %
25.	I am able to deal with whatever comes.	0 %	0 %	25 %	30 %	45 %

The statistic results: number of respondents- 40; total possible score- 100; group mean score- 65; average per item- 2,6/4; resilience level- moderate.

Appendix 2

Component matrix

Questions	Components			
	1	2	3	4
1. How do you usually behave during a long stay in a limited space (for example, on a ship)?	0.523	0.389	0.377	-0.106
2. How do you react to conflict situations (for example, between fellow students/ potential crew members)?	0.150	<u>0.695</u>	-0.486	0.346
3. How do you feel when you need to make quick decisions in conditions of danger?	<u>0.716</u>	0.280	-0.330	-0.143
4. How would you feel during long sea crossings, when there would be difficulties with communication with relatives?	0.505	-0.096	0.011	0.335
5. How do you perceive uncertainty about future working conditions on a ship?	-0.363	0.746	-0.065	0.067
6. How would you behave during adverse weather conditions on the ship?	0.807	0.157	-0.028	0.180
7. How you respond to limitations in your personal space and necessity constant communication with other crew members?	0.374	0.215	0.593	-0.519
8. How do you perceive the long-term lack of access to the internet and other means of communication?	0.411	-0.031	<u>0.643</u>	0.471
9. How would you react to the possibility of emergency situations on the ship?	0.616	-0.196	-0.480	-0.473
10. How would you like to spend time after a hard day's work on a ship?	0.407	-0.647	-0.210	0.265

Factor selection method: Method of principal components

Inverted matrix

Questions	Components			
	1	2	3	4
1. How do you usually behave during a long stay in a limited space (for example, on a ship)?	0.156	0.336	0.168	<u>0.642</u>
2. How do you react to conflict situations (for example, between fellow students/potential crew members)?	0.276	0.212	<u>0.837</u>	-0.197
3. How do you feel when you need to make quick decisions in conditions of danger?	<u>0.741</u>	0.295	0.218	0.191
4. How would you feel during long sea crossings, when there would be difficulties with communication with relatives?	0.177	0.580	-0.070	-0.026
5. How do you perceive uncertainty about future working conditions on a ship?	-0.203	-0.242	<u>0.768</u>	0.083
6. How would you behave during adverse weather conditions on the ship?	0.470	<u>0.655</u>	0.096	0.223

Inverted matrix (continued)

Questions	Components			
	1	2	3	4
7. How you respond to limitations in your personal space and necessity constant communication with other crew members?	0.092	-0.003	-0.135	<u>0.883</u>
8. How do you perceive the long-term lack of access to the Internet and other means of communication?	-0.339	<u>0.747</u>	-0.128	0.340
9. How would you react to the possibility of emergency situations on the ship?	<u>0.898</u>	-0.017	-0.253	0.036
10. How would you like to spend time after a hard day's work on a ship?	0.269	0.445	-0.526	-0.389

Factor selection method: method of principal components

Rotation method: Varimax with Kaiser normalization.

a. The rotation gathered for 8 iterations.