Improving Psychosocial Risk Management Process in Safety and Health at Work Considering Combinations of Dangerous Factors

Удосконалення процесу управління психосоціальними ризиками у сфері безпеки та гігієни праці з урахуванням комбінацій небезпечних факторів

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Purpose: The study aims to develop an improved psychosocial risk management process by analyzing possible combinations of dangerous psychosocial factors within and between groups, including workplace relationships, military activities, and domestic troubles.

Method: a bow-tie model.

Findings: An improved model of psychosocial risk management has been developed, taking into account the impact of combinations of eight groups of psychosocial risks on the occurrence of a dangerous event.

Theoretical implications: The relationship between the level of psychosocial risk and the most dangerous factors has been established, which is determined taking into account three parameters – frequency, duration, and intensity of stress experiences, which are assessed based on a survey of employees on a ten-point scale.

Papertype: practical.

Мета роботи: Дослідження спрямоване на розробку вдосконаленого процесу управління психосоціальними ризиками шляхом аналізу можливих комбінацій небезпечних психосоціальних факторів усередині та між групами, включаючи стосунки на робочому місці, військову діяльність і домашні негаразди.

Метод дослідження: модель краватки-метелика.

Результати дослідження: Розроблено удосконалену модель керування психосоціальними ризиками з урахуванням впливу на настання небезпечної події комбінацій восьми груп психосоціальних ризиків.

Теоретична цінність дослідження: Встановлено взаємозв'язок рівня психосоціального ризику з найбільш небезпечними чинниками, що визначається з урахуванням трьох параметрів – частоти, тривалості та інтенсивності переживання стресу, які оцінюються на основі опитування працівників за десятибальною шкалою.

Тип статті: практичний.

Key words: psychosocial risk, safety, dangerous factors, "black box" method, workplace.

Ключові слова: психосоціальний ризик, безпека, небезпечні фактори, метод "чорної скриньки", робоче місце.

Introduction

EU policy recognizes that improving working conditions is critical to achieve the required level of productivity and occupational safety (Manni et al., 2023). This is stated in the EU strategic

framework on health and safety at work 2021-2027, one of the main objectives of which is to improve the prevention of accidents and occupational diseases (Official site of the European Union, 2021). In this context, the European Foundation for the Improvement of Living and Working Conditions conducts research on working conditions every five years in the EU (Official site European Foundation for the Improvement of Living and Working Conditions, 2024; Parent-Thirion et al., 2007). The research reports analyze the results of many surveys of employees in EU countries on working conditions, physical (Tutak et al., 2020), intellectual (Sorensen et al., 2019) and psychological aspects (Jain et al., 2022, Wang et al., 2021) that form the appropriate work climate (Naji et al., 2020). From their analysis, a certain relationship can be traced between labor productivity and psychological safety (Ahmad et al., 2019), and the safety culture in the organization (Nehrii et al., 2022). Based on the identified relationships, appropriate models for assessing occupational risks (Akhavan et al., 2021), including psychosocial ones, are constructed (Jain et al., 2022). On their basis, appropriate, well-founded, managerial decisions are made to improve working conditions. It is important to identify exactly the existing hazards, dangerous factors that have the greatest impact on both the injury rate and the development of various occupational diseases (Karanikas et al., 2018).

The manifestation of the pandemic has suggested that it is psychosocial risks that pose a significant threat (Toriumi et al., 2021; Koren et al., 2021;). This has accelerated the adoption of an appropriate international standard ISO 45003:2021 “Occupational health and safety management – Psychological health and safety at work – Guidelines for managing psychosocial risks”, on psychosocial risk management in the organizations (Szekér et al., 2023; Di Tecco et al., 2023). This undoubtedly important document suggests proactive management of psychosocial risks (for example, depression, anxiety), giving significant priority to their prevention (Jain et al., 2021).

However, there are several unresolved issues in it that need to be properly substantiated and explained. For example, the issue of determining the combined simultaneous impact of various dangerous psychosocial factors on the level of psychosocial risk. Or determining indicators of the probability and severity of the dangerous event occurring – experiencing stress by an employee when using only questionnaires that record the employee's subjective opinion (Fergusson, 2022). Thus, the management of psychosocial risks requires solving the urgent task of developing an appropriate process that would meet the requirements of both ISO 45003:2021 and ISO 45001:2018 standards (ISO 45003:2021, 2021; ISO 45001:2018, 2018). Ensuring that psychosocial risk assessment is compatible with other similar procedures developed in accordance with the requirements of ISO 45001:2018 will reduce the time spent and additional resources required to implement them. The solution to the above problem requires the development of a register of dangerous psychosocial factors, which will allow for the development of questionnaires in accordance with the external and internal work environment in a particular organization. In addition, the use of qualitative questionnaires will help specialists better identify the cause-and-effect relationships between hazards (stress), occurrence of stress in an employee, and significant dangerous psychosocial factors that influence both the stress occurrence probability in an employee and the severity of consequences of experiencing stress for him. As a result, we will get precautionary measures (Nebbs et al., 2023). There is also a need to develop a scale for determining the severity of the consequences of experiencing stress based on the intensity of experiencing stress and the duration of experiencing stress under the influence of psychosocial dangerous factors on a person.

In many European countries, organizations have a legal obligation to carry out risk assessments for all workplaces and activities in order to preserve the health of employees and prevent accidents (Nixon et al., 2011). Traditionally, occupational risk assessment has focused on examining the effects of physical hazards such as excessive noise, overheating, electro-magnetic radiation, and chemical hazards (asbestos, carbon dioxide, etc.). However, in recent years, more attention has been paid to assessing psychosocial risks, since traditional approaches do not

significantly reduce financial losses from injuries and occupational diseases (Tsopa et al., 2022; Huebner & Zacher, 2021). At the same time, a significant difference has arisen between risk assessment from physical and psychosocial hazards, which is primarily concerned with the need to rely on the questionnaire results of employees who express their subjective opinion, requiring the use of specific tools to reduce cognitive impact (Mustapha & Rau, 2019). In addition, a characteristic peculiarity of the psychosocial risk assessment process is a gradual transition from the general to the specific (Tabanelli et al, 2008), allowing for a more in-depth analysis and more targeted precautions. However, as most researchers note, standardized questionnaires are in most cases too abstract to derive specific measures of work rescheduling (Aronsson et al., 2017).

The analysis of recent studies (Dettmers & Stempel, 2021; Bazaluk et al., 2022) shows that there is a problem in developing objective questionnaires for the subsequent assessment of psychosocial risks, which is aggravated by a significant number of various dangerous psychosocial factors, especially their combinations, which can not only influence on set limits of criterion assessments and lead to false results, but also lead to unpredictable deviations in the mental state of employees (Portoghese et al., 2020; Lesener et al., 2019; Cheberiachko et al., 2023). As noted in the study (Nebbs et al., 2023), the first step to solve this problem is the development of clear registers of dangerous factors, which will allow the creation of questionnaires in accordance with the specifics of the enterprise.

Also, as noted by the authors in (Lesener et al., 2019; Rantanen et al., 2017), to preserve the mental health of employees, it is important to provide an integrated approach involving at least three steps: “prevent harm”, “promote positivity” and “respond to problems”. The authors analyzed more than two hundred different tools to find the most effective ones that will ensure the implementation of the specified three components of an integrated approach to health preservation. The proposed integrated approach has guided other researchers to develop recommendations for occupational safety and health services (Jain et al., 2021), where the key is to ensure the well-being of employees, requiring not only research on working conditions in the workplace but also on living conditions. The authors identified significant gaps in the structure of health care legislation across countries and noted the need to integrate occupational safety and health provisions with those related to psychosocial risk management. Similar conclusions have been made in several other similar studies (Jain et al., 2021; Guillemin, 2021). The need to improve the well-being of employees was also emphasized in work (Schulte et al., 2019). The authors, based on an in-depth analysis of the relationship between psychosocial risks and the evolution of the field of occupational safety and health in organizations, the changing nature of work due to the manifestation of the pandemic and the influence of safety management style, propose a new approach to prevent stress and exhaustion of employees, the essence of which is to increase independence and mutual trust between employees and managers. The need to improve the well-being of employees to reduce the risk of developing stress is shown in (Schulte et al., 2022), a year before the pandemic. The authors propose an interesting model for an extended focus on the field of occupational safety and hygiene by considering personal, social and economic dangerous factors on the level of safety.

The conducted analysis of scientific works shows a significant interest in the field of ensuring psychological safety at work, preservation of mental health of employees, which is the basis for high productivity and reduction of financial losses of organizations. For this purpose, there is a continuous search for result-oriented, convenient tools that would complement the gaps of the ISO 45003:2021 standard and strengthen the capabilities of specialists to conduct assessments, draw conclusions and substantiate precautionary measures (Blinov, 2006). Improving the process of managing psychosocial risks based on the manifestation of possible combinations of dangerous psychosocial factors, in particular, relationships between employees at work, military operations and domestic troubles.

Materials and Methods

The ISO 45003:2021 standard gives five groups of dangerous factors, which are often considered as five: 1. organization of work, 2. social factors, 3. work environment, 4. equipment, 5. dangerous tasks. In each of the above-mentioned groups there is a certain number of dangerous factors that have a significant impact on the probability and severity of stress experienced by an employee. At the same time, the standard does not reflect some of the main trends observed in modern society: the protection of employees from violence and harassment in accordance with International Convention No.190 on the Elimination of Violence and Harassment in the Workplace. In addition, there are no dangerous psychosocial factors inherent in military activities that lead to changes in the functioning conditions of the entire society (being under stress from constant waiting, anxiety, loss of relatives, friends, instability, etc.). Dangerous psychosocial factors that cause household stress combined with production stress are not taken into account. Therefore, we propose that in order to develop questionnaires in organizations to assess psychosocial risks, in addition to the five groups given in ISO 45003:2021, three more groups should be added: factors of relationships between employees, factors of military activities and domestic issues.

It should be noted that the ISO 45003:2021 standard reflects dangerous psychosocial factors associated with discrimination, mobbing, sexism, but they are in the group of social factors at work, which is already overloaded with a significant number of different factors. When compiling surveys or questionnaires, this can lead to a reduction in important questions regarding the clarification of the real state of affairs in the relationships between employees. Hence, we recommend that they should be singled out as a separate group, supplemented by the factors given in Convention 190 on protection from cyberbullying and informal relationships, in times of vulnerability, pandemics, etc.

As a result of the emergence of eight groups of dangerous psychosocial factors, there is a need for an improved model for managing psychosocial stress risks. This will make it possible to establish the appropriate relationship between psychosocial hazard – stress and a dangerous event – its experience, taking into account the influence of various groups of psychosocial factors and as a result of the manifestation of negative consequences. To develop it, a schematic description is used of the path of a dangerous event occurring – experiencing stress by an employee, which occurs due to the presence of danger – stress when performing production tasks (Figure 1). At the same time, the probability of a dangerous event occurring increases under the influence of different groups of dangerous psychosocial factors (in this case, 8 groups), which can form different combinations of simultaneous impact on a person. Also, these groups of dangerous psychosocial factors can increase the severity of the consequences: loss of employee health due to the development of occupational diseases associated with metabolic disorders, cardiovascular system pathologies, hypertension, stomach ulcers, etc. (Crosswell & Lockwood, 2020). It should be noted that the introduction of precautionary measures can reduce both the probability of a dangerous event occurring and the severity of consequences for human health, as reflected in the model (Fig. 1). It also provides for the calculation of the psychosocial risk level through the product of the probability of a dangerous event occurring, the intensity and duration of experiencing stress. The last two components (intensity and duration of employee stress) characterize the severity of the consequences of the experiencing of stress by the employee. They were selected due to the availability of well-known adapted methods for their determination (Pacaiova & Balazikova, 2010).

Based on the listed dangerous psychosocial factors in the ISO 45003:2021 standard and the data given in the table attached in Appendix A, a questionnaire can be developed to identify dangerous psychosocial factors leading to employee stress in the workplace of a certain production organization. For this, the recommendations substantiated in the works (Blinov, 2006; Crosswell & Lockwood, 2020) are used. The questionnaire is developed based on the assumption that the

psychosocial stress risk level depends on the frequency of exposure to the stressogenic factor and its manifestation intensity.

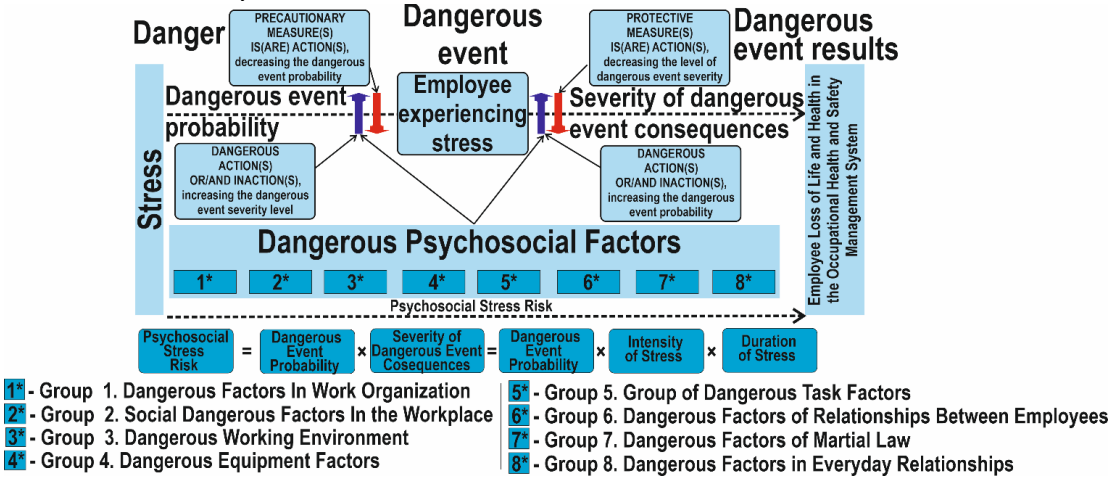

Figure 1 – Proposed model for managing psychosocial stress risks

There is a division of stress reactions into adaptive and damaging ones (Lukina, 2012). In the case of an adaptive stress reaction, the activation of the functions of organs and systems under the influence of a stressor factor prevents the deviation of homeostatic parameters beyond the normal range, and the emergency factor is characterized by the intensity of action and the duration of the exposure (Magdysyuk, 2015; Treumova et al., 2017; Schneider & Stone, 2014). This can lead to significant disturbances in vital activities, the development of an extreme or even terminal state (collapse, shock). At the same time, in order to determine the influence of only production conditions on the process of experiencing stress, there is a need to determine possible adverse conditions influencing the employee's psyche in everyday life.

By interviewing employees, all dangerous psychosocial factors influencing the employee stress experience are determined in the relevant groups. In this case, each factor is assessed on a scale from 1 to 10 according to three components: duration and intensity of influence, as well as the frequency of its occurrence. For convenience, any suitable scale can be used to score the intensity, frequency, and duration of stress experienced by psychosocial hazards. Additional guidelines are provided in Table 1.

Table 1 – Scales for determining the frequency of occurrence, duration and intensity of influence of psychosocial factors for calculating the psychosocial risk level

Scores	Scale		
	Frequency of occurrence	**Duration**	**Tension of experience**
1.	Not more than once in 5 years	More than 4 hours	0-5% - insignificant stress impact on mood and health
2.	Not more than once in 4 years	More than 4 hours, but less than one day	5-15% - a person experiences more than a insignificant stress impact on mood and health, but less than low one
3.	Not more than once in 3 years	More than one day, but less than a week	15-25% - a person experiences low stress impact on mood and health
4.	Not more than once in 2 years	More than one week, but less than two weeks	25-35% - a person experiences more than a low stress impact on mood and health, but less than medium one

Scores	Scale		
	Frequency of occurrence	**Duration**	**Tension of experience**
5.	Not more than once in 1 year	More than two weeks, but less than a month	35-45% - a person experiences medium stress impact on mood and health
6.	Not more than once in 9 months	More than one month, but less than two months	45-55% - a person experiences more than medium stress impact on mood and health, but less than significant one
7.	Not more than once in 6 months	More than two months, but less than 6 moths	55-65% - a person experiences less significant stress impact on mood and health
8.	Not more than once in 3 months	More than 6 months, but less than 9 months	65-75% - a person experiences more than less significant stress impact on mood and health, but less than significant one
9.	Not more than once in 1 month	More than 9 months, but less than one year	75-85% - a person experiences significant stress impact on mood and health
10.	Not more than once in 1 week	More than one year	85-100%- a person experiences more than significant stress impact on mood and health

The risk value for each group of dangerous factors is determined by the risk matrix (Table 2), based on the formula:

$$R_j = B_{ji} \times \frac{(\mathrm{I}n_{ji} \times \mathrm{D}_{ji})}{10}, \quad (1)$$

where B_{ji} – is the frequency of dangerous psychosocial factor occurrence;
$\mathrm{I}n_{ji}$ – is the intensity of the employee's experience of exposure to a dangerous psychosocial factor;
D_{ji} – is the duration of the dangerous psychosocial factor influence.

Table 2 – Matrix for psychosocial risk assessment

Matrix for psychosocial risk assessment			**Level and duration of stress ($\mathrm{I}n_{ji}$ x D_{ji})/10**									
	Criterion	Scores	1	2	3	4	5	6	7	8	9	10
Stress frequency in scores	Not more than once in 20 years	1	1	2	3	4	5	6	7	8	9	10
	Not more than once in 10 years	2	2	4	6	8	10	12	14	16	18	20
	Not more than once a month	3	3	6	9	12	15	18	21	24	27	30
	Not more than once in 3 years	4	4	8	12	16	20	24	28	32	36	40
	Not more than once in 1 year	5	5	10	15	20	25	30	35	40	45	50
	Not more than once in 6 months	6	6	12	18	24	30	36	42	48	54	60
	Not more than once in 3 months	7	7	14	21	28	35	42	49	56	63	70
	Not more than once in 10 days	8	8	16	24	32	40	48	56	64	72	80
	Not more than once in 1 week	9	9	18	27	36	45	54	63	72	81	90
	Not more than once in 1 day	10	10	20	30	40	50	60	70	80	90	100

The total level of psychosocial risk is determined by all groups of psychosocial hazards:

$$\sum R = R_1 + R_2 + \cdots + R_8, \quad (2)$$

Within each group – *j* of a dangerous psychosocial factor-*i*, it is necessary to consider their combination, which results in a cumulative effect (McEwen et al., 2015) of experiencing stress from the influence of various dangerous factors. It is believed that each dangerous factor that causes employees to experience stress due to the peculiarities of its nature causes a specific reaction-

response, adequate to the stimulus strength (Mansouri et al., 2012). However, under the influence of several factors, a non-specific component appears in such a reaction-response, characterized by a state of tension, which can significantly weaken the body's resistance (Samoliuk, 2016). This requires further thorough research to identify the relevant mechanisms of the relationship between the intensity value of exposure to dangerous factors and stress. At the very first stage, an attempt is made to identify such combinations, and, at least by their sum of scores, to take into account their impact on the experience of stress.

The next step is to identify all options of psychosocial risk combinations revealed among 8 groups of psychosocial factors, taking into account that the maximum variation of their combinations R1, R2, R3, R4, R5, R6, R7 and R8 is 256 cases. Determining all options of the psychosocial risk combination is necessary to identify an inappropriate level for implementing appropriate precautionary and protective measures to eliminate a specific danger, a dangerous factor, and not in general for all groups.

To calculate the number of options for other possible combinations of dangerous factors, we use the formula (Kovalenko et. al., 2022):

$$C_n^m = \frac{n!}{m! \times (n-m)!}, \quad C_n^0 = 1, \tag{3}$$

where C_n^m – is the number of options or combinations of n elements by m elements.

The result of the conducted psychosocial risks assessment, taking into account the options of their different combinations, as well as dangerous psychosocial factors in each proposed group, is the development of an improved psychosocial risk management process, which involves ten main steps (Fig. 2).

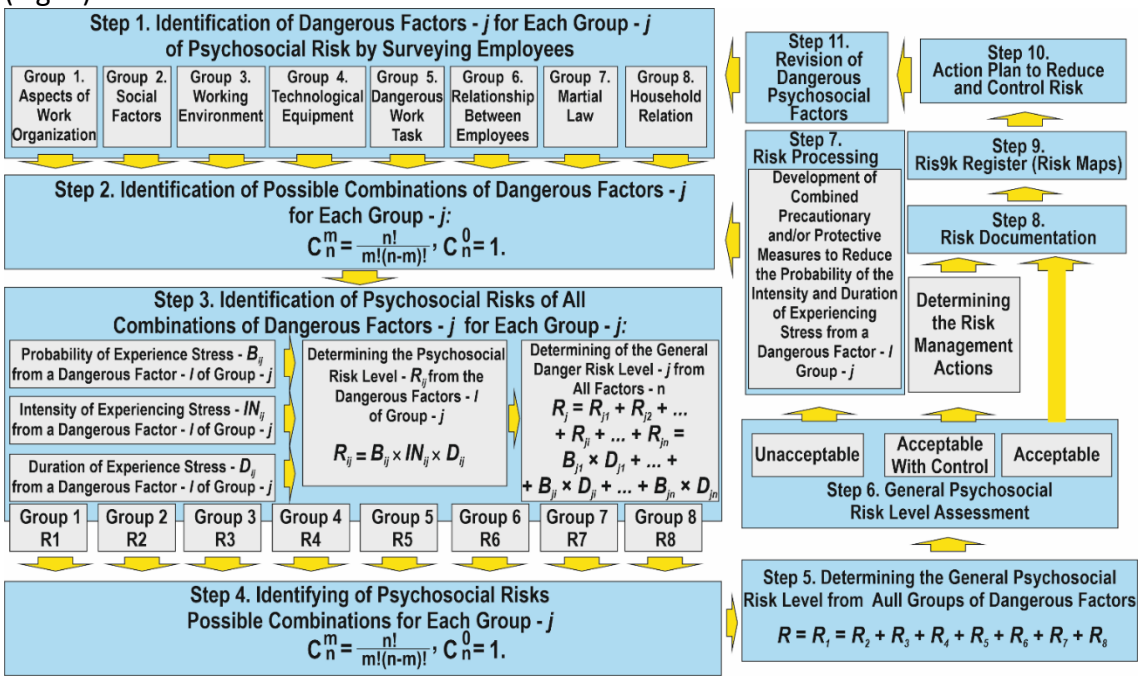

Figure 2 – Improved psychosocial risk management process, taking into account possible combinations of dangerous factors-*i* and combinations of groups-*j* of these factors, which act at the same point in time

These main steps include:

identification of dangerous psychosocial factors - i for the corresponding groups - j, through the use of a questionnaire, with each research participant identifying the psycho-social risk

components; as a result, a form is filled out, which reflects only factors that have an appropriate level of influence on employee stress experience;

determination of possible factor combination options for each group, which will allow identifying the worst option of psychosocial risk level;

assessment and analysis of psychosocial risks for each group of factors identified as a result of the survey;

determination of possible psychosocial risk combinations calculated for each group acting together at the relevant point in time;

calculation of the cumulative psychosocial risk level in the workplace (site, enterprise) with the identification of an acceptable or unacceptable value and further analysis and processing to determine the most dangerous combinations;

creation of a risk register for further monitoring and creation of a comfortable environment with the changing influence of the occurrence of stressful situations;

substantiation of protective and precautionary measures to reduce the psychosocial risk level for each individual group of factors, as well as the specific factor itself in case of its significant level of occurrence, thus ensuring minimal financial costs for treatment and rehabilitation of employees.

Thus, the proposed approach to improving the process of managing psychosocial risks differs from the traditional one by the need to determine all combinations of simultaneous exposure to dangerous psychosocial factors – i in each group – j, as well as combinations of psychosocial risks between groups. This allows to identify those combinations where the psychosocial risk level is unacceptable. This gives the rise to the possibility of using targeted precautionary measures or means to reduce a threatening combination or a specific dangerous factor, by reducing both a specific risk component (the frequency of dangerous event occurring or its impact intensity or experience duration) and their combined impact. The result of the performed work is the substantiation of financial costs for providing precautionary or protective measures.

As an example of psychosocial risk management based on possible combinations of dangerous factors, a survey was conducted at one of the auto transport enterprise in the Dnipro region. This survey has covered 12 people aged 26 to 43 who work in the workplace of a compressor unit operator, responsible for manufacturing and transporting oxygen using specialized trucks to the main consumers. The research was conducted in May - June 2023. Most of the participants (over 65%) were married and had at least one child. At the same time, the average work experience was 13.4 years. Most reported working at least 40 hours per week. Participants voluntarily participated in the survey under the anonymity condition. They had previously been acquainted with the questionnaire completion requirements, as well as with scales for assessing psychosocial dangerous factors based on three components on a ten-score scale: where 1 is the lowest indicator value and 10 is the highest. Subsequently, an average result was obtained for each dangerous factor. The Grubbs' criterion was used to identify outliers (Diener et al., 2009).)

Results

The results of the conducted research on the psychosocial risk level in the workplace of a compressor unit operator are given in Table 3. The specifics of the operator work include control of technological equipment based on monitoring of the main control indicators regarding the adjustment of compressor performance. The basic requirements of the operator include understanding the graphical signaling on the compressor panel to ensure rational operating mode and quick response to emergency situations. He ought also to understand technological schemes and instructions for the compressors being serviced, and how to prevent and correct compressor and engine malfunctions. At the initial acquaintance with the workplace of compressor unit operators, it has been found that the management does not always adequately appreciate the

complexity of their work, may consider that the operators have too much free time (even a working day photo map has additionally been drawn up). Communication with operators also suggested that they are under constant stress due to completing plans, especially for provisioning and support, as well as for setting up and dealing with failures, the constant increase in workload arising from sick colleagues and their redundancies.

Table 3 – The survey results of the compressor unit operator workplace

Identification DFji	Dangerous psychosocial factor (question)	Description of the impact of dangerous factors detected in the workplace
1. Organizational factors		
DF_{1-1}	Is there any uncertainty about performing the work?	Maintenance of compressors and turbocompressors up to 1 MPa pressure (up to 10 kgf/cm^2), starting, adjusting and stopping compressors. Analyzes, detects, maintains, compiles defective repair information for compressor station equipment, performs repair of compressor station equipment within the limits of qualification and sometimes in field conditions, assesses occupational risks.
DF_{1-2}	Are there production tasks that are difficult to combine?	
DF_{1-3}	Do you have to neglect production tasks because of their large number?	
DF_{1-4}	Do you do overtime job?	
DF_{1-5}	Is the job difficult for you?	
2. Social factors		
DF_{2-1}	Is there support from colleagues or managers?	Aggravation of the situation can occur due to the difference in the amount of salaries and bonuses, different physical activity.
DF_{2-2}	Is there an adequate level of interaction between colleagues?	
DF_{2-3}	Is there a management style that does not match the nature of the work?	
DF_{2-4}	Do you feel concern for your well-being?	
3. Work environment factors		
DF_{3-1}	Is there an appropriate safety level in the workplace?	Excess hygienic factors can be detected in the workplace: noise (120 dB), electromagnetic fields from the industrial range (85 V/A), as well as non-compliance with the level of lighting (100 lux) and increased temperatures in summer (above 30˚C). Monitors operation of compressors and auxiliary equipment. Performs lubrication and cooling of rubbing parts of compressor mechanisms. Prevents and eliminates malfunctions in compressor operation and monitors the operation of safety devices.
DF_{3-2}	Are there physical hazards (noise, insufficient lighting, high humidity or temperature, etc.) in the workplace?	
DF_{3-3}	Are all the necessary safety tools available in the workplace?	
DF_{3-4}	Is the work environment adequately monitored?	
4. Infrastructure factors (equipment, tools, etc.)		
DF_{4-1}	Does the spatial planning of the workplace meet the needs of employees and the work performed?	Maintenance and repair of the compressor system requires working in an uncomfortable posture, which can lead to back pain. Employees are also sometimes forced to use outdated tools.
DF_{4-2}	Is the equipment properly maintained?	
DF_{4-3}	Do you use obsolete equipment?	
5. Dangerous task factors		
DF_{5-1}	Is work associated with a significant risk to life?	Emergency shutdowns due to overdue technical inspections, the use of low-quality

Identification DFji	Dangerous psychosocial factor (question)	Description of the impact of dangerous factors detected in the workplace
DF_{5-2}	Do you perform work in high-risk/extreme conditions or situations?	spare parts or oil, the influence of physical and natural factors, power outages, improper operation, etc. have been recorded.
DF_{5-3}	Do you work in volatile environments such as war zones?	
6. Factors in relationships between employees		
DF_{6-1}	Does your organization have incidents between employees involving an overt or covert challenge to health, safety or welfare?	There are cases of employee complaints against each other because of production misunderstandings related to unequal levels of responsibility for the work done, which is associated with an unfair distribution of responsibilities. Also, there is a partial lack of support from managers who issue tasks and do not explain how to perform them in case of an emergency; it is difficult to obtain timely advice regarding further actions that need to be taken to avoid an emergency situation. Employees note isolated cases of threats from experienced employees in case of untimely completion of a production task or failure to ensure adequate labor productivity.
DF_{6-2}	Is there management support for encouraging productivity improvements?	
DF_{6-3}	Is there trust, honesty and fairness in the team?	
DF_{6-4}	Is there fairness on the part of the manager?	
DF_{6-5}	Is there an imbalance between employee effort and formal/informal recognition and reward?	
DF_{6-6}	Is there violence in the workplace: threats, assault (physical, verbal or sexual), gender-based violence?	
DF_{6-7}	Is there harassment because of race, nationality, gender identity, religion or belief, sexual orientation, disability, age, etc.?	
DF_{6-8}	Do you experience bullying?	
7. Martial law factors		
DF_{7-1}	Do emerging missile threats cause neurotic condition?	The territory of the enterprise is located near a war zone, which leads to experiencing stress from constant missile attacks and the need to interrupt work. Employees note concern for the lives of close people in the combat zone, for the lives and health of children attending educational institutions.
DF_{7-2}	Is the power supply well provided? Is there any impossibility of preparing for work?	
DF_{7-3}	Are you located near strategically important objects?	
DF_{7-4}	Is it acceptable to feel frustrated by a constant flow of threatening information?	
8. Household factors		
DF_{8-1}	Has there been a loss of a close relative or friend in your life over the past year?	There is an experience of stress due to the death of relatives associated with diseases, lack of financial savings to maintain an adequate standard of living, depression due to lack of mutual understanding with children, disputes with wife and parents, due to uncertainty about the future.
DF_{8-2}	Are you depressed by the level of your economic income?	
DF_{8-3}	Do you often experience emotional burnout, depression?	

At the first step (identification of dangerous psychosocial factors by relevant groups), all employees were asked to complete an appropriate survey based on the questions, which made it

possible to form a register of dangerous factors for a particular workplace.

As a result, primary psychosocial risk assessment data have been obtained by averaging risk levels for each identified dangerous factor of operators. It should be noted that out of 57 questions presented in the questionnaire, there were identified 26 psychosocial dangerous factors related to the complexity of managerial decision-making, the adequacy of tasks to the level of training, increased workload on the part of management, the complexity of relationships between colleagues, the need for careful control over the compressor production indicators, emergency situations, high-risk tasks.

The example on identifying the worst-case psychosocial risk level for a group of social factors in the second step of the proposed process is shown in Table 4. It is clear that the worst-case scenario is the simultaneous manifestation of all four factors. However, then the information regarding the risk level from a combination of certain dangerous factors can be analyzed in order to implement the most effective precautions. For example, in work environment factor group R3, the cumulative risk from four dangerous factors is unacceptable and amounts to 47 scores. Moreover, even with the combination of R3 = R33+ R34+ R31 = 33 scores, the risk level requires special monitoring conditions. From here it can be determined which of the dangerous factors can best be reduced or eliminated.

Table 4 – An example for determining the psychosocial risk level R_2 for the second group of social factors from various combinations of dangerous factors of the group

Combination No.	Duration	Dangerous psychosocial factors DF_{ji}				Determining the psychosocial risk level R_2	Assessment of the psychosocial risk level R_2
		DF_{21}	DF_{22}	DF_{23}	DF_{24}		
1.	t_1	-	-	-	-	0	Acceptable
2.	t_2	6±0.2	-	-	-	6±0.2	Acceptable
3.	t_3	-	3±0.1	-	-	3±0.1	Acceptable
4.	t_4	-	-	6±0.3	-	6±0.3	Acceptable
5.	t_5	-	-	-	4±0.3	4±0.3	Acceptable
6.	t_6	6±0.2	3±0.1		-	9±0.3	Acceptable
7.	t_7	-	3±0.1	6±0.3	-	9±0.4	Acceptable
8.	t_8	-	-	6±0.3	4±0.3	10±0.6	Acceptable
9.	t_9	6±0.2	-	-	4±0.3	10±0.5	Acceptable
10.	t_{10}	6±0.2	-	6±0.3	-	12±0.5	Acceptable
11.	t_{11}	-	3±0.1	-	4±0.3	7±0.4	Acceptable
12.	t_{12}	6±0.2	3±0.1	6±0.3	-	15±0.6	Acceptable
13.	t_{13}	-	3±0.1	6±0.3	4±0.3	13±0.7	Acceptable
14.	t_{14}	6±0.2	-	6±0.3	4±0.3	16±0.8	Acceptable
15.	t_{15}	6±0.2	3±0.1	6±0.3	4±0.3	19±0.9	Acceptable

In the third step, psychosocial risks are assessed and analyzed for each group of factors as a result of the survey, with the results presented in Figure 3. First, we obtain data for each employee, and then, using their averaged values, we determine the risks for each group of dangerous psychosocial factors. The result is an overall picture of the level of stress experienced in a particular workplace.

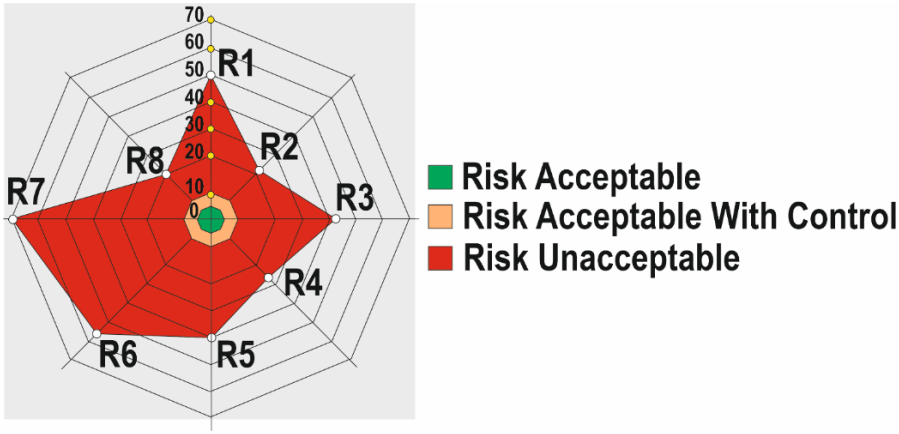

Figure 3 – Distribution diagram of psychosocial risk level for each of the eight groups of dangerous factors

The next step is devoted to identifying possible combinations of psychosocial risks, calculated for each group of dangerous factors, taking into account 256 possible combinations. This approach again makes it possible, first of all, to identify those combinations that have the greatest impact on the experience of stress by employees.

As a result of the conducted survey, it has been found that the cumulative psychosocial risk level is absolutely unacceptable, requiring the introduction of appropriate preventive measures to reduce the impact of certain dangerous factors. The example above shows that the most significant groups of factors with the highest risk level are: military factors, organizational factors, and employee relationship factors. In addition, the analysis of dangerous factors in a specific group reveals the most influential among them. In this case, it is necessary to pay attention to both long-lasting and those with high tension.

In the fifth step, based on the calculation of the cumulative psychosocial risk level in the workplace, we identify the acceptable or unacceptable levels of various risk combinations to determine the most dangerous combinations.

Based on the analysis performed, in the seventh step we create a risk register for their subsequent monitoring. This is the basis for conducting at the ninth step the substantiation of protective and precautionary measures to reduce the psychosocial risk level, based on the revision of job instructions, development of a program for increasing stress resistance, and the implementation of automatic data collection systems according to the physical condition of the compressor unit. The example of recommendations to reduce the impact of dangerous psychosocial factors is provided in Table 5.

The obtained results highlight the importance and, in turn, the benefits of using an integrated approach to stress management and prevention. Therefore, in order to manage stress and prevent its influence on the employee health, organizations should use a number of measures and actions aimed at both increasing the psychological resilience of the employee and organizing a comfortable workplace.

Table 5 – Fragment of psychosocial risk management

Psychosocial DF	Precautionary measures		
	First level	Second level	Third level
Difficulty in making managerial decisions due to uncertainty in performing work.	Review job and work instructions and procedures to ensure that assigned tasks can be performed safely within the work schedule.	Develop a long-term training and advanced training program for each employee in accordance with the enterprise development strategy.	–
Increased workload from management because you are doing work outside of normal working hours due to the need to combine tasks.	Agree on a list of works for which a permit should be issued.	Introduce safety committees to discuss with employee's safety issues related to performing work under new workloads.	Implement automated systems for collecting production performance indicators.
Difficulty of relationships between colleagues with lack of interaction and management support.	Conducting corporate training on teamwork and personal responsibility.	Implementation of a psychological/mental assistance hotline.	–
Are there physical hazards (noise, inadequate lighting, high humidity or temperature, etc.) in the workplace?	Analyze the adequacy of existing personal and collective protective equipment, improve it if necessary.	Conduct a sanitary analysis of workplaces and respond to adverse changes in physical factors affecting the employee working conditions.	–

Discussion

The purpose of this paper was to propose a process for psychosocial risk management that identifies significant risks and dangerous factors by groups, as well as combinations of groups. Such an approach will allow the owners of organizations to substantiate precautionary measures in more details, based on specific preventive measures to eliminate certain dangerous factors. This process involves ten main steps. Their difference from the known ones is the assessment of combinations of both dangerous factors and risks by their groups. It is also proposed to expand the number of groups of dangerous psychosocial factors in ISO 45003:2021 with three additional groups, thereby increasing the effectiveness of the psychosocial risk management process by detailing the adverse effects on the employee. In particular, the need to expand the consideration of potential stress factors is discussed in the works (Jiménez & Dunkl, 2017; Khoshakhlagh et al., 2024).

The general research purpose was to develop the comprehensive questionnaire to identify influential psychosocial factors and their groups in a particular workplace. The questionnaire includes fifty-seven questions assigned to a particular group. Moreover, their number is not constant and can be changed either up or down, based on the specific situation in the workplace and the recommendations given in the relevant well-known COPSOQ II or HSE MS Indicator Tool questionnaires (Moncada et al., 2014; Marcatto et al., 2014). The main prerequisite for developing the questions introduced in the questionnaire is that there is empirical evidence of a relationship between psychosocial factors of stress at work and the employee's experience of stress (Grice et al., 2020; Emmer et al., 2020). On the other hand, for better risk management, it is suggested to calculate its level both for a specific dangerous factor and for each group of dangerous factors separately, as well as for their combinations. This will make it possible to apply precautionary measures to reduce the influence of a factor that belongs to a particular group. At the same time,

although it has been proposed to take into account the influence of combination of different factors on the probability of stress development, still the mechanism of response to their combined action is not taken into account, as it requires a number of additional studies of human reactions to the influence of stressors (Stolk et al., 2012).

The proposed approach allows for a detailed elaboration of each group of dangerous factors, identifying the significant ones by analyzing the duration and the stress experience. In addition, other methodologies could be added to clarify the problem on the basis of specific questions. For example, an employee's level of mental health, emotional burnout or stress tolerance to determine the most effective actions in programs to maintain or improve psychological safety in the workplace (Fauquet-Alekhine, 2023).

To check the proposed approach adequacy, logistic regression analysis is used – a simple method for calculating the probabilities of individual events, taking into account the values of specific dangerous factors. It is used to determine the absolute and relative risk of experiencing stress based on determined questionnaire scores. Quantitative results of psychosocial risks, calculated from the identified dangerous factors through the questionnaire, make it possible to identify reactions to stress with greater probability than in the case of a cumulative psychosocial risk level assessment. This is related to understanding which specific dangerous factor has the greatest impact on the overall risk (Stolk et al., 2012). In addition, this approach makes it easier to interpret the questionnaire results, when assessing risks, and facilitates the further course of precautionary measures. It is important to note that the presented method is independent of a specific psychosocial questionnaire but can be applied to any reliable and valid questionnaires measuring stressors in the workplace (Leiter & Maslach, 2016; Zeike et al., 2018).

In addition, this approach makes it easier to interpret the questionnaire results, when assessing risks, and facilitates the further course of precautionary measures. It is important to note that the presented method is independent of a specific psychosocial questionnaire but can be applied to any reliable and valid questionnaires measuring stressors in the workplace (Aronsson et al., 2017; Studer et al., 2014) and common sense assessment by occupational health and safety professionals. A 10-score scale is used to classify indicators of psychological health and emotional exhaustion with or without deterioration in psychological health.

Taking a closer look at the research results, it has been revealed that certain psychological stressors (work intensity, social stressors) have a stronger impact on increasing the risk of health deterioration than others (for example, insufficient use of skills) (Potocka, 2012; Tsopa et al., 2023) or hazards in the technological process (Akhmetova et al., 2021; Mühlhofer et al., 2023; Kemajl et al., 2024). While a social stressor questionnaire score from colleagues already doubles the risk of health deterioration, the maximum score is insufficient to detect the risk of health deterioration. These differences in the impact of stressors require more detailed study and recommendations for determining a progressive scale for assessing psychosocial risks based on their respective impact on a person.

Further research will be aimed at improving questionnaires for surveying employees in organizations of various industries, as well as refining the matrix for assessing psychosocial risks at work.

Conclusions

A register and questionnaire of dangerous psychosocial factors have been developed in accordance with the ISO 45003:2021 standard recommendations by adding three additional groups: factors of relationships between employees, factors of military activities and domestic troubles. The improved model of psychosocial risk management has been developed that takes into account the influence of combinations of eight groups of psychosocial risks on the occurrence of a dangerous event, thus improving the risk management process, which consists of ten steps and is characterized by the

assessment of combinations of both dangerous factors and risks by their groups based on the three components of frequency, duration and intensity of experiencing stress, which are determined through employee surveys on a ten-score scale.

The matrix is proposed for assessing psychosocial risks and forms for describing them and identifying precautions, taking into account: identification of dangerous psychosocial factors, their analysis, assessment, processing of all possible combinations of first the dangerous factors, then their risks with an assessment of the cumulative risk level and identification of acceptable or unacceptable level. The example is given of determining the level of psychosocial risks in a specific workplace of one of the auto transport enterprises, which shows the process of identifying significant combinations of psychosocial risks of dangerous factors over time, the reduction of which will improve the psychological safety level at the enterprise.

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Competing interests

The authors declare that they have no competing interests.

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