

V. A. Tsopa¹,
orcid.org/0000-0002-4811-3712,
S. I. Cheberiachko²,
orcid.org/0000-0003-3281-7157,
O. O. Yavorska²,
orcid.org/0000-0001-5516-5310,
O. V. Deryugin^{*2},
orcid.org/0000-0002-2456-7664,
T. O. Bilko³,
orcid.org/0000-0003-3164-3298

1 – International Institute of Management, Kyiv, Ukraine
2 – Dnipro University of Technology, Dnipro, Ukraine
3 – National University of Life and Environmental Sciences
of Ukraine, Kyiv, Ukraine
* Corresponding author e-mail: oleg.kot@meta.ua

IMPROVING THE PROCESS OF OCCUPATIONAL RISK MANAGEMENT ACCORDING TO THE HADDON MATRIX

Purpose. Improving the process of managing occupational risk (OR) in occupational safety and health management systems, due to the distribution of dangerous factors which increase the probability of a dangerous event into several phases: before the occurrence of a dangerous event and after its occurrence.

Methodology. The method of morphological analysis is used, which is based on the selection of possible solutions for individual parts of the task based on several morphological typical features important for the problem being solved, and the compilation of all possible combinations of hazardous factors and precautionary measures that will allow reducing the amount of occupational risk.

Findings. A new approach to occupational risk management is proposed, which involves the division of all dangerous factors into several phases: before the occurrence of a dangerous event, after its occurrence, provision of pre-medical assistance, provision of emergency and medical care. Typical dangerous factors are defined that increase the probability of the occurrence of a dangerous event, which relate to the first phase (before the occurrence of a dangerous event), as well as dangerous factors that affect the severity of accidents and are characteristic of the second, third and fourth phases (after the occurrence of a dangerous event). A concept was developed for calculating the magnitude of occupational risks, based on the consequences of the occurrence of a dangerous event or by the type of injury with the area of responsibility of the enterprise; from the consequences of pre-medical care or the condition of an injured person with the area of responsibility of the enterprise and with the consequences of emergency and inpatient medical care or the state of loss of health of the employee with the area of responsibility of the medical institution. The hierarchy of preventive measures has been improved due to the addition of protective measures consisting of pre-medical care, emergency medical care, in-patient medical care.

Originality. When assessing professional risks, it is proposed to determine the amount in accordance with the area of responsibility of the enterprise and and medical institution taking into account dangerous factors corresponding to a specific phase.

Practical value. Examples of three matrices for assessing the occupational risk have been developed, taking into account the classification of the severity of the consequences for the health of the employee, which occurred immediately after the occurrence of a dangerous event (accident), after the provision of pre-medical care and after the provision of emergency and medical care. A description of preventive actions to reduce the severity of the consequences is proposed, taking into account the sphere of responsibility.

Keywords: *occupational risk, Haddon's matrix, occupational safety and health management system*

Introduction. Occupational Health and Safety Management System (hereinafter referred to as the OHSMS) in accordance with the requirements of the ISO 45001:2018 standard "Occupational health and safety management systems. Requirements and guidelines for application" is a set of inter-related (interacting) elements of organizations to implement the policy of preventing injuries and occupational diseases, as well as to ensure a safe and healthy workplace by implementing the occupational risk (hereinafter as OR) management process [1–3].

The specified OHSMS at any enterprise includes several main characteristics: training of all employees in safe work methods; ensuring the safety of technological processes, production equipment, building structures, normalization of sanitary and hygienic working conditions, providing employees with personal protective equipment (hereinafter – PPE), organization of medical and preventive services, improvement of the legal framework on occupational safety, especially with regard to performance evaluation operation of the management system, the presence of its constant improvement, the application of a holistic approach to responding to the prevention of accidents (incidents) [4, 5]. The latter requires enterprises to implement an OR management process. In turn, the mentioned process requires the continuous development of

the methodology for hazard identification, assessment of OR and substantiation of preventive and protective measures in order to reduce OR to an acceptable level and thereby ensure the prevention and protection of employees from accidents (incidents) in the performance of work obligations as best as possible [6]. If a significant number of different approaches are provided for OR estimation, which are described in [7]; as well as methods of general evaluation of OR, which allows you to choose the best one according to the capabilities and conditions in a specific organization, then for the process of their management in accordance with Clause 8.1.2 of ISO 45001 [1] it is proposed to use a hierarchy of preventive and protective measures (Fig. 1).

This approach does not provide a model for ranking measures from the most effective preventive measures to the less effective protective measures. In addition, the OR control hierarchy, unfortunately, does not provide an answer as for the selection of fruitful effective measures or means of protection of workers during the occurrence of an accident (incident) or an emergency, as well as after its occurrence to reduce the severity of the consequences. One of the ways to solve this problem is the application of the Haddon matrix, which was developed by Dr. W. Haddon in the 70s of the last century to improve road safety [8, 9]. Its essence consists in the implemented system of preventive measures to reduce the probability of the occurrence of the road accident (further – RA), as well as mitigation (reduction of negative consequences) during an

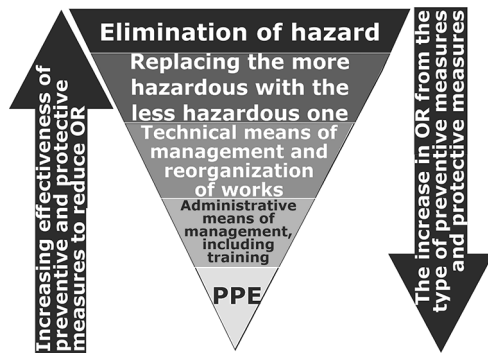


Fig. 1. Hierarchy of OR control measures in accordance with the requirements of ISO 45001 [1]

emergency and after its occurrence. Groups of hazardous factors distinguished by the time of their manifestation: before the occurrence of a hazardous event (hereinafter – HE), during its occurrence and after in each phase characterize the triad “person-vehicle (equipment)-environment” (Table 1).

This matrix identifies and systematizes OR factors depending on the time of occurrence of HE (incident, accident, etc.), as before the hazardous event, during and after HE. It shows that in the first phase preventive measures are necessary, in the second, measures that reduce injury and death, in the third, measures related to treatment and rehabilitation, as well as analysis of the causes that led to HE.

The Haddon matrix is quite a convenient tool for analysing various possible emergency production situations that can lead to HE, which allows effective planning and preparation for a wide range of emergency situations. However, it does not provide for the possibility of taking into account external and internal factors that can increase the probability of HE occurrence and its degree of severity of consequences when evaluating OR. Therefore, there is an urgent task of improving the Haddon matrix in order to make it meet the modern requirements of OR management.

Literature review. The field of occupational injury prevention has long used various methods to understand the impact of hazards and threats to workers’ health [10]. There are many models for managing OR [11, 12]. Among the most common is the “bow tie” method, which allows establishing a connection between the sources of hazards and the consequences of their implementation [13]. However, its shortcomings include the impossibility of reflecting a set of causes that occur simultaneously and cause consequences. In addition, it does not allow for the analysis of complex situations, especially when applying quantitative assessment. A more advanced method is the

construction of the Haddon matrix, which combines the concepts of primary, secondary and tertiary prevention with the concept of the system “person-vehicle (equipment)-environment” as a goal for the implementation of certain preventive measures and actions [14].

One of the disadvantages of this approach is the lack of understanding to which area in the OHSMS the proposed measures belong. To eliminate this shortcoming, the authors of the study [15] suggested changing the form of the matrix to three-dimensional one, where information will be provided in the third dimension regarding the belonging of preventive actions and measures to a certain area of responsibility. Each section of such a three-dimensional matrix represents a separate part for determining the strategy of response or mitigation of traumatism. However, the form of presentation of the matrix of its filling is impractical, but the main drawback of the proposed matrix is the lack of criteria for assessing the probability of the occurrence of hazards.

There are also several developments that expand the scope of hazardous factors [16, 17] by adding a column with social hazards or psychological influences in the workplace. A rather interesting solution for OR management was proposed by the author in work [18], where it was proposed to determine the results based on mathematical models that include indicators related to costs and resources for labour protection, as well as the nomenclature of harmful production factors and the features of their influence on an employee. However, the author neglected to take into account the effectiveness of pre-medical aid. A fairly good analysis of OR management methods is given in [19], which presents different approaches to working out the value of OR under the influence of various hazardous factors. Recommendations are provided on the use of SWOT analysis to find the root causes, which allows you to effectively assess the level of threats to the employee. However, the publication, unfortunately, does not take into account factors that affect the recovery time of an employee after an injury, which is an important element for assessing the economic losses of the enterprise.

Purpose. The purpose of the paper is to improve the OR management process in occupational safety and health management systems, due to the distribution of hazardous factors that increase the probability of the occurrence of HE in several phases: before the occurrence of a hazardous event and after its occurrence.

Methods. To solve the problem, the method of morphological analysis was used, which is based on the selection of possible solutions for individual parts of the problem. For this, several morphological typical signs (phases of the occurrence of an accident) were identified, which are important for the problem to be solved, and the composition of all possible com-

Table 1

Classical Haddon Matrix [8]

Phase		Hazardous factors		
		Person	Vehicle (equipment)	Environment
Before an accident	Accident prevention	- awareness; - behavioural attitudes; - health problems; - police control	- condition of the road; - lighting; - technical condition of brakes; - management quality; - compliance with the speed limit	- road markings; - road speed signs; - pedestrian crossing
During an accident	Prevention of serious injuries during an accident	- use of seat belts; - health problems	- availability and use of seat belts by passengers; - other security devices; - emergency car safety	- road facilities that prevent RA
After an accident	Recovery after an accident	- skills in providing medical aid; - availability of medical aid	- easy access to RA place; - risk of fire	- availability of rescue services; - presence of traffic jams on the road

binations of hazardous factors and precautionary measures that will allow reducing the value of OR. The analysis of the received options allowed us to identify several combinations of the development of events after the occurrence of an accident, which, unfortunately, are missed in the majority of cases with the usual approach of OR assessment. The identified signs were arranged in the form of tables, so-called morphological boxes (matrix), which allowed us to better present the OR management model, as well as to quickly and more accurately navigate the variety of concepts and factors. As a result of targeted and systematic analysis, a new model was generated, which allowed a different approach to the OR assessment process, taking into account the systematization of dangerous factors depending on the time of HE occurrence.

Results. To improve the Haddon matrix, a new OR management concept is proposed for enterprises that do not have their own emergency medical service (Fig. 2) and for enterprises that have their own emergency medical service (Fig. 3).

A feature of the new OR management concept is the division of all hazardous factors that affect the occurrence of HE into four phases: before the occurrence of HE, during the occurrence of HE, during the provision of pre-medical aid and after the provision of pre-medical aid. Moreover, all hazardous factors refer to one of specific areas which are established in the ISO 45001 standard: work organization system, top management, workers, infrastructure, contractors, interested parties, work environment and others (Table 2).

In the first case, i.e. at enterprises without their own emergency medical service, an assessment of three possible OR options are provided:

- by the consequences of HE or by the type of injury with the zone of responsibility of the enterprise;
- by the consequences of pre-medical care or the condition of the injured person with the zone of responsibility of the enterprise;
- by the consequences of emergency and inpatient medical aid or a state of loss of health with the zone of responsibility of the medical institution.

The difference in the second case, when the enterprise has its own medical, emergency service, is the addition of an OR assessment of emergency medical aid.

To calculate the OR (PR) by the consequences of HE or by type of injury, we use the product of the probability of occurrence of HE (B) and the degree of severity of the consequences of HE by type of injury (TH)

$$PR = B \cdot TH.$$

Usually, the first component can be established due to statistical data or conducting relevant scientific research [20], then to determine the second, it is suggested to take into account their classification (Fig. 4), which is used in labour protection.

To estimate the value of OR, a special matrix with a scale of 9×12 (Fig. 5) is proposed, as an example, which is determined, on the one hand, by the number of negative consequences, and, on the other hand, by the frequency of occurrence of HE.

To calculate the OR (PR_1) according to the consequences for medical aid, we will use the product of the probability of occurrence of HE (B) and the degree of severity of the injured person's condition (TT)

$$PR_1 = B \cdot TT.$$

At the same time, the degree of severity of the injured person's state is determined according to the classification shown in Fig. 6, which was also determined in accordance with the classifier of the distribution of injuries by degree of severity. Then, to estimate the value of OR, a quite different matrix with a scale of 5×12 (Fig. 7) is proposed, as an example. It is determined similarly to the first one – by the number of negative consequences, and on the other hand, by the frequency of HE occurrence.

To calculate the OR (PR_2) based on the consequences of medical (emergency) aid, we will also use the product of the probability of occurrence of HE (B) and the degree of health loss after treatment (B_3)

$$PR_2 = B \cdot B_3.$$

To determine the degree of health loss, we will also use the appropriate classification (Fig. 8). Then, to estimate the value of OR, the following matrix with a scale of 9×12 (Fig. 9) is proposed as an example, which is determined similarly to the first one – by the number of negative consequences, and on the other hand, by the frequency of HE occurrence.

The result of the development of the improved Haddon matrix is the determination of actions to reduce the severity of injuries (Table 3).

A peculiarity of the proposed approach is the delimitation of the sphere of influence between the enterprise and medical institutions. On the one hand, it allows us to rationally distribute the funds needed by OHSMS, as well as to foresee the allocation of funding for emergency and medical aid, because the restoration of the health of employees also requires an appropriate assessment to reduce the losses of the enterprise.

To calculate OR from hazard – j and all its hazardous factors – i , which are identified according to the zones of responsibility of the organization, they are determined by the formulas according to [12]:

- a) for the zone of responsibility of the organization (Figs. 1, 2):

- is the risk of a hazardous event (Fig. 1)

$$PR_j = \sum B_{ji} \cdot TH_{ji},$$

where PR_j stands for HE risk from hazard – j taking into account hazardous factors – i (without taking into account pre-medical aid); B_{ji} is probability of occurrence of HE (incident, accident, etc.) from hazard – j under the influence of hazardous factor – i , which affects the probability of occurrence of a dangerous event; TH_{ji} is the degree of severity of consequences from HE (incident, accident, etc.) from hazard – j under the influence of hazardous factor – i , which affects the degree of severity of the health condition of the injured person from HE;

- risk with taking into account the consequences of pre-medical aid for the injured person

$$PR_{2j} = \sum (B_{ji} \cdot TT_{ji}),$$

where PR_{2j} stands for risk of hazard – j taking into account hazardous factors – i taking into account pre-medical aid; B_{ji}

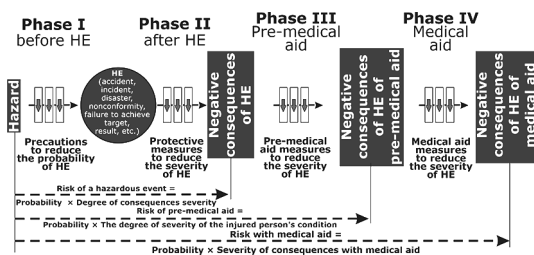


Fig. 2. Model of a new concept of OR management at enterprises without their own emergency medical service

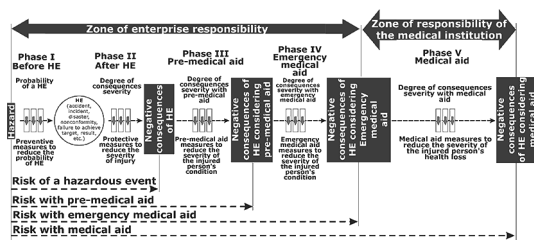


Fig. 3. Concept model of OR management in organizations with their own emergency medical service

Improved Haddon matrix

Workplace			Hazardous factors			
Hazard	HE	Consequences	Phase I	Phase II	Phase III	Phase IV
			Before HE	During the HE	Providing pre-medical aid	From the time of pre-medical aid to medical aid
Sphere of HE						
WORK ORGANIZATION SYSTEM			<ul style="list-style-type: none"> - Lack of implementation of the OR reduction plan. - There is no OR management process procedure. - Absence or non-fulfilment of the requirements of the safe performance card 	<ul style="list-style-type: none"> - The procedure for responding to HE has not been established. - There is no training schedule for workers 	<ul style="list-style-type: none"> - There are no requirements for knowledge of pre-medical aid. - Trainings of workers are not conducted and are not planned 	Lack of conditions for the movement of emergency medical aid
TOP MANAGEMENT			<ul style="list-style-type: none"> - Incompetence. - Indifference. - Carelessness. - Irresponsibility. - Compliance with labour safety requirements is not monitored 	<ul style="list-style-type: none"> - Failure to allocate resources for protective measures. - Failure to provide workers with PPE 	Failure to allocate resources for staff training in pre-medical aid	Failure to allocate resources for social insurance of medical aid
WORKERS			<ul style="list-style-type: none"> - Incompetence. - Indifference. - Carelessness. - Irresponsibility. - Non-fulfilment of labour safety requirements in terms of preventive measures 	Non-fulfilment of labour safety requirements in terms of protective measures	Lack of competence in the area of pre-medical aid	Failure to comply with the hospital regime
INFRASTRUCTURE (BUILDINGS, EQUIPMENT, TOOLS, ETC.)			<ul style="list-style-type: none"> - Old equipment. - Lack of locks. - Fencing of safe zones 	Lack of communication of protective mechanisms.	Lack of a first aid kit	The ambulance is not equipped
CONTRACTORS			<ul style="list-style-type: none"> - Incompetence. - Indifference. - Carelessness. - Irresponsibility. - Non-fulfilment of labour safety requirements in terms of preventive measures 	Non-fulfilment of labour safety requirements in terms of protective measures	Lack of competence in the area of pre-medical aid	Failure to comply with the hospital regime
INTERESTED PARTIES			- Inadequate inspections by the State Labour Office	---//---	---//---	---//---
CONTRACTORS (OUTSOURCING)			<ul style="list-style-type: none"> - Incompetence. - Indifference. - Carelessness. - Irresponsibility. - Non-fulfilment of labour safety requirements in terms of preventive measures 	Non-fulfilment of labour safety requirements in terms of protective measures	Lack of competence in the area of pre-medical aid	Failure to comply with the hospital regime
WORKING ENVIRONMENT			<ul style="list-style-type: none"> - There are no established requirements for the conditions of the working environment. - There is no control over dangerous working environment conditions 	Non-fulfilment of labour safety requirements in terms of protective measures	<ul style="list-style-type: none"> - Lack of promptness of providing pre-medical aid. - Lack of competence in the area of pre-medical aid 	<ul style="list-style-type: none"> - Lack of promptness of providing pre-medical aid. - Lack of competence in the area of pre-medical aid

is probability of occurrence of HE (incident, accident, etc.) from hazard – j under the influence of a hazardous factor – i , which affects the probability of occurrence of HE; TT_{ji} stands for the degree of severity of the injured person's health from HE (incident, accident, etc.) from hazard – j under the influence of a hazardous factor – i , which affects the degree of severity of the injured person's health loss, taking into account pre-medical aid;

b) for the zone of responsibility of emergency medical services and treatment medical facilities (Fig. 2):

- risk taking into account medical aid (Fig. 2)

$$PR_{2j} = \sum (B_{ji} \cdot B3_{ji}),$$

where PR_{2j} stands for risk of hazard – j taking into account hazardous factors – i including medical aid; B_{ji} is probability of occurrence of HE (incident, accident, etc.) from hazard – j under

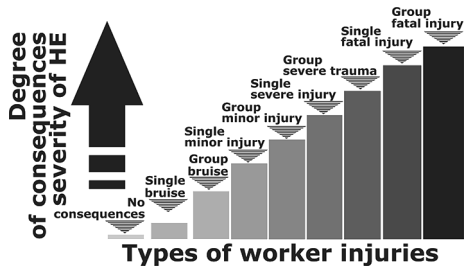


Fig. 4. Degrees of severity of HE consequences by types of worker injuries

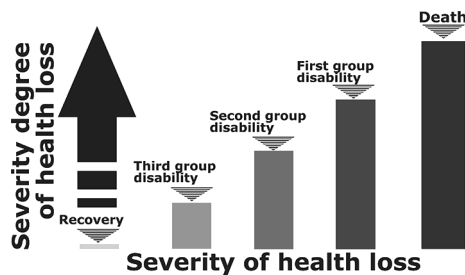


Fig. 8. Degrees of severity of the injured person's health loss

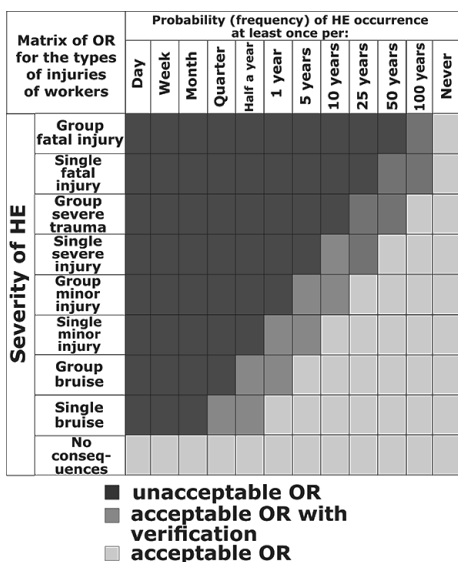


Fig. 5. The form of the OR matrix taking into account the type of injuries of workers

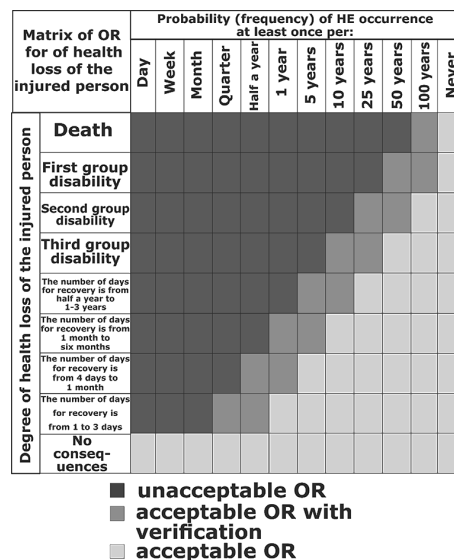


Fig. 9. The form of the OR matrix considering the injured person's health loss

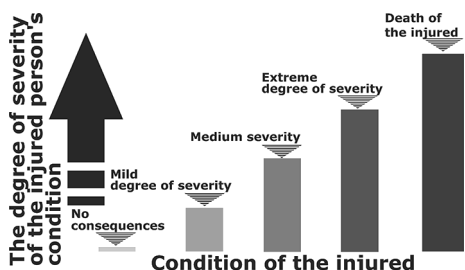


Fig. 6. Degrees of severity of the injured person's health

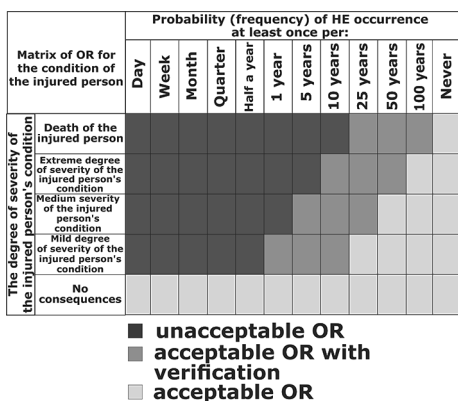


Fig. 7. The form of the OR matrix taking into account the injured person state

the influence of a hazardous factor – i , which affects the probability of occurrence of HE; $B3_i$ is degree of severity of loss of health of the injured person taking into account treatment of the injured person under the influence of a hazardous factor – i , which affects the degree of severity of health loss for the injured person.

Discussion. There are many hazardous factors that lead to injury and death of an employee. Their effect is especially evident after the accident occurs, where the provision of pre-medical, emergency medical aid is often of crucial importance. This requires an appropriate scrupulous approach to the most hazardous factors and assessment of OR at the stage of providing medical aid. Unfortunately, most of the risk management recommendations are limited to a general assessment of OR and justification of measures to reduce the probability of their occurrence. At the same time, much less attention is paid to the documentation and processing of actions to reduce the severity of consequences, due to the lack of OR control in third-party organizations. Meanwhile, ISO 45001 [1] prides requirements for taking into account the risks of partners, this also applies to medical institutions with which close cooperation has been established regarding the medical care of employees, including the provision of emergency aid in case of injury (Table 3).

Note that OR with consequences by types of injuries is used most often in enterprises around the world in the same way that the qualification of the consequences of accidents is used according to the regulations on the investigation of accidents at the enterprise, but at the same time, medical aid and emergency medical aid are not taken into account. Therefore, in the presented improved Haddon matrix, the possibility of taking into account the OR of partners is provided, which together allow us to assess the depth of the work of the responsible persons of the enterprise of the system of ensuring the welfare of employees, including the prevention of accidents, saving their health and life [3].

Determination of preventive actions to reduce the degree of severity from the HE

No.	OR	OR phases	Owner of OR	Impact on OR	Actions to reduce the probability of the occurrence of a hazardous event for phase I and the degree of severity for phases II–IV
1	Probability of HE occurrence	I	Enterprise	Probability of HE occurrence (incident, occupational disease, accident, etc.)	Precautions: - personnel qualification measures (vocational training and professional development, training in safe work methods and knowledge testing, admission to independent work, occupational safety briefings); - measures to match the state of health of employees to the work they perform (medical examinations, attestation of workplaces, control of health during work); - organizational measures for occupational safety due to production processes (providing workplaces with occupational safety instructions, planning and organization of work with increased risk, sufficient informativeness, availability of operational documentation, organization of circulation of means of individual and collective protection of employees); - implementation of the functions of control over the state of labour safety
2	OR of the hazard from the consequences of HE	II		Degree of severity by types of injuries (Fig. 2)	Protective actions: - means of automatic blocking, stopping the production process, equipment, mechanisms and equipment in the case of an emergency; - engineering means designed to reduce the consequences of injury to workers; - personal protective equipment for employees; - documenting the OR management process
3	OR of hazard from the consequences of pre-medical aid	III		The degree of severity according to the condition of the injured (Fig. 3)	Protective actions of pre-medical aid: - measures to respond to industrial incidents, practical skills of employees (educational and training sessions, information procedure, etc.); - pre-medical training (mastering the skills of providing primary pre-medical aid to victims of an accident); - availability and condition of means of providing pre-medical aid (designation of locations, equipment, suitability for use)
4	OR of hazard from the consequences of medical aid	IV	Emergency medical service	The degree of severity according to the condition of the injured (Fig. 3)	Protective actions of emergency medical aid Actions of pre-medical aid are the actions related to emergency medical aid to support the vital activity of the injured person
			Medical institution	The degree of severity according to the state of recovery of the injured person's health (Fig. 4)	Protective actions of medical aid Actions of medical treatment are the actions related to medical treatment to restore the health of the injured person

The use of Haddon's matrix also provides an opportunity to improve the model of the hierarchy of preventive and protective measures in the process of managing occupational risks (Fig. 10). The main difference from the known one is the addition of a block of protective measures consisting of pre-medical aid, emergency medical aid, and in-patient medical aid. Moreover, their ranking is from pre-medical aid, which is

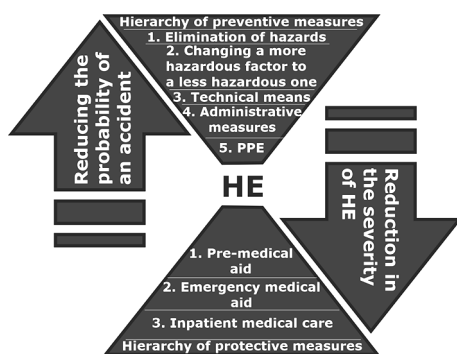


Fig. 10. Improved model of the hierarchy of preventive and protective measures

based on the knowledge and skills of production personnel and available first-aid tools in first-aid kits at workplaces, to inpatient medical aid by highly qualified specialists with relevant professional competencies and medical equipment.

The main difference between the developed approach and the known ones is the classification of hazardous factors into four phases, which are determined by the time of occurrence of a hazardous event and the provision of pre-medical, emergency and medical aid. We draw attention to the fact that OR with consequences for the condition of the injured person is not used in practice at all, although this type of OR should be taken into account in the OR management system in the organization, as it includes actions for pre-medical aid, which significantly affects the degree of severity of the condition of the injured person and the workers should be trained to provide it. Therefore, each phase supposes the assessment of OR level, which allows a thorough approach to the development of preventive actions, since the algorithms are clearly prescribed and the strengths and weaknesses of the necessary processes that occur after the accident are established. OR with consequences for the loss of health of an injured worker is also not used in practice, although emergency medical and inpatient medical aid significantly affect the final degree of severity of the worker's health loss, taking into account the recovery. As

we can see from the data in Table 3, the main part of hazardous OR factors and measures to reduce them are located in the first phase of the Haddon matrix, thereby showing the significant role of preventive measures in the OHSMS of the organization itself.

In addition, precautionary measures and actions in PHASES II, III and IV are provided to reduce the impact of hazardous factors after the occurrence of a HE (accident). All this will significantly reduce the OR of the worker at the workplace with the provision of timely medical and pre-medical aid, as well as reduce the loss of health of injured workers.

Conclusions.

1. A new approach to the management of the OR is proposed, which involves the division of all hazardous factors into several phases: before the HE, after its occurrence, the provision of pre-medical aid and the provision of emergency and medical aid, which made it possible to identify typical hazardous factors that increase the probability of the occurrence of HE, which are related to the first phase (before the occurrence of a hazardous event), as well as hazardous factors that affect the severity of consequences and are characteristic of the second, third and fourth phases (after the occurrence of HE).

2. A new concept is proposed for calculating the value of OR based on the consequences of HE or by the type of injury with the zone of responsibility of the enterprise; from the consequences of pre-medical aid or the condition of an injured person with the zone of responsibility of the enterprise and with the consequences of emergency and inpatient medical aid or the state of loss of health of the employee with the zone of responsibility of the medical institution.

3. Examples of three OR assessment matrices have been developed, which take into account the classification of the severity of the consequences on the health of the worker, occurred immediately after the occurrence of HE (accident), after the provision of pre-medical aid, and after the provision of emergency and medical aid.

4. A description of preventive actions to reduce the severity of the consequences is proposed, taking into account the OR phase, the area of responsibility and the assessment of the degree of severity of the consequences.

5. The hierarchy of preventive measures has been improved, consisting in the addition of a block of protective measures including pre-medical aid, emergency medical aid, and in-patient medical aid.

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Удосконалення процесу керування професійними ризиками за матрицею Хеддона

В. А. Цона¹, С. І. Чеберячко², О. О. Яворська²,
О. В. Дерюгін^{*2}, Т. О. Білько³

1 – Міжнародний інститут менеджменту, м. Київ, Україна

2 – Національний технічний університет «Дніпровська політехніка», м. Дніпро, Україна

3 – Національний університет біоресурсів і природокористування України, м. Київ, Україна

* Автор-кореспондент e-mail: oleg.kot@meta.ua

Мета. Удосконалення процесу керування професійними ризиками (ПР) у системах управління безпекою праці та здоров'я працівників, за рахунок розподілу небезпечних чинників, що збільшують вірогідність настання небезпечної події на декілька фаз: до настання небезпечної події й після її настання.

Методика. Використано метод морфологічного аналізу, що заснований на підборі можливих рішень для окремих частин завдання на основі кількох морфологічних типових ознак, важливих для розв'язуваної задачі, і складання всіх можливих поєднань небезпечних чинників і запобіжних заходів, які дозволять зменшити величину ПР.

Результати. Запропоновано новий підхід до керування професійними ризиками, що передбачає розподіл усіх небезпечних чинників на декілька фаз: до настання небезпечної події, після її настання, надання домедичної допомоги, надання екстреної й медичної допомоги. Визначені типові небезпечні чинники, що збільшують вірогідність настання небезпечної події, які відносяться до першої фази (до настання небезпечної події), а також небезпечні чинники, що впливають на важкість наслідків і характерні другій, третій і четвертій фазам (після настання небезпечної події). Розроблена концепція для розрахунку величини професійних ризиків, виходячи з наслідків настання небезпечної події або за видом травмування із зоною відповідальності підприємства; із наслідків до-

медичної допомоги або стану травмованого із зоною відповідальності підприємства та із наслідками екстреної та стаціонарної медичної допомоги або стану втрати здоров'я працівника із зоною відповідальності лікувального закладу. Удосконалена ієрархія запобіжних заходів за рахунок додавання захисних заходів, що складаються з домедичної допомоги, екстреної медичної допомоги, стаціонарної медичної допомоги.

Наукова новизна. Запропоновано при оцінці професійних ризиків визначати величину тяжкості наслідків відповідно до зони відповідальності підприємства й лікувального закладу з урахуванням небезпечних чинників, що відповідають конкретній фазі.

Практична значимість. Розроблені приклади трьох матриць для оцінки величини професійного ризику, що враховують класифікацію тяжкості наслідків на здоров'я працівника, які виникли відразу після настання небезпечної події (нешасного випадку), після надання домедичної допомоги й після надання екстреної та медичної допомоги. Запропоновано опис запобіжних дій зі зменшення тяжкості наслідків з урахуванням сфери відповідальності.

Ключові слова: професійний ризик, матриця Хеддона, система управління безпекою праці та здоров'я працівників

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