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Assessment of Occupational (Industrial) Risks: New Approaches, Improvements, Methodology

Oleksiy I. Polukarov, Nataliia A. Prakhovnik, Yury O. Polukarov,
Liudmyla O. Mitiuk, Hlib V. Demchuk

National Technical University of Ukraine
“Igor Sikorsky Kyiv Polytechnic Institute”
03056, 37 Peremohy Ave., Kyiv, Ukraine

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Abstract

The relevance of the study presented is conditioned upon the fact that the current national policy of control and supervision, including industrial safety, is designed to detect and prevent violations of the permissible level of danger for people and the environment by entities engaged in economic activities. The purpose of this study is to analyse occupational risks in enterprises and to explore new approaches, methodologies and ways of improving the assessment of occupational risks in production facilities. The methodological foundation of the study is based on a combination of various general scientific methods of scientific knowledge: analysis and synthesis of information, comparative method, and methods of induction and deduction. Improving the state of occupational safety requires improving the principles of occupational safety management. In addition, an assessment of the risk to the life or health of employees from economic activity should be performed and defined as the product of the probability of one accident per year and the probable number of lost working days per employee during the year. The study identified that workplace risk assessment should be re-evaluated whenever changes are expected in the company that may affect safety, such as new processes, new equipment, new materials, or changes in the work organisation or the work environment. The steps of risk assessment are clarified, the means of eliminating or reducing the risk are identified. It was demonstrated that a risk assessment should be developed and used to help employers or managers, and it was emphasised that once risks and dangers have been identified, appropriate action should be implemented with proper legal compliance. The practical significance of the presented research is that it can be used both in practice and for studying the theory of occupational risk assessment at enterprises

Keywords: industrial activity, industrial risk, labour protection, potential threats, safety

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*Corresponding author

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Introduction

Improving the state of occupational safety requires improvement of the principles of occupational safety management. State supervision of labour protection and industrial safety involves various types of inspections depending on the specific features of technological processes, production facilities, and works performed by business entities. The modern national policy of control and supervision, including in the field of labour protection and industrial safety, is designed to identify and prevent violations of safety requirements at these facilities [1].

The main regulatory document in this regard is the Law of Ukraine, "On Basic Principles of State Supervision (Control) in the Sphere of Economic Activity" [2], and the Law of Ukraine, "On Occupational Safety and Health" [3]. As a starting point for the planned organisation of supervision activities, the state supervisory authority determines the criteria by which the risk of business activities is assessed, and supervision activities are designed. Thus, permissible risks for industrial and occupational safety indicators should be determined at the legislative level. Admittedly, one of the main indicators in the field of safety is accidents at work, in particular those with deadly consequences. Improving the state of occupational safety and health requires improvement of the principles of occupational safety and health management. It is conditioned upon modern world trends in the field of labour protection, and requirements of the relevant international law. These include, for example, the International Labour Organisation Convention on the Fundamentals of Occupational Safety and Health [4], and the international standard "Guidelines on Occupational Safety and Health Management, ILO-OSH 2001" [5]. The new principles of occupational safety and health are based on various motivating factors that are determined by analysis, forecasting, personnel management, risk management (industrial, occupational), the process approach, using international practices and, finally, the improvement of occupational safety and health and the management of the industry. The main issues of improving management are the development of a methodology for risk analysis and assessment of their further management [6].

A hazard is defined as a feature or capability of a facility (e.g., production materials, equipment, technology, and procedures) that can result in damage. Risk can be defined as the probability of potential damage and the possible degree of damage. Risk assessment is the process of evaluating the risk to the health and safety of workers in the workplace arising from the circumstances of the danger in the enterprise [7]. The assessment of the risk to the life or health of workers from the economic activity for each type of activity should be determined as the product of the probability of one accident per year and the probable number of lost working days per employee during the year. The following indicators are proposed for evaluation: the average number of occupational

accidents (Lost Time Injuries and Deadly Accidents) over the last three years, the average number of employees in that economic activity over the last three years and the average number of working days missed as a result of incapacity for work conditioned upon accidents over the last three years [8].

According to the International Labour Organisation, the correlation between the total number of accidents at work and deadly accidents at work in Western Europe can be estimated at one thousand. Thus, probable harm should be considered as the risk of injury to the life or health of workers in the economic activity for each activity, which is defined proxy for the probable number of working days lost per worker in the enterprise during the year [9].

During the literature review, it was investigated that risk assessment should be developed and used to assist employers or managers. Thus, the study by M. Rodrigues and co-authors considers the impact of activities related to the prevention of occupational risks on occupational health and safety indicators [10]. The results of the study demonstrated that in Portugal's micro-enterprises, some enterprises did not have a preventive service, and in some cases, there were no occupational safety and health policies, risk assessments, training and accident reporting mechanisms. Insufficient time was devoted by employers to occupational safety and health issues and support of external consulting services.

The issue of the influence of enterprise management and media attention on occupational health and safety at enterprises was exposed in their study by Q. Zhou and co-authors [11]. The authors have established a model that has proven to be efficient by reducing the costs of managing the main enterprise, increasing the probability of receiving precise messages in the media, and reducing the initial costs of labour protection.

Notably is the study of N. Mashwama and co-authors [12] on the problems of occupational health and safety of small and medium-sized business contractors. The authors emphasise that employee safety and health are non-negotiable, and increase employee productivity, improve the company's image, and reduce the number of claims and accidents. Instead, managers and employers should have efficient communication skills, technical and business skills, experience and relevant education.

It is essential to identify the dangers in the workplace and assess the risks associated with these to identify what measures should be implemented to protect the health and safety of workers and their subordinates, with proper regard to legal requirements. The study demonstrated that workplace risk assessments should be re-evaluated whenever changes are expected in the company that may change the perception of risk, such as new processes, new equipment, new materials, changes in work organisation, new production, and conditions such as the opening of new stores or other premises.

The purpose of the research is to analyse occupational risks at enterprises and to consider new approaches, methods and ways to improve the assessment of occupational risks at industrial and other production facilities.

Materials and Methods

The methodological foundation of the study is based on a combination of various general scientific methods of scientific knowledge. In this study, the methods of analysis and synthesis of information, comparative method, and the method of induction and deduction were used, and the analysis of scientific literature relevant to the research subject was performed. Through the methods of analysis and synthesis, the approaches used to assess risks in the workplace and their crucial elements were identified. The ways of conducting risk evaluation at the workplace were identified, and the most efficient ones were analysed. Comparison as a logical technique was used in the study of ways to increase production efficiency and improve its quality. The methods of comprehensive risk assessment were analysed, and possible control measures were identified.

The principles of risk assessment planning were analysed. The first principle states that the assessment should be structured to cover all significant hazards and risks (e.g. not forgetting objectives such as off-site cleaning or ancillary units such as waste compaction). The second principle is that, once the risk has been identified, the assessment should start from purely theoretical principles and consider whether the risk can be eliminated: whether the hazard it represents is required (e.g. whether internal traffic problems can be avoided and if this traffic occurs not only on the road that exists at the enterprise but from the very edge of this road) [13].

Results and Discussion

Each employer has a general responsibility to ensure the safety and health of workers in every aspect of their work. The purpose of the risk assessment is to enable the employer to implement the appropriate measures to protect the safety and health of employees. These measures include: the prevention of occupational risks, informing employees, training employees, organisation and resources to implement the required measures [14]. Though risk assessment involves the prevention of occupational risks, and, this should be the purpose at all times, in practice, it is not always possible to solve this problem. If the risks cannot be eliminated, the risks should be mitigated, and the residual risk should be controlled. At a later stage, as part of the review programme, such residual risks will be re-evaluated, and the possibility of eliminating or further reducing the risk may be considered in light of new findings [15].

Risk assessments should be developed and applied to assist employers or managers. It is essential to identify the dangers in the workplace and assess the risks associated with these to identify what measures should be implemented to protect the health and safety of

workers and their subordinates, with proper regard to legal requirements. The above risks should be evaluated for the most reasonable choice of production facilities, chemicals and medicines, workplace equipment and work management. In addition, it is essential to verify whether the measures implemented are sufficient. If the assessment results indicate the necessity of additional measures, they should be prioritised. It is essential to demonstrate to oneself, the competent authorities, employees and their representatives that all factors relevant to the work have been considered and that an informed decision has been made regarding the risks and necessary health and safety measures. In addition, it is necessary to ensure that the precautions and work methods and production technologies identified as necessary as a result of the risk assessment include an increased level of protection of workers in terms of safety and health [16].

The workplace risk assessment should be re-evaluated whenever changes are expected in the company that may change the perception of risk, such as new processes, new equipment, new materials, changes in work organisation and new production conditions such as the opening of new stores or other premises. In any risk assessment and subsequent measures or controls, it should be essential that the risk is not transferred, i.e. that one problem does not result in another. For example, installing double-glazed windows in the office to reduce street noise will be a dubious advantage if proper ventilation is not provided. It is equally essential that the risk is not transferred to another area. For example, exhaust ventilation should not be provided to remove toxic substances in a way that establishes a hazard to other production areas or to people outside the facility (one hospital installed a mortuary room exhaust under the windows of the children's ward, which resulted in a hazard to life and limb) [17].

Risk assessment consists of the following stages: identification of hazards, identification of workers (or other persons) who may be exposed to these hazards, and assessment of the relevant risk, i.e. qualitative or quantitative consideration of the possibility of eliminating the risk. If it cannot be eliminated, the decision to implement further measures to prevent or reduce the risk. Risk assessment should be performed for all workplaces. In a broader sense, they can be classified as: stationary establishments, such as offices, schools, and factories, change of work, such as construction, docks, and shipyards, mobile work, civil service brigade, and duties associated with the performance of work with visits [18].

Several approaches (and their combinations) can be used for risk assessment, provided they contain the essential elements. Approaches used to assess risks in the workplace are usually based on the following elements:

- 1) monitoring of the production environment (e.g. means of access, floor condition, machine safety, dust and steam, temperature, lighting, noise, etc);
- 2) identification of objectives to be performed at the

workplace (identify all objectives and include them in the risk assessment);

3) consideration of objectives performed at the workplace (risk assessment of various objectives);

4) performance monitoring (verifying that procedures are performed according to the established procedure or forecast and that there are no other risks);

5) consideration of working models (to assess the impact of hazards);

6) consideration of external factors that may affect the workplace (for example, weather conditions for workers outside the buildings);

7) exploring psychological, social and physical factors that may contribute to stress at work, and their interaction with other factors of work organisation and work environment;

8) consideration of organisational measures to maintain conditions, including protective measures (e.g. risk assessment systems for new equipment, materials, etc. to update risk information) [19].

If you require a risk assessment at your workplace, the fastest and most reliable way to discover the details of what's occurring is to conduct a risk assessment. For example, to survey employees involved in the relevant production activities. They know what technological operations are performed, whether there are any simplified methods or ways to accelerate a complex task, and what preventive measures are implemented. Thus, employers should ensure that the risk assessor, whether an employee or an external consultant, communicates with employees or others, such as contractors, who perform the work [20].

In addition, employees can be warned about specific dangers that are difficult to detect. These are issues that can result from the organisation of work, working hours or the workplace that people sometimes take for granted or suffer at the cost of their comfort. Employees may discover that the way work is presented to them causes difficulties: for example, due to the work, being presented too quickly, leading to stress, or presented in a way that requires the employee to extend their hand or occupy an awkward posture, requires constant movement or acute pain and trauma from constant stress [21].

For a more detailed consideration of the problem of industrial risk assessment, it is essential to consider the works of other researchers. D. Pleban and co-authors note [22] that the increase in production efficiency and quality improvement has contributed to the development of ultrasonic technological applications, in which low-frequency ultrasounds are generated to operate, accelerate and facilitate technological processes. Process ultrasonic devices (i.e. ultrasonic noise sources in the working environment, e.g. ultrasonic gaskets, ultrasonic welding machines) have relatively high power and their nominal frequencies range from 18kHz to 40kHz. In Poland, ultrasonic noise (defined as noise containing high audible and low ultrasonic frequencies

from 10 kHz to 40 kHz) is included in the list of harmful factors in the working environment, thus, the permissible values of ultrasonic noise in the workplace are established. The permissible values of ultrasonic noise and the new method of measuring ultrasonic noise allow for an assessment of the occupational risk associated with ultrasonic noise. The measurement range of this method includes the determination of equivalent sound pressure levels in 1/3 octave ranges with intermediate frequencies from 10 kHz to 40 kHz. The research [22] describes both methods of ultrasonic noise measurement and methods of occupational risk assessment related to ultrasonic noise. In addition, examples of the results of occupational risk assessment associated with exposure to ultrasonic noise are discussed.

Uzbekistan is currently in the process of modernising its legislation, especially in the field of occupational safety and health. Modernisation is the transition from a still inefficient remuneration system to a modern system based on preventive approaches, which implies continuous improvement of working conditions. The analysis of legislation in the field of occupational safety and health management, which obliges employers to approach the assessment and management of occupational risks, and the assessment of occupational risks for miners working under the influence of harmful and dangerous factors, is performed in the work [23]. Among such factors, the researchers identified the factors of gold mining in the quarry and the development of measures to reduce hazards. Possible reasons for non-compliance with the stated requirements of the physical factors of the working environment of miners when working in gold mines are considered. Occupational risks for personnel are defined as high and medium, and organisational and technical measures should be implemented to minimise them [23].

M. Palega notes that occupational risk is closely related to the working environment [24]. For the same positions, but in different working conditions, the hazards and levels of risk may be varied. To assess the degree of risk of damage, as many exposures as possible should be applied. However, when assessing the probability of a hazard, it is essential to include, among other things: working conditions, past events or possible behaviour of employees (especially those that may cause an accident at work). The source of the above information can be statistical data or workstation observations. Thus, the research by M. Paleha presents an assessment of occupational risk in the position of laser cutter operator, which was performed by the method of occupational safety analysis. According to this method, the occupational risk is determined based on two parameters, namely: consequences and probability of them, where the probability of consequences is the sum of three factors: the frequency of the hazard, the probability of the event and the limitation of the possibility to avoid damage [24].

Occupational safety issues that occur in the workplace are issues that companies should consider when improving their health and environmental awareness activities [13]. There are many methods in the literature with various justifications for identifying priorities of hazards according to their risk level and for mitigating their consequences. In the study of M. Gül and M.F. Ak, a new model of occupational risk assessment is developed by combining two well-known multicriteria decision-making methods, called the best and worst method (BWM) and multi-attribute ideal real comparative analysis (MAIRCA) in a fuzzy environment. The suggested model is distinguished from other similar models in three aspects. First, it considers the severity of the hazard and the associated risk in terms of risk to humans and the environment. Second, it applies fuzzy BWM (F-BWM) to estimate the comparative significance of three risk factors called “probability, frequency and severity” of the conventional Fine-Kinney method. Thirdly, it applies fuzzy MAIRCA (F-MAIRCA) to rank hazards according to their risk level using the significance values obtained by F-BWM. To demonstrate the applicability of the approach, a case study of a risk assessment in a marble factory was completed. In addition, several validation studies are considered in the research, including a comparative analysis using fuzzy VIKOR and fuzzy TOPSIS methods to highlight the reliability of the proposed approach, and sensitivity analysis is performed according to various weights of the significance of risk factors [13].

The issues of occupational risks and new approaches to their assessment are raised in the study by O. Polukarpov and co-authors [25]. The relevance of this subject is explained by a wide range of situations that occur in modern industries and pose a high degree of risk to employees of the enterprise. The purpose of the study [25] is to identify new approaches to occupational risk assessment and to explore various aspects of improving production activities in the context of using new risk assessment methods. The leading scientific method in the authors' research is a combination of analytical and logical approaches to the complex problems introduced in the subject of this study. The main results of this study are to identify new, efficient methods for assessing the risk of occupational accidents and to estimate the level of occupational accidents in Ukrainian enterprises in 2020 and several previous years. Prospects for further study in this regard introduce a methodology for assessing the real level of occupational risks in the production sphere to reduce the total number of risk situations for employees of modern industrial enterprises occurring in the course of their work. The applied significance of the study by A. Polukarpov and co-authors is the possibility of the further practical application of the results obtained to establish a foundation for the safe performance of professional activities by employees of enterprises and organisations operating respectively in various fields of economy, and industry. production. Identification of

various aspects of occupational risk assessment in different fields contributes to the elimination of such risks and prevents their occurrence in the future [25].

The issue of limited access to the method of biological factors assessment is considered by L. Biktasheva and N. Vadulina. Notably, the impact of the biological factor is underestimated in some occupational groups. The assessment of the biological factor is based only on the current methodology for conducting a special assessment of working conditions, which determines the hazard class for microorganisms-producers according to the excess of their maximum permissible concentration in the air of the working area. For pathogenic microorganisms, the hazard class is determined according to the Classification of biological agents by pathogenicity groups. In both cases, the occupational risks of workers in contact with the biological environment are not considered. In the study [26], additional risk factors of biological agents were identified, which, according to the authors, will help to better assess the biological factor, without avoiding various biological risks. Such an assessment of the biological factor will allow more accurately determining the class of working conditions of workers. It is proposed to improve the methodology for assessing biological factors, which considers the occupational risks of sewage treatment plant workers and the calculation of their occupational risk index by the Fine-Kinney method. At the end of the study, it was concluded that it is expedient and necessary to consider occupational risks in the methodology for assessing biological factors. Such accounting will allow more accurately determining the class of working conditions for the underestimated separate professional group of workers of treatment facilities [26].

In general, a risk assessment should, if possible, identify risks that can be reduced. In many cases, this purpose may be unattainable, but it must be established at all times. Fully consider those hazards that do not require additional measures (e.g. ladders or hand tools that are properly designed and controlled). However, the possible exceptional or specific uses should not be ignored. For example, if you have to lift or lower very heavy loads or if hand tools are used to handle stone, a more detailed risk assessment is recommended. It is essential to identify risks that are well known and for which control measures can be implemented quickly. And, in addition, demonstrate where to perform a more comprehensive assessment and, if appropriate, use more sophisticated methods.

Conclusions

Improving the state of occupational safety and health requires improvement of the principles of occupational safety and health management. The assessment of the risk to the life or health of workers from the economic activity for each type of activity should be determined as the product of the probability of one accident per

year and the probable number of lost working days per employee during the year. In the process of the study, it was determined that the workplace risk assessment should be updated whenever changes are expected in the company that may change the risk status, for example, new processes, new equipment, new materials, changes in the organisation of work or the working environment.

It is demonstrated that risk assessment consists of the following steps: identification of hazards, identification of workers (or other persons) who may be at risk, and assessment of the relevant risk, i.e. qualitative or quantitative consideration of the possibility of eliminating the risk. If the risk cannot be excluded, measures should be implemented to decrease it. Risk assessment

should be performed for all workplaces, which can be classified as follows: stationary establishments such as offices, schools, factories such as construction, docks, shipyards, and mobile work. It was identified that according to the International Labour Organisation, the correlation between the total number of accidents at work and deadly accidents at work in Western Europe can be estimated at one thousand.

The literature review identified that risk assessment should be developed and used to assist employers or managers. It is necessary to identify hazards in the workplace and assess the risks associated with these hazards to determine what measures should be implemented to protect the health and safety of workers, with proper compliance with legal requirements.

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Оцінка професійних (виробничих) ризиків: нові підходи, удосконалення, методологія

Олексій Ігорович Полукаров, Наталія Артурівна Праховнік,
Юрій Олексійович Полукаров, Людмила Олексіївна Мітюк, Гліб Вікторович Демчук

Національний технічний університет України
«Київський політехнічний інститут імені Ігоря Сікорського»
03056, просп. Перемоги, 37, м. Київ, Україна

Анотація

Актуальність представленого дослідження зумовлено тим, що сучасна державна політика контролю та нагляду, зокрема промислової безпеки, спрямована на виявлення та запобігання порушень суб'єктами господарської діяльності допустимого рівня небезпеки для людей та довкілля. Метою представленого дослідження є аналіз професійних ризиків на підприємствах, а також вивчення нових підходів, методології та пошук шляхів щодо вдосконалення оцінки професійних ризиків на виробництвах. Методологічна основа дослідження ґрунтується на поєднанні різних загальнонаукових методів наукового пізнання: аналізу та синтезу інформації, порівняльного методу, а також методів індукції та дедукції. Поліпшення стану безпеки праці потребує вдосконалення засад управління охороною праці. Також необхідно проводити оцінку ризику для життя або здоров'я працівників від господарської діяльності та визначати її як добуток ймовірності одного нещасного випадку на рік і ймовірної кількості втрачених робочих днів на одного працівника протягом року. У процесі дослідження визначено, що оцінку ризиків на робочому місці треба переоцінювати щоразу, коли очікуються зміни в компанії, які можуть впливати на рівень безпеки, наприклад нові процеси, нове обладнання, нові матеріали, зміни в організації праці або у виробничому середовищі. З'ясовано кроки проведення оцінки ризику, виявлено засоби усунення чи зниження ризику. Показано, що оцінка ризику повинна бути розроблена та використана для допомоги роботодавцям або керівникам, і підкреслено, що після виявлення ризиків та небезпек необхідно вжити відповідних заходів з належним дотриманням вимог законодавства. Практичне значення представленого дослідження полягає в тому, що воно може бути використане як на практиці, так і для вивчення теорії оцінки професійних ризиків на підприємствах

Ключові слова: промислова діяльність, промисловий ризик, охорона праці, потенційні загрози, безпека