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System model for the formation of organizational and technical processes for the prevention of emergency situations in transport complex projects

The article explores the current challenges related to occupational safety in the transport sector of Ukraine, emphasizing the growing importance of systematic prevention and effective risk management. The study analyzes the main causes of occupational injuries and emergencies, highlighting both technical and organizational shortcomings in existing safety management systems. Particular attention is given to the insufficient implementation of modern risk-oriented approaches and the limited integration of advanced organizational and technical solutions at transport enterprises. The authors substantiate the need to transform traditional occupational safety practices by adopting international standards, such as ISO 45001 and ISO 31010, and by strengthening digitalization processes that enable real-time monitoring of hazards. Based on the results of the analysis, a comprehensive model is proposed for forming organizational and technical prerequisites that aim to reduce injury rates, enhance the efficiency of preventive actions, and improve the reliability of production processes. The model integrates key components such as hazard identification, risk assessment, digital monitoring systems, personnel training, modernization of equipment, and development of a corporate safety culture. It also provides mechanisms for coordinating management decisions, improving regulatory and methodological support, and implementing preventive programs tailored to the specifics of the transport industry. The findings demonstrate that using a systemic approach, supported by digital technologies and analytical tools, significantly strengthens the ability of enterprises to predict and prevent dangerous events. The proposed model can serve as a practical foundation for improving occupational safety management systems, supporting the development of industry programs, and ensuring sustainable and safe functioning of the transport sector.

***Keywords**: occupational safety; occupational health and safety, management, model, risk, diagnostics, process automation, reliability, transport complex; DSTU ISO standard.*

Introduction. The modern transport complex is one of the key sectors of the economy, ensuring population mobility, effective functioning of industry and development of foreign economic relations of the state. At the same time, transport activity belongs to the category of increased danger, as it is accompanied by a significant number of potential risks to the life and health of workers, as well as to the safety of production processes. Industrial injuries and accidents remain relevant problems that negatively affect the socio-economic indicators of enterprises and require systematic management at all levels of production organization.

One of the main directions of improving occupational safety in the transport industry is the formation of effective organizational and technical prerequisites that ensure the minimization of risks of personnel injury and the prevention of emergency situations. This requires the implementation of modern methods of assessing occupational risks, improving the occupational safety management system, modernizing technical means and technological processes, as well as developing a corporate safety culture. The relevance of the study is due to the need to improve approaches to the integration of organizational and technical solutions in the field of occupational safety, which will contribute to reducing the level of industrial injuries, increasing the reliability of transport systems and ensuring the sustainable development of enterprises in the industry. The purpose of this article is to identify and substantiate the organizational and technical prerequisites that form the basis for reducing industrial injuries and increasing the level of safety of production activities in the transport complex.

Analysis of recent research and problem statement. In the conditions of modern development of the transport complex, the issue of ensuring occupational safety and preventing accidents is becoming one of the key factors in increasing the efficiency of enterprises. Analysis of international and domestic research shows that an integrated approach to safety management, which combines technical, organizational and behavioral aspects, is the most effective for reducing the level of occupational injuries and accidents in transport [1-4]. In this context, the emphasis is on a comprehensive risk assessment, the implementation of occupational safety management systems in accordance with ISO45001 standards and the adaptation of procedures to the specifics of transport subsectors [4-6].

An important area of research is the formation of a safety culture at transport enterprises, which includes organizational measures, personnel training, and motivation to comply with safety rules [7-8]. Along with this, scientists emphasize that the regulatory framework in Ukraine requires further adaptation to modern European standards, and the practical implementation of existing recommendations is often formal in nature, which reduces the effectiveness of preventive measures [9-10].

Despite the existing developments, a number of problems remain: first, there is a lack of comprehensive models that simultaneously take into account technical, organizational and behavioral factors; second, the mechanisms for adapting occupational safety management systems to modern technological challenges, such as automation of transport systems and transportation of dangerous goods, have not been sufficiently studied. Based on this, a relevant research problem is formed: it is necessary to develop and implement a set of organizational and technical prerequisites that will ensure a real reduction in industrial injuries and accidents in the transport complex of Ukraine.

The purpose and tasks of the study. The purpose of the study is to determine and substantiate the organizational and technical prerequisites aimed at reducing the level of industrial injuries and preventing accidents in the transport complex. To achieve this goal, the current state of industrial injuries and accidents in the industry was analyzed, the main factors affecting occupational safety were identified, the effectiveness of existing occupational risk management systems was investigated, a set of organizational and technical measures to minimize dangerous industrial situations was substantiated, and practical recommendations were developed to improve the occupational safety management system at transport complex enterprises.

Materials and methods of research. Improving the state of industrial safety requires improving the principles of occupational health and safety management. This is determined by modern global trends

in occupational safety, the requirements of relevant international acts. The new principles of industrial safety are based on taking into account various motivational factors, which are determined through analysis, forecasting, personnel management, risk management (industrial, professional), using a process approach, using international practice data and, ultimately, improving the occupational health and safety management system. Among the main issues of improving management, it is important to develop a methodology for analyzing and assessing risks for the purpose of further managing them.

Transport enterprises are enterprises with an increased risk of occupational injuries, occupational diseases and accidents. Currently, many transport enterprises are entering the European market, and therefore, first of all, they need to comply with all international standards, including those on occupational safety. Studying and solving problems related to ensuring healthy and safe conditions in which human work takes place is one of the most important tasks in the development of new technologies and production systems. Researching and identifying possible causes of industrial accidents, occupational diseases, accidents, explosions, fires, developing measures and requirements aimed at eliminating these causes allow creating safe and favorable conditions for human work. Comfortable and safe working conditions are one of the main factors that affect productivity and occupational safety, and the health of employees.

To determine Ukraine's position in the field of occupational safety in the transport sector, a comparative analysis was conducted with EU countries for the period 2020-2024 (Fig. 1).

According to Eurostat and ILO data, the level of occupational injuries in Ukraine remains higher than the EU average, but has a tendency to gradually decrease. This emphasizes the importance of adapting European safety management standards and implementing digital technologies for risk control [11].

Year	Ukraine (injuries/100 thousand works)	EU average	Difference, %
2020	175	120	+45.8
2021	168	118	+42.4
2022	160	115	+39.1
2023	148	110	+34.5
2024	140	107	+30.8

Fig. 1. **Comparison of occupational injury rates (Ukraine vs. EU, 2020-2024)**

The results of the comparative analysis indicate that the issue of occupational safety remains relevant for all types of transport, but it is most acutely manifested in the railway industry. This is due to the specifics of production processes, a high level of technogenic load and the need for constant compliance with safety requirements during the operation of rolling stock and infrastructure. Therefore, further consideration should focus on the specifics of ensuring occupational safety in the railway transport sector.

In modern conditions of railway transport, the issue of occupational health and safety at work is becoming particularly relevant. A high level of occupational injuries not only poses a threat to the life and health of workers, but also negatively affects the overall efficiency of the industry, leads to material losses, downtime and a decrease in the level of trust in the safety management system. Given the complexity of technological processes, traffic intensity, significant energy load and the use of heavy equipment, the formation of an effective accident prevention system is a necessary condition for the sustainable development of railway transport.

In this context, special attention is required to analyze the actual state of occupational injuries and identify key risks inherent in the industry. According to official data, over the past five years, more than 1,147 accidents have been recorded in the railway transport of Ukraine, resulting in injuries to 1,000 workers, 147 of them fatal. Such statistics indicate the presence of systemic problems in the organization of safe working conditions and the need to strengthen control over compliance with occupational safety requirements at all levels of management.

Analyzing the dynamics of indicators for 2020–2024, it can be noted that the situation in the railway industry remains difficult: the severity of the consequences of accidents is almost twice as high as the national average. In particular, in the last two years alone, out of 150 injured workers, 29 people died (Fig. 2). This emphasizes the need to develop and implement a comprehensive program to improve occupational safety, which should include the modernization of technical equipment, improving the personnel training system, strengthening control over hazardous work, and introducing modern information technologies for monitoring working conditions.

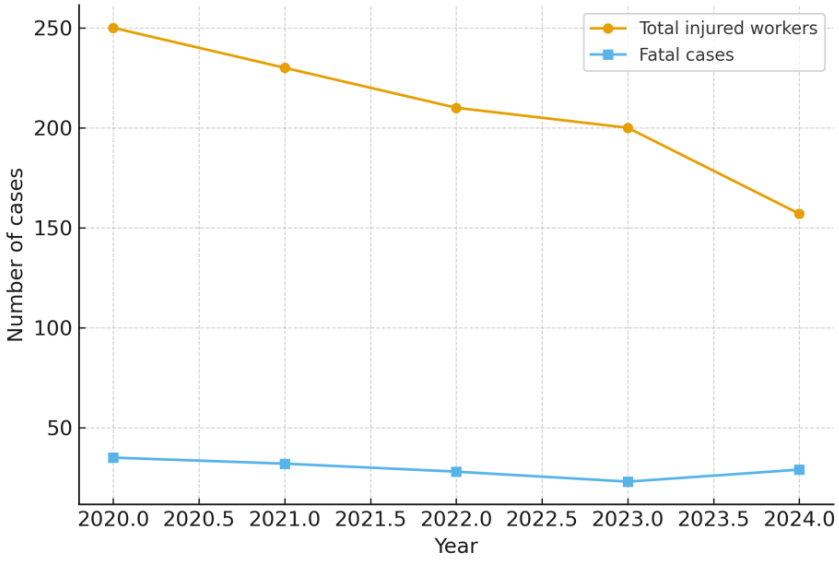

Fig. 2. **Dynamics of Occupational Injuries (2020–2024)**

The analysis of the dynamics of occupational injuries shows that a significant proportion of accidents in the railway industry are related to technical and organizational reasons. This indicates the need to improve the risk management system and implement modern preventive measures.

Creating the prerequisites for reducing the level of occupational injuries at railway transport enterprises requires a comprehensive approach, which includes improving the regulatory framework, upgrading equipment, systematic training of personnel and the use of personal protective equipment. An important role is played by the creation of a safety culture, where each employee is aware of personal responsibility for compliance with occupational safety requirements.

To determine the priority areas of preventive measures, it is important to analyze the main causes of accidents, which allows us to assess the share of technical, organizational and human factors in the overall structure of injuries (Fig. 3.).

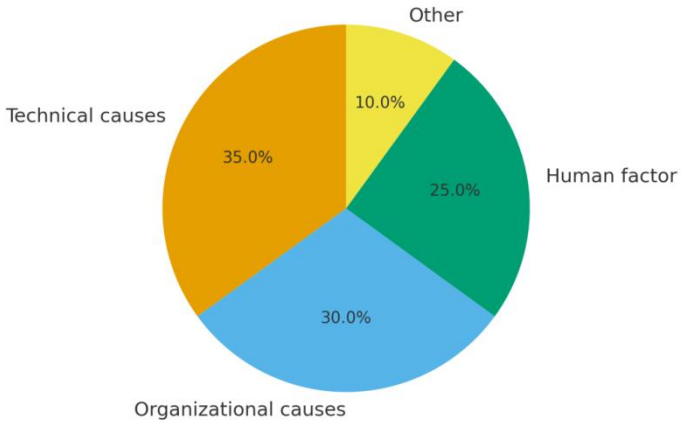

Fig. 3. **Distribution of Causes of Occupational Accidents**

Prevention of emergency situations is possible thanks to timely technical maintenance of railway infrastructure, constant monitoring of the technical condition of rolling stock and implementation of automated control systems. An important component of this process is effective communication between all structural divisions of the enterprise, which ensures prompt response to potential threats.

Analysis of the distribution of accident causes shows that a significant proportion of incidents are related to technical and organizational factors, which emphasizes the need for a systemic approach to risk management. In this context, the analysis of previous incidents is of particular importance, which allows identifying typical errors, determining patterns of their occurrence and developing effective preventive measures to prevent recurrence.

Occupational injury is a direct consequence of the realization of hazards, the probability of which is determined by the level of occupational risk. Approaches to assessing the degree of safety of the production environment and the level of occupational risks depend on the scale of the research object - from a separate workplace to an enterprise or industry as a whole.

Depending on the purpose of the research, three main approaches to assessing occupational risks are distinguished:

- ✓ assessment of primary factors of safety of the production environment;
- ✓ assessment of indicators of injury and occupational morbidity;
- ✓ assessment of economic losses associated with accidents and occupational diseases.

In the risk management process, the primary task is:

1. Risk prevention - the process of recognizing the presence of a hazard and determining its characteristics (DSTU ISO 45001:2018) [12];

2. Risk assessment and identification in accordance with the requirements of the ISO 31010:2018 standard [13].

Risk assessment consists of determining the magnitude of risks, analyzing possible consequences and the probability of their occurrence, and making a decision on the acceptability or unacceptability of risks in accordance with ISO 31010:2018. Risk assessment is the most effective preventive measure, which takes into account not only those incidents that occurred in the past, but also hazards that have not yet caused negative consequences. To conduct hazard identification and risk assessment on an ongoing basis, it is necessary to develop a hazard identification and risk assessment methodology focused on incident prevention, which ensures the establishment of priorities, documentation of risks and the use of necessary safety measures. When developing a hazard identification and risk assessment methodology, the scope of the OH&S management system, the nature of possible hazards, the need for detail in the data obtained based on the results of hazard identification and risk assessment, the necessary resources, and other factors important for the enterprise are taken into account.

The results of hazard identification should at least establish:

– hazard (object, situation or action, or a combination thereof);

– location where the hazard occurs (unit, site, etc.);
– type of work, operations during which the hazard occurs;
– employees exposed to the hazard (in particular, their position, profession), as well as all third parties who have access to the location of the hazard.

The results of the risk assessment should establish the magnitude of the identified risk, in particular, unacceptable risks. This information is used when determining the priority of implementing safety measures.

An integrated approach based on international standards, such as ISO 45001:2018 and ISO 31010:2018, allows not only to identify potential hazards, but also to implement effective preventive measures in a timely manner. The formation of a safety culture, the active participation of employees in the risk identification processes, the use of modern analysis methods and monitoring the technical condition of the infrastructure - all these are integral components of reducing the level of injuries. The implementation of the proposed recommendations will not only save the lives and health of employees, but also increase the overall efficiency and reliability of the industry.

Occupational risk assessment is one of the key elements of the occupational health and safety management system at transport complex enterprises. In accordance with the requirements of the international standards ISO 31000:2018 “Risk management – Guidelines” and ISO 45001:2018 “Occupational health and safety management systems – Requirements with guidance for use”, the risk assessment process should ensure the identification of hazardous factors, analysis of their consequences and determination of the probability of potentially dangerous events.

In modern transport safety management practice, a number of methods are used that differ in depth of study, quantitative and qualitative indicators, and complexity of implementation. Among the most common approaches, one can single out HAZOP analysis (Hazard and Operability Study), which is used to systematically identify possible deviations in technological processes and determine their consequences for the safety of workers and equipment. The FMEA (Failure Mode and Effects Analysis) method is aimed at assessing possible failures of system elements and their impact on the overall level of safety. Its advantage is the possibility of early identification of critical components of a vehicle or technological process, which allows for timely prevention of emergency situations [14,15].

To assess the effectiveness of implementing a risk-based occupational safety management system, the authors conducted an analysis of the dynamics of the main indicators of occupational safety at transport complex enterprises.

The results are presented in Table 1, which compares the frequency and severity of injuries before and after the implementation of the risk management system. As can be seen from the table, after implementing the OHSMS measures, the injury frequency rate decreased by 35.4%, and the severity rate decreased by 34.3%. There was also a 39% reduction in the number of days of downtime due to accidents, which indicates an increase in the effectiveness of preventive actions and safety discipline among employees.

Table 1. ***Comparison of injury rates before and after implementation of the risk-based OHS system***

Indicator	**Before implementation**	**After implementation**	**Change, %**	**Result**
Injury frequency rate	4.8	3.1	–35.4	Fewer incidents per 1 million hours
Injury severity coefficient	0.32	0.21	–34.3	Reduction of lost working time
Number of days of downtime due to accidents, days	410	250	–39.0	Process optimization

Level of implementation of preventive measures, %	72	94	+30.6	Increased security discipline

Risk matrices are also used to analyze working conditions and production processes at transport enterprises, which combine a qualitative assessment of the probability of an event and the severity of its consequences, allowing to determine the priorities of preventive measures. The use of multifactor risk matrices during the analysis of road accidents allows to establish the main patterns and critical risk zones [14]. In addition, the "5 Whys" method is actively used to determine the root causes of dangerous events, especially in cases of organizational and behavioral errors of personnel.

An important component of modern methods is their integration into information and analytical security management systems, which allows for real-time risk monitoring. As noted, the introduction of digital technologies and data collection systems within the framework of the SSM ensures increased efficiency of management decisions and the formation of an effective feedback system regarding incidents and potential hazards [16].

For a comprehensive assessment of the safety level, a safety index (Safety Performance Index) was used, which integrates key parameters: the frequency and severity of injuries, as well as the level of implementation of preventive measures. The calculation was carried out according to formula 1, which takes into account the weighting factors of the influence of each indicator.

$$SPI = w_1 \cdot F + w_2 \cdot S + w_3 \cdot P, \quad (1)$$

where SPI – Safety Performance Index;
F – Injury Frequency Rate, which characterizes the number of accidents per 1000 employees;
S – Injury Severity Rate, which is determined by the ratio of lost work capacity to the total working time;
P – Preventive Measures Index, which reflects the level of implementation of planned actions to improve occupational safety (in percentages or points);
w_1, w_2, w_3 – weighting factors, which characterize the relative importance of each indicator in the overall assessment (provided that $w_1+w_2+w_3=1$).

The safety index allows for an integrated assessment of the state of occupational safety at an enterprise or in the industry as a whole, taking into account not only the consequences of accidents, but also the effectiveness of preventive actions. A high SPI value indicates a reduction in production risks and an increase in the level of organizational safety, while a low one indicates the need to strengthen preventive work and improve the risk management system.

The results confirmed that increasing the level of digitalization of the system (through the use of IoT, Big Data and analytical modules for risk monitoring) is positively correlated with a decrease in the number of incidents. This demonstrates the feasibility of moving to a digital model of occupational safety management. (Fig. 4).

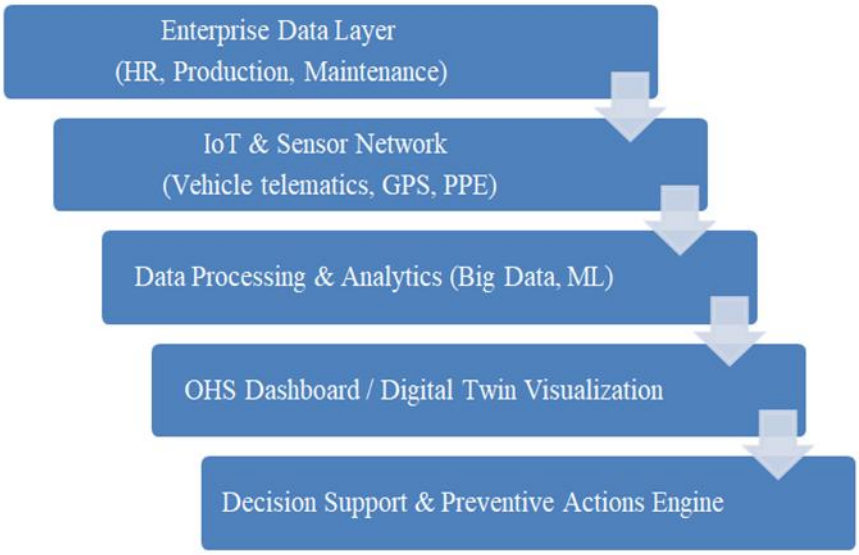

Fig. 4. **Architecture of the digital OHS management system for the transport sector**

Therefore, the use of comprehensive risk assessment methods in the transport complex allows to increase the level of control over hazardous factors, optimize the processes of planning preventive measures and create a basis for the formation of organizational and technical prerequisites aimed at minimizing occupational injuries and preventing emergency situations. This approach provides a systematic combination of analytical, managerial and technical tools that increase the stability of the transport infrastructure.

The results of the comparative analysis confirm the need for further improvement of the occupational safety management system in the transport sector of Ukraine. Reducing the level of occupational injuries is possible only if a comprehensive approach is implemented, which covers organizational, technical, information-analytical and socio-psychological aspects.

Further improvement of occupational safety is achieved through the implementation of an occupational health and safety management system (OHSMS) in accordance with the international standard ISO 45001:2018. It ensures consistency in the processes of hazard identification, risk assessment, planning and implementation of preventive measures. An important component of this system is the development of incident prevention programs (Near Miss Programs), which allow to identify potentially dangerous situations before accidents occur, which significantly increases the level of proactive safety management [17].

Technical modernization of transport enterprises should be based on the implementation of intelligent transport systems (ITS), online monitoring tools based on IoT (Internet of Things) and digital twins of transport processes. Such technologies make it possible to monitor safety parameters in real time, predict risks and promptly make management decisions to prevent accidents [18].

An important aspect of ensuring occupational safety is also ergonomic workplace design, aimed at optimizing the physical and psycho-emotional stress of employees. Improving the microclimate, lighting, and reducing noise and vibration levels help reduce operator fatigue and errors, increasing the overall efficiency of production processes.

To improve the quality of risk analysis, it is advisable to use modern management techniques - FMEA (Failure Mode and Effects Analysis), HAZOP (Hazard and Operability Study), Bow-Tie Analysis, which allow you to systematically structure information about the probability and consequences of events, identify critical elements of processes and set priorities for the implementation of preventive measures.

The use of these approaches contributes to the transition to a proactive model of occupational safety management, focused not only on response, but primarily on preventing accidents and minimizing the

consequences of dangerous events. This is one of the key prerequisites for the sustainable development of the transport industry.

To achieve a high level of occupational safety in the transport sector, it is necessary not only to analyze existing risks, but also to systematically create conditions for their reduction. In view of this, the study proposes a conceptual model for the formation of organizational and technical prerequisites for reducing occupational injuries and preventing accidents. It reflects the relationship between the initial risk factors, safety management processes (assessment, prevention, technical modernization, development of a safety culture) and the expected results - reducing the level of injuries, increasing the reliability of production processes and ensuring the sustainable functioning of transport enterprises.

The proposed model (Fig. 5) demonstrates the relationship between input risk factors, digitalized management processes (risk identification, assessment, monitoring and control) and results in the form of increased occupational safety and reliability of transport systems. Its use ensures the integration of organizational, technical and digital solutions into a single occupational safety management system focused on the prevention of dangerous events and increasing the efficiency of the transport complex.

In the current conditions of digital transformation of the transport industry, the creation of unified information and analytical systems for occupational safety management that integrate data from various sources - sensors, video surveillance, GPS trackers, technical maintenance databases and personnel training is of particular importance. The use of Big Data analytics and machine learning algorithms allows not only to record incidents in real time, but also to predict their probability, increasing the effectiveness of preventive measures and ensuring timely management decisions [19].

Throughout 2025, JSC Ukrzaliznytsia is carrying out work on automating processes in the field of labor protection, aimed at increasing the efficiency of collecting and analyzing performance indicators. The main areas of digitalization include:

1. Modernization of the automated system "Industrial Safety" by integrating the subsystem "Highly Hazardous Equipment";
2. Implementation of the functionality "Industrial Injuries" as part of the Unified Automated Personnel Management System of the IT-Enterprise complex;
3. Creation of the module "Labor Protection Training", which provides electronic accounting, control and verification of the completion of briefings and knowledge tests;
4. Development of the module "Personal Protective Equipment" in the supply chain management system, which allows optimizing logistics and accounting for employee protective equipment.

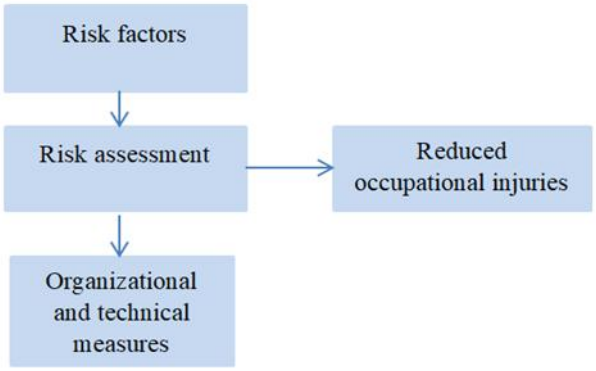

Fig. 5. **Conceptual Model of Organizational and Technical Preconditions for Reducing Occupational Injuries and Preventing Emergencies in the Transport Sector**

The integration of these solutions forms a single digital ecosystem of occupational safety management, which provides automated collection, processing and visualization of data on risks and incidents. This approach contributes to making informed management decisions, increases the

transparency of processes and strengthens preventive mechanisms at all levels of the production organization.

To verify the practical effectiveness of the developed system, testing was carried out at the transport enterprise. Based on the results obtained, a phased algorithm for implementing an organizational and technical model of occupational safety management was proposed (*Table* 2).

Each stage includes specific actions – from the initial diagnostics of the state of occupational health and safety to digital monitoring and assessment of the system maturity according to the OHS Maturity Model. This approach ensures a gradual increase in the level of management safety culture, systematic improvement of processes and minimization of production risks

Table 2. **Stages of implementing the organizational and technical safety model**

Stage	Basic actions	Expected result
1	Initial diagnostics of occupational safety status	Identifying key risks and weaknesses
2	Development of a preventive action plan	Establishing priorities and prevention strategies
3	Implementation of digital modules (monitoring, training, PPE accounting)	Automation of data collection and control
4	Digital monitoring and system maturity assessment	Determining the level of management efficiency and process improvement

Thus, the integration of the conceptual model of organizational and technical prerequisites, digital technologies and practical implementation mechanisms allows for a systematic and proactive approach to occupational safety management in the transport sector. The use of unified information and analytical platforms, automated monitoring modules and digital twins ensures timely identification of potential risks and increases the effectiveness of preventive measures. The phased implementation of the model, taking into account the maturity of the management system, allows for a gradual increase in the safety culture at enterprises and a reduction in the level of occupational injuries. Such an integrated approach creates a solid foundation for the sustainable development of the transport industry, ensures the reliability and safety of production processes and is the basis for formulating final recommendations and strategies for improving the occupational safety management system.

Conclusions. The study confirmed the relevance of the problem of ensuring occupational safety and preventing accidents in the transport complex of Ukraine. Analysis of the current state of industrial injuries showed that the most common causes of accidents are technical and organizational factors, which indicates the presence of systemic deficiencies in the existing safety management systems. Comparative analysis of injury rates in Ukraine and EU countries confirmed the need to adapt international standards, in particular ISO 45001:2018 and ISO 31010:2018, to the specifics of the Ukrainian transport sector and the introduction of modern digital technologies for risk monitoring.

The paper proposes a model for the formation of organizational and technical prerequisites for reducing the level of industrial injuries and preventing emergencies, based on the principles of systematicity, prevention and integration with quality and risk management processes. The model provides for a comprehensive approach that includes:

• identification and assessment of risks, including the use of HAZOP, FMEA and "5 Whys" analysis methods;

• modernization of technical equipment of enterprises and the implementation of digital monitoring systems (IoT, Big Data, digital twins);

• development of a corporate safety culture, personnel training and monitoring of the implementation of measures;

• formation of a single information and analytical platform for automated collection, processing and visualization of data on risks and incidents.

The results of the practical implementation of the model at a transport enterprise showed a significant reduction in the frequency of injuries (by 35.4%), the severity of consequences (by 34.3%) and the number of days of downtime due to accidents (by 39%), which indicates the effectiveness of the proposed approach and its ability to increase the level of safety and reliability of production processes.

Thus, the integration of organizational and technical solutions, digital technologies and practical implementation mechanisms provides a systematic and proactive approach to occupational safety management. The use of unified information and analytical platforms and automated monitoring modules allows for timely identification of potential risks, increases the effectiveness of preventive measures and forms the basis for the sustainable development of the transport industry. The proposed conceptual model can serve as a methodological basis for the development of strategies and programs to improve occupational safety at enterprises in the transport sector of Ukraine.

REFERNCES

1. Pustiulha, S., Samchuk, V., Prydiuk, V., Pasichnyk, O., & Shymchuk, O. (2024). Improving safety criteria for transporting hazardous goods by road through optimizing the geometric parameters of their stowage. *Eastern European Journal of Enterprise Technologies*, 3(129), 74–84. https://doi.org/10.15587/1729-4061.2024.307235.
2. Lyashuk, O., Mironov, D., & Martyniuk, V. (2024). Risk analysis of road traffic accidents in Ukraine. *Transport*, 39(4), 350–359. https://doi.org/10.3846/transport.2024.23190.
3. Makarova, I., Yakupova, G., Buyvol, P., Abashev, A., & Mukhametdinov, E. (2022). Risk Management Methodology for Transport Infrastructure Security. *Infrastructures*, 7(6), 81. https://doi.org/10.3390/infrastructures7060081.
4. Russo, F., & Comi, A. (2017). From the analysis of European accident data to safety assessment for planning: the role of goods vehicles in urban area. *European Transport Research Review*, 9, 9. https://doi.org/10.1007/s12544-017-0225-0.
5. Sorochynska, O., Melnichenko, O., Kulbovskyi, I., & Derehuz, I. (2025). Implementation of the occupational health and safety management system model according to DSTU ISO 45001:2018: challenges and opportunities for transport enterprises. *Transport Systems and Technologies*, 45. https://doi.org/10.32703/2617-9040-2025-45-8.
6. Protasenko, O., & Mykhailova, Ye. (2024). Implementation of European standards for occupational safety and health in Ukraine. *Municipal Economy of Cities*, 4, 185–204. https://doi.org/10.33042/2522-1809-2024-4-185-204-210.
7. Bal, O. (2023). Formation and management of safety culture in the railway industry: best practices and strategies. *Transport Systems and Technologies*, 42(6). https://doi.org/10.32703/2617-9059-2023-42-6.
8. Chabanov, A. (2023). Features of regulatory and legal regulation of transport safety in Ukraine: realities and perspectives. *Public Management*, 3(36). https://doi.org/10.32689/2617-2224-2023-3(36)-8.
9. Shatrava, S. O., Denyshchuk, D. Y., & Pohorilets, O. V. (2023). State policy in the field of ensuring road safety in Ukraine through the prism of regulatory initiatives: analysis and prospects for implementation. *Law and Safety*, 89(2), 54–65. https://doi.org/10.32631/pb.2023.2.05.
10. Vasylieva, O. (2024). Regulatory and legal support of the functioning of public transport in Ukraine: realities and prospects. *Public Administration and Regional Development*, 1. https://doi.org/10.34132/pard2024.23.05.
11. Eurostat. (2024). *Accidents at work: Statistics by economic activity*. Retrieved November 13, 2025, from https://ec.europa.eu/eurostat/statistics-explained/SEPDF/cache/70752.pdf.
12. ISO 31000:2018. Risk management – Guidelines. Geneva: International Organization for Standardization, 2018. 20 p.
13. ISO 45001:2018. Occupational health and safety management systems – Requirements with guidance for use. Geneva: International Organization for Standardization, 2018. 48 p.
14. Tsopa, V., Cheberiachko, S., Yavorska, A., & Chernysh, V. (2023). Occupational safety and health management in transport companies: organizational and technical aspects. *Environmental Safety and Sustainable Development*, 5(2), 56–67. https://doi.org/10.32347/2411-4049.2023.2.85-99.
15. Stasiak-Betlejewska, R. (2022). Occupational risk management in the transport company. *System Safety: Human-Technical Facility-Environment*, 4(1), 135-149. https://doi.org/10.2478/czoto-2022-0014.
16. Jiang, L., Zhang, J., & Wong, Y. D. (2024). *Digital technology in occupational health of manufacturing industries: a systematic literature review***.** Discovery in Applied Sciences, 6, 631. https://doi.org/10.1007/s42452-024-06349-4.
17. Agnusdei, G. P., Elia, V., & Gnoni, M. G. (2021). *Is Digital Twin Technology Supporting Safety Management? A Bibliometric and Systematic Review*. *Applied Sciences*, 11(6), 2767. https://doi.org/10.3390/app11062767.
18. Agnusdei, G. P., Elia, V., & Gnoni, M. G. (2021). *Is Digital Twin Technology Supporting Safety Management? A Bibliometric and Systematic Review*. *Applied Sciences*, 11(6), 2767. https://doi.org/10.3390/app11062767.
19. Wang, B. (2021). *Big data in safety management: An overview*. Safety Science, 148, 105671. https://doi.org/10.1016/j.ssci.2022.105671.

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Системна модель формування організаційно-технічних процесів з запобігання аварійних ситуацій в проєктах транспортного комплексу

Анотація.*У статті досліджено актуальні проблеми забезпечення безпеки праці на підприємствах транспортного комплексу України, що зумовлені високим рівнем професійних ризиків, техногенним навантаженням та недоліками в організації виробничих процесів. Проаналізовано основні причини виникнення виробничого травматизму й аварійних ситуацій, серед яких технічні несправності, порушення технологічних регламентів, недостатній рівень контролю та недосконаліть систем управління охороною праці. Наголошено на необхідності переходу до ризик-орієнтованого підходу, який ґрунтується на системній ідентифікації небезпек, кількісній та якісній оцінці ризиків і впровадженні превентивних заходів. Запропоновано модель формування організаційно-технічних передумов для зниження рівня виробничого травматизму та запобігання аварійним ситуаціям у транспортному комплексі. Модель включає інтеграцію сучасних організаційних рішень, технічної модернізації, цифрових технологій моніторингу, удосконалення системи навчання персоналу та розвитку корпоративної культури безпеки. Додатково підкреслено значення впровадження цифрових інструментів, таких як автоматизовані системи контролю, моніторинг у реальному часі та аналітичні платформи для оцінки ризиків, що забезпечують оперативне реагування на потенційно небезпечні ситуації. Акцентовано увагу на важливості застосування міжнародних стандартів, зокрема ДСТУ ISO 45001 та ISO 31010, що забезпечують послідовність, прозорість і ефективність процесів управління ризиками. Обґрунтовано, що використання комплексного підходу до управління охороною праці, який поєднує аналітичні, технічні та організаційні інструменти, сприяє своєчасній ідентифікації небезпек, зменшенню кількості інцидентів і підвищенню надійності виробничих процесів. Представлені у статті результати можуть бути використані для підвищення ефективності систем управління охороною праці, удосконалення нормативно-методичного забезпечення та розроблення галузевих програм із запобігання аварійності у транспортному комплексі.*

Ключові слова*: безпека праці; охорона праці, управління, модель, ризик, діагностика, автоматизація процесу, надійність, транспортний комплекс; стандарт ДСТУ ISO.*