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APPLICATION OF ARTIFICIAL INTELLIGENCE IN THE PROBLEMS OF ANALYSIS AND SYNTHESIS OF TECHNOGENIC AND ANTHROPOGENIC RISKS

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Abstract

This article explores the use of artificial intelligence in assessing and managing man-made and anthropogenic risks. It analyses the potential of neural networks, machine learning and intelligent data processing methods for forecasting and identifying risks associated with human activity. It considers intelligent systems for monitoring and assessing risks that provide increased accuracy in predicting negative events and optimizing management decisions in situations of uncertainty. The key areas of evolution of intelligent risk management systems, and their role in strengthening industrial safety and environmental protection, are also identified.

Keywords: artificial intelligence, anthropogenic risks, technogenic risks, forecasting, predictive analytics, risk management, industrial safety

I. Introduction

Technogenic and anthropogenic risks are the probability of occurrence of negative consequences caused by technical human activity and its impact on the environment, human health and stability of socio-economic systems. Technogenic risk is a potential threat arising as a result of human activity in the technical and technological sphere. It is an integral companion of scientific and technological progress and is manifested through the possibility of accidents, disasters and other adverse events at industrial facilities, transport systems, power plants and other technical complexes. This risk is of a potential nature, can lead to complex negative consequences for the population and the environment, has varying degrees of controllability and predictability, depends on many factors (human factor, equipment wear, design flaws, disruption of technological processes), and also tends to increase due to the growth of industrial production, continuous complication of technologies, increased energy saturation of production processes and concentration of potentially hazardous objects, which requires a systematic approach to the assessment and prevention of such risks through technical control, improvement of the regulatory framework and enhancement of safety culture.

The concept of anthropogenic risk has a broader meaning and covers the entire spectrum of negative consequences of human activity for the environment, human health and social systems. Anthropogenic risks are associated with both direct human impact on natural ecosystems and indirect influence through changes in natural, social and technological processes, which can manifest themselves on various time and space scales. While man-made risks often manifest themselves as discrete events (accidents, incidents), anthropogenic risks can be realized gradually,

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over a long period of time, which complicates their timely identification and assessment. The key characteristics of modern man-made and anthropogenic risks are:

- complexity and interconnectedness – many risks are systemic in nature and interconnected, which leads to the possibility of a cascading development of emergency situations;
- dynamism – changes in risk parameters over time under the influence of technological progress, socio-economic factors and natural processes.
- uncertainty – limited knowledge about the probability and possible consequences of risks, especially in the context of the emergence of new technologies and changes in the external environment.
- cumulative effect – accumulation of negative effects from anthropogenic impact over a long period of time;
- transboundary nature – the spread of the consequences of the implementation of risks beyond administrative and state borders [[3]].

In the modern world, the analysis and forecasting of man-made and anthropogenic risks are becoming critically important due to the growing complexity of technological systems and the increasing impact of human activity on the environment. Technological progress contributes to an improvement in the quality of life, but at the same time creates unprecedented pressure on natural ecosystems and generates new categories of risks.

II. Methods

Systematic assessment of man-made and anthropogenic risks is a necessary tool for ensuring safety and sustainable development. This approach allows identifying potential threats before they materialize, making a quantitative assessment of possible damage and developing effective preventive measures. The result is a significant reduction in the likelihood of emergency situations and minimizing their consequences. Such analysis is especially important in the context of accelerated urbanization, territorial concentration of industrial facilities and the introduction of innovative technologies, where the price of an error is measured not only in economic losses, but also in human lives.

Comprehensive risk analysis forms a scientifically sound basis for making management decisions at all levels – from individual enterprises to public policy. It promotes the development of a safety culture, optimization of resources allocated to prevent negative consequences of human activity, and improvement of the regulatory framework in the field of technological and environmental safety. In the era of global challenges, including climate change, depletion of natural resources and accelerated technological transformation, risk analysis is becoming a strategic tool for achieving a balance between economic development, social well-being and preserving a favorable environment for future generations.

III. Results

The rapid development of artificial intelligence (AI) technologies opens up unprecedented opportunities for improving the methodology for analyzing man-made and anthropogenic risks. The ability of AI to process colossal volumes of heterogeneous data, identify non-obvious relationships and patterns, and model complex scenarios allows us to take the processes of forecasting and risk assessment to a qualitatively new level. The integration of machine learning technologies, neural networks, and predictive analytics into security monitoring systems creates the basis for the transition from reactive to proactive risk management, which is critically important in the context of the increasing complexity of the technosphere and increasing anthropogenic impact on the biosphere.

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The key areas of application of artificial intelligence in the tasks of analysis and synthesis of man-made and anthropogenic risks are presented in Fig. 1.

APPLICATION DIRECTIONS OF ARTIFICIAL INTELLIGENCE IN TASKS ANALYSIS AND SYNTHESIS OF TECHNOGENIC AND ANTHROPOGENIC RISKS	
Risk forecasting and modeling	Monitoring and early detection of threats
Complex data analysis	Optimization of risk management processes
Decision support	Improving the regulatory framework and safety standards
Personalized risk assessment	Integration into systems automated control
Integration into systems automated control	Interdisciplinary risk analysis

Figure 1: *Directions of application of artificial intelligence in tasks analysis and synthesis of man-made and anthropogenic risks*

Thus, artificial intelligence offers revolutionary approaches to forecasting man-made and anthropogenic risks that go far beyond traditional statistical methods. Modern AI systems are capable of processing petabytes of data from various sources, including historical information on accidents, process parameters, geographic and meteorological data, creating multidimensional models of probable scenarios for the development of events. This allows not only to assess the probability of certain incidents, but also to simulate chains of interconnected events that can lead to cascading accidents. An important advantage of AI in this area is the ability to simulate complex scenarios for the spread of pollution in the atmosphere, hydrosphere and lithosphere, taking into account many factors. For example, in the case of a toxic release, machine learning algorithms can predict not only the trajectory of the pollutant, taking into account weather conditions, but also assess the potential impact on ecosystems and human health in the short and long term, which is critical for making operational decisions in emergency situations [[1]].

AI monitoring systems are redefining approaches to early detection of potential threats by continuously analyzing huge amounts of data from thousands of sensors in real time. Machine learning algorithms trained on historical data on the normal operation of technical systems can effectively detect even minor deviations from standard operating modes long before these anomalies become obvious to traditional monitoring systems. Deep learning methods and recurrent neural networks, which are able to capture complex temporal dependencies in data streams, are especially effective in this regard. The advantage of AI monitoring also lies in the ability to integrate and analyze heterogeneous data from various sources - from temperature and vibration sensors to satellite images and environmental monitoring data. For example, modern systems can simultaneously track changes in the composition of the atmosphere above an industrial facility, anomalies in the vibration characteristics of equipment and structural changes in structures, linking this data into a single picture to identify potential risks at the early stages of their formation.

The use of artificial intelligence for big data analysis enables a qualitative breakthrough in identifying and forecasting man-made and anthropogenic risks by processing petabytes of heterogeneous information from distributed sources. Modern machine learning algorithms, especially deep neural networks, successfully integrate telemetry data from production equipment, environmental monitoring readings, meteorological observations, satellite images, information from social networks and open sources, forming multidimensional models to identify precursors of

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potential accidents and environmental disasters. AI systems for big data analysis are capable of detecting implicit correlations and anomalies that remain unnoticed when using traditional statistical methods, which is especially valuable for early warning of emerging threats based on identifying deviations from normal patterns of functioning of technical or natural-technical systems.

A key benefit of AI-powered big data analytics is the ability to create dynamic risk models that take into account the temporal and spatial aspects of the development of potentially hazardous situations in near real time. For example, natural language processing (NLP) systems can analyze thousands of incident reports to identify common patterns and risk factors, and computer vision systems can automatically recognize potentially hazardous situations at industrial facilities based on video surveillance data [[5]]. Stream processing systems with integrated machine learning algorithms can continuously analyze information from thousands of sensors at industrial facilities, identifying specific sequences of events preceding incidents and generating predictive estimates of accident probability with a high degree of detail in time and localization. Such systems become the basis for the creation of intelligent risk management centers, where big data processing algorithms not only identify threats, but also model the effectiveness of various preventive measures, optimizing response strategies and resource allocation to minimize potential damage.

Artificial intelligence is transforming approaches to risk management by automating and optimizing the processes of risk identification, analysis, and control. Machine learning algorithms are capable of not only automating routine risk assessment tasks, but also significantly increasing their accuracy, taking into account the complex relationships between multiple factors. AI systems can perform multi-factor prioritization of risks in real time, taking into account both the probability of their occurrence and potential damage, which allows for more efficient allocation of limited resources for preventive measures. The use of AI-based optimization methods for planning investments in security systems and preventive measures is especially significant. Algorithms such as genetic algorithms and evolutionary computations make it possible to find optimal solutions in a multidimensional space of variables, taking into account budget constraints, the effectiveness of measures, time frames, and interdependencies of various risk mitigation measures. This makes it possible to multiply the return on investment in security, ensuring maximum risk reduction under given resource constraints.

Modern decision support systems (DSS) based on artificial intelligence provide a qualitatively new level of management of man-made and anthropogenic risks due to the integration of cognitive analysis and machine learning methods. These systems not only provide decision makers with up-to-date information on the current state of risks, but also generate intelligent recommendations based on a multi-criteria analysis of possible scenarios. The key advantage of such systems is the ability to generate and evaluate alternative courses of action in real time with modeling of their probable consequences, taking into account complex networks of interdependent factors and the stochastic nature of uncertainties. This functionality is of particular importance in crisis situations characterized by time shortages, high stress levels, and a limited information base. The most important distinguishing feature of modern DSS is their adaptability, implemented through continuous self-learning mechanisms based on feedback. The use of reinforcement learning algorithms allows systems to evolve, accumulating empirical data on the effectiveness of decisions made and optimizing their predictive models accordingly. In particular, such systems are capable of analyzing the effectiveness of preventive measures, dynamically adjusting the analysis parameters and recommendation algorithms, which ensures a progressive improvement in the quality of management decisions in the field of risk management and technical safety.

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IV. Discussion

Industrial and environmental safety regulation is also receiving a powerful boost in transformation thanks to the introduction of artificial intelligence technologies. Machine learning algorithms can perform a comprehensive analysis of existing regulations, assessing their effectiveness by simulating different scenarios and comparing them with real data on incidents and accidents. Such analysis helps identify gaps and inconsistencies in current regulations, as well as areas where regulations do not correspond to the current level of technological development or do not take into account new types of risks. AI systems can also generate informed proposals for improving safety standards based on the analysis of large volumes of incident data, equipment specifications, and scientific research. Particularly valuable is the ability of AI to simulate the potential impact of proposed regulatory changes on safety, which enables a more informed approach to regulation [[1]]. In the context of rapid technological development and the emergence of new types of production and technologies, such a proactive approach to the formation of regulatory requirements becomes critically important to ensure an adequate level of safety.

The transition from unified approaches to personalized risk assessment is one of the most promising areas of AI application in the field of security. Machine learning algorithms make it possible to create unique risk models for specific objects, taking into account their individual characteristics – from the technical characteristics of equipment and the specifics of technological processes to geographical location and climatic conditions. This approach significantly increases the accuracy of risk assessment compared to the use of standardized methods that do not take into account the unique characteristics of each object. The use of transfer learning and federated learning methods is especially effective, allowing general risk assessment models to be adapted to the specifics of specific enterprises without the need to develop such models from scratch. This allows even relatively small organizations to gain access to highly accurate personalized risk assessment tools, previously available only to large corporations with solid R&D budgets. As a result, a fairer and more uniform risk management system is formed on the scale of the entire industry or the economy as a whole.

The integration of AI algorithms into automated process control systems represents a qualitatively new level of ensuring industrial safety. Unlike traditional control systems based on hard-coded rules, systems with elements of artificial intelligence are capable of adaptively responding to changing conditions, potential threats and abnormal situations. Such systems can not only detect deviations from normal operation, but also proactively adjust process parameters to prevent the development of dangerous situations. An important aspect is the use of self-learning algorithms that allow control systems to constantly improve their models and response strategies based on accumulated experience. Reinforcement learning methods enable systems to optimize their actions to achieve the highest level of safety while maintaining the efficiency of production processes. At the same time, special attention is paid to ensuring the reliability and interpretability of the AI components, which is critical for systems on the stability of which the safety of people and the environment depends [[2]].

Artificial intelligence is fundamentally changing approaches to training specialists in the management of man-made and anthropogenic risks through the creation of realistic virtual environments for training and education. Modern virtual and augmented reality systems controlled by AI algorithms allow simulating complex emergency situations with a high degree of realism, providing personnel training in conditions as close to real as possible. Such simulators make it possible to practice skills for responding to critical situations without risks to people, equipment and the environment. Of particular value are adaptive training systems that can adapt to the individual characteristics of each trainee - their level of training, speed of information perception, strengths and weaknesses. Machine learning algorithms analyze the trainee's actions, identify gaps in their knowledge and skills, and based on this, create a personalized training program. This methodology significantly surpasses conventional educational practices in terms of training

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effectiveness, which is of paramount importance in the development of professional skills necessary for the control and administration of technological complexes with an increased level of danger.

Interdisciplinary analysis of anthropogenic and technogenic risks using AI helps overcome traditional fragmentation in threat assessment by combining technical, environmental, economic and social aspects into a single comprehensive system. The integration of machine learning and deep neural networks allows processing unprecedented volumes of data from diverse sources, including geographic information systems, industrial equipment sensors, meteorological stations, socio-economic indicators and Earth remote sensing data. Artificial intelligence algorithms are able to identify non-obvious correlations between risk factors, predict the development of complex systems and model cascade effects that could go unnoticed using traditional analysis methods. This allows expanding the forecasting horizon and increasing the accuracy of assessing the probability of adverse events in conditions of multi-parameter uncertainty.

Of particular value is the ability of artificial intelligence systems to self-learn and adapt risk assessment methodologies based on accumulated experience and new data. Intelligent decision support systems based on AI technologies provide continuous monitoring of dynamic risk indicators and automatic adjustment of predictive models in real time. This creates a qualitatively new level of risk management, when preventive measures can be implemented even before obvious signs of a threat appear. In addition, the use of AI contributes to the democratization of risk analysis, making complex analytical tools available to a wide range of specialists and decision-makers, which ultimately increases public resilience to man-made and anthropogenic threats and contributes to the formation of a culture of proactive risk management.

Despite its significant potential, the use of artificial intelligence in the analysis of man-made and anthropogenic risks faces a number of challenges. These include:

1) The "black box" problem – many modern AI algorithms, especially deep neural networks, operate on the "black box" principle, which makes their results difficult to interpret and reduces the trust in them on the part of decision makers;

2) Dependence on the quality and completeness of data – the effectiveness of AI systems directly depends on the quality and representativeness of the training data. Lack of information about rare events can lead to underestimation of the corresponding risks;

3) Vulnerability to deliberate attacks – AI systems can be susceptible to manipulation and attacks aimed at distorting their operation, which is especially critical for security systems;

4) Difficulty in taking social factors into account – many AI algorithms are focused on analyzing technical parameters and have difficulty taking into account the complex social, cultural and psychological factors that influence the emergence and perception of risks.

Further development of artificial intelligence technologies opens up new horizons in the field of analysis and management of man-made and anthropogenic risks. Particularly promising areas are:

1) Development of Explainable AI – creation of algorithms that are capable of not only making accurate predictions, but also providing human-readable explanations of their decisions, which is critically important for risk management systems;

2) Integration of AI with quantum computing technologies, which will allow solving highly complex modeling and optimization problems that are inaccessible to modern computers;

3) Creation of collaborative "human + AI" systems that combine the strengths of human intelligence (intuition, creativity, empathy) and artificial intelligence (big data processing, pattern detection, non-stop work).

4) Development of federated learning and other methods that allow training AI models without centralized collection of sensitive data, which is especially important for international cooperation in the field of risk management.

5) Use of augmented reality technologies in combination with AI to visualize risks and train personnel to act in emergency situations.

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In conclusion, it should be noted that artificial intelligence is becoming not just an auxiliary tool, but a fundamental element of modern systems for analyzing and managing man-made and anthropogenic risks. The integration of AI methods with traditional approaches to ensuring security creates a synergistic effect, allowing us to solve the problems of preventing man-made disasters and minimizing the negative impact of human activity on the environment at a qualitatively new level. At the same time, the key factor for success is the balance between the automation of processes based on AI and maintaining human control over the adoption of critical decisions.

CONFLICT OF INTEREST.
Authors declare that they do not have any conflict of interest.

References

[1] Budko, D. V. The concept of a risk-oriented approach in the context of the development of artificial intelligence technologies / D. V. Budko // Bulletin of the Kazan Law Institute of the Ministry of Internal Affairs of Russia. - 2024. - Vol. 15. - No. 3 (57). - P. 49-58.

[2] Zagumennova, M. V. Review of artificial intelligence technologies used to assess damage from natural and man-made emergencies / M. V. Zagumennova // Information Society. - 2024. - No. 5. - P. 156-165.

[3] Karakeyan, V. I. Organization of safety in emergency situations / V. I. Karakeyan, I. M. Nikulina. - 2nd ed., revised. and additional. - Moscow: Yurait, 2025. - 138 p.

[4] Krutokhvostov, I. G. The Impact of Innovations in the Field of Artificial Intelligence on the Social and Technogenic Development of the World / I. G. Krutokhvostov // Intelligent Technologies in Ergonomics and Cognitive Sciences: Collection of Materials of the All-Russian Scientific and Practical Online Conf. with International Participation. – Bryansk, 2024. – Pp. 354-357.

[5] Solovskoy, A. S. Development of a neural model for forecasting anthropogenic risks / A. S. Solovskoy // Computer and information technologies in science, engineering and management. - Taganrog, 2021. - P. 218-223.

[6] Basnukaev M., Musostov Z., Tokaeva A. Socio-economic aspects of sustainable development of the region / Reliability: Theory & Applications // 2024 // Т. 19. № S6 (81) // С. 1609-1614.