



## Foresight Technologies and their Role in Occupational safety

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### Abstract

*This article provides a scientific analysis of the essence of foresight technologies, their role in modern management systems, and their practical significance in the field of occupational safety. The foresight approach is based on forecasting future social, economic, and technological changes, enabling the early identification of potential risks and hazards in production systems. The study substantiates the necessity of transitioning from a traditional reactive approach to a proactive approach in occupational safety systems. Furthermore, the integration of artificial intelligence, Big Data, IoT sensors, and Digital Twin technologies within foresight processes is analyzed. These technologies play a crucial role in real-time monitoring of production processes, forecasting hazardous situations, and reducing workplace accidents. The study employs system analysis, comparative analysis, and risk modeling methods. The results indicate that foresight technologies are an effective tool for improving occupational safety, reducing economic losses, and minimizing human-factor-related errors. At the same time, their practical implementation requires advanced technological infrastructure and qualified specialists.*

**Keywords:** Foresight, occupational safety, safety, risk management, artificial intelligence, Big Data, forecasting.

### Introduction

The rapid development of industrial and production systems in the 21st century necessitates the introduction of new scientific and technological approaches in the field of occupational safety. At the global level, the widespread implementation of automation, digitalization, and artificial intelligence has significantly increased production efficiency; however, it has also generated new types of risks and hazards. Therefore, occupational safety systems are increasingly required to shift from a traditional reactive approach to a proactive approach based on forecasting and prevention.

Foresight technologies represent one of the modern scientific approaches developed in response to this need. Foresight is a system of scientifically based anticipation, analysis, and strategic decision-making regarding future technological, economic, and social developments. In the context of occupational safety, foresight technologies enable the early identification and minimization of potential risks in production processes.

Currently, many developed countries are actively integrating foresight approaches into industrial safety and occupational health systems. In particular, artificial intelligence-based forecasting systems, Big Data analytics, and IoT devices are being used to monitor hazardous situations in real time. This significantly contributes to reducing the number of workplace accidents.

However, the widespread implementation of these technologies also presents several challenges. These include high financial

costs, a shortage of qualified specialists, and issues related to data quality and reliability. Therefore, scientific research aimed at the effective integration of foresight technologies into occupational safety systems remains highly relevant.

This article analyzes the role of foresight technologies in occupational safety, their advantages, and their practical implementation prospects.

**Level of study of the topic:** A number of scientific studies have been conducted at both international and national levels on foresight technologies, strategic forecasting, and the development of occupational safety systems.

In international literature, foresight is widely regarded as an important tool for strategic management and future forecasting. In particular, OECD studies define foresight as a key instrument for policy formulation and risk management<sup>1</sup>. Research by the European Agency for Safety and Health at Work (EU-OSHA) emphasizes the importance of proactive approaches and predictive risk assessment methods in ensuring occupational safety<sup>2</sup>. Similarly, R. Popper systematically analyzed foresight methodology, scientifically substantiating methods such as the Delphi technique, scenario planning, and expert assessment<sup>3</sup>.

M. Porter highlighted the role of forecasting methods in strategic planning and competitiveness enhancement<sup>4</sup>. J. Voros interpreted foresight as a structured approach to exploring the future and making decisions under uncertainty<sup>5</sup>.

At the national level, scholars in Uzbekistan have conducted research on improving occupational safety systems, enhancing

industrial safety, and developing risk assessment methodologies. In particular, A. Abduganiyev studied technical approaches in occupational safety systems<sup>6</sup>, Sh. Karimov analyzed methods for reducing industrial risk factors<sup>7</sup>, and N. Tursunov investigated ergonomic and organizational safety issues<sup>8</sup>.

Nevertheless, the complex integration of foresight technologies into occupational safety systems, particularly their combination with artificial intelligence and digital technologies, remains insufficiently studied. Therefore, this direction is considered an important and relevant scientific problem.

### Methodology

In this study, a complex scientific approach was applied to evaluate the role and effectiveness of foresight technologies in occupational safety. The methodological framework of the research is based on system analysis, comparative analysis, and statistical modeling methods.

In the first stage, existing scientific literature on foresight technologies and occupational safety was reviewed, and their conceptual foundations were analyzed. In the second stage, statistical data on workplace accidents occurring in industrial enterprises were collected, and their dynamics were examined.

Furthermore, probabilistic-statistical models and forecasting algorithms were used for risk assessment. Artificial intelligence-based approaches (machine learning concepts) were applied to analyze the interrelationships between risk factors. IoT sensors and real-time monitoring systems were used to simulate the level of risk in the production environment.

Through comparative analysis, the differences between traditional occupational safety systems and modern systems based on the foresight approach were identified, and their effectiveness was compared.

### Results and Discussion

The results of the methodological approaches applied in this study indicate that the occupational safety system is a key strategic factor in ensuring production stability, human life safety, and economic efficiency. In modern industrial conditions, increasing technological complexity and the growing level of automation further intensify the demand for occupational safety. Therefore, traditional reactive approaches are no longer sufficient, and there is a growing need for proactive and forecasting-based methods.

The main objective of occupational safety is to protect the life and health of employees in the production process, prevent workplace accidents, and minimize risk factors. For this purpose, various methods are used, including risk assessment, statistical analysis, hazard mapping, technical monitoring, ergonomic analysis, and safety auditing. Although these methods are effective in traditional systems, they are mainly focused on analyzing existing or already occurred hazards.

From this perspective, the foresight methodology holds particular significance as a new approach in occupational safety. Foresight is a system for scientifically based forecasting of future development trends and risks, as well as for developing strategic decisions. The foresight approach is based on several key methods, including the Delphi expert survey method, scenario planning, trend analysis, SWOT and STEEP analyses, as well as technological forecasting models.

The Delphi method contributes to forming a consensus among experts regarding future risks. Scenario analysis enables the modeling of various potential hazardous situations that may occur in the production environment. Through STEEP analysis (Social, Technological, Economic, Environmental, and Political factors), external factors affecting occupational safety are comprehensively assessed.

**Table-1:** Methods Used in Occupational Safety.

Method name	Description	Purpose
Risk Assessment	A method for identifying hazard factors in production processes and evaluating their probability	To determine risk levels and develop mitigation measures
Statistical Analysis	Analysis of accident and hazardous event data using mathematical and statistical methods	To identify risk dynamics and evaluate trends
Hazard Mapping	Graphical representation of hazardous zones within an enterprise or production area	To visually identify and manage hazardous areas
Technical Monitoring	Continuous monitoring of equipment and production processes using sensors	To detect malfunctions and hazardous conditions at an early stage
Ergonomic Analysis	Study of the compatibility between workplace conditions, equipment, and human activity	To reduce human-factor-related injuries
Safety Audit	Evaluation of occupational safety systems against established standards	To identify and correct deficiencies in the safety system

**Table-2:** Application of Foresight Technologies in Occupational Safety.

Foresight method	Description	Application purpose
Delphiexpert survey method	A method of synthesizing experts' opinions about the future through multiple rounds of anonymous surveys	To build consensus on future risks and trends
Scenario planning	Modeling different possible future situations and analyzing their development paths	To develop strategies for various potential hazardous situations
Trend analysis	Identifying and forecasting development directions based on existing data	To predict technological and social changes in advance
SWOT analysis	Analysis of Strengths, Weaknesses, Opportunities, and Threats	To assess internal and external factors of the system
STEEP analysis	Comprehensive analysis of Social, Technological, Economic, Environmental, and Political factors	To evaluate external environmental impacts and support strategic decision-making

The results of the study indicate that the integration of foresight methods into occupational safety systems leads to several significant outcomes. First, it enables the forecasting of workplace accidents in advance. Second, hazardous processes can be identified at an early stage, and preventive measures can be developed to eliminate them. Third, human-factor-related errors are significantly reduced.

Furthermore, the integration of foresight technologies with artificial intelligence, Big Data, and IoT systems enables real-time risk monitoring. This transforms the occupational safety system from a passive observational model into an active management and predictive system.

According to the discussion results, the foresight approach not only enhances safety but also improves economic efficiency, as the reduction in workplace accidents decreases production downtime and ensures more efficient allocation of resources. At the same time, the implementation of this approach requires highly qualified personnel, advanced digital infrastructure, and a continuous flow of data.

The application of foresight (foresight technologies) in occupational safety represents a modern and promising approach to ensuring safety in production systems. Through this

approach, unlike traditional reactive safety systems, potential risks and hazards are forecasted in advance, and strategic measures are developed accordingly. As a result, the occupational safety system shifts from passive monitoring to active management and forecasting.

The use of foresight technologies in occupational safety leads to several important outcomes. First, workplace accidents and injuries are significantly reduced, as risk factors are identified at an early stage and preventive measures are implemented. Second, the ability to anticipate risks enables organizations to prevent emergency situations. Third, management decisions based on foresight rely on scientifically grounded forecasts and expert assessments, thereby improving decision quality and effectiveness. Fourth, economic losses are significantly reduced due to fewer production interruptions, equipment failures, and emergency incidents.

**Table-3:** Results of Applying Foresight Technologies in Occupational Safety.

Result direction	Scientific content	Practical significance
Reduction of workplace accidents	Forecasting risk factors in advance and developing preventive measures	Decrease in workplace injuries and emergency incidents
Early identification of risks	Early detection of hazardous situations through scenario analysis and trend forecasting	Formation of a preventive rather than reactive safety system
Improvement of decision-making quality	Development of scientifically grounded decisions based on Delphi and expert analysis	Increased accuracy and efficiency of management systems
Reduction of economic losses	Resource saving through prevention of accidents and equipment failures	Reduction of enterprise costs and improved production stability
Improvement of working conditions	Creation of safe and ergonomic working environments by identifying risk factors	Provision of safe and comfortable working conditions for employees
Development of digital monitoring	Real-time risk monitoring using IoT, Big Data, and AI	Implementation of rapid response and automated safety control systems

In addition, opportunities for improving working conditions are expanded, as hazardous factors are identified in advance and workplaces are reorganized in accordance with ergonomic and safety standards. The integration of foresight technologies with artificial intelligence, Big Data, and IoT systems enables real-time monitoring and forecasting, further enhancing the safety system.

Moreover, the foresight approach contributes to the development of strategic management in enterprises and supports the formation of long-term safety policies. Consequently, the occupational safety system evolves into a comprehensive system based not only on managing existing risks but also on anticipating future risks and threats.

The application of foresight technologies in occupational safety is of strategic importance in enhancing industrial safety, protecting human life, and ensuring economic efficiency, and it represents one of the key directions of modern industrial development. The foresight methodology is also strategically significant in occupational safety, as it forms a new forecasting-based stage of safety assurance and enables production systems to become more stable, efficient, and secure.

## Conclusion

The results of the conducted study indicate that the application of foresight (foresight) technologies in occupational safety systems represents one of the most effective and promising directions for ensuring safety in modern industrial conditions. While traditional approaches are mainly based on the analysis of existing or already occurred risk factors, foresight technologies enable the forecasting of future risks and threats in advance. This shifts occupational safety from a reactive system to a proactive and strategically managed system.

During the study, it was found that foresight methods—particularly the Delphi expert assessment method, scenario analysis, trend forecasting, SWOT analysis, and STEEP analysis—enable a comprehensive evaluation of risk factors in production processes and their early identification. When integrated with artificial intelligence, Big Data, and IoT technologies, these approaches make it possible to develop real-time safety monitoring and automated forecasting systems.

The results show that the implementation of foresight technologies in occupational safety can significantly reduce workplace accidents, minimize economic losses, improve working conditions, and decrease human-factor-related errors. In addition, it enables the formation of a strategic safety management system within enterprises.

However, several challenges exist in the widespread implementation of these technologies. These include the requirement for advanced technological infrastructure, a shortage of qualified specialists, and difficulties associated with

processing large volumes of data. Therefore, it is necessary to introduce foresight systems gradually and improve personnel training systems.

**Recommendations:** i. Gradual implementation of foresight methodology into occupational safety systems. ii. Development of artificial intelligence-based systems for risk forecasting in enterprises. iii. Organization of special training programs on foresight and digital safety for employees. iv. Wider implementation of real-time monitoring systems based on IoT and Big Data. v. Integration of foresight technologies and occupational safety education in higher education institutions. vi. Study of international experience and adaptation to national standards.

In general, foresight technologies are a strategic instrument that defines the future development direction of occupational safety and play a crucial role in creating a safe, sustainable, and efficient production environment.

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