

Implementation of Innovative Approaches and Mechanisms in Occupational Safety Management for Rescuers

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Abstract: This article substantiates innovative approaches and mechanisms for improving occupational safety management in rescuers' activities. The proposed framework includes a digital risk passport, real-time monitoring of rescuers' functional condition, wearable sensors, a differentiated competence matrix, and post-operation recovery with psychological debriefing. The study considers innovation not merely as the introduction of technical devices, but as a management mechanism that supports preventive, data-driven safety decisions. The analysis shows that these mechanisms can provide timely information on hazards, support early detection of excessive physiological and operational loads, improve task-specific competence assessment, and strengthen post-operation learning and recovery. Their integrated application transforms occupational safety from predominantly static control into a proactive and adaptive management system.

Keywords: Innovative Approach, Digital Risk Passport, Real-Time Monitoring, Wearable Sensors, Competence Matrix, Psychological Debriefing, Occupational Safety.

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I. INTRODUCTION

At the current stage of development, occupational safety management in rescue services should not be limited to traditional instructions, control procedures, and reporting forms. Rescuers operate in rapidly changing, uncertain, and high-risk conditions; therefore, digital technologies, real-time monitoring, data-driven management, and differentiated competence approaches are increasingly important for improving occupational safety.

Under such conditions, relying solely on general safety rules is insufficient. Hazard sources must be identified in advance, assessed according to scientifically grounded criteria, prioritized, and linked to management measures that can be revised as the operational situation changes. The occupational safety legislation of the Republic of Uzbekistan, the Labour Code, legislation on rescue services, and regulatory measures in the field of emergency protection

establish the legal and organizational basis for risk-oriented safety management [1–8].

The relevance of the study is also associated with the combined nature of hazards in real rescue operations. At a fire scene, for example, high temperature, smoke, toxic gases, reduced visibility, time pressure, physical fatigue, and psychological stress may affect personnel simultaneously. In such situations, management decisions require timely information not only about the external environment but also about the functional condition and task readiness of the rescuer.

Scientific and educational sources address the organization of rescue operations, professional and combat training, physical and psychological preparedness, occupational safety, and the use of technical equipment [9–18]. Recent studies additionally consider occupational safety methods in fire-rescue training and the adjustment of

operational standards when respiratory protective equipment is used [19–21]. These works form a methodological basis for developing innovative mechanisms capable of integrating hazard information, physiological monitoring, competence assessment, and post-operation feedback into a unified management process.

II. RESEARCH METHODOLOGY

The purpose of the study is to develop the scientific and practical foundations for introducing innovative mechanisms into the management of occupational safety in rescuers' activities. The research objectives are to clarify the content and functional role of a digital risk passport, real-time monitoring, wearable sensor technologies, a differentiated competence matrix, and post-operation recovery and debriefing mechanisms.

The study employed innovative management analysis, systems modeling, a risk-based approach, functional analysis, and scientific interpretation of regulatory and legal

documents. The principal methodological position is that innovation should be evaluated not merely as a technical tool, but as a mechanism for improving the quality, timeliness, and preventive orientation of safety-management decisions.

The proposed mechanisms were systematized according to three criteria: the type of information generated for management, the stage of rescue activity at which the mechanism is applied, and its expected contribution to occupational safety. This approach makes it possible to connect pre-operation preparation, operational monitoring, task-specific competence, and post-operation analysis within a single management logic.

III. INNOVATIVE MECHANISMS FOR OCCUPATIONAL SAFETY MANAGEMENT

The proposed system comprises five complementary innovation mechanisms. Their main content and expected impact on occupational safety are summarized in Table 1.

Table 1 Innovative Mechanisms Proposed for Occupational Safety Management in Rescuers' Activities

Innovative mechanism	Content	Impact on occupational safety
Digital risk passport	Electronic maintenance of risk profiles by rescue unit, equipment, typical operation, protective-equipment set, and personnel-related data.	Provides rapid access to hazard information and supports more precise preventive decisions.
Real-time monitoring	Monitoring of heart rate, body temperature, oxygen supply, exposure time, and location during high-risk operations.	Supports early detection of fatigue, excessive workload, and prolonged presence in hazardous zones.
Wearable sensors	Monitoring devices integrated into a rescuer's clothing or equipment.	Provides operational commanders with condition-related information for timely intervention.
Differentiated competence matrix	Separate competence indicators for fire-rescue operations, chemical hazards, work at height, water rescue, search under debris, and evacuation.	Transforms certification from a formal procedure into an assessment of task-specific practical readiness.
Post-operation recovery and debriefing	Medical-functional assessment, stress evaluation, experience analysis, recovery recommendations, and psychological debriefing after operations.	Reduces occupational strain, repeated errors, and longer-term safety risks while strengthening organizational learning.

A. Digital Risk Passport

The first mechanism is the digital risk passport. It provides for maintaining an electronic risk profile for each rescue unit, item of equipment, protective-equipment set, typical operation, and relevant personnel data. The passport consolidates typical hazard factors, exposure limits, available protective measures, information on previous incidents, health-monitoring data, and preventive recommendations. In this form, a conventional paper-based risk register becomes an operational information resource that can support faster and more consistent safety decisions.

B. Real-Time Monitoring and Wearable Sensors

The second mechanism is real-time monitoring of the rescuer's functional condition. During high-risk operations, monitoring heart rate, body temperature, oxygen supply, exposure time, and location can provide the operational

commander with information needed to intervene before a dangerous condition develops. Wearable sensors integrated into clothing or equipment act as the technical means for collecting such data. Their management value lies in supporting preventive decisions related to fatigue, excessive workload, prolonged exposure, and the rescuer's continued suitability for the assigned task.

C. Differentiated Competence Matrix

The third mechanism is a differentiated competence matrix. Although general professional training remains essential, different rescue operations require different combinations of knowledge, practical skills, and psychological resilience. For this reason, separate indicators are proposed for fire-rescue operations, chemical hazards, work at height, water rescue, search under debris, and mass evacuation. Such a matrix allows certification and

professional development to be connected more closely with actual operational tasks.

D. Post-Operation Recovery and Psychological Debriefing

The fourth management direction combines post-operation recovery with psychological debriefing. After returning from an operation, the rescuer should not be limited to equipment handover or a brief operational report. Medical-functional assessment, stress-level evaluation, analysis of accumulated experience, and recovery recommendations are particularly important after consecutive call-outs, incidents with major casualties, or rescue operations involving children and other high-emotional-load situations. The resulting information can also be used as feedback for future training and preventive measures.

IV. RESULTS, SCIENTIFIC NOVELTY AND PRACTICAL SIGNIFICANCE

➤ *Results*

The systematization of the proposed mechanisms shows that innovative occupational safety management can link hazard information, the rescuer's functional condition, task-specific competence, and post-operation feedback within a single preventive framework. The digital risk passport provides structured information before and during an operation; real-time monitoring and wearable sensors support operational control; the competence matrix strengthens task-specific readiness; and post-operation assessment converts operational experience into subsequent preventive decisions.

In this framework, the value of innovation is not limited to automation or digitalization. Its principal management effect is the transition from delayed response and static recordkeeping toward earlier recognition of hazards and conditions that may lead to operational errors. Consequently, occupational safety becomes more data-driven, adaptive, and closely connected with the actual dynamics of rescue work.

➤ *Scientific Novelty*

The scientific novelty of the study lies in the systematization of innovative occupational safety mechanisms in a form adapted to the specific characteristics of rescuers' activities. The digital risk passport, real-time functional monitoring, wearable sensors, differentiated competence matrix, and post-operation debriefing are considered as interrelated elements of a dynamic management system rather than as isolated technical or organizational measures. In particular, the digital risk passport and competence matrix are substantiated as mechanisms for moving occupational safety from predominantly static control toward preventive and adaptive management.

➤ *Practical Significance*

The proposed approaches can be applied in rescue services to digitalize risk registers, pilot wearable and sensor-based monitoring, improve certification and professional-development programs on the basis of specialized competencies, and introduce structured post-operation medical-functional and psychological debriefing. Their

practical implementation can also support more consistent documentation of preventive decisions and the accumulation of operational safety information for subsequent analysis.

V. CONCLUSION

The introduction of innovative mechanisms can bring occupational safety management for rescuers to a qualitatively new level. A digital risk passport, real-time monitoring, wearable sensors, a differentiated competence matrix, and post-operation recovery and psychological debriefing provide complementary tools for monitoring functional condition, identifying hazards in advance, improving task-specific readiness, and reducing repeated operational errors. Their integrated use supports the transition of occupational safety from mainly static control and reporting toward a proactive, data-driven, and adaptive management system. At the same time, the proposed mechanisms should be implemented as part of an integrated management process in which information obtained before, during, and after rescue operations is used to refine subsequent preventive decisions.

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