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DECISION SUPPORT IN EMERGENCY SITUATIONS BASED ON RISK ASSESSMENT

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Review paper

Abstract: *One of the fundamental characteristics of modern society is the increasing number of situations where security is compromised. Special significance is given to situations caused by human, natural, or technical-technological actions, collectively referred to as "emergency situations." They are termed "emergencies" due to their sudden, unexpected, and asymmetric negative consequences for people, property, and the environment. The primary characteristic of emergency situations is uncertainty. Uncertainty arises from the lack of sufficient human knowledge about certain phenomena and the genesis of their occurrence. As a result, there is an inability to accurately predict such occurrences or plan protective measures against these dangers.*

The extent to which certain characteristics of dangers are understood allows humans to act preventively, i.e., to prepare for action in case of danger escalation. The quality of both preventive and curative measures depends on the quality of the decision-making process regarding the type, location, timing, and forces needed for response. Most of the necessary information is obtained by assessing the risks of specific dangers occurring and determining their potential consequences..

Key words: *Emergency situation, Danger, Risk*

1. INTRODUCTION

Information, especially in emergency situations, serves as the foundation for making quick and high-quality decisions. It is regarded as a resource on which, directly or indirectly, the quality of decisions depends. A decision made in an emergency situation is characterized by a lack of time for decision-making, lack of information, confusion, dependence on teamwork, etc.

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Despite the presence of adequate information, delays in the management system occur due to the inertia of the information system, the need to verify the reliability of information, and the psychological characteristics of individuals.

2. RISK AND RISK ASSESSMENT IN EMERGENCY SITUATIONS

Risks are present in all forms of social activity: administrative, economic, political, security, etc. Modern aspects and the scope of development in contemporary society contribute to an increase in the number of events and activities that are potentially dangerous to human life, the working environment, and the natural environment. Individuals, society, and the entire human community, as well as the environment, are at risk. Contemporary global problems have made achieving sustainable development and protecting societal values from natural, technological, and social sources of danger a key priority. Technology occupies a central position in the world of risks, from the perspective of organizing, improving, and harmonizing systemic connections between different social structures, conducting a systemic analysis of alternative options at various levels of management, and choosing optimal technologies (Vladimirov, 2000).

2.1. Definition of risk in the context of emergency situations

In the broadest sense, an emergency situation represents a set of special conditions and factors that occur in a specific area as a result of an emergency event. An emergency event is a set of circumstances or occurrences of natural, technological, or social origin within a given territory, which deviate from the norms and principles of normal functioning of ongoing processes or phenomena, and significantly negatively affect people, property, the economy, and the environment. The term "risk" appeared and was first used in European languages in the late 15th century. For the term risk (Eng: risk, Lat: riscare, Fr: risque, It: rischio, Sp: riesgo, Port: risco, Ger: risiko), various synonyms or related terms are associated: danger, exposure to danger, gambling, hazard, chance, randomness, possibility, speculation, riskiness, probability, likelihood, threat, endangerment, insecurity, fear. In modern theory, risk is viewed from various perspectives, which has resulted in the creation of numerous theories of risk. Special attention is given to complex situations determined by a larger number of factors. Such situations or circumstances include emergency situations. All events in emergency situations can be found in states of certainty, risk, and uncertainty. Risk, as a phenomenon, is associated with uncertainty. A state of certainty is characterized by the ability to choose a specific alternative that leads to a specific known (expected) outcome. This state is also known as a state of determinacy and certainty. A state of risk is characterized by the possibility that choosing a specific alternative could lead to any outcome from a set of possible outcomes (certain outcomes), where the probabilities of each outcome's occurrence are known (each alternative is characterized by a finite set of outcome probabilities). This state is known as a state of stochastic uncertainty. A state of uncertainty is characterized by the possibility of choosing a specific alternative that could lead to any outcome (due to the absence of appropriate statistical data and the inability to make subjective or objective probability assessments).

2.2. The concept and elements of the risk assessment process in emergency situations

Risk represents a measure of deviation from a desired outcome, or the possibility that a certain event may occur and result in negative consequences. Accordingly, to assess risk would mean evaluating the likelihood that a harmful event will occur and result in negative consequences. In emergency situations, the degree of uncertainty is very high, due to the lack of information, understanding, and knowledge regarding the event, its consequences, and its probability. The elements of risk are the likelihood of the occurrence of an emergency event and the

consequences it may cause. Data on the probability of the occurrence of an emergency event and its possible consequences are the output results of the risk assessment process. The risk assessment process (Figure 1) consists of several phases (ISO Standard 31000, 2022 edition): Risk identification; Risk analysis; and Risk evaluation..

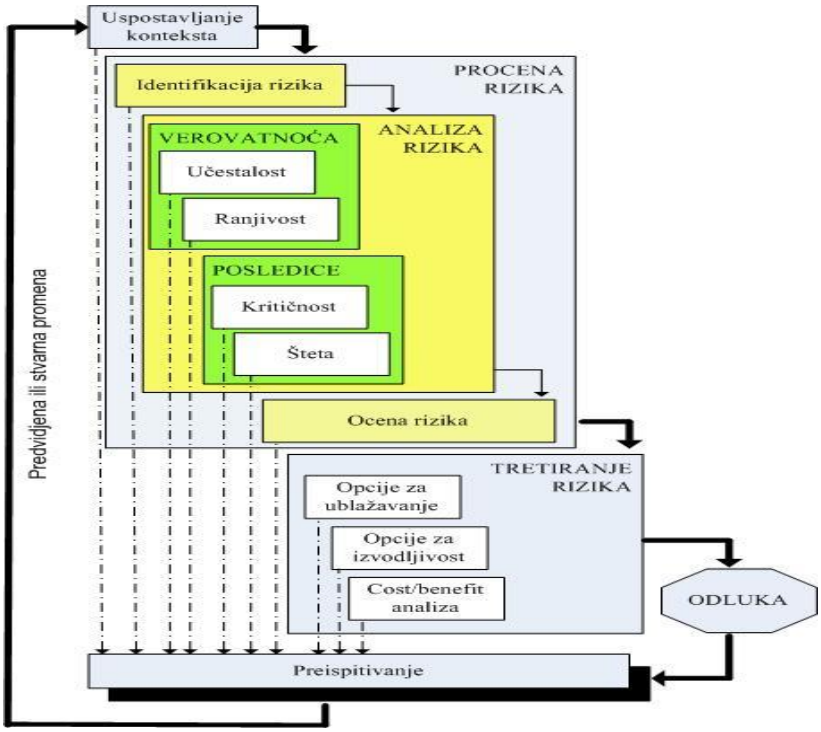

Figure 1: Risk assessment process
Source: ISO Standard 31000, 2022 edition

Risk assessment is a process-oriented approach aimed at quantifying risk by determining the probability and consequences of an emergency event. The risk assessment process for emergency events begins with the identification and understanding of the emergency event. The mere occurrence of an emergency event does not imply an emergency situation, but rather its potential existence. By analyzing the elements of the emergency event, such as the likelihood of occurrence and the consequences of realization, the size of the risk is determined. The complexity of the risk assessment process is defined by the complexity of emergency situations as phenomena. No emergency situation is composed of a single simple element, nor does it have simple consequences for the protected values. Accordingly, the risk assessment process itself is a complex and multidimensional process, with different approaches to problem-solving.

3. DECISION-MAKING IN EMERGENCY SITUATIONS

The complexity of emergency situations requires highly rational decisions, which makes decision-making increasingly difficult, especially in the field of emergency management. Due to advancements in decision theory and the study of decision support systems, new systems, methods, and tools have been developed and are widely used. However, the design and tools for decision-making support are not able to help the decision-maker solve all problems when addressing complex issues related to emergency situations (Boboşatu, 2008).

3.1. Concept and characteristics of the decision-making process in emergency situations

Humans live in an environment where they are constantly exposed to a variety of more or less dangerous situations, generated by numerous factors. Extreme natural events such as storms, floods, droughts, earthquakes, landslides, as well as technological accidents and conflict situations, can directly affect the lives of individuals and society as a whole. These events, referred to as disasters and hazards, must be well understood for quick resolution. Reducing and mitigating the effects of such disasters requires an interdisciplinary study of hazards, vulnerabilities, and risks, as well as proper communication of information. Information systems play a very important role in this area. Essentially, a decision support system is a computerized system that enhances the decision-making process and operates at various levels of the command chain (from monitoring different processes to making decisions at the highest levels of the organization). At the same time, it stimulates the creativity of the decision-maker and contributes to improving the decision-making process and making the right decision to achieve quickly visible results (decision effectiveness) (Filip & Bărbat, 1999). Several theorists, including Peter G. W. Keen, Michael S. Scott Morton, and Ralph H. Sprague Jr., have noted the restrictiveness of the initial definition of a decision support system, which is defined as a computerized system that assists the decision-maker in using data and models to solve unstructured problems. Recent research and theoretical analysis have contributed to expanding this definition to include any system that participates in the decision-making process.

3.2. Structuring the risk management process as a function of decision support in emergency situations

Since emergency situations, by their nature, are complex and multidimensional, the risk management process has the same characteristics. Issues related to emergency situations fall into unstructured problems with a high degree of uncertainty. Therefore, structuring the risk management problem in emergency situations is of great importance. The risk management process can be structured in several ways. The elements of the risk management process are divided into programmatic and process elements. Programmatic elements ensure the development and implementation of the risk management process as an integral part of quality management, and they include administration, communication, documentation, evaluation, and improvement. Process elements represent the technical and analytical components of the risk management process necessary for risk analysis and evaluation, resource allocation for risk control, performance monitoring, and the use of information to improve the process through the decisions made. Process elements include: Risk analysis and evaluation; risk control and decision support and performance monitoring and feedback.

3.3. Scenario of Emergency Situation Development Based on Risk Assessment Using a Risk Matrix

The culmination of the emergency management process is the definition of the scenario for the development of the emergency event, both individually and in interaction with other events. Key data for developing the emergency event scenario is provided to the decision-maker through the risk assessment process. In ideal circumstances, risk identification should take into account all possible potential hazards, the probability of their occurrence, and their possible impacts on all protected values. In most cases, however, it is impossible to achieve such perfection. In reality, there are situations where one potential hazard triggers other potential hazards. It is essential to consider that the range of potential hazards to be considered, their impacts, and accompanying effects are entirely unlimited (Guidelines on the Methodology for Risk Assessment and Emergency Response Plans, 2013). Due to this

complexity, risk identification usually includes a detailed scenario of potential risky situations, narrowing the scope of possibilities to a limited number of identified situations. A risk scenario represents a depiction of a situation involving one or more impacts of potential hazards that lead to significant consequences, prioritizing hazards to protected values. In developing the risk scenario, it is necessary to analyze all possible combinations, both those that represent hazards and those that may seem harmless at first but could potentially occur in the future. Risk scenarios must provide an accurate description of what can be expected in the future. The formation of scenarios is mainly based on past experiences, but it is also necessary to consider events and impacts that have not yet occurred. Scenarios should be based on a coherent and internally consistent set of assumptions about key connections and driving forces.

4. CONCLUSION

In a changing societal environment, organizations, managers, emergency management professionals, specialized government bodies, and others must make important decisions when society is threatened by internal and external factors. Decisions made in emergency situations must balance the advantages and disadvantages, short-term forecasts, and medium- and long-term consequences for the subject or types of hazards that may affect the community, while also considering preventive measures. Decision support systems should meet such demands. The development of such systems is time-consuming, and activities in this field can only be carried out by specialized personnel. The modeling, implementation, and formalization of efforts and knowledge in developing decision support systems for emergency situations are significant. Numerous methods, models for supporting emergency management, and implementation solutions have been developed, but the process of data collection itself is highly complex. Once the system is created, it must undergo a series of tests, all deficiencies must be corrected, and only then can it be utilized under the direct supervision of experts. This paper consolidates fundamental knowledge about decision support in emergency situations based on risk assessment. The paper has shown that effective communication is one of the key factors for successful risk management and that risk assessment provides decision-makers with greater certainty and more accurate predictions of emergency situation developments. This enables the optimal organization of protection and rescue forces. It can be concluded that decision support systems in emergency situations must be integrated into organizational processes and tailored to the specific needs of users. Although the development and implementation of these systems are complex and resource-intensive, they provide invaluable support in making decisions that can save lives and minimize damage. Despite the challenges, continuous improvements and testing of these systems ensure their reliability and effectiveness in emergency situations. Understanding the complexity and importance of risk management in emergency situations highlights the key aspects of communication and risk assessment that are necessary for effective decision-making. The need for future research and development in this field remains relevant, with the aim of achieving even better preparedness and responsibility in addressing emergency situations.

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