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Improvement Of The Methodology For Conducting Rescue And Other Emergency Operations In Fire-Related Emergency Situations

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Abstract: This study analyzes existing methodologies, identifies their shortcomings, and proposes innovative approaches aimed at optimizing the planning and execution of emergency rescue and other urgent operations. The IRM-24 model was improved based on experimental testing, and its advantages and practical applications were demonstrated.
Keywords: fire, emergency situations, rescue operations, urgent actions, methodology, safety engineering, risk, improvement, firefighting, emergency response, IRM-24 model.

Relevance of the study: Fire emergencies are one of the most serious threats at the global and national levels. Every year, hundreds of fires occur around the world, negatively affecting the lives of people, infrastructure and economic activity. In Uzbekistan, the risk of fire in industrial enterprises, residential areas and transport systems remains high. Therefore, it is necessary to create and improve high-level methodologies for the rapid and effective organization of emergency rescue operations in fires. This is important not only for reducing material damage, but also for saving human life and protecting the environment.

Also, the development of modern technologies and information systems, as well as the emergence of new risks and dangers, require constant improvement of emergency response methods. With the help of clear and integrated methods, emergency response teams will be able to act quickly and purposefully, which will significantly mitigate the consequences of emergency situations.

Scientists who have studied the topic and their scientific works: In Uzbekistan and the region, a lot of scientific research has been carried out in the field of fire safety and the development of theoretical foundations for combating them, as well as on improving emergency and rescue systems. Among them: V. I. Kuznetsov, B.R. Islomov, O.J. Toychiyev, V. A. Ivanov, N. Petrov, J. Smith, L. Johnson, . K. Muller, M.S. Kadyrov, etc., have conducted research in the field of fire safety and the organization of emergency and rescue and other urgent work in emergency situations.

The main objective of the study is: To improve methods of conducting emergency rescue and other urgent work in fire-related emergencies, thereby increasing their effectiveness and protecting human life and material assets.Bu maqsadga erishish uchun quyidagi **vazifalar** belgilangan:

- analysis of existing fire safety methodologies;
- development of new technologies and approaches to optimize emergency and rescue processes;
- identification of measures to ensure the effective use of human resources in emergency work;
- testing of updated methodologies based on experimental training and modeling;
- development of recommendations for further improvement of fire fighting systems.

Methods used in the study: The study used analytical analysis, modeling, experimental research, comparative analysis, and expert survey methods. Tests and experiments were conducted with automatic fire safety detection equipment based on the simulation method**.**

Analysis and results: Fire safety is an important area aimed at protecting human life and health, reducing material and environmental damage. In each country, legislation, regulatory documents and scientifically based methodologies have been developed in this area. However, rapidly changing economic, social and technological conditions require constant improvement of these methodologies.

There are laws and standards regulating fire safety in Uzbekistan. Among them, documents such as the Law "On Fire Safety" and "Fire Safety Rules" occupy an important place. Among the international standards, ISO 45001 and NFPA standards are widely used. Based on these documents, fire safety methodologies, preventive measures, and action plans in case of fire are developed [1].

Hazard-based fire safety methodology, in which the risks and consequences of a fire are assessed using statistical and modeling methods. Resources are allocated based on the level of risk. The specificity is to identify and prioritize hazards.

Computer modeling, using such models, analyzes the physical and chemical processes of fire spread. This is very effective in determining how a fire spreads, air currents, heat dissipation, and damaged areas.

Automated emergency response systems - using modern sensors, alarm systems, and information and communication technologies, fires are quickly detected and emergency rescue measures are carried out quickly. These systems significantly reduce the time required.

Practical exercises and training - aimed at increasing the level of preparedness and professionalism of emergency service personnel. This method ensures quick and effective response to incidents.

The methods described above have some advantages as well as disadvantages:

Table 1

Advantages and disadvantages analysis

Methodology	Advantages	Disadvantages
Legislative and regulatory framework	Legal basis, general provisions	Real-time response is limited
Risk-Based Fire Safety	Accurate risk assessment	Requires a lot of information
Computer modeling	Full forecast and analysis	Technically complex
Automated systems	Rapid detection and response	Cost and technical issues
Practical training	Practical skills	Dependence on human resources

In emergency situations, especially in cases of fire, explosion, gas leak or technical accidents, rapid, coordinated and effective implementation of emergency and rescue operations is crucial for saving human life and the environment. [4] Today, modern technologies and innovative approaches are widely used in this area. For example, drones (unmanned aerial vehicles) and aerovisuals, which provide information without entering a dangerous area, coordinate actions based on GPS and GIS in regulating movements, identify risks in advance in dangerous areas where humans cannot enter, intelligent sensors and automatic signaling systems, and robotics that allow working in areas dangerous to humans are widely used in the international arena today [9]. Unfortunately, this area is not yet developed in our country.

In emergencies, real resources, especially human resources, are essential. Effective management is [7]:

-making quick and clear decisions;

-ensuring that everyone understands and fulfills their role;

-maintaining stability and trust.

The following human resource index is presented to measure the reserve status of an organization's human resources in emergencies.

$$\text{Human resource index (HRI} = \frac{\text{Rx number of tasks completed}}{\text{Project or construction task number}}\ 100\%$$

HRI $\geq$ It is desirable to have 80% - this means quick and effective mobilization of personnel.

2- table

Rapid and effective staff mobilization (for example)

Item	Usually available staff	Called in an emergency	Backup
Medical assistants	5	8	3
Technical specialists	10	15	5
Coordination officers	3	5	2

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Analysis: It is shown that the reservoir is sufficient in each direction.

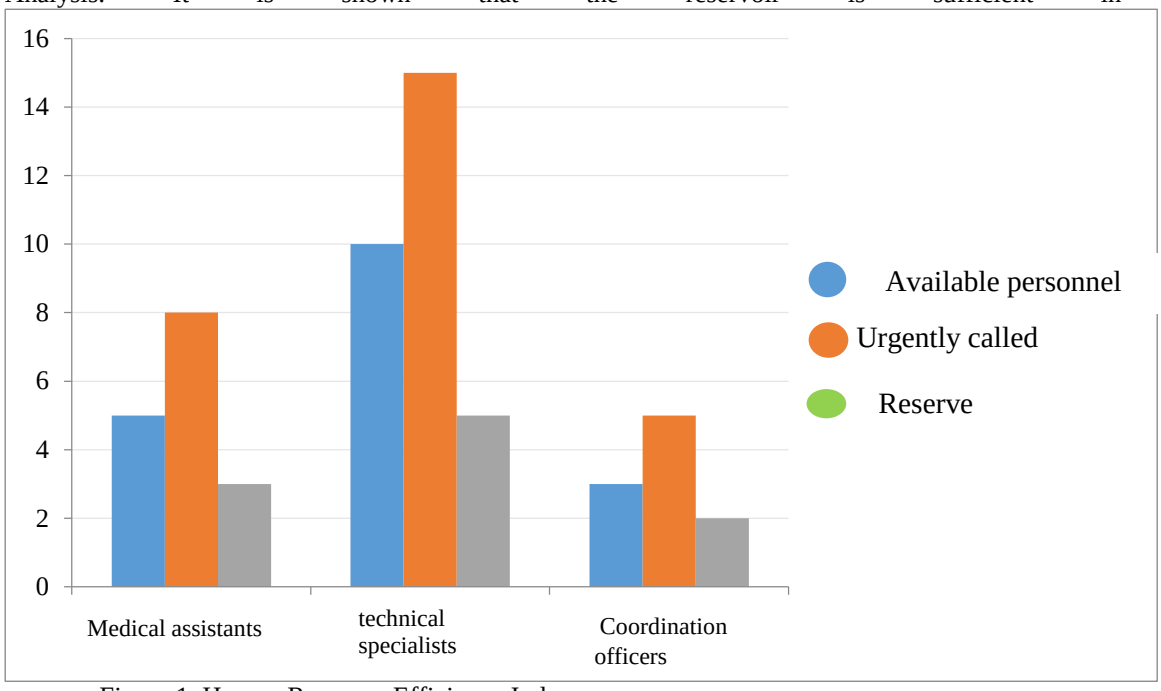

Figure 1. Human Resource Efficiency Index

We conduct a pilot study to determine the effective utilization index of personnel through an experimental model.
1. The problem is formulated.
2. The team is assigned and assigned tasks.
3. Time and efficiency criteria are established (for example, task completion time, quality of results, communication).
4. The result of the team's work, HRI and other indicators are determined.

$$\text{SI} = \frac{\text{Task completed} f \text{ati (ball)}}{\text{Time (min.))}} 100\%$$

We will determine the calculation through the following problem formulated in the test experiment: total task: 20. completed task: 18.

HRI = (18 / 20) × 100% = 90%, in medical assistance: 5 people, 6 tasks - in 5 minutes;

SI (medics) = (6 points/5 minutes)×100 = 120, which indicates high efficiency.

8 people in the technique, 10 tasks — 12 min.; SI (technique) = (10 / 12) × 100 ≈ 83.3%

Based on the pilot experience, we will improve the IRM-24 (Emergency Human Resource Mobilization Model – 2024) model through pilot training [2].

This model is designed to optimize management of human resources in emergency situations based on the level of preparedness, response time, and task performance.

3- table

IRM-24 modeli takomillashtirilgan matritsasi

Indicator	Previous methodology	IRM-24 model (Updated)
Roles	Determined, determined	Modular, multifunctional
Reaction time	60–90 daqiqa	15–30 minutes
Reserve personnel	Not available	In the electronic database, quickly called
KPI indicators	No	KZI, SI, VQI
Training	Rare, unconventional	Regularly based on the scenario

A pilot exercise was conducted based on the scenario "Accident related to fuel leakage at a manufacturing enterprise" to assess the rapid, accurate and effective management of human resources on an experimental basis.

4- table

Test experiment results

Group	Time (min.)	Number of tasks	Backup support (%)	SI/ VQI
Technical repair	30	5	40%	16.6/3.3
Information service	20	3	33%	15/5.0
Emergency medical care	18	4	50%	22.2 /5.5

5- table

Comparative analysis of the impact of the methodology

Indicator	Previous situation	IRM-24 in experience
Number of personnel involved	15	30
Number of reserve personnel involved	0	6
Percentage of task completed	60%	90%
Reaction rate	60 daq.	*20 daq.*

Reaction time index (RTI):

$$\text{RTI} = \frac{1}{\text{Time (min.)}} 100\%$$

As a result of the IRM-24 model testing experience, the response time was reduced by 3 times, the overall efficiency increased by 30–40% with the help of reserve personnel, the ability to analyze based on KPI indicators was created, and the model was formulated for practical use.

Based on the data obtained during the research and test experiments, we can conclude the following.

Fire emergencies pose a serious threat to human life, property, the environment, and infrastructure. In such cases, effective organization of emergency and rescue operations, proper management of human resources, and a reliable and fast system for making operational decisions are crucial.

Based on recent experience and modeling, current emergency response methods are often “reactive,” meaning they are activated after a fire has occurred. This process can be made proactive by introducing elements such as backup personnel, rapid communication, task allocation, and KPIs. Education, training, and rapid scenario exercises can increase the level of staff readiness several times over.

Recommendations:

№	Recommendations	Recommendations
1	IRM-24 implementation of personnel management based on the model	Backup personnel, multi-functional tasks, and response index KPIs are implemented.
2	Automation of instant communication system (Telegram bot, SMS communication)	A system for sending messages to each employee according to their role will be created

3	Optimize the deployment of rescue equipment	Equipment and responsibilities are distributed in each sector
4	Implementation of an employee KPI system (KZI, SI, VQI)	Each employee is evaluated for their reaction speed and efficiency.
5	Digitizing reporting and analysis	All information is collected in an electronic register.

The improved methodology will not only ensure rapid and systematic action in the event of a fire, but also form a responsible and systematic management of the entire rescue system. This will be an important factor in saving lives and reducing economic losses.

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