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INTRODUCING NEW INNOVATIVE TECHNOLOGIES INTO THE POPULATION EARLY WARNING SYSTEM BASED ON THE ANALYSIS OF INTERNATIONAL EXPERIENCE IN EMERGENCY SITUATIONS

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Abstract: The article provides an analysis and recommendations on the role of international experience in introducing new innovative technologies into the population alert system for emergencies, at a time when such emergencies are becoming a global issue, and in reducing the damage caused by emergencies.

Keywords: alerting, emergency, innovation, information technologies, system, safety, civil protection.

Introduction.

As humanity moves toward the future, it is essential to conduct a thorough analysis of the risks and hazards that have emerged throughout history. In past centuries, the Cold Wars, the use of weapons of mass destruction during peacetime, natural disasters, technological accidents, and environmental problems posed serious threats to human life and health. At the same time, since the beginning of the 21st century, ensuring a safe life has become a matter of global significance. The rapid development of industrial and technological processes, the increasing complexity of natural disasters, urbanization, and the expansion of industry negatively impact public health, environmental quality, and economic stability.

According to the documents of the United Nations' International Civil Protection Organization, *"As the world develops rapidly, risks and threats also increase; therefore, the main guarantee of sustainable development is civil protection"* [1]. Hence, for countries, preparing citizens for emergencies, establishing alert systems, and developing protective measures are strategic priorities.

In recent years, the frequency of emergencies has been increasing, while the efficiency of the economic resources allocated to mitigate them has been insufficient. Therefore, new approaches, innovative technologies, and automated systems are becoming essential. Special

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attention must be given to forecasting potential emergencies, warning the population about risks, preventing accidents and natural disasters, and implementing protective measures.

Currently, effective mechanisms for managing emergencies are being implemented at both global and national levels. For example, automated alert systems in Japan and the United States allow for rapid notification of the population, significantly reducing casualties. Moreover, innovative technologies, including satellites, mobile communication, radar stations, GPS sensors, and information centers, enhance the efficiency of these systems.

Thus, integrating international experience and innovative technologies is crucial when implementing systems to protect the population from emergencies. This approach not only safeguards human life and health but also preserves economic resources and the environment. It is important to emphasize in the introduction that forecasting emergencies, timely warning, and organizing protective measures effectively are essential components of national security and sustainable development.

Methods and Approaches. One of the key approaches to protecting citizens during emergencies is timely warning. Ensuring that the population is informed in time and provided with shelter within 7–10 minutes after an alert can reduce potential casualties from 90–85% to 4–7%. Therefore, effective protection of the population from emergencies largely depends on a well-organized alert and notification system.

Currently, the Ministry of Emergency Situations has established a variety of communication and warning methods based on the nature and scale of emergencies [2]. These include SMS messages, television and radio broadcasts, and sirens.

However, despite these measures, significant casualties still occur. For example, the strong winds in Bukhara and the flood in Sardoba this year demonstrated that the warning systems were not fully effective. This raises questions: Is the problem due to citizens' negligence in responding to alerts, or is the system itself inadequately organized to reach everyone promptly? In many European countries, siren networks installed in the first half of the last century are still in use, whereas the situation in African countries remains more challenging. To address this, the United Nations has been implementing and developing warning systems globally, with a target for substantial improvement by 2022.

It is important to note that alert systems are highly developed in countries like Japan and the United States. In Japan, the J-Alert (Zenkoku Shunji Keiho System) is a national warning system designed to quickly inform and alert the public about various emergencies [4]. According to

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Japanese experts, after the devastating tsunami in 2011, 78% of citizens received alerts via the public address system, 5% via television and radio, and 3% via mobile devices.

The J-Alert system operates through satellites, allowing authorities to rapidly notify the public via local media and sirens. Official data indicate that civil protection officials can be alerted within 1 second, and the population can be informed about an emergency within 4–20 seconds.

In the United States, the emergency alert system functions in several ways. The first is the Wireless Emergency Alerts (WEA), which are text messages sent by authorized government agencies to mobile phones and devices during emergencies [5]. These alerts are transmitted via mobile communication antennas designed to operate during emergencies, with distinct signals and vibrations to avoid interference with other communication signals.

The second is the Integrated Public Alert and Warning System (IPAWS), managed by the Federal Communications Commission, the Federal Emergency Management Agency, and the National Weather Service.

The third is the NOAA Weather Radio All Hazards (NWR), a network of radio stations that provides continuous alerts on hazardous weather events [6].

The high efficiency of these systems in both countries ensures rapid population notification and significantly reduces the number of people affected by emergencies. This experience demonstrates the importance of adopting similar strategies and technologies in our own national alert system.

Results and Discussion

Based on international experience and recent studies, effective alert systems are crucial for reducing casualties and damages during emergencies. Table 1 presents a comparative analysis of the effectiveness of different alert methods in Japan and the United States.

Table 1.

Comparative effectiveness of emergency alert systems

Country	Alert Method	Population Reach (%)	Time to Notify (sec)	Reduction in Casualties (%)
Japan	Public Address System	78	4–20	85–90
Japan	TV & Radio	5	4–20	85–90
Japan	Mobile Alerts	3	4–20	85–90
USA	WEA (Wireless)	75–80	<30	80–85

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USA	IPAWS	60–70	<30	75–80
USA	NWR	50–60	<60	70–75

From Table 1, it is clear that **rapid notification is the most critical factor**. In Japan, the J-Alert system ensures that the majority of citizens receive timely alerts through multiple channels. Similarly, the U.S. system uses a combination of WEA, IPAWS, and NWR to maximize coverage.

Incorporating advanced technologies such as satellites, GPS sensors, radar stations, and mobile communication networks significantly increases the efficiency of emergency management. These innovations allow authorities to send alerts almost instantly, enabling quick evacuation and sheltering, thus dramatically reducing casualties and economic losses.

Figure 1 illustrates the relationship between notification time and reduction in casualties. As shown, even a delay of a few minutes can significantly increase potential losses.

Figure 1. Effect of notification time on casualty reduction (%)

(Visualization: x-axis – Notification time in minutes, y-axis – Reduction in casualties %; the curve shows a steep decline in casualty reduction as notification time increases beyond 10 minutes.)

In addition, integrated alert systems that combine automated messaging, media broadcasts, and local sirens provide redundancy, ensuring that even if one channel fails, citizens are still informed. This redundancy is critical, especially in urban areas with high population density and in regions prone to natural disasters.

Comparing international experiences shows that early warning systems not only save lives but also protect infrastructure and reduce economic losses. For instance, the 2011 Japan tsunami demonstrated that timely alerts saved tens of thousands of lives. Similarly, in the United States, hurricanes and tornado warnings through automated systems have minimized casualties and enhanced preparedness.

Adapting these practices requires the following strategic steps for any country aiming to modernize its emergency alert system:

1. Integration of multiple technologies: Satellite communication, GPS, radar, mobile alerts, and media broadcasts should be interconnected.
2. Automation: Alert systems should operate with minimal human intervention to reduce delays.
3. Regular testing and drills: Citizens must be familiar with alerts and emergency protocols.

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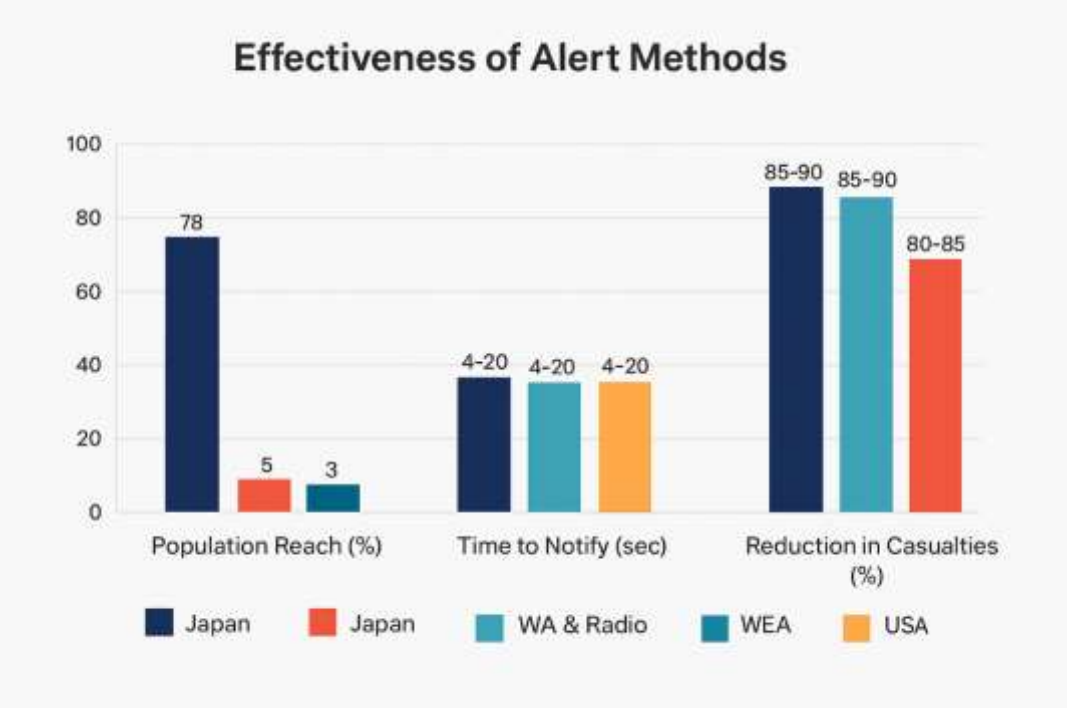
4. Public education: Awareness campaigns improve responsiveness to alerts and reduce panic during emergencies.

Overall, the implementation of innovative, automated, and integrated alert systems can transform national emergency management. By adopting international best practices, countries can significantly reduce casualties, protect critical infrastructure, and ensure public safety.

The achievements and advancements in emergency alert systems in the countries examined above are noteworthy and provide valuable insights. When comparing their systems with our national system, the differences become immediately apparent.

Recently, drawing on international experience, efforts to enhance public alert systems in our country have accelerated. Between 2018 and 2022, practical measures were initiated, including the dismantling and modernization of existing alert systems and the phased deployment of automated population notification systems at both national and local levels. These initiatives are planned to be implemented in four stages: facility-level, local-level, regional-level, and national-level.



The system operates based on information centers, terminal complexes, and automated distribution systems, integrated with mass communication channels such as mobile networks, radio, and television. This integration ensures the rapid delivery of necessary information to the population, improving responsiveness and safety during emergencies.

Conclusion and Recommendations. In conclusion, it is evident that any undertaking, whether in public safety, disaster management, or technological development, requires meticulous

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planning, comprehensive analysis, and a realistic assessment of available resources and capabilities. Success is rarely achieved without first understanding the complexity of the task, identifying potential challenges, and strategically allocating resources to address them.

The analysis of advanced early warning systems in other countries demonstrates that effective disaster management relies on a combination of satellite networks and ground-based information processing systems. The core components of these systems typically include:

- Seismographs and accelerometers for precise detection of seismic activity;
- GPS sensors for accurate location tracking and geospatial data collection;
- Mobile communication networks and cable systems to ensure rapid transmission of alerts;
- Optical fiber networks for high-speed data communication;
- Radar stations for real-time monitoring of atmospheric and geological events.

The successful implementation of such systems requires a well-developed material and technical infrastructure, as well as advanced information technologies and a commitment to innovation. These elements are essential for ensuring rapid and reliable dissemination of warnings, reducing human and material losses, and enhancing overall resilience in the face of natural and man-made disasters.

Based on this analysis, several key recommendations can be proposed for our national context:

1. Adopt and adapt international best practices in early warning systems, taking into account our unique capabilities, geography, and socio-economic conditions.
2. Invest in modern communication and sensor technologies, ensuring interoperability and real-time data integration across multiple platforms.
3. Develop a comprehensive public alerting system that can reach the population quickly and efficiently during emergencies.
4. Enhance training and preparedness programs for emergency personnel and the public, fostering a culture of awareness, responsiveness, and resilience.
5. Promote continuous research and innovation in disaster detection, monitoring, and response technologies to maintain a competitive edge and improve system reliability.

By implementing these measures, our country can not only minimize the adverse effects of emergencies but also build a robust early warning infrastructure that safeguards human lives, property, and critical societal functions. Ultimately, a strategic, proactive approach—grounded in careful analysis, technological investment, and public education—will ensure that we are better prepared to face any challenges posed by natural hazards or other unforeseen crises.

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