# ANALYSIS OF THE PUBLIC WARNING SYSTEM

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**Abstract.** Modern public safety paradigms require an immediate, resilient, and ubiquitous mechanism for emergency notification. This paper analyzes the digital transformation of Public Warning Systems (PWS) within the Republic of Moldova, transitioning from obsolete analog sirens to centralized digital platforms.

The core research question examines how modern digital standards and wireless technologies can overcome the delivery latency, institutional fragmentation, and regulatory limitations inherent in legacy analog notification networks. Utilizing a comprehensive systems framework and comparative-legal analysis aligned with the newly enacted Law of the Republic of Moldova No. 72 "On Electronic Communications" (2025), a central component of this study is the development of a technical and regulatory verification matrix that evaluates public notification success probabilities within specific timeframes.

Based on United Nations vulnerability assessments and the General Inspectorate for Emergency Situations (IGSU) data, the analytical results demonstrate that digital point-to-area Cell Broadcast configurations fundamentally outperform legacy infrastructures by distributing geo-fenced alerts within 5 to 10 seconds without inducing cellular network congestion or violating subscriber privacy.

Furthermore, the study evaluates the integration of the Common Alerting Protocol (CAP) as a universal XML data standard to completely automate message processing and eradicate manual dispatch delays. The primary practical contribution of this research is that its findings served as the foundational basis for the official technical documentation and project blueprints of the "MD-ALERT" national initiative.

Ultimately, the paper concludes that robust civil protection requires a strict architectural separation between multiple hazard-detecting Early Warning Systems (EWS) and a single, unified national Public Warning System (PWS), delivering a conflict-free technological shield.

**Keywords:** Public warning systems, Cell Broadcast, Common Alerting Protocol, Digital Security, Moldova, Emergency Notifications.

**JEL Classification:** O32, H56.

## INTRODUCTION

The digital security and technological modernization of public safety infrastructure represent critical components for protecting national security and achieving digital transformation. In the modern information society, traditional public notification mechanisms face severe structural obsolescence. Legacy methods—such as traditional acoustic sirens, wired broadcasting, analog radio, and linear television—fail to ensure total population coverage during localized crises.

This systemic failure is further compounded by the structural shift from analog to digital telecommunications and the total transformation of domestic media consumption habits. Historically, national public warning frameworks relied on centralized analog television interception and mandatory urban wired radio networks (radio-outlets) installed in every household, ensuring baseline resilience even during power grid failures. In the modern post-transition landscape, the migration to digital multiplexes, fragmented IP-TV streaming platforms, and the complete domestic extinction of linear radio receivers have created an institutional decoupling. Consequently, legacy mass-media

interception has lost its operational ubiquity, leaving a significant portion of the population completely isolated from traditional real-time emergency broadcasts inside their residences.

Under escalating climate, technological, and geopolitical threats, public notification practices require an urgent modernization toward advanced digital technologies and internet platforms that ensure immediate data dissemination (United Nations Moldova, 2024; Karaman *et al.*, 2024). For the Republic of Moldova, this technological shift must align directly with national security frameworks and European integration strategies.

Global public warning frameworks in nations such as the United States, Japan, and Romania rely heavily on Cell Broadcast technology, which utilizes a point-to-area functional design and delivers alerts within 5 to 10 seconds over dedicated radio channels (IGSU, 2026; United Nations Moldova, 2024; Kim *et al.*, 2021).

Building on previous research regarding the efficiency of digital platforms, Peancovschii (2024, pp. 17–27) utilizes a systems approach to demonstrate that digital point-to-area configurations fundamentally outperform legacy analog alert networks by eliminating their inherent limitations in transmission speed, geographic precision, and operational stability, thereby drastically reducing notification latency.

Existing research points to the importance of Cell Broadcast technologies in building resilient emergency communication infrastructure. Compared to conventional SMS-based architectures, 5G Public Warning Systems provide higher dissemination speeds and greater geographic precision (Kim *et al.*, 2021). Similarly, LTE-based Cell Broadcast Services offer scalable, congestion-free notification capacity when mobile networks experience peak traffic during large-scale emergencies (Suryandari et al., 2020). Disaster management strategies increasingly rely on these communication channels to address climate-related, technological, and geopolitical hazards (Karaman *et al.*, 2024).

Despite these operational advantages, implementing modern public warning solutions involves substantial structural challenges. Deploying national systems requires addressing technical, financial, regulatory, and institutional constraints that vary across countries. As a result, technical adoption cannot follow a uniform template; it must adapt to existing domestic operator networks and the specific legislative frameworks governing emergency communications.

In response to these challenges, this study develops a methodological framework to identify and mitigate deployment barriers facing the Republic of Moldova's national Cell Broadcast network (MD-ALERT).

## MAIN CONTENT

### 1. Materials and Methods

The methodological framework combines systems analysis with comparative legal assessment to examine Public Warning Systems (PWS) operating under complex crisis conditions. The study evaluates the integration of public notification infrastructure into national security policy, digital transformation initiatives, and the Republic of Moldova's European integration agenda.

The assessment focuses on four notification mechanisms: acoustic sirens, linear broadcasting, Cell Broadcast technology, and automated data exchange protocols. Their performance is evaluated against three technical criteria: transmission latency, geographic targeting accuracy, and network reliability under peak-load conditions. Technical parameters provided by mobile network operators are analyzed alongside domestic telecommunications regulations governing emergency alerting.

To examine the technological architecture of the warning process, information flows are traced from environmental monitoring systems to end-user mobile devices. The Common Alerting Protocol (CAP v1.2) serves as the reference interoperability standard for analyzing data exchange between system components (OASIS, 2010; ITU-T X.1303). Geographic delivery performance is evaluated by combining population vulnerability indicators with mobile network coverage maps, allowing the assessment of warning capabilities in areas exposed to different levels of risk.

To evaluate alert dissemination performance, the verification model incorporates empirical telecommunications data alongside existing regulatory requirements. This model estimates the probability of successful alert delivery within predefined time intervals ranging from 10 to 300 seconds under different emergency scenarios.

The proposed approach was applied during the preparation of technical and project documentation for Moldova's national MD-ALERT initiative (IGSU, 2026). Population exposure and network topology were analyzed to identify the main technical and organizational constraints affecting deployment and to assess their implications for system implementation.

## 2. Results and Discussion

Analytical assessments confirm that legacy notification methods face structural obsolescence. Traditional acoustic sirens, linear television, and analog radio networks fail to ensure total population coverage in modern information societies. Data from the United Nations vulnerability report for Moldova indicate that infrastructure developments, such as improved structural insulation and double-glazed windows, severely decrease the indoor penetration index of acoustic sirens (United Nations Moldova, 2024). Furthermore, shifting media consumption habits isolate a significant portion of the population from linear television and radio broadcasts during localized crises.

Digital technologies and internet platforms resolve these operational limitations through immediate data dissemination. Evaluating international public warning practices established the baseline for this technological transition. Frameworks in most countries that have already implemented this technology, including the United States, Japan, the Netherlands, Canada, New Zealand, South Korea, Israel, and Romania, rely heavily on the deployment of Cell Broadcast technology (IGSU, 2026; United Nations Moldova, 2024).

According to technical documentation, Cell Broadcast bypasses the standard point-to-point architecture of conventional short message services (SMS) (IGSU, 2026; United Nations Moldova, 2024; ETSI TS 122 268, 2024; 3GPP, 2026; Suryandari *et al.*, 2020). Instead, it utilizes a point-to-area functional design. This specific design avoids network congestion because the transmission does not require an active subscriber telephone database. The system distributes messages, transmitting communication over a technically dedicated radio channel, to all mobile devices within a single cell tower sector inside 5 to 10 seconds (IGSU, 2026; United Nations Moldova, 2024).

Despite these substantial technological advantages, the large-scale implementation of modern public warning infrastructures remains operationally complex.

The implementation of digital warning systems reveals distinct structural challenges (Karaman et al., 2024). The research isolates five main global barriers to this integration:

**Infrastructural barrier:** The urgent necessity to modernize digital infrastructure and existing communication systems.

**Financial barrier:** The deficit of financial resources required for total technology deployment and further maintenance of this technology.

**Regulatory barrier:** The urgent necessity to improve the legislative and technical frameworks of the Republic of Moldova to establish a legal baseline for new public warning technologies.

**Institutional barrier:** The localized ambition of individual emergency monitoring departments to develop proprietary Early Warning Systems (EWS) instead of integrating into a unified national Public Warning System (PWS).

**Socio-technological barrier:** The critical requirement to improve public digital literacy, as even the most advanced technology fails without basic user adaptation.

The regulatory provisions of the new Law of the Republic of Moldova No. 72 "On Electronic Communications", enacted on April 10, 2025, directly incorporate the specific recommendations of this study (Law of the Republic of Moldova No. 72, 2025). This research determines the enforcement mechanisms to mandate technical cooperation between state emergency departments and commercial telecommunication providers. Concurrently, amendments to other regulatory and legal frameworks are expected in the near future.

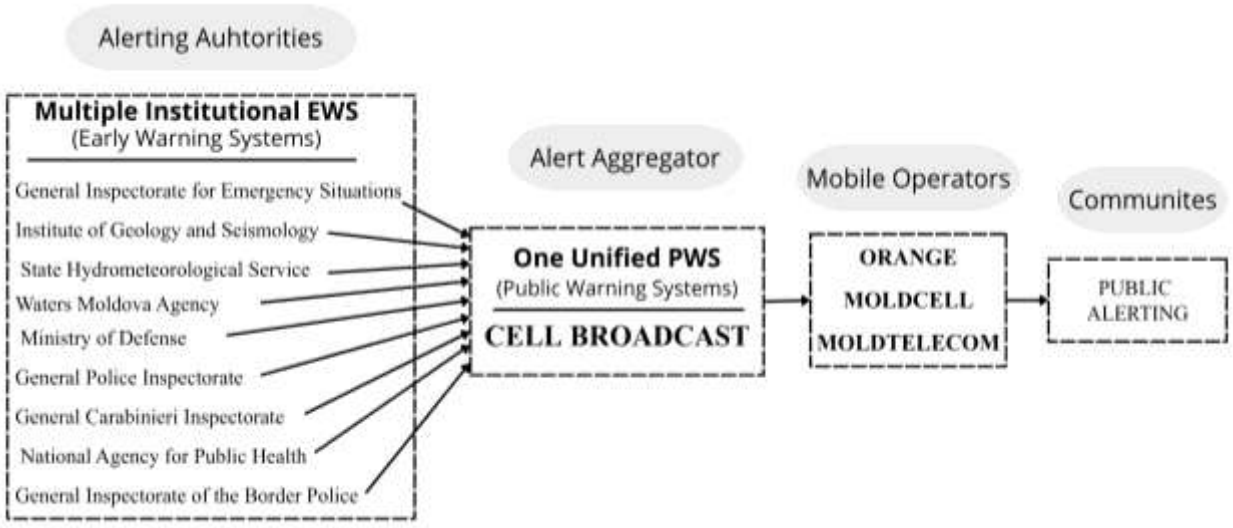



**Figure 1. MOLDOVA PUBLIC WARNING STRATEGY: Method to Overcome Institutional Barriers (EWS vs. PWS)**

**Source:** *Compiled by the author*

As a strategic method to overcome the institutional barrier, the emergency management framework of the Republic of Moldova must clearly distinguish between localized and unified platforms. Within this framework, numerous institutional Alerting Authorities operate their own Early Warning Systems (EWS) tailored to monitor and analyze specific hazards. While these analytical systems can be numerous to process distinct environmental and security data, the national Public Warning System (PWS) must remain strictly unified as a single platform. This clear architectural separation guarantees real-time alert dissemination without technical conflict, as EWS and PWS operate on entirely different algorithms to serve distinct purposes: while the former focus on data analysis and threat detection, the latter is dedicated exclusively to immediate, mass public notification. This institutional interaction model is illustrated in Figure 1.

The quality of public warning directly depends on the speed of interaction between threat detection platforms Early Warning Systems (EWS) and the Public Warning System (PWS). To ensure their coordinated operation, the implementation of the national Public Warning System (PWS) must

strictly prioritize technologies that natively support the Common Alerting Protocol (CAP). Concurrently, all institutional Early Warning Systems (EWS)—both currently operational and newly developed—must dynamically support this protocol to ensure seamless integration into the unified national PWS, providing a standardized data exchange between systems at both national and international levels. To achieve automated data processing, the CAP data standard uses an XML structure to digitize critical alert parameters, including threat type, geographical boundaries, and precise safety protocols (OASIS Standard, 2010; ITU-T Recommendation X.1303, n.d.). This digital format links real-time environmental sensors and geographic information systems directly with mobile operator switches. The automation removes manual dispatch delays, decreases notification latency, and creates a unified technological shield to protect citizens. This interoperability is essential for maintaining synchronized communication between multiple institutional Early Warning Systems and the unified national Public Warning System.

Table 1 summarizes the comparative technological and regulatory differences between legacy public warning infrastructures and the proposed national PWS (MD-ALERT). The comparative matrix highlights how the enforcement of Law No. 72 'On Electronic Communications' and the integration of the Common Alerting Protocol (CAP) systematically eliminate the delivery latency, network congestion, and structural limits inherent in the old public notification mechanisms of the Republic of Moldova (IGSU, 2026).

**Table 1. Comparative Matrix of Legacy and Modern Public Warning Systems**

| Evaluation Metric | Legacy Warning Systems | Modern PWS / MD-ALERT |
|---|---|---|
| **Technical Baseline** | Analog networks, sirens, wired broadcasting, linear television, and traditional SMS-cell broadcasting. | Digital Cell Broadcast infrastructure utilizing specific network nodes (BSC, RNC, MME, AMF) across 2G, 3G, 4G, and 5G networks. |
| **Notification Latency** | **High latency.** Sequential SMS dispatching creates severe network bottlenecks, taking from tens of minutes to several hours. | **Near real-time (5–10 seconds).** Simultaneous broadcast transmission to all active devices within the targeted coverage area. |
| **Geographical Precision** | Broad/macro-level broadcasting (regional or nationwide) without the capability for localized geo-fencing. | Highly precise target alerting based on the cell sector architecture of mobile network operators (Geo-fencing). |
| **Network Congestion** | High risk of cellular network collapse and congestion due to massive, concurrent traffic loads on standard signaling channels. | **Zero network impact.** Does not utilize public signaling channels; operates via a dedicated Cell Broadcast frequency. |
| **Data Standard** | Non-standardized text or voice messages requiring manual dispatching and administrative intervention. | Standardized XML data structures fully compliant with the international **Common Alerting Protocol (CAP).** |
| **Regulatory Framework** | Outdated civil protection acts that lack mandatory technical integration requirements for commercial telecom operators. | Direct compliance and enforcement under the new **Law of the Republic of Moldova No. 72 "On Electronic Communications"** dated April 10, 2025. |

| Evaluation Metric | Legacy Warning Systems | Modern PWS / MD-ALERT |
|---|---|---|
| **B2G Integration** | Absence of legally binding or automated technical cooperation mechanisms between state agencies and private operators. | Contractually and legally mandated technical interaction architecture with major operators: Orange, Moldcell, and Moldtelecom. |
| **User Awareness & Literacy** | Requires active user adaptation (tuning in to radio/TV, waiting for SMS) or triggers mass panic (analog sirens). | Guaranteed, high-priority pop-up push notifications with distinct audio overrides, delivering actionable safety protocols. |

**Source:** *Compiled by the author based on the cited technical and legal sources*

## CONCLUSIONS

The digital security and technological modernization of the public safety infrastructure in the Republic of Moldova require a systematic transition from legacy notification methods to an advanced, unified platform. This research addresses the critical institutional, legal, and technological barriers to the deployment of the national cell broadcast public warning network (MD-ALERT).

Based on the results of this study, several primary conclusions can be drawn:

- **Institutional Integration via Architectural Separation:** The study establishes a strategic method to overcome the institutional barrier by clearly separating localized **Early Warning Systems (EWS)** from the unified **Public Warning System (PWS)**. While individual alerting authorities must operate multiple decentralized platforms for deep data analysis and hazard detection, the mass notification infrastructure must remain strictly unified under a single PWS. This architectural division prevents technical conflicts, leverages distinct algorithms for specific tasks, and guarantees rapid, non-interfering message delivery.
- **Regulatory Adaptation and Harmonization:** The regulatory provisions of the new Law of the Republic of Moldova No. 72 "On Electronic Communications," enacted on April 10, 2025, directly incorporate the specific recommendations and enforcement mechanisms determined by this research. This framework establishes the necessary statutory authority to mandate technical cooperation between state emergency departments (such as IGSU) and commercial telecommunication providers (Orange, Moldcell, and Moldtelecom). Concurrently, rapid amendments to adjacent civil protection regulatory frameworks are expected in the near future to fully adapt the legal ecosystem to new digital capabilities.
- **Technological Standardization through CAP:** To eliminate operational latency and network congestion inherent in legacy systems, the implementation of the MD-ALERT infrastructure must strictly prioritize technologies natively supporting the **Common Alerting Protocol (CAP)**. Ensuring that both currently operational and future EWS platforms utilize this standardized XML data structure allows for complete automation. This configuration bypasses public signaling channels, eliminates manual dispatch delays, and reduces response latency to a critical baseline of **5–10 seconds**.

Ultimately, the technical and regulatory verification matrix developed in this study confirms that the cross-platform integration of MD-ALERT effectively mitigates structural infrastructure limits. By harmonizing state administrative mandates with the network nodes of private mobile operators, this research delivers a comprehensive, automated technological shield capable of ensuring rapid, geo-fenced public safety notification across the Republic of Moldova.

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