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DEVELOPMENT OF SCANDINAVIAN PUBLIC WARNING SYSTEMS

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ABSTRACT

Our research shows that Digital Audio Broadcasting warning systems are effective in Norwegian rural settings when implementing specific audio parameters and message strategies. Five case studies address the development and testing of public warning systems. The authors researched the first case and selected four others for comparison supported by the AI-tool Elicit. The problem to be solved is to find a method with accompanying products and services to be able to alert and evacuate the population/public regardless of nationality in a range of different events. Research question: Uncover user needs and validate components and the fully integrated system. Field tests in a Norwegian rural school and in two municipal centers, showed that a Digital Audio Broadcasting system works well when short, repeated, and multilingual audio messages are used. An avalanche warning service spanning 21 regions in Norway and Svalbard received positive user feedback when messages offered detailed, comprehensible information. An observational study of wildlife warning systems at 29 railway sites in Norway and Sweden recorded an 88% response rate to human voice alerts. A literature review on medicine overdose warning systems noted that integration with existing monitoring infrastructure promotes rapid alerting, and a case study across 26 Norwegian municipalities revealed how risk and vulnerability analyses guide system adaptation to local conditions. These studies imply that public warning systems can meet varied emergency scenarios. Adjustments in signal delivery and tailored message strategies are essential for success across environments and risk profiles. Key findings: 1. Integration of existing systems should be prioritized over creating new infrastructure. 2. Investment in competence development and training is crucial for effective implementation. 3. User involvement should be incorporated throughout system development and deployment.

KEYWORDS

User Involvement, Public Warning Systems, Digital Audio Broadcasting

1. INTRODUCTION

The main task of public warning technologies is to inform people about danger, make evacuation easier, and guide them to a safer place (Bean and Botterell, 2019; Toyoda and Kanegae, 2014). An increasing number of new technologies is being developed, having the potential to improve existing warning systems. One of them is an innovative, DAB-based system developed by a Norwegian company called Paneda, together with its partner-companies of regional and national range. Digital Audio Broadcasting (DAB) is designed for delivery of high-quality digital audio programs and data services for mobile, portable and fixed reception from terrestrial transmitters in the Very High Frequency (VHF) frequency bands (WorldDAB, n.d.). And furthermore, using DAB makes it possible to 'take over' audio equipment, interrupt other broadcasting, and send a message or trigger specialised equipment (visual, sound, text, etc.) that will warn people about a threat (e.g., natural disasters or terror attack). However, this new technology needs structured user testing and evaluation before introduction to a broader market. That is why a research project called Public Warning System (PWS) has been conducted and is about to finish now in 2025, to test this new system's ability to inform different societal groups about dangerous events. Western Norway Research Institute has had the responsibility of conducting tests and evaluation to assure the usability of the new technology (Vestlandsforsking, 2020, Urbaniak-Brekke et al, 2022). This paper's main goal is to compare lessons learnt from the DAB project in Western Norway with other identified relevant Scandinavian studies. The comparison will include and present selected results of applying a user involvement method to test and evaluate the new Norwegian DAB warning system.

2. METHOD

In the DAB research project, the authors use an action research approach, where researchers are participants in the development and their conclusions are grounded in this action research (Greenwood and Levin, 2007). The use of case studies is a key element as "the study of the particularity and complexity of a single case, coming to understand its activity within important circumstances" (Stake, 1995, p. xi). The three selected studies are single cases where one, with their consent, investigates specific local communities. According to Yin (1981, pp. 98-99) the strength of the case study is that it both covers a contemporary phenomenon and its context. Findings are from a select few single cases, but we claim that these findings also can be a "force of example" (Flyvbjerg, 2006) for other communities of the same nature (rural, school environments) facing similar challenges related to emergencies and population evacuation. The DAB project was carried out in accordance with the Norwegian Research Ethics Act, which is a Norwegian law intended to ensure that research is conducted according to recognized research ethical standards. To compare lessons learnt from the DAB project in Western Norway with other identified relevant Scandinavian studies we conducted a literature review supported by the AI tool Elicit (Elicit, 2025). We then selected relevant cases and then also supported our meta-analysis with Elicit. To ensure comprehensive and unbiased extraction of relevant data across studies, we implemented a structured data extraction protocol aided by a large language model (LLM). Extraction instructions were provided for each column and included study design, data collection methods, technology details, testing contexts, and performance outcomes. All extracted data were subjected to independent human verification by two reviewers to maintain rigor and reproducibility. Discrepancies were resolved by consensus. This two-tier process aligns with standards for systematic reviews (e.g., PRISMA) and demonstrates robust integration of AI tools within systematic literature review workflows (Page et. Al, 2021).

2.1 Screening

The authors screened papers that met these criteria:

- **Warning System Type**: Does the study examine public warning systems or emergency notification systems, including but not limited to DAB-based or digital radio network technologies?
- **Community Setting**: Does the study focus on or include small communities or rural areas (rather than exclusively urban metropolitan areas)?
- **Implementation Evidence**: Does the study include practical field testing, experimental studies, or real-world implementation data (rather than purely theoretical models)?
- **Performance Evaluation**: Does the study evaluate system effectiveness, performance metrics, or evacuation outcomes?
- **Hazard Scope**: Does the study examine warning systems capable of addressing multiple types of hazards or threats?
- **Community Feedback**: Does the study include community response, user feedback, or public inter- action with the warning system?
- **System Integration**: Does the study address integration with emergency response operations or emergency response centers?
- **Data Type**: Does the study present empirical data or practical testing results rather than purely theoretical or conceptual discussion?

We considered all screening questions together and made a holistic judgement about whether to screen in each paper.

2.2 Data Extraction

We asked the large language model to extract each data column below from each paper. We gave the model the extraction instructions shown below for each column.

- **Study Design Type**:
  Identify the primary research design used in the study. Look in the methods section for explicit description of study design. Possible categories include:
  • Field test/pilot study, Case study, Observational study, Intervention study, Mixed methods study
  If multiple design types are used, list them in order of prominence. If unclear, note “design not clearly specified”. Specific to this review's context of public warning systems, pay special attention to whether the study involves:
  • System testing, User involvement, Technology evaluation
- **Research Methods and Data Collection Approaches**:
  List all research methods used for data collection. Look in methods section and identify specific techniques such as:

- Qualitative interviews, Observation, User surveys, System testing, Technical verification, Dialogue workshops

  For each method, if possible, note:
  - Number of participants/respondents, Duration of data collection, Specific focus or purpose of the method

  If multiple methods were used, describe how they were integrated or triangulated.
- **Public Warning System Technology Details**:

  Describe the specific warning system technology being studied:
  - Technology platform (e.g., DAB network), Communication modes (audio, text, visual), Geographical coverage, Technical specifications

  Look in methods, results, and discussion sections. Extract specific technical details about system design, implementation, and performance.

  If multiple system configurations were tested, describe each variant and its specific characteristics.
- **Testing Scenarios and Contexts.**

  Identify and describe:
  - Geographic locations of testing
  - Types of emergency scenarios simulated
  - Specific local conditions considered

  Look in methods and results sections. Note details about:
  - Urban vs rural settings
  - Types of potential emergencies (natural disasters, terror threats)
  - Specific environmental or infrastructural challenges

  If multiple scenarios were tested, list them with brief descriptions.
- **Key Performance and Effectiveness Findings**:

  Extract primary findings related to warning system performance:
  - Effectiveness of communication
  - User comprehension rates
  - Technical reliability
  - Areas requiring improvement

  Look into the results and discussion sections. Prioritize quantitative metrics if available but also include qualitative insights. Note specific performance indicators such as:
  - Message clarity, Sound quality, Coverage effectiveness, User satisfaction levels

  If multiple findings exist, rank them by significance or prominence in the study.

2.3 Case-Study in Depth. The DAB project in Western Norway

In Norway today, we have a well-developed mobile network, and a system for public warning, that broadcasts via our mobile network in the same way as TV and radio broadcasting. We also have Nødnett integrated in the mobile network, which is used for communication between the emergency services and to control the alerts from the approximately 1,250 sirens the Civil Defence has around the country. Many of the Nødnett transmitters are located in the mobile masts, and on several occasions, Nødnett has failed. 4G and 5G internet run via the mobile network. In addition, we naturally have fiber for the internet. But during "Hans" (a storm in Norway, Sweden, Finland and the Baltics in august 2023), the fiber network was also destroyed in many places in Norway. The broadcasting networks, where TV and radio are important actors in emergency preparedness for serious incidents. This has repeatedly proven to be reliable technology for warning the population.

"Public Warning System" (PWS) is a national research project aimed at developing, testing, and researching a new future population warning and evacuation system built on the DAB network (Digital Audio Broadcast). The project is co-funded by the Research Council of Norway through the IPN program (Innovation Project in the Business Sector). In the PWS project, alerts in pilot tests have been given via audio, images, text, and sirens (audio messages on modern speakers). All these alert options are provided with predefined local alerts (audio, image, and text) triggered by DAB signals over the broadcasting network. The need has been clearly demonstrated through numerous acts of terrorism, extreme weather events, and environmental disasters. The authorities' warning systems complement each other and are robust in a real crisis. The EU sets requirements for population warning, and Norway is subject to the same requirements through the EEA agreement (European Union, 2018). The need for a new supplementary and innovative solution is clear, as existing systems have several weaknesses. Alerts via the mobile network are disabled if the power goes out in the local area, i.e., at the base stations, and battery backup runs out. Additionally, many people don't listen to the radio or don't have their mobile phone with them all the time or have it in silent mode when they are sleeping. Furthermore, there is a problem with the distance/time factor before the emergency services arrive and how larger crowds should be evacuated quickly before the emergency services arrive.

Technological Solutions

The DAB (Digital Audio Broadcasting) network has the potential to carry emergency communications and public warning systems and to trigger local predefined alerts. Research shows that DAB can effectively transmit emergency alerts to terminals in 0.2-3 seconds, allowing for rapid dissemination of critical information during disasters (Hongsheng Zhang et al., 2019). The system also enables two-way communication between transmitters, which simplifies information exchange to and from affected areas (Hongsheng Zhang et al., 2019).

Several studies have explored techniques to improve DAB's potential in this area. Zhang et al. (2019) proposed methods to improve the reception and display of emergency warning messages (EWM) on DAB terminals, as well as enabling two-way multimedia communication between DAB transmitters. Their experiments demonstrated the rapid delivery of emergency messages and successful communication between disaster areas and the outside world. Falkowski-Gilski (2018) focused on the transmission of alarm information in DAB+ systems, emphasizing the need for clear voice messages with a low bit rate without compromising ensemble management or audio services. Wieser & Adamec (2019) analyzed the use of digital radio standards, including DAB and DRM, for the dissemination of warning messages. They highlighted the Emergency Warning Function (EWF) and Emergency Warning System (EWS) as key features for broadcasting alerts to the population in certain areas.

While not directly addressing DAB, other studies highlight the importance of effective communication systems in large-scale projects. Internal alerting mechanisms can act as a safety valve, ensuring that critical information reaches decision-makers and reducing risk in ICT projects (Bjørkelo & Taraldset, 2010). Additionally, networks, which were once seen as management challenges, are increasingly recognized as potential tools for leadership and democracy (Jensen & Sørensen, 2004). These findings suggest that DAB networks can be valuable resources in public warning systems, offering reliable and effective communication channels in crisis situations. The project, initiated and owned by Paneda DAB in Selje in

Nordfjord, therefore built on DAB as a technology for warning residents in various hazard situations in different locations and conducted three field tests.

About Paneda

Paneda is an SME with head office in Western Norway and an office in Sweden that offers DAB solutions: Safety systems, broadcast networks and broadcast systems. Paneda was founded in 2001 after developing an idea for TV distribution to UHF from satellite to areas that have no other coverage. In 2007, Paneda won a major contract with national service provider Telenor for terrestrial TV broadcasting with 165 transmitters. For tunnel systems, Paneda has developed its own radio break-in system and has equipped hundreds of tunnels with technology from Paneda.

Paneda is also a world leader provider of DAB head-end systems for DAB/DAB+ multiplexing and encoding with several hundreds of systems installed around the world, many of these are public broadcasters demanding high quality systems with specific requirements that requires a close co-operation in the development (Paneda, 2025).

The perceived potential for a <u>new DAB-based system </u>(Digital Audio Broadcast)

- DAB radio broadcast warning will break into radio broadcasts in defined region
- DAB radios in defined region will be turn on and provide warning & evacuation messages
- DAB network will trigger a set of local control units
    - To trigger text and audio messages in specific areas like harbours, railway stations, etc
    - To activate road block and barriers
    - To activate light arrow leading to safe locations

DAB services reach a large part of the population before emergency services arrive

Key R&TD activities in interaction loop:

- Specify and develop DAB Multiplatform and Management system
- Implementation of Pilot services
- Verification and validation
- Dissemination

Test framework / methodology:

- Building on iterative nature of software development processes (IEEE90, IEEE94)
- Key elements
    - <u>Verification</u> – Did we <u>build the system right </u>(according to specifications)?
    - <u>Validation</u> – Did we <u>build the right system </u>(solve the problems of the user)?
    - Technical testing and user testing with real users in real life conditions

Project tests conducted

- First test: Local school Selje, Norway. «Simulated gas leak» close to local Selje school, June 2023. Alert: Sound (voice message and alarm), texts, pictures (arrows)

- Second test: “Tidal Wave 1”: Area Sykkylven, Norway, December 2023. Alert: Sound

- Third test: “Tidal Wave 2”: Area and local school Hellesylt, November 2024. Alert: Sound

Schools were chosen because they seem to be a relevant arena for testing public alerts:

-Evacuation exercises can be disseminated to large parts of society often linked to schools

-Residents build awareness around the possible need for evacuation early in life.

If boulders were to fall into the fjord, alongside where Sykkylven and Hellesylt are situated, it could trigger a tidal wave that would wash over towns like them. The risk is considerable.

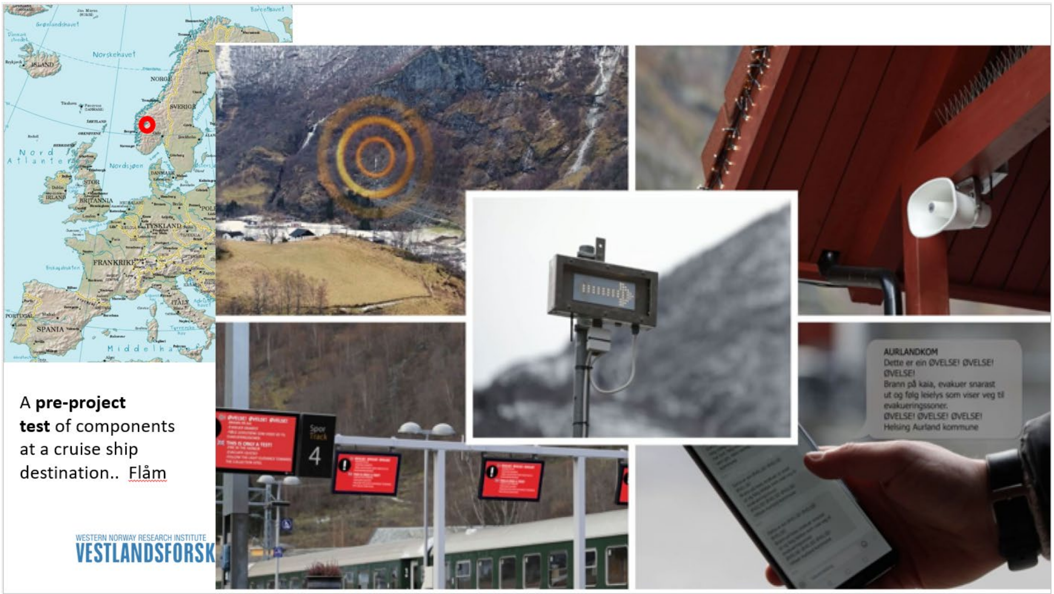

Figure 1. A visual example from a pre-project test

3. RESULTS

3.1 Characteristics of Included Studies

The studies analyzed encompassed five distinct warning system types, including Digital Audio Broadcasting (DAB), avalanche warnings, overdose monitoring, general emergency preparedness, and wildlife railway warnings. Quantitative outcomes revealed high effectiveness rates, such as an 88% user response to human voice warnings at railway sites and the delivery of avalanche alerts to 21 regions within four hours. Performance metrics such as message clarity, coverage effectiveness, and user satisfaction were documented, with DAB field tests demonstrating improved comprehension when message volume was reduced from 75 to 50 dB and messages were repeated in multiple languages.

Thematic analysis was conducted using an inductive coding approach, identifying recurrent patterns related to technical implementation, user involvement, integration with infrastructure, and system adaptability. Thematic saturation was reached through iterative review of extracted data and was validated by inter-coder agreement.

Table 1. Characteristics of included studies

Study focus	**Study**	**Geographic Context**	**Warning System Type**	**Testing Methodology**	**Full text retrieved**
Testing Public Warning System at School, 2022	Testing a new Digital Audio Broadcasting (DAB) public warning system	Rural school setting in Norway	DAB-based public warning system	Field test/pilot study; Case study	No
Borge and Muller, 2023	Overdose warning systems	Not specified (literature review)	Overdose warning systems	Scoping review of existing literature	Yes
Engeset et al., 2018	Avalanche warning communication	Norway and Svalbard	National Avalanche Warning Service	Web-based user survey; Expert panel evaluation	Yes
Njå and Vastveit , 2016	Risk and vulnerability analyses in municipalities	26 municipalities across Norway	General emergency preparedness systems	Case study; Qualitative interviews; Document analysis	Yes
Seiler et al., 2022	Wildlife warning systems for railways	29 railway sites in Sweden and Norway	Acoustic wildlife warning systems	Intervention study; Field test/pilot study; Observational study	Yes

The studies we analyzed covered five different warning systems, each focusing on a unique area:

1. Digital Audio Broadcasting (DAB)-based public warning system
2. Overdose warning system
3. Avalanche warning system
4. General emergency preparedness system
5. Wildlife warning system for railways (acoustic)

Regarding geographic context:

- 4 studies were conducted in Norway
- 1 study included both Norway and Sweden
- We didn't find specific geographic information for 1 study (literature review)

We found a variety of methodologies used across the studies, including field tests, case studies, literature reviews, surveys, and interviews.

3.2 Thematic Analysis

3.2.1 Technical Implementation and Performance

Table 2. Technical Implementation and Performance

Theme	Key Findings	Implementation Challenges	Success Factors
DAB network effectiveness	No mention found	No mention found	No mention found
System coverage and reliability	Avalanche warning system covers Norway and Svalbard with 21 regional warnings; Wildlife warning systems tested at 29 railway sites	Technical limitations in mounting speakers on trains for wildlife warning systems	Broad coverage of avalanche warning system; Timely alerts (within 4 hours) for overdose warning systems
Integration with existing infrastructure	Overdose warning systems may not require new infrastructure, but can link existing monitoring and harm reduction systems	Challenges in implementing risk-based management principles in municipalities	Potential for integrating existing systems in overdose warnings

Key Findings:
1. Limited information on DAB network effectiveness
2. Avalanche warning systems: 21 regional warnings covering Norway and Svalbard
3. Wildlife warning systems: Tested at 29 railway sites
4. Overdose warning systems: Potential integration with existing systems

Implementation Challenges:
1. Technical limitations for wildlife warning systems on trains
2. Challenges in implementing risk-based management in municipalities

Success Factors:
1. Broad coverage of avalanche warning system
2. Timely alerts for overdose warning systems
3. Potential for integrating existing systems in overdose warnings

3.2.2 User Response and System Effectiveness

Table 3. User Response and System Effectiveness

Theme	Key Findings	Implementation Challenges	Success Factors
Public reception and understanding	Avalanche warning service generally found useful by users	Effectiveness varies with user competency and scenario complexity	Detailed information improves comprehension, especially at lower danger levels
Response time and behavior	Wildlife warning systems elicit high response rates (88% for human voice)	No mention found for human response	Clear and recognizable signals (e.g., human voice) in wildlife warning systems
Communication clarity	Importance of clear, informative, and repeated messages emphasized in DAB system testing	Environmental factors like wind and noise can interfere with audio messages	Short, clear messages; Repetition of messages; Use of multiple languages

Key findings:
1. Avalanche warning services: Generally useful to users
2. Wildlife warning systems: High response rates (88%) for human voice signals
3. DAB system: Emphasis on clear, informative, repeated messages

Implementation challenges:
1. Effectiveness varies with user competency and scenario complexity
2. Environmental factors (wind, noise) interfere with audio messages

Success factors:
1. Detailed information improves comprehension
2. Clear, recognizable signals (e.g., human voice)
3. Short, clear messages with repetition and multiple languages

3.2.3 Testing and Validation Methods

Table 4. Testing and Validation Methods

Theme	Key Findings	Implementation Challenges	Success Factors
Field test outcomes	DAB system functions well in most tested locations; Wildlife warning systems show high effectiveness	Need for adjustments to cover all areas effectively in DAB system; Technical limitations in wildlife warning system implementation	Reduction of sound volume from 75% to 50% improved effectiveness in DAB system
User involvement approaches	Web-based surveys used for avalanche warning system evaluation; User involvement method applied in DAB system testing	Potential for self-selection bias in web-based surveys	Inclusion of both expert and general user perspectives in avalanche warning system evaluation
System adjustments and improvements	Need for adaptation to different scenarios and local conditions identified across studies	Challenges in implementing risk-based management principles in municipalities	Iterative testing and adjustment process evident in wildlife warning system development

Key findings:
1. DAB system: Functions well in most tested locations
2. Wildlife warning systems: High effectiveness reported
3. User involvement: Web-based surveys and user involvement methods used
4. Adaptation needs: Identified across studies for different scenarios and local conditions

Implementation challenges:
1. DAB system: Adjustments needed for effective coverage
2. Wildlife warning systems: Technical limitations in implementation
3. Web-based surveys: Potential self-selection bias
4. Municipalities: Challenges in implementing risk-based management principles

Success factors:
1. DAB system: Reduced sound volume (75% to 50%) improved effectiveness
2. Avalanche warning system: Inclusion of expert and general user perspectives
3. Wildlife warning system: Iterative testing and adjustment process

3.3 Cross-Context Analysis

3.3.1 Geographic and Demographic Factors

The studies covered diverse geographic contexts, from rural school settings to national-level systems in Norway and Sweden:

- DAB-based public warning system: Tested in a rural school environment in Norway
- Avalanche warning system: Covers all of Norway and Svalbard
- Wildlife warning systems: Tested at multiple railway sites across Sweden and Norway
- Municipal risk and vulnerability analyses: Covered 26 municipalities across Norway

3.3.2 System Adaptability

System adaptability across studies:

- DAB-based system: Adjustments needed for effective coverage and local adaptation
- Avalanche warning system: Effectiveness varied with scenario complexity
- Both systems indicated a need for adaptable communication strategies

Technical adjustments:

- DAB system: Reducing sound volume from 75% to 50% improved effectiveness
- Wildlife warning systems: Different acoustic signals tested, with human voice proving most effective

Integration capabilities:

- Overdose warning system: Potential to integrate with existing monitoring and harm reduction infrastructure

These findings highlight various approaches to system adaptability, including technical adjustments, integration capabilities, and the need for context-specific adaptations across different warning system types and geographic settings.

4. DISCUSSION

The review of warning systems in Norway reveals several important patterns and challenges across different domains. Digital platforms have emerged as a key component of modern warning systems, with evidence of successful implementation in avalanche warning services (Johnsen, 2013). The exploration of DAB-based warning systems represents an innovative approach to public alerting (Urbaniak-Brekke, et al., 2022), though effectiveness data remains limited.

A significant challenge identified across studies is the integration of warning systems into existing municipal operations. Research indicates that municipalities struggle with implementing risk and vulnerability analyses due to competence gaps and resource constraints (Njå and Vastveit, 2016). This suggests that technical solutions alone may be insufficient without adequate organizational capacity and support.

The evaluation of warning system effectiveness presents particular challenges, as demonstrated in the overdose warning system study (Borge and Muller, 2023). The difficulty in isolating the impact of warning systems from other preventive measures highlights the need for more robust evaluation methodologies.

User engagement emerges as a crucial factor, with evidence supporting the value of public participation in both system development (Urbaniak-Brekke, et al., 2022) and data collection (Johnsen, 2013). This suggests that future warning system implementations should prioritize user involvement and public education components.

Findings from Norwegian case studies demonstrate the relevance of digital broadcasting networks in public emergency alerting, corroborating international research on the efficacy of digital radio technologies (Johnsen, 2013). The observed need for multi-modal communication (audio, text, visuals) mirrors best practices identified in global standards (WorldDAB). However, implementation challenges persist, notably in the integration of warning systems into municipal and emergency infrastructures, as shown in studies from both Norway (Nj and Vastveit, 2016) and wider European contexts. The importance of user engagement aligns with recommendations from the broader literature, affirming that participatory design and feedback mechanisms improve system trust and effectiveness (Urbaniak-Brekke et al., 2022).

5. CONCLUSIONS

The findings from this review highlight both the potential and challenges of warning systems in Norway. While digital platforms and new technologies offer promising solutions (Johnsen, 2013), successful implementation requires addressing fundamental challenges in competence, resources, and system integration (Njå and Vastveit, 2016).

Several key recommendations emerge from this analysis:

- Integration of existing systems should be prioritized over creating new infrastructure
- Investment in competence development and training is crucial for effective implementation
- User involvement should be incorporated throughout system development and deployment

Future research should focus on:

- Developing robust methodologies for evaluating warning system effectiveness
- Investigating ways to better integrate warning systems with municipal operations
- Exploring opportunities for cross-system coordination and standardization

This review is subject to some limitations. The number of directly relevant studies was limited, constraining the generalizability of findings across different geographic and demographic settings. The heterogeneity of methodologies used, ranging from field testing to survey-based studies, may influence the consistency of reported outcomes. Additionally, the use of LLM tools for initial data extraction raises questions regarding potential extraction bias or misclassification, which was mitigated by subsequent human validation. Finally, the effectiveness data available for DAB and other warning systems remain sparse, underscoring the need for further empirical evaluations in diverse real-world settings.

It is important to predict and avoid dangerous situations, so that there is as little need as possible for the evacuation. Emergencies occur, especially when it comes to natural disasters in some areas (e.g., the risk of avalanches and tsunami waves in parts of Norway), and the warning will then have an essential role in evacuating and securing life of citizens. The national warning system in Norway today, based mainly on alarm sirens and mobile phone networks, should be supported by the innovative DAB equipment and other new technologies, making it more robust and resilient to potential threats setting human health and life in danger. DAB is also built on a separate infrastructure, digital broadcast, not the mobile network, and will be operational even if the local mobile network is not working due to failure in local power supply or other elements in the mobile infrastructure.

Our analysis of selected studies suggests that public warning systems based on digital broadcasting and related technologies can be designed to meet varied emergency scenarios. Adjustments in signal delivery and tailored message strategies are essential for success across different environments and risk profiles.

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